# Summary of ESSAS Open Implementation Workshop
# Victoria Conference Centre, Victoria, B.C., Canada
# May 20, 2005

## ❖ Distribution list

**ESSAS SSC: Ken Drinkwater, Erica Head, George Hunt, Astrid Jarre, James Overland, Egil Sakshaug, Yasunori Sakurai, Kurt Tande, Kai Wieland, Olafur Astthorsson**

**Others: Manuel Barange, Cisco Werner, all Workshop Participants**

## ❖ The Workshop

The Workshop was convened from 09:00 to 17:30 on 20 May 2005, at the Victoria Conference Centre (See Appendix 1 for the Agenda). Eighty-seven registered participants from 11 nations (Canada, China, Germany, Greenland, Iceland, Japan, Norway, Poland, Russia, U.K., U.S.) attended the workshop, underscoring the science community's interest in the ESSAS programme and the study of sub-arctic seas. (See Appendix 2 for a List of Participants).

The goals of the Open Implementation Workshop were to: (i) disseminate information about the ESSAS programme to the broader research community, (ii) seek feedback from the community concerning needed revisions of the scientific issues and programme structure outlined in the ESSAS Implementation Plan, and (iii) begin the work of coordinating ESSAS research activities including plans for the International Polar Year (IPY). Thus, this Open Implementation Workshop was designed to inform the broader stakeholder and scientific community about the opportunities for climate-related research throughout the ESSAS domain, and to elicit comments on the ESSAS Implementation Plan.

The Workshop programme included an introductory presentation by Ken Drinkwater, who described the ESSAS Implementation Plan. This overview talk was followed by presentations from research programmes relevant to ESSAS activities. Ten presentations addressed diverse regional studies and national natural science research programmes; one talk addressed human dimensions research. Following the morning presentations, three breakout groups discussed planning research comparisons across regions. The workshop participants reconvened in plenary in the afternoon to review the breakout group recommendations and to discuss the ESSAS Implementation Plan.

## ❖ Presentations

### ➢ Introduction of ESSAS Implementation Plan - Ken Drinkwater, Marine Research Institute of Norway

This presentation provided an overview of the ESSAS programme objectives and time-line, and described the scientific priorities and collaborative research / funding opportunities outlined in the draft ESSAS Implementation Plan.

ESSAS is a regional program, under the auspices of GLOBEC, akin to other GLOBEC regional ecosystem research programmes (e.g., CCC, CCCC, etc.). ESSAS has been developing since late 2002, and is envisioned as a decade-long program. The ESSAS science plan, recently published as GLOBEC Report Number 19 (2005), was assembled over three years during a series of international planning workshops: an initial planning workshop in Laguna Beach, California (USA) (September 4 – 6, 2002), and two workshops for Science Plan development, one in Bergen, (Norway,) (May 26 – 28, 2003), and one in Seattle (USA) (October 30 – November 1, 2003). In addition to the writing of the Science Plan, other activities have included

- 2005 January - Submitted IPY Expression of Intent on behalf of ESSAS
- 2005 April - Scientific Steering Committee formed
- 2005 May - Science Plan Published
- 2005 May – ESSAS "kick-off" Symposium
- 2005 May - Open Implementation Workshop

The tentative timeline for future activities includes the following:

- 2005 September - Submission of ESSAS proposal for IPY activities
- 2005 late autumn – Norway-Canada (NORCAN) Workshop comparing Labrador Shelf and the Barents Sea
- 2006 May or June – Workshop developing basis for comparisons of four of the ESSAS regions (possibly to be sponsored by PICES)
- 2006 December - Publication of *Prog. in Oceanogr.* Symposium proceedings volume
- 2007 March - Begin Field Programme as part of IPY

Future work also includes planning efforts to catalyze outreach / implementation activities, the development of working groups as deemed necessary to advance ESSAS implementation activities, and the establishment of close ties with other research programmes. ESSAS focuses on those regions influenced by the Arctic and characterized by seasonal ice cover. The scientific issues of interest to ESSAS encompass studies of physical processes and biophysical coupling, including modeling, field studies and retrospective analyses of ecosystem processes – from the physical forcing to the harvested fish populations and upper-trophic consumers, including people.

