ESSAS

(*Ecosystem Studies of Sub-Arctic Seas*)

Scientific Steering Committee

Report

of the

2014 Annual Meeting

Copenhagen, Denmark

10-11 April, 2014

Compiled by

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May 2014

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1. Participants

SSC Members in Attendance

Ólafur Astthorsson	Iceland
Ken Drinkwater	Norway
Naomi Harada	Japan
Erica Head	Canada
George Hunt	USA
Sen Tok Kim	Russia
Franz Mueter	USA
Sei-Ichi Saitoh	Japan
Kai Wieland	Greenland/Denmark

SSC Members Unable to Attend

Sung-Ho Kang	Korea
Yasunori Sakurai	Japan

Invited Guests

Ben Fitzhugh (WGPESAS)	USA
Ron Heinz (WGBSA)	USA

Contact Information for the participants is listed in Appendix 1.

2. Introduction and Adoption of Agenda

The 2014 annual meeting of the ESSAS Scientific Steering Committee (SSC) was held on April 10-11 at the Natural History Museum of Denmark in conjunction with and directly following the ESSAS 2012 Annual Science Meeting (7-9 April). The meeting was kindly hosted by Morten Meldgaard. Ken Drinkwater, ESSAS Co-chair, opened the meeting by welcoming the SSC members and guests. The meeting agenda (see Appendix 2) was modified slightly to accommodate the timing of the presence or absence of certain SSC members and Working Group representatives.

3. Adoption of last year's SSC Meeting Report

A motion to adopt last year's SSC meeting report passed unanimously.

4. Follow-up from last year's SSC Meeting in Hakodate

The status of the action items from last year's SSC meeting was reviewed. The following is the list of action items and their follow-up.

- **ESSAS Co-chairs** will write a letter to requesting that Drs. Curchitser and Ito continue as co-chairs of WGMER at least until the publication of the special issue on modeling is completed. At that time, they can decide whether they wish to continue the WG or not.
    - *Letter written and Drs. Curchitser and Ito agreed to continue until at least the publication was completed.*
- **Margaret McBride** to post the ToRs for the WGASI on the ESSAS website.

- *This was not done prior to the closure of the ESSAS IPO and Margaret leaving.*

- **Franz Mueter** will contact ISAR to look into the possibility of holding an ASI sponsored workshop on the effects and fate of advected organisms and characteristics between the Arctic and the Subarctic in conjunction with their meeting. He will also contact and discuss the format of such a workshop with key researchers from Canada, China, Japan, Korea, Russia, and the USA.
  - *The 2013 ISAR meeting took place in Tokyo only a week after the ESSAS meeting (1/15 – 1/17/2013) and a fourth meeting had not been scheduled. Therefore, an ASI theme session was proposed for the 2014 PICES Annual Science Meeting in Yeosu, South Korea, and was accepted. It was proposed to include both the Atlantic and Pacific Ocean. The invited speaker will be Dr. Georgina Gibson from UAF.*
- **Ken Drinkwater** will contact Paul Wassmann with regard to holding a similar ASI workshop but focused on the Atlantic advection in association with Arctic Frontiers. Ken will also contact scientists working in Canada, Denmark, Germany, Greenland, Iceland, Norway, Russia, and the USA to determine their interest in such a workshop.
  - *There was not enough time to organize such a workshop in association with Arctic Frontiers. Instead an ASI theme session proposal for the ICES ASC in La Coruna, Spain (15 – 19 September 2014) was written. ICES required that the theme be broadened to consider advection throughout the Atlantic, which was done and the theme session accepted.*
- **Margaret McBride** will contact ICES & PICES to find out if they can provide links on their website to the ESSAS website.
  - *This was not done prior to the closure of the ESSAS IPO and Margaret leaving.*
- **Margaret McBride** will check with authors and, when permission is granted, convert presentations from 2013 ASM to pdfs and have them posted on our website.
  - *This was not done prior to the closure of the ESSAS IPO and Margaret leaving.*
- **Margaret McBride** will check on the possibility of the addition of a search engine that goes outside of the IMR website.
  - *This was not done prior to the closure of the ESSAS IPO and Margaret leaving.*
- **Margaret McBride** will look into posting the PICES link to presentations from the 2011 OSM on our ESSAS reports page.
  - *This was not done prior to the closure of the ESSAS IPO and Margaret leaving.*
- **Olafur Astthorsson** will write a brief description to be posted together with a new publication from Iceland on ESSAS-related research.
  - *This was done and posted under Feature Research on the ESSAS website.*
- **Ken Drinkwater** will keep an eye on funding calls to determine if a proposal for extension of the ESSAS IPO will fit within the calls, and will follow-up with the submission of proposals, if appropriate. He will also look into other possible funding options besides the Research Council.
  - *No other calls were appropriate and no other funding opportunities to support the ESSAS IPO in Norway were available.*
- **George Hunt** will contact Bill Wiseman to determine the possibility of NSF funding ESSAS WG activities.
  - *Franz Mueter followed up with George Hunt and subsequently contacted Bill Wiseman, who was helpful in providing several contacts within NSF for possible funding. Since the focus of ESSAS is the Sub-Arctic, he directed Franz to the*

Biological Oceanography program. Unfortunately, the program officer for Biological Oceanography was not at all receptive to funding for ESSAS. However, Ben Fitzhugh successfully pursued NSF funding through the Arctic Social Science program for the Paleo-Ecology WG and Franz Mueter successfully pursued separate funding for the Arctic cod workshop at the 2014 ASM (funding from IASC and POLARISATION).

- **Margaret McBride** will contact George by mid-February to remind him in case he has not already made the contact.
    - Done.
- **Sei-Ichi Saitoh** will provide a short biography to Margaret McBride to post on the ESSAS website.
    - *Done and posted.*
- **The ESSAS Co-Chairs** will write a letter of invitation to Dr. Naomi Harada to join the ESSAS SSC.
    - *Email written and Dr. Harada accepted.*
- **Ken Drinkwater**, as ESSAS representative to the IMBER SSC, will inform Eileen Hofmann (Chair of IMBER) regarding changes in ESSAS SSC membership.
    - *IMBER was informed.*
- **Ken Drinkwater** will contact Jim Overland to determine his interest in continuing as member of the ESSAS SSC.
    - *Dr. Overland decided to step down from the SSC due to other commitments but he asked to stay on as co-chair of the ASI WG.*
- **The ESSAS co-chairs** will draft a letter to Klaus Nygaard (Director of the Greenland Institute) requesting that he recommend a person to appoint as Kai Wieland's replacement.
    - *Letter sent on 3/17/2014.*
- **Ken Drinkwater** will check with IMBER to determine if there is a limit to the number of members on our SSC.
    - *IMBER informed us that 10-12 is typical. One of the problems with having more members is the ability to pay for them as the available money from IMBER is our sole means of support. Presently we are 11 SSC members and 3 WG chairs. Our funds were fully utilized for support of SSC members for the Copenhagen meeting.*
- **The Co-chairs** will write a letter on invitation to Dr. Michael Klages from Germany to join the ESSAS SSC if we have not exceeded the SSC membership limit.
    - *As a result of the funding situation, this action item was not acted upon.*
- **Ken Drinkwater** will contact Dr. Jinping Zhao to enquire if he might be interested in joining the ESSAS SSC as the representative of China. If Dr. Zhao is not interested, his suggestions for eligible candidates for appointment to the SSC will be requested.
    - *As a result of the funding situation, this action item was not acted upon.*
- **Olafur Astthorsson** will contact the Nordic Council to see if they have a meeting room available during early April.
    - *Done but no meeting rooms at the Nordic Council office were available.*
- **ESSAS Co-chairs** will explore other options in Copenhagen, e.g. the Danish Meteorological Institute, DTUaqua, or a private hotel, if the Nordic Council does not have available facilities.

- *Other options were explored including an offer from the Danish Meteorological Institute however, we eventually accepted the offer from the Natural History Museum as it could accommodate more participants..*

- **ESSAS Co-chairs** will draft and send a letter to all WG Chairs to get their suggestions for theme sessions to be held at the 2014 ASM.
  - *Done. Theme sessions on Arctic cods, Paleo-ecology and Human Dimensions were accepted along with one on local research from Denmark.*

5. Working Group Status Reports

5.1 WG on Modeling Ecosystem Response (WGMER) – Enrique Curchitser

Enrique provided the following written report.

A special volume in Progress in Oceanography is being organized in Memory of Bern Megrey with guest co-editors Enrique Curchitser, Shin Ichi Ito and Kenny Rose. The theme of the volume is *Modeling and observational approaches to understanding marine ecosystem dynamics*. To date, 14 manuscripts have been submitted and are in the review process. The first decisions are making their way through the system. The original November 2013 deadline was extended to January 2014. However, a few manuscripts are still expected from authors that contacted the editor in advance as long as they are submitted while the review process is ongoing. The topics of the submitted manuscripts span lower and upper trophic levels, NPZ, IBM and one management related paper. We anticipate most of the reviews to be completed by summer with potential publication in the late fall or early 2015.

5.2 WG on Climate Effects at Upper Trophic Levels (WGCEUTL) - Franz Mueter

The working group completed its terms of reference with the publication of a special topic session in Marine Ecology Progress Series in 2013. At last year's meeting, it was decided to maintain the WG to determine if further work related to the interaction between invertebrates and gadoid fishes would be carried out. However, during the year it was decided that the WG should be terminated in order for its members to focus on other activities.

