

Progress Report
SEARCH Biocomplexity Incubation Activity Grant (OPP-0083331)
July, 2001

This is a progress report on the SEARCH Biocomplexity Incubation Activity Grant (OPP-0083331). The Study of Environmental Arctic Change (SEARCH) has been conceived as a broad, interdisciplinary, multiscale program with a core aim of understanding *Unammi*, the recent and ongoing, decadal (e.g., 3–50 year), pan-Arctic complex of interrelated changes in the Arctic. These changes include, among other things, a decline in sea level atmospheric pressure, an increase in surface air temperature, cyclonic ocean circulation, and a decrease in sea ice cover. The physical changes are producing changes in the ecosystem and living resources and affecting the human population. The changes are affecting local and hemispheric economic activities such as shipping and fisheries totaling billions of dollars. SEARCH will involve:

- long-term observations to detect and monitor the environmental changes,
- modeling to synthesize observations, test ideas about the coupling between different components of *Unammi*, and to predict *Unammi*'s future course,
- process studies to understand potentially important feedbacks, and
- application of what we learn to understanding the ultimate impact of the physical changes on the ecosystems and societies.

The aim of the SEARCH Biocomplexity Incubation Activity is to hold two workshops to explore the impact of *Unammi* on ecosystems and society. To plan these workshops the Search Biocomplexity Incubation Activity Steering Committee was formed and met January 23-24, 2001 at the University of Washington, Applied Physics Laboratory. The Steering Committee members in attendance included Lou Codispoti, Glenn Cota, Jackie Grebmeier, George Hunt, Jack Kruse, and John Walsh.

The Steering Committee agreed that biocomplexity philosophy and funding could benefit SEARCH greatly and structured the workshops with two aims: 1) plans for learning how *Unammi* affects the ecosystem and society, and 2) possible Biocomplexity proposals that would implement one or more of those plans. The first workshop was envisioned as planting the seeds for future collaborations and possible biocomplexity proposals. The second workshop in 2002 will build out of the results of the first workshop.

The Steering Committee agreed that focused workshops would be most likely to produce concrete results. A group of experts was selected for the first workshop, and the workshop was held in Seattle, Washington at the U.W. Applied Physics Laboratory on June 19–21, 2001.

The attendees were: Vera Alexander, Carin Ashjian, Ed Carmack, John Christensen, Glen Cota, Jackie Grebmeier, Brad Griffith, Anne Hallowed, Larry Hamilton, Henry Huntington, Art Ivanhohoff, Gunnar Knapp, Jack Kruse, Libby Laggerwell, Dennis Lettenmaier, Jamie Morison, Jim Overland, Kim Petersen, Scott Rupp, Egil Sakshaug, Jim Schumacher, Beth Sinclair, Phyllis Stabeno, Skip Walker, and John Walsh.

The workshop attendees were given several exercises designed to stimulate vigorous interdisciplinary effort and at the same time address the research priorities of SEARCH. These exercises posed 5 questions: Given a change in the strength of the polar vortex, perhaps as indicated by a rise in the Arctic Oscillation index, what is the effect on

- 1) subarctic fisheries,
- 2) intangible social values through the marine environment,
- 3) intangible social values through the terrestrial environment,
- 4) biogeochemical fluxes in the marine environment, and
- 5) biogeochemical fluxes in the terrestrial environment?

The attendees were asked to derive strawman schemes or formulas for answering these questions and identify the critical research and observations needed to implement them. The goal was to generate discussion and ideas. In this the five questions were successful but the workshop effort naturally came to focus on three slightly different subjects: Climatic Variation and Subarctic Fisheries, Coastal Domain Response To *Unammi*: The Timing of Spring Transition, and A Holistic, Regional Approach to *Unammi*. We broke into three working groups to address these questions. The working group reports, which follow, best describe the individual outcomes. Enthusiasm within the groups is high for continuing work on these three initiatives through small meetings and correspondence. Development of them into proposal actions will culminate at the second SEARCH Biocomplexity to be held in 2002.