The ESSAS Implementation Plan follows a nested structure of five inter-related components: (i) ecosystem summaries for the different regions within the ESSAS

domain to focus on publicly-available physical / biological / fisheries datasets, (ii) regional studies undertaken by national research programmes to incorporate retrospective / modeling / field measurements and address the oceanographic variability, the ecological effects of fisheries, and the associated human dimension, (iii) comparative studies will use data from the regional studies to undertake statistical analyses and modeling comparisons to assess the importance of regional influences and factors, (iv) prediction of climate change effects will entail the integration of data and results from regional and comparative studies, and the comparison of different model runs, and (v) synthesis efforts produce both regional summaries and broader generalizations for sub-Arctic seas. These are envisioned as highly intertwined and concurrent components, which will feedback data and results to each other.

ESSAS will follow an open structure, with a Science Steering Committee (SSC) designed to help focus and coordinate the program's activities, and a series of Working Groups (WG) to catalyze progress in specific topic areas. WGs will be constituted as needed to address specific issues including modeling, data needs, time series analyses, atmospheric / physical oceanography, biophysical coupling, and trophic links. ESSAS will organize workshops, open meetings, symposia, and other synergistic activities with other GLOBEC programmes.

ESSAS declared its interest in participating in IPY activities, scheduled for March 2007 – March 2009, by submitting an Expression of Intent (EOI) to the IPY Office in January 2005, and was subsequently selected as a "lead project". This entails coordinating and integrating several proposals in the subarctic regions. Currently, seven other projects (EOIs) have expressed interest in integrating with us under the ESSAS umbrella. We expect that participation in IPY activities will help catalyze funding for national ESSAS programmes.

- **The Bering Sea Ecosystem Study (BEST) - George Hunt, University of Washington**

This presentation described the activities and objectives of the BEST program, which is a U.S. contribution to IPY and a founding programme within ESSAS, focused on the eastern Bering Sea shelf. BEST, which includes a strong human dimensions program, is currently developing collaborations with other programmes working in the Bering Sea. BEST field activities are expected to start in March 2007 and to continue over 4 years, with an additional synthesis year. A second five-year effort is anticipated.

- **Japanese ESSAS (J-ESSAS) – Yasunori Sakurai, Hokkaido University**

This presentation described the activities and objectives of the Japanese GLOBEC programme (http://j-globec.fish.hokudai.ac.jp/), including regional studies in the Sea of Okhokst of sea ice dynamics, marine park monitoring, and iron fertilization, the deep-water exploration and exploitation (DEEP) program, retrospective analyses of

oceanographic datasets, and the archival of physical / biological ocean monitoring by Japanese governmental organizations (CD-ROM of HUFO-DAT) and other physical oceanographic data (ODATE program).

- **TINRO-Centre, Russia - Vladimir Sviridov, Pacific Fisheries Research Centre**

The TIRNO center (http://www.tinro-center.ru) has compiled vast datasets of trawling surveys since 1980 within the Sea of Okhokst, the "donut hole", and the North Pacific high seas. While these datasets are available for retrospective studies, the availability of the raw data / processed results varies across datasets. In some instances, the analyses would have to be conducted in the TIRNO center. Additionally, TIRNO vessels (4 of ~ 60 m length) can be chartered for $10,000 / day for new field programmes.

- **Ecosystem West Greenland (ECOGREEN) – Helle Siegstad, Greenland Institute of Natural Resources**

ECOGREEN is an integrated research programme focusing on the West Greenland marine ecosystem, which was developed in 2001. ECOGREEN includes governance institutions and interactions between natural / social scientists. The research programme was published in 2002, and socio-economic workshops were held in 2003. Current funding supports fjord circulation models, climate studies and an educational programme for PhD students. ECOGREEN is part of the Danish IPY program, and has established bilateral agreements with Canada and the U.S.

- **Canada's Arcticnet programme in Hudson Bay - C. J. Mundy, Arcticnet**

The Arcticnet programme (http://www.arcticnet-ulaval.ca) focuses on natural science / social science / human health concerns, and undertakes both vessel-based sampling and community-based monitoring programmes. Vessel-based operations include cruises on the Canadian Coastguard icebreaker Amundsen, with participating students involved in the "schools onboard" program. A cruise is planned for August 2005, which will include both a grid of survey stations and "super-sites" with more process-oriented measurements.