5.3 WG on Arctic-Subarctic Interactions (WGASI) – Ken Drinkwater

While no ESSAS-sponsored activity by the WGASI was planned for 2013 after the very active 2012 season, WG members were involved in other Arctic-Subarctic activities. Ken Drinkwater and Jim Overland participated in the Gordon Research Conference (GRC) on Polar Marine Science (Linking Polar Observations, Processes and Models at Regional and Global Scales) held in Ventura, California, March 10-15. Franz Mueter organized The Wakefield Symposium on Responses of Arctic Marine Ecosystems to Climate Change that was held 26-29 March 2013 in Anchorage. Harald Loeng (Norway) was on the meeting's SSC and Franz Mueter, George Hunt, Jim Overland and Ken Drinkwater attended. The WGASI also sponsored the theme session on Arctic cods at this year's ESSAS ASM.

Based on discussions at the last ESSAS SSC meeting, it was decided to attempt to organize workshops on (1) the exchanges between the Arctic and the Sub-Arctic and (2) the fate of

the materials (physical, chemical and biological) that are exchanged. A workshop proposal entitled Variability in advection and its biological consequences for Subarctic and Arctic ecosystems to focus upon the Bering Shelf-Chukchi Sea region was submitted to PICES in 2013 and accepted. This workshop will be held at the PICES Annual Science Meeting in Yeosu, Korea, during October 2014. It is co-sponsored by ICES with lead Franz Mueter (USA) and co-chairs, Enrique Curchitser (USA), Ken Drinkwater (Norway), Sen Tok Kim (Russia), Hiroshi Kuroda (Japan), and Sei-Ichi Saitoh (Japan). A Theme Session at the 2014 ICES ASC was proposed with the same aims but focusing upon the Atlantic Sector of the Arctic. The idea was to explore advection and exchanges through Fram Strait, the Barents Sea and the Canadian Arctic Archipelago. The fate of the fluxes, both biological and physical/chemical, means that this Theme Session covers the geographical boundaries well into the Subarctic (Iceland, Greenland, Labrador) as well as into the Arctic. ICES asked us to combine our proposal with one from Spain that broadened our geographical boundaries to include the subtropics. The combined Theme Session, entitled The Role of Advection in the North Atlantic, was accepted. It will be held in A Coruña, Spain in September 2014, is co-sponsored by PICES. It will be co-chaired by Olafur Astthorson (Iceland), Seth Danielson (USA/PICES), Ken Drinkwater (Norway) and Cesar Gonzalez-Pola (Spain).

The longer-range plan is to hold another workshop in 2015 or early 2016 that would compare the Arctic-Subarctic exchanges in the Atlantic and Pacific Sectors. It was suggested at the Hakodate SSC meeting in 2013 that such a workshop might follow the format adopted at the Yeosu workshop with small groups of selected scientists tackling particular issues and would include members from both sectors. Their task would be to compare and contrast what was occurring in the two sectors. Sei-Ichi Saitoh noted that the Arctic Science Summit Week will be held in April of 2015 in Japan and this might be a possible venue at which to hold the workshop. After discussion it was decided that this was probably too soon after the ICES and PICES meetings and in addition Franz Mueter would likely not be able to attend since he would be on sabbatical in Australia. A decision on the time and location of the workshop was left until after the PICES and ICES meetings.

There was discussion on the co-chairs for the WGASI. Franz agreed to become a co-chair and Ken will stay on. Jim Overland, who is presently listed as a co-chair, will be approached to see if he still wishes to remain a co-chair.
ACTION: Ken to contact Jim Overland regarding his position as co-chair of the WGASI.

5.4 Working Group on Bioenergetics of Subarctic Fishes (WGBSF) – Ron Heinz

The WG on Bioenergetics of Subarctic Fishes held their first workshop last year at the Hakodate meeting. The main objective of the WG was to develop a deeper understanding of climate impacts on the match between juvenile fish and their prey and the implications of that relationship for future production. They considered a session at the ASM in Copenhagen but this did not materialize. Ron Heinz, one of the WG co-chairs, did make a presentation and held a WG meeting during the ASM. During the last year this working group attempted to obtain funding for a Bioenergetics Workshop offered through NOAA's International Office. The proposal was developed by the co-chairs Trond Kristiansen (Norway) and Ron Heinz (USA) along with Ken Lough (USA) from NOAA's Northeast Fisheries Science Center. The workshop was aimed at comparing the effects of climate change on food webs in subarctic

ecosystems and evaluation of their impacts on recruitment. They envisioned a manuscript to catalogue what is known about this subject and identify important data gaps. Unfortunately the proposal was not successful but as the funding is available annually, they plan to resubmit towards the end of 2014 for a workshop in 2015. In addition, Jason Link and Ron put together a symposium that will be held in conjunction with the annual meeting of the American Fisheries Society in Quebec City, Quebec in August 2014. Fifty-one papers and posters were accepted for this symposium which is titled "Community Ecology and Trophic Interactions of Fishes". It is intended to restart a biennial series of workshops on trophic ecology called "GutShops". There apparently is a lot of interest in restarting these workshops. Much of the work in the upcoming AFS symposium is consistent with the terms of reference for the ESSAS WG on Bioenergetics of Subarctic Fisheries. At this August symposium, we will advertise the upcoming working group meeting at the 2015 ESSAS ASM.

5.5 Working Group on Human Dimensions (WGHD) – Ken Drinkwater

Keith Criddle, the chair of the ESSAS Human Dimensions WG tried to organize a session at the Copenhagen ASM on “How human systems have responded to past regime shifts between gadoids and invertebrates”. This topic was one that was discussed at the last SSC meeting in Hakodate and follow up discussions seemed to generate some enthusiasm for the subject. However, in spite of Keith’s efforts, no presentations other than Keith’s were submitted. Keith is willing to try again next year to generate a theme session on Human Dimensions at the ESSAS ASM but likely with a new topic. This topic will be decided by Keith following his discussion with potential participants.

5.6 Working Group on Comparative Paleo-Ecology in Sub-Arctic Seas (WGCPESAS) – Ben Fitzhugh

The working group met in two break-out sessions, one during the ASM and one on the day following the ASM, to frame and flesh out a series of integrative research themes that will ultimately structure the development of a special issue on the paleoecology, anthropology and history of the seasonally frozen northern hemisphere seas from the Late Glacial Maximum to recent centuries.

Goals of the working group meeting were:

- to introduce a paleoceanographic and paleoecological perspective to ESSAS, with attention to scales of change and dynamics at longer phases than instrumental records permit.
- to integrate the history of human engagement in the subarctic marine ecosystems into this picture.
- to draw relevant insights from comparative analyses of time and space.

The PESAS working group discussions proceeded from an exploration of big questions that could be best answered with data from several different disciplines to finer scale planning of how specific data sets could be brought together to help address those questions. The natural science questions were drawn from a set of unresolved puzzles in the archaeology and history of the subarctic regions. Discussions of these problems led quickly to the recognition of possible connections and synergies with processes and transitions in the

paleoclimatology, paleoceanography, and paleoecology data sets. From this starting point, the work of the PESAS group in the next two years was organized to explore correlations and potential mechanisms linking climate, oceanographic, ecological and human system relationships at four time scales in the past. These are summarized here.

TIME FRAME 1: Glacial – Deglacial Subarctic Ecological Dynamics and the Peopling of the Americas.

Long standing questions in the archaeology of the Americas are when and how human first migrated into these continents. Discoveries in recent decades have made it most likely that migration/s occurred during the Late Glacial, perhaps between 20,000 and 15,000 BP and by a coastal route – either around the North Pacific (most likely) or the North Atlantic (plausibly). While the archaeological record of coastal migration routes would now be more than 120-150 meters below sea level, a better understanding of the climatology and paleoecology of the subarctic North Atlantic and North Pacific regions would provide insights into the most likely routes and timing of human movement. PESAS participants plan to explore these issues using models and proxy data comparing the conditions in the interval of 20Kya-15Kya to those in the interval 15Kya-10Kya. Conditions of interest include winter temperatures, storminess, sea-ice extent and variability, ocean currents, freshwater runoff and stratification/mixing, nutrient supply (e.g. iron in the North Pacific, silica in the North Atlantic), primary productivity, and trophic feeding dynamics.

TIME FRAME 2: Mid-Holocene Regime Shifts, 6000-4000 BP

In the North Pacific, humans don't appear to settle the seasonally frozen coasts and islands until 5000 BP or later. This is in contrast to adjacent unfrozen coasts (where warm ocean currents modify coastal temperatures) that have solid evidence of occupation back to at least 10,000 BP or more. In the North Atlantic, a similar pattern is witnessed, in which the coastal zones of oceanographically moderated Northern Europe were settled by maritime peoples by 10,000 BP while the seasonally frozen coasts of NE North America were only settled in the last 6000-7000 years. In the North Pacific, proxy evidence from marine cores indicates major increases in marine primary productivity around 5000 BP. This was also a time seasonality was starting to decrease and summer temperatures were cooling substantially. Changes in the position of the Siberian High and Aleutian Low tracks, reductions in winter sea ice and increased productivity may all have facilitated the expansion of human settlement and subsistence into the subarctic marine zone. We will examine changes in climatology, sea-ice cover, productivity, and human settlement distributions in the context of known mechanisms of ocean-atmospheric coupling.

