



## Research, Synthesis, and Knowledge Transfer in a Changing Arctic: The Study of Environmental Arctic Change (SEARCH)



*Brief summary of a new SEARCH vision, goals, and future activities*

### INTRODUCTION

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The complex nature of arctic change requires a crosscutting and transdisciplinary research program that also engages decision-makers in a substantial way. SEARCH is uniquely positioned to serve this function. No other entity can claim such an established base from which to support activities that transcend individual research projects and bring together participants from diverse backgrounds and fields of research.

To move SEARCH to full implementation and to respond to changing needs in the scientific, agency, and decision-maker communities, SEARCH has developed a new vision and mission, a set of prioritized cross-disciplinary five-year goals, an integrated set of activities, and an organizational structure.

The SEARCH vision is: **achieving scientific understanding of arctic environmental change to help society understand and respond to a rapidly changing Arctic**. The SEARCH mission is: to provide a foundation of arctic change science through collaboration with the research community, funding agencies, and other stakeholders. The SEARCH five-year science goals are:

1. Improve Understanding, Advance Prediction, and Explore Consequences of Changing Arctic Sea Ice
2. Document and Understand How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems
3. Improve Predictions of Future Land-ice Loss and Impacts on Sea Level
4. Analyze Societal and Policy Implications of Arctic Environmental Change

The details of the goals can be found at: <http://www.arcus.org/search/goals>. These goals address areas of scientific and societal urgency and were developed with significant input from the broader scientific community. They also complement existing agency priorities and national research plans.

### EXAMPLES OF PLANNED ACTIVITIES

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**Arctic Futures 2050** – The development of scenarios (“Arctic Futures 2050”) is a potentially transformative activity. Scenarios describe plausible future states of the arctic system based on recent trajectories and projected changes. They combine a range of data including climate model output, paleo-data, results from data synthesis and systems modeling, as well as expert scientific and traditional knowledge. SEARCH activities (through meetings, action team activities, coordination with existing efforts) will result in peer-reviewed papers as well as scenarios products or decision-support tools that are co-defined by scientists and stakeholders.

**Knowledge Exchange (KE) Fellowships** – KE fellowships will address the challenge of cooperation across the different perspectives among and within academia, stakeholder

organizations, and agencies. Fellowships will allow agency personnel and stakeholders to immerse themselves in an academic environment, with junior researchers participating in a reciprocal arrangement with an agency or stakeholder organization.

**“SEARCH for Answers”** – SEARCH will serve as an arctic science think tank. Scientists, agency personnel, and decision-makers will be able to contact SEARCH to obtain answers to scientific questions related to the five-year goals.

### **Goal #1 Activities: Improve Understanding, Advance Prediction, and Explore Consequences of Changing Arctic Sea Ice**

Core objectives for this goal are: (1) assessing the predictability of summer arctic sea ice extent, thickness, and properties on seasonal to decadal timescales and improving ice forecasts, and (2) exploring consequences of the changing ice cover on arctic ecosystems, the global climate system, and people. Specific activities will include:

- Build on partnerships developed through the Sea Ice Outlook (<http://www.arcus.org/search/seaiceoutlook/index.php>) and Sea Ice for Walrus Outlook (<http://www.arcus.org/search/siwo>) activities, for example with the World Climate Research Program, Climate and Cryosphere (CliC), Eskimo Walrus Commission, and others; these partnerships will continue to generate data products and sea ice forecasts.
- Contribute to Scenario Development / Arctic Futures 2050 – Work with stakeholders to develop scenarios of ice-diminished Arctic Ocean using online tools (e.g., model simulations). Products will include scenarios presented in the form of narratives, visuals, data products, model output, and summary documents for different audiences.
- Knowledge Exchange Meetings – Transdisciplinary meetings that bring together scientists and stakeholders to develop targeted products, such as: a synthesis of plausible consequences of an ice-diminished Arctic Ocean on ecosystems on 5-10 year time scales, analysis of the value of geographic or paleo-analogs for sea ice in a warming Arctic, and summarized findings from other research.

### **Goal #2 Activities: Document and Understand How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems**

This goal has three main themes: (1) improve observation and prediction of the nature, timing, and location of permafrost thaw, (2) improve prediction of how degradation of near-surface permafrost will influence the dynamics of the arctic landscape, and (3) improve prediction of how permafrost degradation will influence fish, wildlife, and human communities. Specific activities will include:

- Scenario and Data Product Development – Identify a set of scenarios for impacts of permafrost degradation on ecological and human communities. The scenarios will be used to identify where data already exist to address scenarios and where urgent research questions could be addressed in the short-term.
- Research Coordination Activities – Build on the successful Permafrost & Carbon Research Coordination Network, which is coordinating researchers who focus on carbon dynamics in the permafrost zone. Expand that coordination to evaluate how scientific information and knowledge is assimilated by potential end users and seek partner funding to begin to address questions that also meet end users’ interests. Facilitate development of a data “showcase” focused on borehole temperature data to standardize data formats from automatic loggers to

facilitate broader data use.