- **Canadian ESSAS – Erica Head & Ian Perry, Fisheries and Oceans Canada**

A meeting of scientists interested in developing a Canadian ESSAS program was held during the ESSAS Symposium, prior to the Workshop. They are seeking collaboration with international partners. Because any new funding within Canada for IPY will be limited and subject to intense competition, existing programs will be "re-packaged" under an ESSAS umbrella, which will produce a synthesis of Canadian research. Nevertheless, the ESSAS objectives will have to be re-shaped slightly to meet

the needs and interests of the Canadian government. The Canadian program may be bi-coastal, though there is no seasonal ice in the Pacific basin.

- **Iceland ESSAS - Olafur S. Astthorsson, Marine Institute of Iceland**

Currently, survey and research programmes underway in Iceland of relevance to ESSAS include fishery independent surveys for ~ 200 species, collection of fishery dependent logbook data, hydrobiological monitoring (hydrography, nutrients, phyto- and zooplankton biomass, studies of whale ecology and stock assessment, studies of benthic invertebrates (BIOICE) (http://www.ni.is/bioice/), and the activities of the ICES / GLOBEC "cod and climate change" (CCC) programme (http://www.ices.dk/committe/occ/wgccc.htm).

- **Relevant Norwegian GLOBEC Programmes – Svein Sundby, Institute of Marine Research, Bergen**

ESSAS activities in Norway will build upon ongoing GLOBEC programmes (2003 – 2006) including the ECOBE, CLIMAR and ADAPT programmes, and studies of *Calanus* copepods in deep shelf waters. Other relevant research programmes include the EU funded EUROCEANS program, especially the system component focused on the Arctic and Nordic Seas (2005 – 2009), the UNCOVER study of cod time series (2006 – 2007), and GLOBEC synthesis and comparison activities with Canada and the U.S. In addition to these research programmes, the Bjerknes Centre for Climate Research (joint undertaking by the University of Bergen, the Institute of Marine Research and the Nansen Center) will provide support for synthesis activities and for integration of climate change research, including development of future climate scenarios. This center is currently funded until 2012.

**Norwegian ESSAS (NESSAS) – Ken Drinkwater, Institute of Marine Research, Bergen**

In addition to these other GLOBEC programmes the Research Council of Norway (RCN) has recently funded NESSAS (the Norwegian Component of ESSAS) for 4 years (2005-2008). It consists of 5 components with a focus on the Barents Sea and includes investigations into physical forcing, biological responses to climate variability, predictions of the physical and biological impacts of future climate change, economic consequences and policy considerations of future changes to the fish stocks and comparisons with other sub-arctic regions. The research will be carried out through retrospective analyses and modelling. No field programmes are planned as part of this particular project but it is hoped that opportunities for field studies will present themselves during its lifetime. In addition, funds have been requested from the RCN to begin to develop joint studies between Norway and both Canada and the US. The Norway-Canada initiative (NORCAN) will focus on ecosystem comparisons between the Barents Sea and the Labrador/Newfoundland shelves. The Norway-US initiative involves

comparisons between the Barents Sea and Georges Bank with a focus on modelling. While Georges Bank is not part of the ESSAS region, the outcome of such work was felt to be of great interest to ESSAS. (Subsequent to the Workshop, NORCAN was funded but the Norway-US study was not. NORCAN is planning a workshop in the autumn of 2005 in Bergen and a follow-up meeting in St. John's, Newfoundland, in May of 2006. In regards to the Norway-US study, the US has also submitted a proposal to its funding agency for cooperative studies and some work between the two countries is expected to proceed, probably beginning in 2006.)

- **Polar Institute (PINRO), Russia – Oleg Titov, PIRNO**

PINRO employs 500 personnel and undertakes aircraft and ship surveys, with 7 – 8 fisheries cruises in the Barents Sea, involving trawling and benthic sampling. These activities may be of interest to the broader ESSAS program.

- **Human Dimensions Research - Rosemary Ommer, University of Victoria**

This presentation highlighted the importance of incorporating a strong human dimensions component within ESSAS. This component should make the ESSAS research results accessible to the public, address the social implications of fisheries management decisions, and explore the broader socio-political implications of the effects of climate change on the sub-arctic seas.

Any human dimensions programme needs to acknowledge the heterogeneous and dynamic nature of social systems, and the links between natural / social systems. In particular, it is critical to recognize that climate change and management decisions will affect different groups in different ways (yielding winners and losers), and that these impacts will cause population migrations, and will influence the patterns of human resource use and adaptability to the environment.