Climatic Variation and Subarctic Fisheries

Outline for Biocomplexity Research

1. Observations

- a. Large-scale changes have been observed in the Arctic (*Unammi*) and adjacent northern-climate/ocean systems in recent decades. Examples include the intensification of Arctic Oscillation and North Atlantic Oscillation; cooling in the Northwest Atlantic; and decreasing overflow of deep water (related to the “global conveyor” thermohaline circulation system) from the Nordic Seas into the Northeast Atlantic. The Bering Sea has shown influences from the Pacific Decadal Oscillation and Southern Oscillation as well.
- b. Broad changes, including step-like “regime shifts,” have occurred in northern fisheries. In 1977 and 1989 regime shifts in the North Pacific and Bering Seas, involved changes in sea ice extent, air temperatures, primary production, and higher trophic levels including commercial fisheries and marine mammals. Changing regimes might be discerned in the Atlantic with the very cold East North Atlantic and east Nordic Seas in the 1960s, and the warm period 1988–94.
- c. Substantial demographic, social, economic, technological, and market changes have affected high-latitude fisheries-dependent regions such as Newfoundland/Labrador, Greenland, Iceland, and North Norway. These complex changes include the technological, spatial, and seasonal intensification of fishing effort; population declines in rural fishing communities; the key role played by government policies including fisheries regulation as well as direct and indirect subsidies. Marketing changes had substantial effects, such as new markets and rising prices for invertebrates (e.g., crab, shrimp). Markets also created a social mechanism “teleconnecting” the changes in fisheries around the world. Because circumpolar fisheries pursue similar species, the market connections are particularly strong in this realm.

2. Questions Needing Research

- a. In what ways are the Arctic/northern Atlantic climate variations related to fisheries-

ecosystem changes? Although climate variations undoubtedly have impacts, they are not the whole story in fisheries transitions. Research is needed to disentangle the separate effects of climate and other factors. Extensive but disparate time series data exist on climate/ocean conditions, fish population biomass and abundance, and fisheries catches. These data could be integrated and analyzed together in multivariate models, informed by theoretical/substantive knowledge, in order to better understand the relative contributions of different drivers (e.g., natural/climatic v. anthropogenic/fisheries) of ecological change.

- b. How do fisheries-ecosystem changes interact with socioeconomic changes on land? For example, how does fishing at “maximum sustainable yield” levels interact with environmental variations that affect ecosystem carrying capacity? Following similar methods, biological and socioeconomic data would be integrated for multivariate analysis of the relative contribution of environmental and other (market, technical, policy) influences on social change. Case-study work in selected fishing communities would help guide and interpret the analytical work.
 - c. Does the science give a basis for predictions or policy recommendations concerning fisheries management under climatic change? For example, what can we learn about interactions between climate variations and fishing activities, in sustaining/exhausting fisheries resources? How do human adaptive responses feed back to the biological system and resource base? What generalizations can we draw that seem applicable of other social systems and other large-scale environmental change?
3. Scope: the study is comparative and interdisciplinary. Its temporal focus is the twentieth century, and particularly the years since ca. 1970. Where possible, older data such as Norwegian records of herring going back into the 1800s would be consulted for additional insights.
- a. The Bering Sea component will look at U.S., Russian, and Japanese fisheries.
 - b. The North Atlantic component will consider fisheries of Newfoundland, Greenland, Iceland, and Norway.
 - c. Disciplines covered include oceanography, marine biology, economics and sociology.

4. Data sources: ocean/climate
 - a. Oceanographic cruise data
 - b. Fixed-station temperature/salinity time series (e.g. Greenland's Fylla Bank, Newfoundland's Station 27)
 - c. Long-term land weather station time series (e.g. Nuuk, Stykkisholmur, St. John's)
 - d. Large-scale atmospheric indexes: NAO, AO, PDO
5. Data sources: biology/fisheries
 - a. Trawl surveys of species abundance and biomass (e.g. W. Greenland shrimp survey, Canadian DFO groundfish survey, ECNASAP dataset)
 - b. Fish catch and landings data from international (e.g., ICES, NAFO) and national (e.g., DFO, Statistics Iceland) sources
 - c. Qualitative data from interviews in fishing communities
6. Data sources: socioeconomic
 - a. Time series of population, economic and social indicators data on regional or community scales, from national statistical agencies (e.g., Statistics Iceland, Statistics Canada) and their regional counterparts (e.g., Newfoundland Statistics Agency)
 - b. Market data
7. Requirements
 - a. Interdisciplinary research team, 1–2 Co-PIs each from oceanography, biology, social science
 - b. 3–4 year time frame
 - c. Meeting with interested participants to work out details and begin drafting a proposal in winter/spring 2002.

Coastal Domain Response to *Unammi*: The Timing of Spring Transition

Statement: The Coastal Domain is pivotal to Arctic Systems, and is dominated in its annual cycle by the freeze/thaw cycle. Analysis of atmospheric data shows that the timing of seasonal transitions – especially that of spring – is tightly linked to *Unammi* (AO) signals.