TIME FRAME 3: Late Holocene Density Dependence, Intensification, and Demographic Oscillation: The North Pacific from 2000 – Present.

Human population expanded in the subarctic through the late Holocene resulting in large, semi-sedentary population densities around much of the North Pacific and North Atlantic rims. By the late Holocene they were engaged in intensive exploitation of the marine system with specialized technologies, techniques for evening out seasonal variability in resources, and even ownership of natural resource patches in some areas. Two of these populations – in the Kuril Islands and the Lower Alaska Peninsula – show inverse patterns of population growth and declines over the past 2000 years. One hypothesis to explain this asynchronous pattern is some form of oscillating ecosystem dynamic like the Pacific Decadal Oscillation, only at multi-century scales. The increased density-dependence of human populations on

an intensified subsistence ecology may have rendered these populations more vulnerable to negative perturbations to their food supply. A possible mechanism for an east-west oscillation in available food thus might relate to shifts in the dominant positions of the Siberian High and the East Asian monsoon/Aleutian Low storm track and its attending effects on the direction and intensity of winds, upwelling, hydrography, and productivity. A potential alternative hypothesis for this oscillating pattern lies in the propagation of oceanic Rossby waves from the tropics into the North Pacific. Paleoclimatological and oceanographic data will help us estimate changes in the position of the East Asian Monsoon and Aleutian Low, sea ice, and primary productivity over this 2000 year time interval. Zooarchaeological and other sources of data on upper trophic productivity and diversity can help us examine East-West changes in the economically important resources available to, and utilized by, human consumers. While this time frame explicitly addresses an emergent question about the North Pacific, we aim to examine North Atlantic evidence for similar asymmetries that could be tied to climate-ocean dynamics.

TIME FRAME 4 – Commercialization of the Subarctic – 1000-present. N. Atlantic and N. Pacific.

Whereas subsistence-oriented cultures faced density-dependent limits to exploitation of the marine system on which they depended, the growth of a capitalized commercial economy in fish, whales, and fur bearing sea mammals expanded in the last 1000 years in the North Atlantic, and was followed by similar expansion during the 18th to 20th centuries in the North Pacific. Explorers and entrepreneurs, and by extension, the markets they participated in, found their way into every subarctic cove and bay by the late 20th century. Overhunting of whales, overfishing of cod, the near extinction of sea otter, these were repeated outcomes of the expansion of the globalized market into subarctic economies. Starting with Norse colonization of the North Atlantic shortly before 1000 BP, we see how large, globalized markets can undermine regional ecological stability. European whaling (e.g. Basque, English, Dutch); cod fishing (e.g. Scandinavian, Basque, Portuguese); and the fur trade (e.g. Russian, British, Chinese) commoditized subarctic “ecosystem services” and created a demand large enough that stocks could be severely impaired. These impacts happened at the boundaries of the literate world, in places of contact between indigenous communities and commercial entrepreneurs. It happened against a backdrop of climate changes and variable weather. The experiences were more and less well documented, and our focus is on both the written history and the archaeological and environmental proxies. This last time frame allows us to address shorter scales of temporal variability and to bridge the study of deep time to the contemporary present.

Conclusion

These questions and hypotheses will motivate synthesis research over the next two years, leading to a publication in an interdisciplinary journal by 2017. We plan to devote the next year to disciplinary syntheses focusing on high resolution studies of the time intervals identified above with lower resolution coverage of intervening intervals. These will be presented at the next ESSAS Annual Science Meeting (ASM) (Seattle, June 2015). The second year of the project will focus on the integration of the disciplinary research results into syntheses that seek to address the above questions. The 2016 ESSAS ASM will provide an opportunity to present these integrated syntheses, and a publishable collection will be submitted for journal review within 6 months after that meeting.

6. ESSAS Ongoing Issues

6.1 ESSAS Project Office

The ESSAS Project Office funding by the Research Council of Norway and the Institute of Marine Research ended in June, 2013, after 5 years. A proposal to extend the period of funding was written by Ken and submitted to the Research Council of Norway but was unsuccessful. They indicated that although they were pleased with the job that was performed by the ESSAS PO, they felt that given the large number of organizations requesting support that they would prefer to spread their support around. With the lack of the funding from the Research Council, this has meant that we had to close the ESSAS PO and terminate Margaret McBride's position. Franz contacted various agencies in the US to see if they would be willing to fund the Project Office, but without success. Sei-Ichi Saitoh along with Yasunori Sakurai and Naomi Harada submitted a proposal to obtain funding for an ESSAS PO in Japan. It too was unsuccessful, but they will resubmit this year in the fall. Several SSC members offered to provide letters of support if these would help their proposal.

ACTION: Sei-Ichi Saitoh will lead the effort to revise the proposal for Japan to fund and host the ESSAS PO in Japan. He will contact other SSC members if support letters would help.

George Hunt noted the 5 years that Margaret McBride headed the ESSAS PO and suggested that a letter on behalf of the SSC be send to her expressing our appreciation.

ACTION: Ken Drinkwater will write the thank you letter to Margaret on behalf of the SSC.

6.2 ESSAS Website

With the loss of the Project Office and Margaret's position, the website has unfortunately been rather neglected during most of the year. Margaret had spent a lot of time on the website as part of her job. Discussions led to the decision that individual SSC members would take responsibility for certain sections of the website and consider if they needed to be reorganized and to update them.

ACTION: Ken Drinkwater will take responsibility for the Home Page and the Endorsement Section of the website including updating the featured research and ESSAS news; Franz Mueter will work on the Working Group Section: George Hunt offered to reorganize the publications including indicating which publications came from which project.

6.3 SSC membership

In response to the request for the Greenland Institute to appoint an SSC member to replace Kai Wieland who is no longer working there or conducting research in Greenland waters, we received an email indicating that they suggested AnneDorte Burmeister who has been conducting research on crabs. The SSC accepted the nomination but it was suggested that AnneDorte be asked to report not only the fisheries activities but also the research conducted by the climate centre. With this appointment, Kai will step down from the SSC.

ACTION: ESSAS co-chairs to send a letter to AnneDorte welcoming her to the SSC and indicate what we expect, including that we would like her to keep us abreast of the research of the Climate Centre as well as the fisheries group.

There was also discussion regarding the Korean participation in the SSC and their lack of involvement over the years. While they supply reports, they have not attended many meetings nor been involved in many ESSAS activities. Their lack of attendance at the SSC has in part been due to their heavy involvement in Antarctic research. It was suggested that we should discuss with the Koreans if they are still interested in ESSAS and also if there would be a session in an upcoming ASM or OSM that would really attract their interest. With their lack of attendance at the SSC it has been difficult to know what kind of sessions they would like to see or become involved in.

ACTION: Ken Drinkwater will approach Drs. Shin and Kang about their continued interest in ESSAS. If they are still interested he will enquire what session or sessions might be of interest to them.

There is the Pacific Arctic Group (PAG) and the Russian-American Long-term Census of the Arctic (RUSALCA) – maybe ESSAS could collaborate with these organizations. There is also cooperation between China and Korea and ESSAS could work with these groups.

6.4. IMBER

Ken Drinkwater reported on the changes to the International Global Biosphere Program (IGBP) and IMBER. Global Change science is under the International Council for Science (ICSU), which is comprised of several core projects including WCRP (World Climate Research Program), IGBP and others. A couple of years ago ICSU decided that they would like to reorganize the research. All of the core projects should conduct more cross disciplinary research and there should be more cross fertilization between natural and social sciences. The result has been that all of the core projects except WCRP will disappear to be replaced by a new program called FUTURE EARTH. WCRP is associated with the WMO (World Meteorological Organization) and has duties that fall outside of those of the other core projects. Projects such as IMBER are being asked to join FUTURE EARTH. While IMBER has positioned itself well in terms of the human dimension aspects, it is holding off on its decisions. This is for two reasons. First, FUTURE EARTH has not guaranteed money equivalent to what IGBP provided, even though FUTURE EARTH is asking the projects to provide more, in particular on the human dimension side. Second, FUTURE EARTH has not consulted with the Scientific Committee on Oceanic Research (SCOR), which is a cosponsor of IMBER, along with IGBP. SCOR is asking that FUTURE EARTH consult with them and not to make unilateral decisions. SCOR, which gives IMBER more money annually than IGBP, has said that they would continue to fund IMBER even if IMBER decided not to join FUTURE EARTH. However, SCOR may pull their support of IMBER if IMBER goes with FUTURE EARTH in an agreement that SCOR is not happy with. At the IMBER Open Science Meeting in June in Bergen discussions will be held on what IMBER should do.

Ken Drinkwater also noted that IMBER will be publishing a special edition of their Newsletter that will highlight ESSAS and its research. Lisa Madisson requested 6-8 articles of 1-2 pages with 1-2 figures in each that would show the scope of ESSAS research. These would

be similar to an extended abstract. The following indicated the willingness to submit an article: Ken on his AMO paper; George Hunt on the Chukchi-Barents comparison; Ben Fitzhugh on the WG on Paleo-ecology; Erica Head on *Calanus finmarchicus* and the comparisons between the Labrador and the Norwegian Sea; Sei-Ichi Saitoh and Naomi Harada will write something about Japanese research; Olafur Asthorsson will write about the highlights from the Iceland Sea Project. The articles should be sent to Ken Drinkwater by the end of April.