- An annual “State of Permafrost Research” Report - This product will assist in the location, analysis and digestion of important and useful existing permafrost data and will be designed for use by non-technical audiences.
- Activities will be done in coordination with related national and international efforts, for example, NASA's Carbon in Arctic Reservoirs Vulnerability Experiment and Arctic-Boreal Vulnerability Experiment, DOE’s Atmospheric Radiation Measurement program and Next Generation Ecosystem Experiment, and DOI’s Landscape Conservation Cooperative initiative, as well as several international groups.

### **Goal #3 Activities: Improve Predictions of Future Land-ice Loss and Impacts on Sea Level**

Progress in this goal requires a multi-faceted approach as the environmental science involves not only ice and ocean processes, but also atmospheric dynamics and geodesy, and while the topic intersects the interests of many organizations, it falls fully within none.

- The first activity for this goal will be an initial meeting to develop specific plans that define what measurements must be undertaken, where to undertake these studies, how to maintain these measurements, and what products the studies must produce.
- Working group activities – The details will be determined after the initial meeting, but in the case that the initial meeting identifies two ‘focal’ fjords that hold an advantage as research sites, then an interdisciplinary working group might coalesce around each site with investigators and local residents in establishing a suite of measurements. Another working group might focus on net sea level change to work with stakeholders in the most vulnerable areas to develop mitigation strategies.
- Contributions to Arctic Futures 2050 – Activities will make a number of specific contributions to SEARCH’s synthesized assessment of the state of the Arctic in 2050. Predictions of land ice loss will provide not only the obvious projections of contributions to global sea level change, but geodetic analysis will provide a regional to local distribution of relative sea level along arctic coastlines, highlighting the risk level at each location.
- Participation in ongoing national and international activities – SEARCH’s integrated, end-to-end approach will complement existing activities related to the land ice/ sea level goal. It will leverage existing reports defining necessary science (e.g., the recent white paper from the U.S. CLIVAR Working Group on Greenland Ice Sheet/Ocean Interactions), informal discussions, and workshops.

### **Goal #4 Activities: Analyze Societal and Policy Implications of Arctic Environmental Change**

The implementation of this goal requires two overall strategies.

The first strategy will be to focus on the social science of arctic change. SEARCH will undertake two major tasks: (1) summarize findings to date and identify gaps in knowledge about how Arctic communities are perceiving, understanding, responding, and adapting to arctic change, and (2) generate a comprehensive assessment of societal response based on that summary.

The second strategy is to integrate society-policy issues into the other SEARCH five-year goals and into crosscutting activities. Society-policy issues will be used in concert with scientific needs to define all products and activities. Society-policy issues will be addressed, in part, by involving social scientists in all SEARCH activities and workshops.

SEARCH will develop innovative ways to strengthen communication efforts through effective outreach and education approaches. In addition, there continues to be a need to entrain more society-policy experts in the arctic science enterprise. This need will be addressed through targeted capacity-building activities, for example, through inclusion of social science experts outside the Arctic into SEARCH activities, networking at meetings, and closer collaboration with other U.S. and international programs with a social-science component.