Hypothesis: The system dynamics of the coastal domain – including physical, biological and human components – is strongly linked to the melting of ice and snow. With an advance in the timing of spring transition, systematic and/or cumulative changes to the ecosystem are expected.

Approach: We propose research be advanced on three fronts:

- Retrospective Analysis – linking climate records and extreme situations (spring focus) to rapid or cumulative ecological responses.
- Exploratory Modeling of system response based on:
 - 1.) Ecosystem Modeling
 - 2.) CAS Modeling
- Field-Oriented Process Studies encompassing:
 - 1.) Dynamics of the freeze/thaw cycle on coastal conditions, hydrology and coastal ocean transports, and consequences to
 - biological rates and processes
 - fluxes to terrigenous and oceanic materials
 - habitat structures (landfast ice, polynyas, deltaic lakes, etc.)
 - biogeochemical cycles and trace gasses
 - vegetation and dry season length
 - 2.) Overall productivity of coastal land and oceanic ecosystems, including both bottom-up and top-down concerns

- 3.) The role of *Unammi* Timing (UT) on traditional harvesting practices; e.g.
 - seals, bears, and whales
 - anadromous fish
- 4.) The role of UT on community infrastructure, travel, security and safety
- 5.) Comparative studies of spring transition on transects that exhibit contrasting thermal gradients/regimes

*A major emphasis of all the above is a **SEARCH** for feedbacks!

A Holistic, Regional Approach to *Unammi*

SEARCH is intended to address underlying hemispheric, decadal, multivariate change happening in the Arctic, and its impacts on Arctic regions and the globe. In short, it addresses the question “What is *Unammi* and what are its implications?”

SEARCH may examine this question in several ways. In much of SEARCH the approach is to look for the top-down mechanisms controlling *Unammi*. Another approach, which may be most important at determining the implications of *Unammi*, is to explore the question “What does *Unammi* mean from a community perspective?” This was the focus of the “regional” working group—to outline a research program that would encompass all aspects of *Unammi*, but in a relatively small area among a group of culturally and ecologically similar human communities.

The participants in the group intended this approach to complement and link to the work of the other groups, which examined fisheries and the band of coastal zone processes around the Arctic Basin. Those groups looked at similar processes or relationships across the entire Arctic. The “regional” approach, if carried out in several locations, can examine in depth the topics and implications raised in breadth by the other approaches.

For a regional approach to work, it must be done in collaboration with the communities of that region. The initial goal is to develop a research program that makes sense from a local perspective as well as from an outside scientific one. This could be done, in cooperation with one or more communities, by:

1. identifying local concerns, observations, and issues;
2. exploring the observations, data, and research needed to understand them and relate them to large-scale patterns; and
3. creating a collaborative research, analysis, and interpretation program based on (1) and (2).

Some work of this kind has been done, notably by Jack Kruse and a large, multi-disciplinary team in the Gwich'in region of northeastern Alaska, the northern Yukon Territory, and the northwestern Northwest Territories. Their experience can both inform SEARCH's efforts and perhaps be used as a case study of *Unammi*-like change.

Within SEARCH, a pilot project to explore the possibilities of community-based research is a reasonable starting point. The Native Village of Unalakleet, an Iñupiat community on the eastern shore of Norton Sound in western Alaska, offers an excellent opportunity. The community participates in commercial fishing as well as subsistence hunting and fishing, is concerned about coastal erosion and other signs of environmental (but not necessarily climate-related) change, and has indicated a willingness to work with researchers on these topics.

The first step of the pilot project would be for two scientists to meet with the Tribal Council in Unalakleet to determine how the Tribe would like the heart of the pilot project to be organized and conducted. These exploratory discussions would also identify the key concerns and topics of interest to Tribe, in order to help identify scientists to participate in the project.

The pilot project would then explore the Tribe's concerns in a workshop involving tribal members and a small number of scientists from relevant disciplines. The goal would be to create a research program, based in Unalakleet in close collaboration with the tribe and with the involvement of whichever outside researchers are interested and relevant, to explore the implications of *Unammi* at the local level. If successful, this collaborative model could be carried out elsewhere in the Arctic to establish a network of regional studies complementing the pan-Arctic studies done in other components of SEARCH.

While the ideas of the "regional" group may or may not meet the criteria of NSF's Biocomplexity initiative, the importance of a strong community component of SEARCH means that the pilot project should be undertaken soon, so that its results can help guide the implementation of SEARCH.