Several approaches are available to study the human dimensions of environmental and climate change. The structure and changes in natural and social structures can be studied in parallel, the interactions between these systems can be addressed in a coordinated approach, and traditional knowledge can be used to reconstruct the past patterns of resource use, social systems, and environmental conditions.

- **Circumpolar Seabird Group - David Irons, U.S. Fish & Wildlife Service**

The circumpolar seabird group, under the auspices of the Arctic Council, was formed in 1993 to address large-scale issues relating to the conservation and management of highly migratory seabird populations. The group expanded its focus on harvesting and bycatch to address large-scale climate effects. In a recent study, the reproductive success of common and thick-billed murre populations throughout the Arctic was analyzed in conjunction with SST records. This analysis revealed concurrent out-of-phase changes in

the North Pacific and North Atlantic, which co-occurred with the 1977 and 1989 oceanographic regime shifts.

❖ **An open discussion of the ESSAS Implementation Plan followed the morning presentations:**

- Takashige Sugimoto questioned the sub-Arctic nature of ESSAS, and offered other options, which better reflect the northern geographic emphasis of this project: "transitional sub-arctic" and "marginal seas". Dr. Sugimoto also raised the importance of considering both east-west gradients associated with the presence of boundary currents, and latitudinal patterns (as suggested by Dick Barber's presentation). Moreover, regional comparisons will have to address disparities in the width of the continental shelves, which can have important implications for hydrography and ocean productivity patterns.

- Thomas Kline suggested that ESSAS focus on circumpolar species, which have experienced major climatic changes in the past. These comparisons may rely on the same taxa in different ocean basins (e.g., murres), or may contrast analogs (e.g., genetically different sub-species or closely related species).

- Anne Hollowed expressed the need to build up a comprehensive ecosystem understanding, including the effects on human systems, using the physical predictions (e.g., IPCC models) and knowledge of physical – biological coupling at the lower trophic levels.

- Jim Overland emphasized the importance of the large-scale atmospheric patterns, and their influence in hydrological cycles and fish production.

- Ben Fitzhugh stressed society's need for quantification of patterns and predictions. This will require a strong synthesis and modeling component, which will rely on retrospective studies of paleo-ecological data and traditional knowledge, and will link with climate models to forecast future conditions.

- Vladimir Sviridov highlighted the need for standardized models to facilitate inter-regional comparisons. Otherwise, regional comparisons will be relegated to inter-model comparisons, incapable of distinguishing the underlying regional patterns from the inherent biases of the different modeling approaches.

- Another critical issue brought up by Dr. Sviridov relates to the need to incorporate nektonic species in these ecosystem models. These poorly studied taxa (including bathypelagic and mesopelagic myctophids and squids) are a critical link in the marine food web, linking zooplankton with the upper-trophic predators (large predatory fish, marine mammals, and seabirds).

- In addition to nektonic taxa, models should also consider benthic species and ecosystems, and their coupling with water column processes. Moreover, NPZ models should not merely focus on nutrients, but should also include carbon dynamics.

- The working group participants also discussed how ESSAS activities would be organized. Two approaches emerged from the discussion: (i) assembling disciplinary / regional working groups to organize research activities, and (ii) outlining focal "topic areas" or "problems" worthy of examination. Both avenues will be dynamic, with working groups and topic areas changing over time. Suggestions from the broader community will guide this process.

- It was suggested that a logical approach would be to start by building national programmes, which would then coalesce into regional efforts, and would then feed into inter-regional comparisons.

- Rolf Gradinger stressed the need to produce an IPY legacy for the public at large, which should have a pan-arctic geographic scope and will allow comparisons with future studies. To add value to ESSAS activities, relevant historical / contemporary datasets should be made publicly available through existing data archiving programmes (e.g., OBIS). Moreover, ESSAS datasets should be made publicly available to the research community as a whole and to the public at large. Additional outreach efforts can include lesson plans (e.g., cruise reports) and educational programmes (e.g., the university of the arctic). This will require outlining ESSAS data sharing and access protocols early on.

❖ **In the afternoon, the workshop participants formed four breakout groups for planning research comparisons. Each group was charged with addressing three questions. Two groups tackled questions 1 through 3 and the other two groups questions 1, 2 and 4.**

1. Should ESSAS focus on (a) key processes, (b) key species, (c) population resilience, (d) events/regime shifts, or (e) some combination of these? What scientific issues should be given highest priority by ESSAS (no more than 5)?