Action: The above mentioned SSC members to submit their 1-2 page articles by 30 April.

6.5 ESSAS Budget

ESSAS did not spend any of its money allotted to it by IMBER for 2013. This was because the money that was used to pay for the SSC meeting in Hakodate in January 2013 came out of our 2012 budget. We thus had $15 K (US) left over from 2013 and received an additional $15 K from IMBER for 2014, giving us $30 K for the year.

The 2014 budget is only very rough as the final figures are not in.

Income			
IMBER	$30000	SSC	$15000
NSF (Paleo)	20000	IMBER OSM	15000
IASC (Arctic cods)	9500	ESSAS ASM (Paleo)	20000
PICES*	3500	ESSAS ASM (cods)	9500
ICES**	3000	PICES TS	1500
		PICES (ICES rep)	2000
		ICES	3000
Total	$66000		
		Total	$66000

Expenditures

*The PICES money is to support an invited speaker at the ESSAS-sponsored Workshop during the 2014 PICES Annual Science Meeting and a PICES representative to the ICES Theme Session.

**The ICES money is to support an ICES representative (Ken Drinkwater) at the PICES Annual Science Meeting.

7. National Programs

7.1 Canada (Erica Head)

Canada currently has no national ESSAS programme, although in the past Canadian scientists were involved in the international programme “NORCAN”, which compared physical and biological processes in the Labrador Newfoundland Shelf/Sea and Norwegian Sea/Barents Sea regions. A special volume of Progress in Oceanography (Volume 114) was published in 2013, which was comprised of 7 papers and 1 overview paper, all of which had joint Canadian/Norwegian authorship. This was the final product of this project.

Canadian scientists were also involved in ESSAS Working Group 4 “Relative effects of ocean climate variation on demersal fishes versus crustaceans”. An introductory article and a series of 8 papers on this topic were published in a special section in a volume of Marine

Ecology Progress Series (Volume 469) late in 2012, with Canadian authors contributing to 5 papers and the Introduction.

In addition, Canadian scientists carry out a series of activities on a routine basis that contribute to ESSAS goals. These include:

Monitoring of the ecosystem in the Northwest Atlantic by scientists from the Department of Fisheries and Oceans – the Atlantic Zone Monitoring Programme (AZMP) and the Atlantic Zone Offshore Monitoring Programme (AZOMP)

Outlines of the programmes and examples of the products can be found at http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/azmp-pmza/index-eng.html and http://www.bio.gc.ca/monitoring-monitorage/azomp-pmzao/index-eng.htm, respectively.

The AZMP includes running sections on the Scotian, Newfoundland and Labrador shelves and in the Gulf of St Lawrence 1-3 times per year to measure hydrographic, chemical and biological (lower trophic levels) variables. The same measurements are made at monthly intervals at a series of fixed stations including locations off Halifax (Stn HL2, Scotian Shelf), St John's (Stn 27, Newfoundland Shelf) and in the Bay of Fundy and St Lawrence Estuary. In addition, survey cruises to assess macrofauna (fish and invertebrates) biomass are also routinely made 1-2 times per year.

The AZOMP involves running a section across the Labrador Sea once per year and sampling in the deep western boundary current beyond the Scotian Shelf. ARGO floats are also deployed in this programme. These floats drift at 2000 m, and re-surface periodically recording profiles of temperature and salinity and relaying the data to shore via satellite telemetry.

Other AZMP activities include (1) providing financial support to the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) for the collection and analysis of samples by means of the continuous plankton recorder (CPR) in the Northwest Atlantic (and the analysis/interpretation of data by DFO researchers), and (2) processing remotely-sensed satellite data on ocean colour and sea-surface temperature. Images are available at http://www2.mar.dfo-mpo.gc.ca/science/ocean/ias/seawifs/seawifs_1.html.

The AZMP and AZOMP routinely report on conditions for the previous year at annual meetings held in late March. Research Documents, containing summaries of the results for the preceding year, are peer-reviewed internally and published on the DFO website (http://www.isdm-gdsi.gc.ca/csas-sccs/applications/publications/index-eng.asp#RES).
AZMP Bulletins containing articles based on the programmes are also published annually (http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/azmp-pmza/publications-eng.html) and individual scientists use AZMP data to write articles that are submitted to scientific journals.

The AZMP report for 2012 (published in 2013) showed that the Scotian Shelf was unusually warm that year, and had an unusually low abundance for the ecologically significant zooplankton species *Calanus finmarchicus* compared with the 1999-2011 average. The same low levels were seen in abundance measurements obtained from CPR (Continuous

Plankton Recorder) sampling for eastern and western parts of the Scotian Shelf when the 2012 data became available, early in 2014.

Activities within the Department of Fisheries and Oceans ACCASP (Aquatic Climate Change Adaptation Services Program)

Preparation of a Technical Report assessing climate change in Canadian regions of the Arctic Basin
Steiner, N., Azetsu-Scott, K., Galbraith, P., Hamilton, J., Hedges, K., Hu, X., Janjua, M.Y., Lambert, N., Larouche, P., Lavoie, D., Loder, J., Melling, H., Merzouk, A., Myers, P., Perrie, W., Peterson, I., Pettipas, R., Scarratt, M., Sou, T., Starr, M., Tallmann, R.F. and van der Baaren, A. 2013. Climate change assessment in the Arctic Basin Part 1: Trends and projections - A contribution to the Aquatic Climate Change Adaptation Services Program. Can. Tech. Rep. Fish. Aquat. Sci. 3042: xv + 163 pp.

Other ESSAS-relevant research initiatives

BASIN
The "Science Plan and Implementation Strategy" for the BASIN (**B**asin-scale **A**nalysis, **S**ynthesis, and **In**tegration) programme was published in 2009 and is available on the IMBER (**I**ntegrated **M**arine **B**iogeochemistry and **E**cosystem **R**esearch) website (http://www.imber.info/products/BASIN_article.pdf). Its goal is to understand and predict the impact of climate change on key species of plankton and fish, and associated ecosystems and biogeochemical dynamics in the North Atlantic Subpolar Gyre System and surrounding shelves, in order to improve ocean management and conservation. Thus, it shares some of the objectives of the ESSAS programme.

Canadian scientists contributed substantially to one of the work-packages of the EURO-BASIN programme (WP3), as authors on a synthesis paper, describing aspects of the ecology of the N Atlantic basin-wide dominant species, *Calanus finmarchicus*. This paper is currently in press.

Melle, W, Runge, JA, Head, E, Plourde, S, Castellani, C, Licandro, P, Pierson, J, Jonasdottir, S., Johnson, C, Broms, C, Debes, H, Falkenhaug, T, Gaard, E, Gislason, A, Heath, MR, Niehoff, B. Nielsen, T.G., Pepin, P, Stenevik, EK & Chust, G 2013, 'The North Atlantic Ocean as habitat for *Calanus finmarchicus*: environmental factors and life history traits' Progress in Oceanography (In press)

In addition, Canada also provided a platform for two scientists from the UK EURO-BASIN group to work in the Labrador Sea during the 2013 AZOMP cruise, where they collaborated with DFO scientists on projects focussed on phytoplankton species composition and carbon sedimentation in relation to bloom status.

VITALS
A proposal received funding in 2013 from the NSERC Climate Change and Atmospheric Research (CCAR) Program, which involves a network of Canadian researchers including university scientists and Government collaborators entitled "Ventilation, Interactions and Transports Across the Labrador Sea (VITALS)". Colleagues from the US will also be

involved and the project will run for 5 years. The first field campaign will be in 2014. The VITALS research network will answer fundamental questions about how the deep ocean exchanges carbon dioxide, oxygen, and heat with the atmosphere through the Labrador Sea. New observations and modelling will determine what controls these exchanges and how they interact with varying climate, in order to resolve the role of deep convection regions in the Carbon Cycle and Earth System. The project includes the deployment of new technologies (*e.g*. Sea-cycler, gliders, biologically-instrumented Argo floats) in the Labrador Sea, and new experimental measurements to evaluate the role of biological components within the system. Even though the project is focused in the central Labrador Sea (not a seasonally ice-covered area), it seems possible that it could be a candidate for ESSAS sponsorship, since it will investigate the hydrological cycle including the impact of runoff, sea ice and glacial melt on the ocean, stratification and on the cycling of gases, and because these investigations are to be made to improve predictive models at regional and global scales in the context of future climate change. Erica Head will inquire of the project leader (Paul Myers, University of Alberta) whether he is interested in seeking ESSAS sponsorship.

7.2 **Iceland** (Olafur Astthorsson)

The main contribution of the Marine Research Institute in Iceland to the ESSAS program has been through the Iceland Sea Ecosystem (ISE) project, which started with a field phase in 2006-2009. The main aim of the project is to further understanding of the Iceland Sea with particular reference to the capelin stock for which the Iceland Sea is the main feeding area. This includes investigations on hydrography (temperature, salinity, currents, watermasses), nutrients, phyto- and zooplankton and energy transfer through the ecosystem and how these factors interact with respect to the life history and distribution of the capelin. Several other smaller projects at the Marine Research Institute are relevant to the goals of ESSAS and the activity of some of those are also reported on below.