*An overview of outcomes and products of SEARCH activities*

	Permafrost	Land Ice Loss	Arctic Sea Ice	Societal & Policy	AON	Arctic 2050	New goals
<p><b>Scientific Syntheses</b> (for science) assess, describe, budget, integrate, assimilate, predict</p>	<ul style="list-style-type: none"> <li>observing &amp; predicting nature &amp; timing of thaw</li> <li>carbon budget</li> <li>community report on landscape response to thaw</li> </ul>	<ul style="list-style-type: none"> <li>design targeted instrument network</li> <li>integrating modeling tools (energy, melt, geodesy, sea level)</li> </ul>	<ul style="list-style-type: none"> <li>determine sea ice predictability seasonal – decadal</li> <li>guide observ. network design</li> <li>seasonal outlook</li> <li>support CliC in sea ice prediction</li> <li>find low summer ice analog</li> </ul>	<ul style="list-style-type: none"> <li>develop databases of: (i) social science/ interdisciplinary research in Arctic communities on climate change; (ii) qualitative &amp; quantitative approaches proven to work efficiently</li> <li>develop best-practices recommendations for integrating across disciplines &amp; stakeholders</li> <li>integration into each goal</li> </ul>	<ul style="list-style-type: none"> <li>ACADIS integration</li> <li>pilot project with ACADIS data</li> <li>network design</li> <li>Arctic-systems reanalyses</li> <li>serve activities</li> <li>Barrow flagship site + new ones</li> </ul>	<ul style="list-style-type: none"> <li>Environmental &amp; human scenarios across all SEARCH goals</li> <li>feedback systems in 2050</li> <li>Interdisciplinary workspaces</li> </ul>	<ul style="list-style-type: none"> <li>...</li> </ul>
<p><b>SEARCH Coordination for New Research Needs and Opportunities:</b></p> <ul style="list-style-type: none"> <li>SEARCH works with agencies, industry &amp; communities to identify data &amp; research needs, then coordinates development of new funding opportunities.</li> <li>Each Action Team will rely on team websites &amp; collaborative tools to facilitate synthesis &amp; collaborative research</li> </ul>							
<p><b>Applied Syntheses</b> (for stakeholders) deliver timely information, predict, warn, link broad range of interests</p>	<ul style="list-style-type: none"> <li>prediction of social-ecological system responses</li> <li>2050-scenarios</li> </ul>	<ul style="list-style-type: none"> <li>projected regional sea level estimates</li> <li>Stakeholder-driven products</li> <li>2050-scenarios</li> <li>coastal risk tool</li> </ul>	<ul style="list-style-type: none"> <li>Sea ice prediction network with outlooks</li> <li>Sea Ice for Walrus Outlook</li> <li>sea ice area, property &amp; thickness products</li> <li>2050-scenarios</li> </ul>	<ul style="list-style-type: none"> <li>perception of Arctic change in &amp; outside of Arctic</li> <li>ecosystem &amp; people response to changes</li> <li>Life in 2050-Arctic</li> </ul>	<ul style="list-style-type: none"> <li>Internat. Arctic Observing Summit</li> <li>open data archives</li> <li>real time data</li> <li>develop funding opportunities to fulfill agency needs</li> </ul>	<ul style="list-style-type: none"> <li>2050-scenarios</li> <li>scenario tools</li> <li>multi-media products</li> <li>novel tele/meet framework to link scientists &amp; stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>...</li> </ul>
<p><b>Knowledge Exchange Interns/Fellows:</b> Junior scientists &amp; managers bridging between science, government, business &amp; local communities to educate about tools and scientific knowledge, ensure data quality, learn from needs &amp; develop response options</p> <p><b>SEARCH Coordination for New Tools:</b> SEARCH works with agencies, industry &amp; communities to identify monitoring, management &amp; prediction tools for stakeholder needs &amp; adaptation planning</p>							
<p><b>Education, Public Outreach &amp; Strategic Communication</b> exchange knowledge &amp; capability, translate</p>	<p><b>SEARCH Knowledge Exchange Workshops:</b> Every 2 or 3 years, Open Science meeting with Knowledge Exchange activities provides cross-links between science &amp; stakeholder groups &amp; activities and sets research plans &amp; products with agencies</p> <p><b>SEARCH for Answers:</b></p> <ul style="list-style-type: none"> <li>Communication and Educational Outreach by SEARCH Program Office building on its community resources</li> <li>Organize regular open Webinars and distribute Newsletters, Multimedia products and videos, and other products for scientists and stakeholders</li> <li>Expand knowledge about Arctic change across Arctic communities and beyond the Arctic</li> </ul> <p><b>SEARCH Publication Series:</b></p> <ul style="list-style-type: none"> <li>Arctic Now and Arctic Futures 2050 book, White papers, Special issues, Review articles, Team and Topic Monographs for State of Science or Management Challenges</li> </ul>						

## NEW SEARCH STRUCTURE

A SEARCH structure to support the goals and activities will include the following integrated components:

- **Science Steering Committee (SSC)** – The SSC will ensure that the SEARCH vision and mission is implemented in SEARCH activities; supervise the Executive Director; monitor progress; and adjust the program’s trajectory, as needed.
- **Action Teams** – Action teams will be organized around each of the five-year goals and will implement specific goal activities. They will include scientists, agency personnel, and stakeholders with a range of disciplinary backgrounds and perspectives.
- **Ad-hoc Working Groups** – Working groups may be convened on a short-term basis to maintain flexibility in the SEARCH structure, involve broader representation, and increase capacity without creating more standing committees.
- A **Science Office** will perform all the program management functions and will consist of:
  - **An Executive Director (ED)** will oversee all day-to-day activities related to implementing SEARCH; serve as the primary liaison to agencies; forge partnerships with other programs and efforts; and direct progress of the Action Teams.
  - **Project Office** functions will be provided by the Arctic Research Consortium of the U.S. (ARCUS); responsibilities will include: strategic planning, project management, meeting planning, organizational/administrative support for Action Teams and the SSC, and communications and outreach.
  - An **Arctic Observing Network (AON) Coordinator (AC)** will focus on activities that ensure the interagency AON is meeting the needs of the scientific and stakeholder communities. The AC will translate needs and findings between the Action Teams into data management activities and agency recommendations for AON.

*Schematic outline of a structure and framework for SEARCH science.*