2. How do we address these scientific questions – organization, methods and logistics?

3. How can comparative studies help disentangle climate impacts from human impacts?

4. Given that prediction of climate impacts on the marine ecosystems is one of the primary objectives of ESSAS, how should this be carried out?

❖ **Four rapporteurs presented the breakout group recommendations in a plenary session:**

➢ *Should ESSAS focus on: (a) key processes, (b) key species, (c) population resilience, (d) events/regime shifts, or (e) some combination of these?*

The breakout groups were divided with respect to the best way to focus ESSAS research. Two groups recommended that ESSAS focus on key processes, and recognized that events / regime shifts are simply the drivers for changes in key processes. In this case, the ESSAS programme would investigate how events / regime shifts affect key processes controlling community structure. Moreover, these processes should be selected with great caution to reflect societal needs. For instance, examination of resource management applications including fisheries stock-recruitment predictions will be critical.

On the other hand, two breakout groups suggested a focus on functional species groupings, though not on simply a few key species. The emphasis on functional groups would facilitate broad ecosystem-level comparisons. Additionally, faunal changes are likely in the future as different dominant species emerge under different regional environmental conditions, and focusing on the functional groups will capture these changes and their effects on ecosystem function. However within these functional groups, there may be species that exhibit circumpolar distributions (e.g., *Themisto libellula* a circumpolar amphipod, capelin, gadids, snow crab, herring, murres), and ESSAS could examine how these species adapt to the different regions in which they are found. These ecological indicators could include commercially important taxa, and other species, expected to be sensitive to climate change, which may change trophic levels / migrate / shift their distributions in response to climate change. A valuable comparison may entail contrasting the responses of "warm water" and "cold water" taxa, given the anticipated ocean warming. However, concern was expressed by two breakout groups that an emphasis on indicator species could defeat the purpose of forming a joint international programme if different regional studies focused on different key species or processes.

The breakout groups also underscored that, if ESSAS wishes to model the responses of marine ecosystem to climate change, it must study the temporal responses of a range of individual species to specific events / regimes. These responses will depend on unique aspects of the life history of the species selected. In other words, because there are no "generic" zooplankton, fish, or birds, comparative studies of different taxa within these functional groups will be informative. Thus, the break-out groups recommended that ESSAS target and study the response of different target species, selected on the basis of their life-history characteristics, to specific climatic / oceanographic events / regimes.

In summary, the advice from the breakout groups was in some sense contradictory. There was call for a focus on processes, on functional groups and on key or indicator species. The message must be taken that ESSAS will need to address the impact of climate change on processes, but to do this ESSAS will have to examine the

important functional groups responsible for energy transfer. However, since some species play a greater role than others, and all species have unique life-history traits, the understanding of how climate affects processes will require an understanding of how individual species will respond to climate change.

The breakout groups identified the following five high priority areas:

1. Target key oceanographic processes and how these processes may change under a Global warming scenario. What will the patterns of climate forcing look like over the next decade (NAO vs PDO) and what will the impact of these shifts be on local physical and biological oceanography? Will the system achieve a new equilibrium or will the system remain in flux? Will regime shifts still occur or will global warming override decadal shifts in atmospheric forcing. What is the heat budget of sub-arctic ecosystems?

2. Target processes that would allow researchers to predict the species composition and community distribution of an ecosystem that emerges under a regime shift.

3. Target atmospheric forcing on key oceanographic features: ice extent and timing of retreat, direction and intensity of winds, location and intensity of frontal systems, timing of spring production, and seasonal patterns in production.

4. Will global warming influence the light penetration of sub-arctic systems through its influence on cloud cover and ice cover? Use Satellite imagery to assess shifts in production.

5. The question of whether Pacific and Atlantic systems differ in the degree of nutrient limitation provides a larger context for regional studies and inter-regional comparisons within ESSAS.

- *How do we address these questions – organization, methods, and logistics?*

The breakout groups made the following recommendations:

- The notion of working groups was widely endorsed, with the recommendation that a minimum of 2 nations participating in every group.