Iceland Sea related papers published

During 2013, activity concentrated mainly on data analysis and publications. The publications were as follows (for detailed list of titles of articles and posters mentioned below see ESSAS combined publication list on ESSAS website).

- A paper on the influence of increased cod abundance and temperature on recruitment of *P. borealis* was published by I. Jonsdottir and co-authors in Marine Biology.
- A paper on the anticyclonic eddy east of Kolbeinsey was published by Jonsson and Valdimarssson in the Technical Report Series of the Marine Research Insitute (Hafrannsóknir).
- A paper on long-term changes of euphausiids in shelf and oceanic habitats southwest, south and southeast of Iceland by Silva and co-authors is in press in the Journal of Plankton Research.
- An overview article on the life history and role of capelin in the Iceland Sea by Palsson et al. has been submitted to the journal of the Icelandic Natural History Society.
- A paper on the trophodynamics of amphipod and calanoid species is under preparation by Petursdottir et al.
- A paper on the distribution, abundance and biology of polar cod is under preparation by Astthorsson.

Other ESSAS related activity in Icelandic waters

At the ICES annual science meeting in Reykjavik in September several members of the Marine Research Institute presented posters and presentations connected to the aims of the Iceland Sea Ecosystem project and the ESSAS program and which are listed here below.

Posters presented at ICES 2013

- Inter-annual variation in fat content of the Icelandic capelin (*Mallotus villosus*) by Engilbertsson et al.
- Climate change and the distribution of the northern shrimp (*Pandalus borealis*) by Guðlaugsdottir et al.
- Inter-annual variability in abundance of *Calanus finmarchicus* south and north of Iceland in relation to environmental conditions in spring 1990-2011 by Gislason et al.
- Environment induced changes in krill abundance in the North Atlantic Ocean by Silva et al.
- Contrasting shifts in abundance and distribution of southern vs. northern groundfish species on the Icelandic shelf by Solmundsson and Björnsson.
- Increased spawning of capelin (*Mallotus villosus*) at the North coast of Iceland during warm periods by Thorison and Gunnarsson.

Talks presented at ICES 2013

- Trophic Relationships and the Role of Calanus in the Oceanic Ecosystems South and North of Iceland by Petursdottir and Gislason
- Recent changes in migration and distributionof capelin in the Iceland-East Greenland-Jan Mayen area and their effect on managing the fisheries by Gudmundsdottir et al.
- The role of the Kolbeinsey Ridge and the Spar Fracture Zone in the circulation in the Iceland Sea by Jonsson et al.
- New and improved estimate of freshwater transport in the East Greenland Current by Macrander et al.
- Gadoid predation on a small local shrimp population by Jonsdottir et al.

Routine ongoing activity

Current Iceland Sea field activity is mainly related to routine hydrography and acoustic assessment of the capelin stock. Hydrographic work is undertaken on standard transects four times during the year while acoustic surveys on capelin are conducted in November and January. This work will enable the analysis of the 1996-1999 Iceland Sea field activity to be placed into a longer term perspective.

Routine activity on demersal fish in Icelandic waters is also of relevance to ESSAS and contributes studies on climate-related changes in spatial distribution and abundance.

MRI scientist participate in the EU supported Euro-BASIN program which has relevance to some of the main goals of ESSAS.

NACLIM (North Atlantic Climate) is an EU supported program that aims at understanding the effects of climate on thermohaline circulation and assess future forecasts in surface temperature and sea ice. MRI is to monitor variability in flow of Atlantic water to Nordic Seas and deepwater flow south across Denmark Strait.

7.3 Japan (Sei-Ichi Saitoh, Naomi Harada, Yasunori Sakurai)

The Japanese ESSAS (J-ESSAS) program works to quantify the impact of climate variability on the structure and function of the Okhotsk Sea and Oyashio marine ecosystems, to predict the response of these ecosystems to future climate change, and to predict the associated potential economic impact. The program consists of several projects and activities:

- Shiretoko Natural World Heritage Site: the Multiple Use Integrated Marine Management Plan (2nd phase, 2013-2017). The objectives of this project are: to satisfy both conservation of the marine ecosystem and stable fisheries through the sustainable use of marine living resources; to apply ecosystem-based fisheries and tourism management; and socio-economical and socio-ecological evaluations for sustainable local communities. They have documented a number of significant changes in the ecosystem including declines in chum salmon returning to the coast of northern Japan, delays in migration, northward distributional shifts in some fish species and the occurrence of several unusual warm water species, all possibly linked to warming of the waters in the region.

- The ECOARCS/GRENE projects. In June 2010, the Japanese Cabinet decided upon a new strategy for growth: the "Strategy for becoming an environment and energy power through green innovation." In response, the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) initiated the Green Network of Excellence (GRENE) Program in 2011. One of the projects under this program is the Arctic Climate Change Research Project with funding from 2011-2016. Under this umbrella are a number of research projects including Ecosystem Studies on the Arctic Ocean Declining Sea Ice (ECOSARCS). A number of JESSAS activities involving biogeochemistry and food web research are ongoing. Cruises to the Chukchi Sea were carried out by T/S Oshoro-Maru in July and R/V Mirai in August-September 2013, the results of which were presented during the ASM. Two cruises of R/V Mirai and CCGS Amundsen are planned in September and October 2014.

- “Catastrophic reduction of sea-ice in the Arctic Ocean – its impact on the marine ecosystems in the polar region” is an ESSAS endorsed project, funded by the Japan Society for the Promotion of Science from 2010 to 2014. Naomi Harada has been leading this project as PI. Sea-ice in the Arctic Ocean has been dramatically reduced over the past decade. This reduction causes complex and enigmatic changes in the marine ecosystem throughout the Arctic Ocean, because of the simultaneously occurrence of “disadvantageous” phenomena, such as ocean acidification and “advantageous” phenomena such as improved light conditions for marine organisms. The project focused on the western Arctic Ocean where there has been the most serious sea-ice reduction in the Arctic region. The aims of the project were to 1) understand the temporal changes in primary production and the biological pump, 2) understand the physiological response of marine phyto- and zooplankton to ocean acidification that is occurring simultaneously with warming and freshening from the sea-ice melting, and 3) develop a model to simulate the primary production, and understand the response of marine ecosystems and the biological pump to the environmental changes caused by rapid sea-ice reduction in the Arctic Ocean.

- Development of an integrated coastal fisheries information system for sustainable fisheries in southern Hokkaido, Japan. This project will develop the information system by combining direct measurements, satellite imagery and modeling in productive coastal waters (Oyashio and Tsugaru Warm Current) and include aquaculture sites (scallop and kelp) and valuable coastal fishing grounds. From the end of July, potential fishing zone maps (three days nowcast) of Japanese common squid were disseminated to local

fishermen through the internet (http://innova01.fish.hokudai.ac.jp/marinegis) and by e-mail during the fishing season from July to December 2013.

- Some results from the Japan-Russia joint survey for Steller sea lions in the Okhotsk Sea were given. Northern Okhotsk rookeries have been found to be saturated since the mid-2000s. There is also an increasing trend at the Saalin rookeries/haul-outs as a result of overflow from Northern Okhotsk rookeries. From brandings of sea lions, there is persistence of original rookeries in the Northern Okhotsk but in the Sakhalin rookery some fractions were from Kuril, but their contribution to reproduction was very limited (<2% of total pups). There appears to be a new subpopulation being established in Sakhalin but they are not detectable by mt-DNA yet.

- The new Hakodate Marine Science Center called "Hakodate Research Center for Fisheries and Oceans" is scheduled to open on June 2nd 2014. Hokkaido University, Hakodate Future University, Hakodate Fisheries Research Laboratory, and 6 private companies will share the space and are starting to develop innovations in fisheries and marine science through cooperation among government, industryand academia. The facility includes a special pier for research vessels, including Oshoro-Maru (Hokkiado University), Ushio-Maru (Hokkaido University) and Kinsei-Maru (Hakodate Fisheries Research Laboratory).

- A new scientific book entitled "Ecosystem and its conservation in the Sea of Okhotsk" was published in Japanese during March 2013. Dr. Sakurai is the lead editor of this volume.

- A new ship, the Oshoro-Maru V, is being built and is scheduled to be finished in July of 2014. It is slightly larger than the Oshoro-Maru IV, 78m in length and 1600 ton, capacity has 99 beds including 60 beds for students. Hokkaido University has planed a celebration party for the new Oshoro-Maru V on August 1st 2014 in Hakodate Research Center for Fisheries and Oceans

- A new program "Japanese – Russian Collaborative Expedition Field Observation in the East Kamchatka current" was launched and has a cruise planned from June 2 to July 8 covering southeastern Okhotsk Sea and East Kamchatka current regions along Kuril Islands (ESSAS study region) using Russian Research Vessel Prof. Multanovskiy. The PI is Jun Nishioka from the Low Temperature Science, Hokkaido University. 32 scientists from Japan, Russia, USA and China are participating in this cruise to observe bio-optics, geochemical parameters, turbulent mixing process, etc.

7.4 Korea (Hyung-Cheol Shin)

Sung-Ho Kang (Korean SSC member) expressed his regrets that he could not attend due to other commitments. The Korean report was sent in by Hyung-Cheol Shin (former Korean SSC member) in the form of a Powerpoint presentation. Up until 2009 Korea mainly piggybacked on foreign ships mostly in the Sub-Arctic seas. However, since the launch of their icebreaker R/V *Araon* they have been concentrating on ocean and sea observations and geological studies in the High Arctic but do have interest in the Arctic-Subarctic connections. Summer oceanographic cruises were carried out in 2010, 2011, and 2012 in the Chukchi Sea. Sampling in 2012 included hydrography, currents (LADCP and 2 mooring stations), 2 ice stations and cores for paleoceanographic analysis. They also measured CO_2 in the atmosphere and the ocean. Biological studies included the distribution and community structure of bacteria and viruses, species composition of phytoplankton, chlorophyll-a

concentrations and primary production, abundance and community structure of heterotrophic protists, the mesozooplankton community and grazing impacts on phytoplankton biomass and the algal composition in melt ponds on the sea ice. They have also undertaken sea ice studies, deploying 2 ice buoys to measure ice drift, and conducted sea ice surveys by helicopter. They will be conducting a survey in the Beaufort and Chukchi seas in August of 2014 and indicated that some berths are available for foreign scientists if anyone is interested.

7.5 Norway (Ken Drinkwater)

NESSAR is the Norwegian IPY project which focused on the physics and biology of the fronts between the warm, salty Atlantic waters and the colder, fresher Arctic or Polar waters. Several cruises to the Norwegian Sea and the Barents Sea were conducted during 2007, 2008 and 2009. A special issue of the Journal of Marine Systems with 12 papers, mainly on results from the Barents Sea, was published in February 2014 (Drinkwater and Tande (Eds., 2014). Four additional papers on the Norwegian Sea front have been submitted to the same Journal or are near completion. These papers cover various aspects of physics, bacteria, phytoplankton, zooplankton and fish and their interactions.

BarEcoRe (Barents Sea Ecosystem Resilience) is a Norwegian project that was endorsed by ESSAS in June of 2010 and was completed at the end of 2013. Its objective was to evaluate the effects of global environmental change on the future structure and resilience of the Barents Sea ecosystem through investigating the effects of past changes in climate and fisheries on the Barents Sea ecosystem, by developing indicators of ecosystem resilience, diversity and structure, and by forecasting the possible future states of the Barents Sea ecosystem under particular environmental and fisheries scenarios. The Project has produced to date 16 papers and 2 book chapters. The project developed several new analysis methods and a simplified ecosystem model.

Although not ESSAS sponsored, Norway is participating in the BASIN project that is investigating the zooplankton in the Norwegian, Iceland, Irminger and Labrador seas. A cruise on the Norwegian research vessel G.O. Sars was conducted over 6 weeks during May-June of 2013. It crossed all four basins having sailed from Bergen to Nuuk, Greenland and back and took physical, chemical and biological measurements on route with special focus on the zooplankton community structure and life histories of the important zooplankton species. Hydrographic and current meter data were collected in addition to the zooplankton and phytoplankton data. A special issue of Progress in Oceanography is planned to present the results of the cruise.

Drinkwater, K.F. and K. Tande (Eds.) 2014. Biophysical studies of the Polar Front in the Barents Sea and the Arctic Front in the Norwegian Sea: Results from the NESSAR Project. Journal of Marine Systems 130: 131-262.

7.6 Russia (Sen Tok Kim)

Russian studies during recent decades clearly demonstrate the cyclical nature of environmental processes. For the last 50 years, Arctic and Subarctic zones have been experiencing warming trends in climate and sea water temperature. These same conditions

have been observed in the Sea of Okhotsk. On the background of this warming there has been a periodic fluctuation in the population abundance for several different fish stocks. There was rapid growth of the fish resources in the Far-Eastern Seas at the end of the 1980s – beginning of the 1990s. Then, after a distinct decrease in their biomass at the turn of this century, a new increase happened in the second half of the first decade of the 2000s. Now the available data indicates that there is again a reduction of stock abundance for many of the studied fishes.

The West Pacific Index is often used as an indicator of the environment for fish populations in the Northwestern Pacific. In the period between 1950 and 2012 there were only two phases defining the overall climate dynamics – a negative mode in 1956-1986 and a positive one from 1987 to 2013, with impressive decadal oscillations. The current positive phase was characterized by the relatively mild climate in 1987-2003 and warm winter conditions in 2004-2012. The previous negative phase was characterized by a cool climate regime persisting for 30 years, thus the climate variability has a period of about 60 years. This periodicity suggests that the WP index should possibly change to negative values in 2017 ±2 years. However, the tendency of negative anomalies of the ocean surface temperature in Northwestern Pacific was noted as early as 2011-2012, which could be an indicator of an earlier climate shift from a warm to a cool regime.

A 60-70 year periodicity in climate variation in the dynamics of air temperature over the northern hemisphere was suggested by Klyashtorin and Lyubushin (2012). They reported that the next cold period should begin in 2008 and the cooling would continue through the 2010s to the 2030s. Thus, climate variability is an important factor in the northern Pacific, including the Sea of Okhotsk. From the beginning of this century in the Sea of Okhotsk, the occurrence of extreme events has increased considerably. Ice cover in the Sea declined after the extreme cold event in the winter of 2000-2001. The ice-cover intensity then decreased gradually through about 2005 after which ice extent was relatively low but variability until 2012 when ice-cover intensity began to increase. On the whole, the oceanological regime of the Sea in 2004-2012 featured low ice-cover extent, very cold waters over the top 0-200 m in winter, and slow ice melting on the shelf in spring. During the summers, a rapid switch from negative to positive water temperature anomalies was noted, with strong warming of the sea surface.

An extraordinary situation was observed in the summer-fall 2013 caused by the unusually strong Amur River discharge. The Amur River is very important in the Sea of Okhotsk and western Pacific for the phytoplankton bloom. In 2013, heavy rain at the end of July resulted in intense flooding of the Amur River with a subsequent large discharge. Great amounts of freshwater entered the northwestern part of the Sea of Okhotsk. In August, the Amur River waters continued to spread widely in the northwestern and central parts of the Sea. Consequently, chlorophyll concentrations were fourfold higher than in the previous year. In the fall, the resultant low salinity water mass flowed to the south along the east coast of Sakhalin Island by East Sakhalin Current. Phytoplankton concentrations near southeastern Sakhalin were threefold higher than in the previous year. The East Sakhalin Current flowed to the South Kuril Islands and eventually out into the Pacific Ocean. Along the track of the Current there were multiple local zones with high concentrations of phytoplankton. We expect that this should result in increasing regional biological productivity at the higher trophic levels through the food web of phytoplankton-zooplankton-fish and lead to higher survival of fish hatched in 2013. Unfortunately a scientific survey on assessment of walleye pollock eggs and larvae was not conducted that year. The distribution of the Amur River freshwater in 2013 was determined from satellite imagery and from this we can estimate its expected influence on fish productivity in the future when the commercial stocks will be recruited by that year's generation.

Strong year classes of walleye pollock occurred in the Sea of Okhotsk in 2005 and 2007, with intermediate abundances of the 2006 and 2008-2009 year classes. As a result, the walleye pollock biomass increased fourfold in the second half of the first decade of the 2000s compared with the first half of the decade. In the 2010s, the biomass peaked and then began to decline. The period of decreasing ice extent in the Sea coincided with the appearance of frequent abundant year classes and rapid growth of stock biomass. In contrast, strong ice cover could be associated with poor year classes.

The demersal fish such as flatfish, cottid and gadid fish species within three different areas of the Sea (West Kamchatka, East Sakhalin, South Kuril Islands) have noticeable similarities in their long-term dynamics but with some local differences. In the West Kamchatka Peninsula waters the long-term dynamics of all demersal fish have similar trends to that of the walleye pollock resources. At the south Kuril Islands, the tendency of perennial changes in fish biomass over the past 25 years has been close to that in the Western Kamchatka area. In the northeastern waters of Sakhalin, the demersal fish complex show interannual dynamics that differ from pollock. A noticeable increase in demersal fish resources was observed during the 1990s; thereafter it was followed by a decline to the mid-2000s and then an increase up to the present. During the same period, pollock demonstrated only one cycle of changes.

The demersal resources off eastern Sakhalin have a similar trend with other areas but the periods of variability of growth or decline in fish biomass in the region have lagged by about five years. Perhaps the more severe thermal regime in the western part of the Sea, in spite of the warming, does not reach high enough temperatures that are favorably for most of the fish stocks. The opposite may be applicable to waters off the west Kamchatka Peninsula and southern Kuril Islands that are influenced by the warmer West Kamchatka and Soya oceanic currents, respectively.

7.7 U.S.A. (Franz Mueter)

There are currently three ESSAS affiliated research programs in the US: (1) the Bering Sea Ecosystem Study / Bering Sea Integrated Ecosystem Research Program (BEST/BSIERP, http://bsierp.nprb.org), (2) the Gulf of Alaska Project (http://www.nprb.org/gulf-of-alaska-project) and (3) the Arctic Ecosystem Integrated Survey (https://web.sfos.uaf.edu/wordpress/arcticeis).