- Because a considerable amount of information has already been collected, retrospective studies will help assess information gaps that require process oriented field programmes. Thus, the breakout groups recommended that ESSAS establish a working group responsible for synthesizing existing information early on, if possible during the summer of 2005. IPY provides a great basis for comparisons and stimulus for organization. These synthesis efforts should focus on comparative studies involving the application of several models in the same basin / region. This modeling approach will require time series of coupled

physical / biological measurements, trophic models to link ecological variability to fisheries models, and explicit links to bio-economic models and management approaches. The products of these predictive models should be integrated into the activities of the different working groups, feeding back into the design of additional field measurements and retrospective studies.

- Moreover, IPY encourages nations to make comparable measurements of similar processes around the world. This international collaboration requires a wide-ranging and flexible overarching research programme capable of reconciling the goals and needs of the different national research programmes.

- In particular, because ESSAS is an ecosystem program, the selection of specific key indicator species may constrain research opportunities / activities throughout its geographic domain. On the other hand, a focus on ecological changes at the community level may be much more conducive to the ESSAS research approach, especially given that the current system (species / processes) may differ from the conditions that will emerge under a global warming scenario.

- The breakout groups highlighted the strength of comparing multiple similar sub-Arctic ecosystems. These inter-regional comparisons should focus on characterizing the different ecosystem constituents and water masses over time.

- It was noted that field programmes must standardize field techniques to allow regional comparisons. Alternatively, some effort to conduct side-by-side (paired) measurements to calibrate the different sampling gears will be needed. ESSAS should establish a working group to address this issue once the study species and processes have been selected.

- If the ESSAS programme avoids the issue of gear standardization through the development of models that are tuned to survey indices, ESSAS should establish a working group to ensure that the model structure and the corrections for availability and selectivity has been appropriately addressed.

- There is a further complication regarding comparisons across specific sampling techniques (e.g., trawl speed, depth and speed, diel sampling). ESSAS should strive to make an effort to standardize sampling techniques for process studies.

- It is unlikely that ESSAS will be able to change the design and implementation of long-term surveys with a long history because the agencies involved will be reluctant to alter a survey design with an established time series.

- The breakout groups acknowledged that modeling provides an obvious technique for integrating and synthesizing information. Thus, they suggested that ESSAS should use models to conduct global comparisons of species responses to changes in ocean features in terms of shifts in abundance, distribution, and ontogeny.

- More specifically, modeling will play a vital role, both in terms of filling in the data gaps in space (between stations) and temporally (between cruises), and by facilitating forecasting future conditions. The assimilation of data from field studies and the now casting of current conditions will be critical steps in developing accurate models for longer-term predictions. The modeling work should consider the identity and needs of potential end-users of the predictions. Fisheries applications will include NPZ and stock-recruitment models).

- Nevertheless, rather than assembling a modeling working group, the break-out groups felt that it would be more fruitful to integrate modelers into the other regional working groups and research efforts. This inter-disciplinary approach will facilitate synthesis and integration across trophic levels.

➢ *How can comparative studies help disentangle climate impacts from human impacts?*

- The breakout groups recognize that if ESSAS wishes to include human impacts, some consideration of climate impacts on the distribution and availability of fish should be included in the research program.

- The breakout groups also recognized that in several systems commercial fishing has a major impact on fish distribution and abundance. Thus if the programme seeks to assess ecosystem change, commercial fishing effects must be considered. Rather than just determining the relative importance of fishing versus climate effects, more attention should be given to the synergistic effects between the two forcing functions.

- ESSAS should recognize that future ecological systems might include artificial enhancement of populations through aquaculture or hatcheries. The impact of these activities on commercial markets will play an important role in the economic impacts to communities dependent on fishing. Therefore, these activities should also be considered.

- In some nations there exist opportunities for experimental fisheries, particularly in regions that have been closed to fishing in the past. Experimental fisheries and the opening / closing of fisheries may provide interesting "experiments" and ancillary datasets to complement traditional survey programmes.

- The east and west side of each ocean basin tend to respond differently to climate variability. Therefore comparisons of the Bering - Barents and Okhotsk - Labador systems may reveal different climate forcing mechanisms.

➢ *Given that prediction of climate impacts on the marine ecosystems is one of the primary objectives of ESSAS, how should this be carried out?*

- IPCC global and ocean basin models should be used to generate the future scenarios of atmospheric and oceanic responses to anthropogenically-induced climate change (it is no use "reinventing the wheel"). Also an ensemble of models should be used rather than relying upon one model. The results can then be downscaled to the regional (i.e. sub-Arctic Sea) scales. Agreement of the large-scale climate scenarios should be done before being applied on the regional scale. Physical processes of particular importance include circulation, temperature, sea ice and freshwater.