(1) The BEST/BSIERP program completed three successful field seasons in 2008-2010 and is currently completing its final synthesis stage with a fourth special issue in Deep-Sea Research II that is expected to be published in early 2015. A total of 120+ papers have been published (http://www.nprb.org/bering-sea-project/detailed-results-findings/scientific-publications/), including the following species issues in Deep-Sea Research Part II

- Understanding Ecosystem Processes in the Eastern Bering Sea. Volumes 65-70 (2012) (25 papers)
- Understanding Ecosystem Processes in the Eastern Bering Sea II. Volume 94 (2013) (28 papers)
- The third special issues in the final review stages with several papers available in the 'In Press' section on the DSR II website

(2) The Gulf of Alaska Project is a 5-year study (2010-2014) with two full field seasons (2011, 2013) and focuses on regional comparisons between the eastern and western Gulf of Alaska. The eastern Gulf of Alaska is characterized by a narrow shelf, a relatively low biomass of fishes and high species diversity, while the western Gulf of Alaska has a broad

continental shelf, a very high biomass of demersal fish and shellfish, and relatively low species diversity.

The overarching hypotheses of the project focus on three themes:

1. Connectivity between offshore spawning areas and inshore nursery areas: The primary determinant of year-class strength for marine groundfishes in the GOA is early life survival. This is regulated in space and time by climate-driven variability in a biophysical gauntlet comprising offshore and nearshore habitat quality, larval and juvenile transport, and settlement into suitable demersal habitat.

2. Regional comparison: The physical and biological mechanisms that determine annual survival of juvenile groundfishes and forage fishes differ in the eastern and western GOA regions.

3. Species interactions: Interactions among species (including predation and competition) are influenced by the abundance and distribution of individual species and by their habitat requirements, which vary with life stage and season.

Spatial analyses in physical and biological variables have revealed a clear breakpoint that is associated with opposite patterns of variability in the eastern and western Gulf of Alaska (Fig. 1). A similar breakpoint is evident in upper trophic level variability.

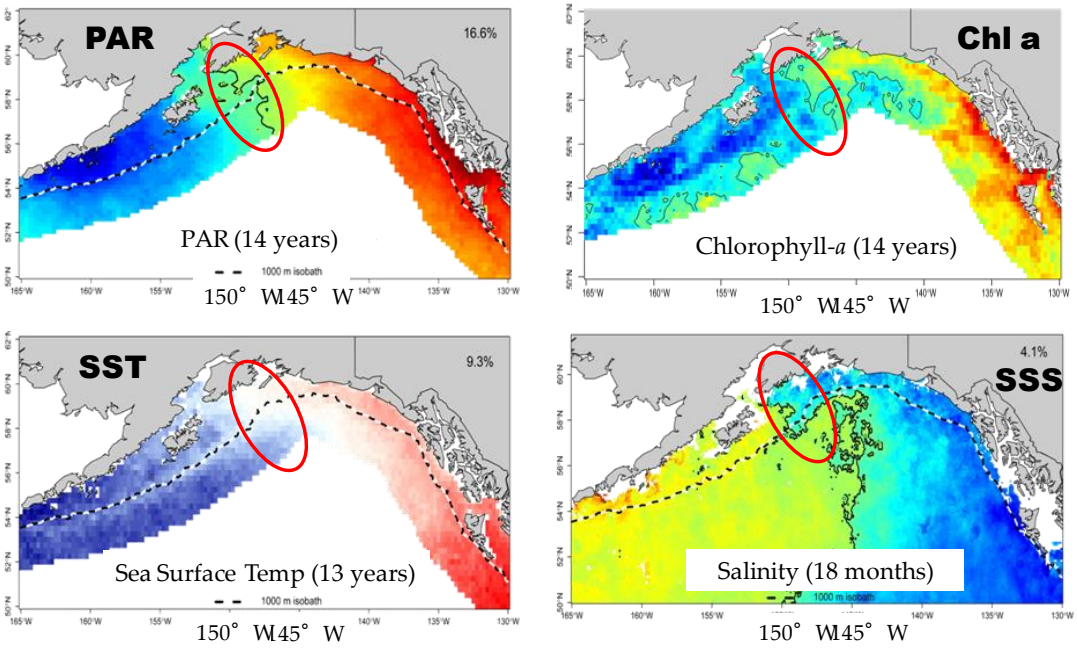

Figure 1: Spatial patterns of first mode of variability in photosynthetically active radiation (PAR), Chlorophyll-a concentrations (Chl a), sea-surface temperature (SST) and sea-surface salinity, based on Empirical Orthogonal Function analysis of 8-day time series.

(3) Arctic Ecosystem Integrated Survey (Arctic Eis)

This 4-year study (2012-2016) has completed two field seasons (2012, 2013) during which comprehensive surveys were conducted to assess the abundance, distribution, and ecology of Arctic marine species throughout the northern Bering and Chukchi Seas (Fig. 2). The project meets research needs identified in the Arctic Fishery Management Plan (Population

structure, life history parameters, ecology and food web dynamics, population dynamics), provides benchmarks for assessing and mitigating potential impacts from oil and gas development, and aims to understand regional effects of climate variability and climate change on the Arctic marine ecosystem. These surveys help fill large gaps in our understanding of the life history of Arctic fish and invertebrates and have revealed high concentrations of juvenile (age-0) *Boreogadus saida* in the Northeast Chukchi Sea. *B. saida* (Arctic or Polar cod) are a key prey species for numerous upper trophic level predators. Bottom trawl surveys show low abundances and no obvious difference in the abundance of demersal fish species between the early 1990s, when a similar survey was conducted, and the 2012 survey, suggesting a relatively stable groundfish community (Fig. 3). In contrast, pelagic surveys show a highly variable composition of the pelagic fish community consisting of juvenile fishes and small pelagic species.

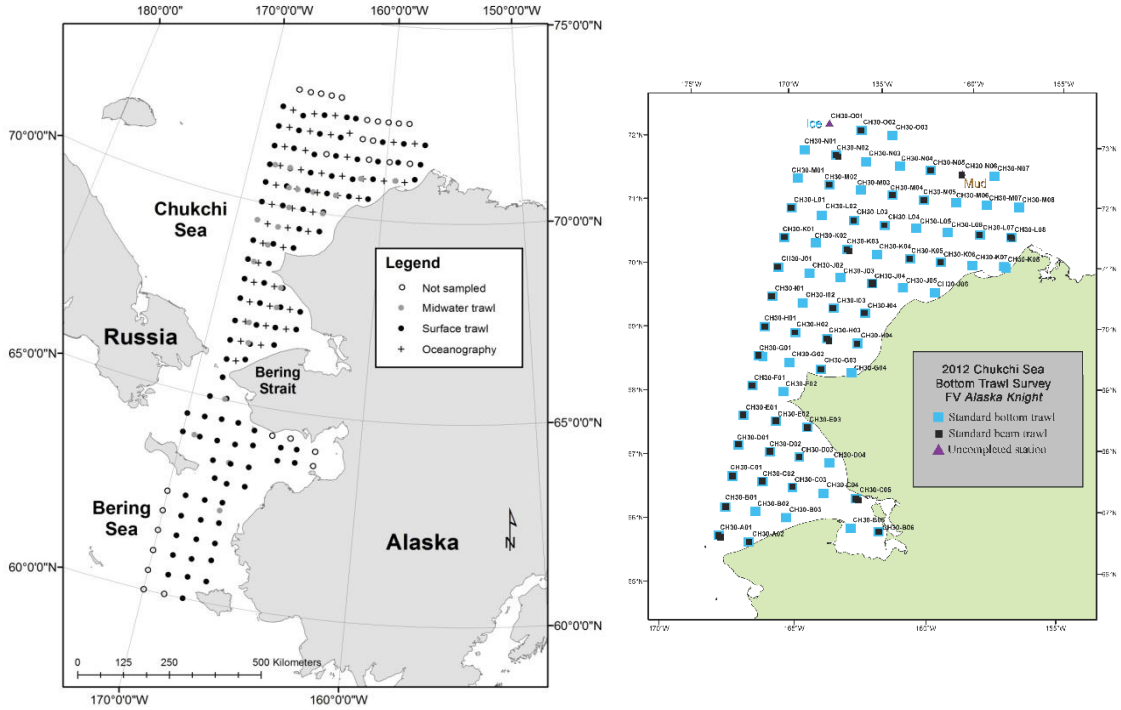

Figure 2: Geographic scope and sampling grid for the Arctic Ecosystem Integrated Survey surface and acoustic / midwater trawl survey (left) and bottom trawl survey (right).

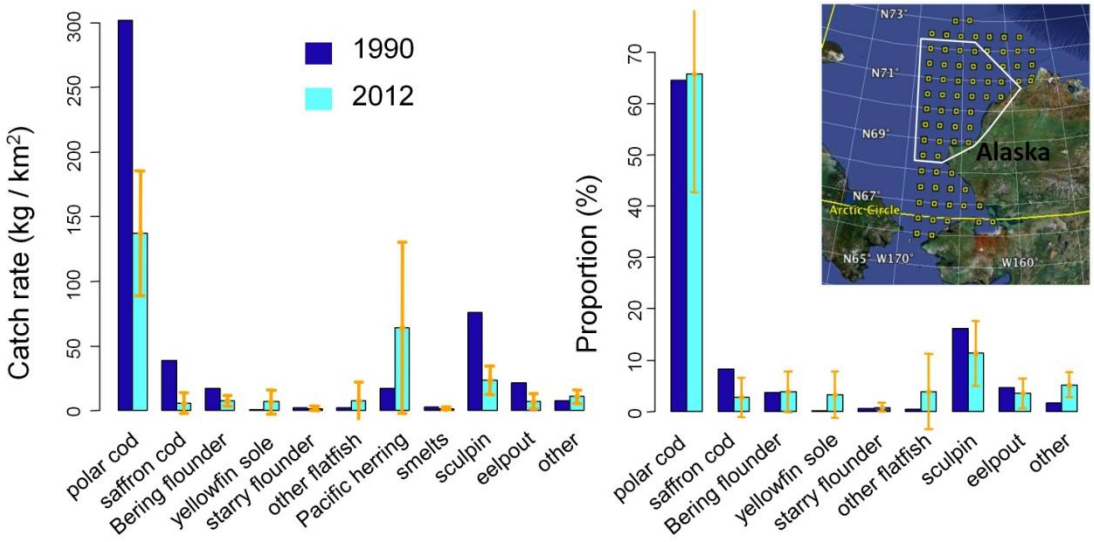

Figure 3: Average catch rates (left) and relative proportions (right) of major species groups captured in the central and northern Chukchi Sea (stations within white polygon, map inset) during bottom trawl surveys in 1990 and 2012. Pelagic species (Pacific herring and smelts) are not included in the proportional composition plot. Orange bars represent 95% confidence intervals for catches in 2012. Only mean estimates are available for 1990. From Mueter et al (2013. Marine Fishes of the Arctic. Arctic Report Card).

7.8 **West Greenland** (Kai Wieland)

Greenland does still not have any projects which are officially endorsed by ESSAS. Ecosystem studies are being conducted in Greenland fjord systems as well as in coastal and offshore waters by the Greenland Centre for Climate Research (GCCR), the Greenland Institute of Natural Resources (GINR) and its partners, in particular the National Institute of Aquatic Resources at the Technical University of Denmark (DTU Aqua).

8. Multi-national Programs

8.1 USA/Norway/Canada (MENUII and @eco)

MENUII, Marine Ecosystem Comparisons of Norway and the United States II, was a Norwegian funded project (2009-2012) endorsed by ESSAS that was to compare different types of ecosystem models applied to Norwegian and US ecosystems. As part of the project, an end-to-end ecosystem model called Atlantis that was developed in Australia was built to cover the Norwegian Sea and the Barents Sea. A follow-on project called *@eco* that was also endorsed by ESSAS has continued the development of the Atlantis model off Norway began in 2013 and will finish in 2015. During this phase of the project, a fisheries component of the model is being built. This will allow exploration of the ecosystem responses to different climate and fishing scenarios.

8.2 Canada/Norway (NORCAN)

NORCAN, the comparative study between the Labrador Sea and the Norwegian/Barents seas, published a series of 8 papers in 2013 in Progress in Oceanography (Drinkwater and Pepin (Eds.), 2013. All papers had co-authorship between Norwegian and Canadian scientists. Comparative papers were published on the physical oceanography, phytoplankton, zooplankton, 3 on capelin and one on cod. The introductory paper describing the project also had an extended section on the expected ecosystem responses to climate change.

Drinkwater, K.F. and P. Pepin (Eds.) 2013. Norway-Canada comparisons of marine ecosystems (NORCAN). Progress in Oceanography 114: 1-125.

8.3 Germany/USA/Norway (Atlantic Multidecadal Oscillation (AMO) Workshop)

The international AMO Workshop held at Woods Hole, MA in June, 2011 was endorsed by ESSAS. The AMO Index is the detrended SSTs averaged over the North Atlantic from the equator to 60° or 70°N, depending on the definition chosen. Changes in abundance and distribution of plankton and fish populations have been recorded in ecosystems on both sides of the North Atlantic that vary with the AMO. The objectives of the AMO workshop held Jun 6-10 in Woods Hole, MA were to assemble all relevant information on the physical and biological processes related to AMO dynamics, to investigate whether AMO dynamics can be predicted, to determine if an AMO-like signal could be observed in paleo records and finally to investigate the climate impacts on multi-decadal fluctuations in the marine communities around the North Atlantic. Recently a special publication based on 10 papers presented at the workshop appeared in the Journal of Marine Systems (Alheit et al. (Eds.), 2014). These papers described the temporal variability of the AMO, the spatial structure of the SSTs within the North Atlantic, the possible mechanisms governing the AMO dynamics, the impacts on other physical characteristics such as currents and sea ice, past variability in temperature from paleo records, the biological impacts of the AMO including affects on phytoplankton, zooplankton and fish stocks, and the links to temperature changes in the Antarctic and the Pacific.

Alheit, J., K.F. Drinkwater and J. Nye. 2014. Atlantic Multidecadal Oscillation-mechanism and impact on marine ecosystems. Journal of Marine Systems 133: 1-130.

8.4 Norway/US/Canada/Russia (Trophic Interactions in the Arctic-TrophArct)

The ESSAS endorsed project, *TROPHARCT*, spearheaded by the University of Oslo, assembled a series of 5 joint papers from Canadian, US, Russian and Norwegian scientists plus an introductory paper. These papers were published during 2013 in a special section of MEPS under the title “Harvested fish stocks in a changing environment” (Durant and Stenseth, 2013). Two of the papers were co-authored by ESSAS members.

Durant, J.M. and N. C. Stenseth (Eds.) 2013. Harvested fish stocks in a changing environment. Marine Ecology Progress Series 480, 199–287.

9. Next Meeting

The location of the next ESSAS ASM and SSC meetings will be in Seattle, Washington in the US. George Hunt and Ben Fitzhugh volunteered to organize the meeting and guaranteed at least $4000 between Ben's project and a new project at the University of Washington called Future of Ice. Because of the later it was decided to have a day to 1.5 day meeting on ice and its effects on biology. Additional sessions that were suggested included one on paleo-ecology that would be an extension of the session held this year, on Human Dimensions that Keith Criddle would organize, and one on bioenergetics that the WG on Bioenergetics would organize under Ron Heinz and Trond Kristiansen. The meeting would most likely take place at the University of Washington during the third week in June. George and Ben will find out the availability of rooms at this time. George also requested support from his department (another $2000) and felt that there might be additional sources that they could tap.

10. End of the Meeting

Ken Drinkwater thanked Kai Wieland for his many years of representing Greenland on the SSC and hoped that we would see him at ESSAS activities in the future. Ken and Franz Mueter also thanked the other remaining SSC members for their input and participation in the discussions. The meeting was then adjourned.

Appendix 1 – Participant Contact Information

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Appendix 2 - ESSAS 2014 SSC Meeting Agenda

Thursday April 10, 2014

09:00 Introduction

- **Adoption of the Agenda** — **Ken Drinkwater/Franz Mueter**
- **Adoption and follow up of 2012 Meeting Report** — **Ken Drinkwater**
- **IMBER and Future Earth** — **Ken Drinkwater**
- **ESSAS Budget & Funding** — **Ken Drinkwater/Franz Mueter**
- **SSC and WG co-chair Memberships** — **Open Discussion**
- **ESSAS Website** — **Open Discussion**
- **ESSAS Project Office** — **Franz Mueter**

12:30 Lunch

13:30 Reconvene

Up Coming Activities

- **IMBER Open Science Meeting** — **Franz Mueter/Ken Drinkwater**
- **IMBER Newsletter Special on ESSAS** — **Ken Drinkwater**
- **ESSAS Workshops and Special Sessions** — **Franz Mueter**

National Program Updates

- **Canada** — **Erica Head**
- **Greenland/Denmark** — **Kai Wieland**
- **Iceland** — **Ólafur Astthorsson**
- **Japan** — **Sei-Ichi Saitoh/Naomi Harada**
- **Korea** — **Sung Ho Kang/Hyoung C. Shin**
- **Norway** — **Ken Drinkwater**
- **Russia** — **Sen Tok Kim**
- **USA** — **Franz Mueter/George Hunt**

International Program Updates

- **Russia/Japan in the Sea of Okhotsk** — **Sen Tok Kim**
- **Canada/Norway in North Atlantic (NORCAN)** — **Ken Drinkwater**
- **USA/Norway in multiple areas (MENU&MENUII)** — **Ken Drinkwater**

17:00 Adjourn

Friday April 11, 2014

09:00

Working Groups

- **WG on Modelling Ecosystem Response** — **Enrique Curchister**
- **WG on Climate Effects at Upper Trophic Levels** — **Franz Mueter**
- **WG on Arctic-Subarctic Interactions** — **Ken Drinkwater**
- **WG on Human Dimensions** — **Keith Criddle (presented KD)**
- **WG on Bioenergetics** — **Ron Heinz**
- **WG on Paleo-ecology** — **Ben Fitzhugh**

12:30 Lunch

13:30 Reconvene

Future Directions **Open Discussion**

- **2015**
  - **Workshops, Comparative Studies, Theme Sessions**
  - **Climate Change in the World's Oceans in Brazil**
- **Longer-term**
  - **Another ESSAS OSM**

Next year's meeting **Open discussion**

- **Dates and Location (Venue)**
- **Theme/ Objectives, Workshops**
- **Organization**

15:00 Adjourn