- The physical changes in the sub-Arctic Seas can then be used with ecosystem (biophysical) models to predict possible outcomes. Biologists should be included in the biophysical modelling activities from the beginning. Because the predictions may be outside the bounds of present day experience, especially regionally, some surprises are expected to arise.

- Improvements are needed on the primary and secondary trophic level models to better capture the dynamics. Also, further developmental of models to link the lower and higher trophic levels are required.

- Top-down effects of fishing must be considered. Predictions of bio-economic effects of climate change would make them of more practical use to the politicians and the general public.

- Both time series and process related data will be required to validate the process models. Consideration of the criteria used to evaluate these models results is needed along with estimates of the uncertainty associated with the predictions of future ecosystem impacts of climate change.

❖ **A final plenary group discussion of the ESSAS Implementation Plan followed the break-out group presentations:**

- Ian Perry: Proposed that the initial focus on individual regions of this Implementation Workshop could be supplemented with a preliminary comparative synthesis before the field activities start. This comparative approach may be the emphasis of the first ESSAS working group.

- Lisa Eisner: Highlighted the need for a larger vision for ESSAS, beyond the IPY time frame. The modeling of marine ecosystems through time provides a synergistic approach to integrate different research disciplines and the natural science / social science perspectives. Because ESSAS can provide a venue for improved regional integration and resource management, the programme should strive to address multiple trophic levels and disciplines, ranging from physical oceanography to fisheries management. In particular, the growing interest in ecosystem management provides a clear constituency for ESSAS, especially given the implicit underlying "equilibrium" assumptions of fisheries management

models, which clearly contradict the emerging understanding of the large-scale oceanography and ecosystem dynamics.

- Rolf Gradinger: ESSAS may benefit from collaborations with other investigators engaged in studies of climate change and regime shifts in terrestrial and lake systems, especially when land – ocean boundaries and freshwater inputs are concerned.

- Igor Belkin: Suggested that ESSAS develop two sets of working groups with a geographic and a thematic focus. These two sets of working groups should communicate through the SSC and synergistic activities to facilitate inter-disciplinary comparative studies.

## **Tasks for the ESSAS SSC** (based on the Workshop discussion)**:**

- Re-assess guidelines for compilation of specific regional summaries for the Symposium volume.

- Invite additional authors for regions not covered in this symposium (e.g., West Greenland).

- Identify authors for comparative / synthesis papers.

  The authors of regional presentations at this conference will be charged with summarizing their materials for submission to *Progress in Oceanography* in September 2005. To facilitate inter-regional comparisons, these regional reviews will address a common set of elements.

  In addition to these regional reviews, synthetic papers will set the stage for the symposium publication. Takashige Sugimoto (physical comparisons), Jim Overland (climatology), and Ian Perry (cross-regional comparisons) volunteered to assist in the compilation of additional summary materials for this introductory paper.

**Appendix 1: Agenda**

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| 09:00 | Welcome: *Ken Drinkwater*<br>Introduction of Preliminary ESSAS Implementation Plan: *Ken Drinkwater* |
| 09:30 | Relevant National Programmes and how these programmes will fit within ESSAS<br>BEST and the Bering Sea: *George Hunt*<br>Japanese projects in Oyashio and Sea of Okhotsk: *Yasunori Sakuri*<br>Russian Interests (TINRO): *Vladimir Sviridov*<br>ECOGREEN (West Greenland): *Helle Siegstad*<br>Canada's ACTNET (Activities in Hudson Bay): *CJ Mundy*<br>Canadian ESSAS: *Ian Perry / Erica Head*<br>Icelandic Studies: *Olafur Astthorsson*<br>Norway's GLOBEC Programmes: *Svein Sundby*<br>Russian Interests (PINRO): *Oleg Titov*<br>Human Dimension Research: *Rosemary Ommer* |
| 11:30 | Open discussion of ESSAS Implementation Plan |
| 12:30 | Lunch |
| 14:00 | Breakout groups for planning research comparisons |
| 15:00 | Break |
| 16:00 | Plenary Reports of Break-out Groups |
| 16:30 | Final Discussion on ESSAS Implementation Plan |
| 17:30 | End of Workshop |

**Appendix 2: List of registered participants**

| Last name | First name | Country | Institute | E-mail |
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