Study of Environmental Arctic Change (SEARCH) AGU Town Hall Meeting, 3 December 2012

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Chair, SEARCH Science Steering Committee

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Chair, SEARCH Observing Change Panel

- SEARCH 5-year Goals
- AON Design & Implementation Report, AON Coordination Mtg, Arctic Observing Summit planning
- Moving SEARCH forward: Ongoing & future activities

SEARCH Objectives

The overall objective of SEARCH is to

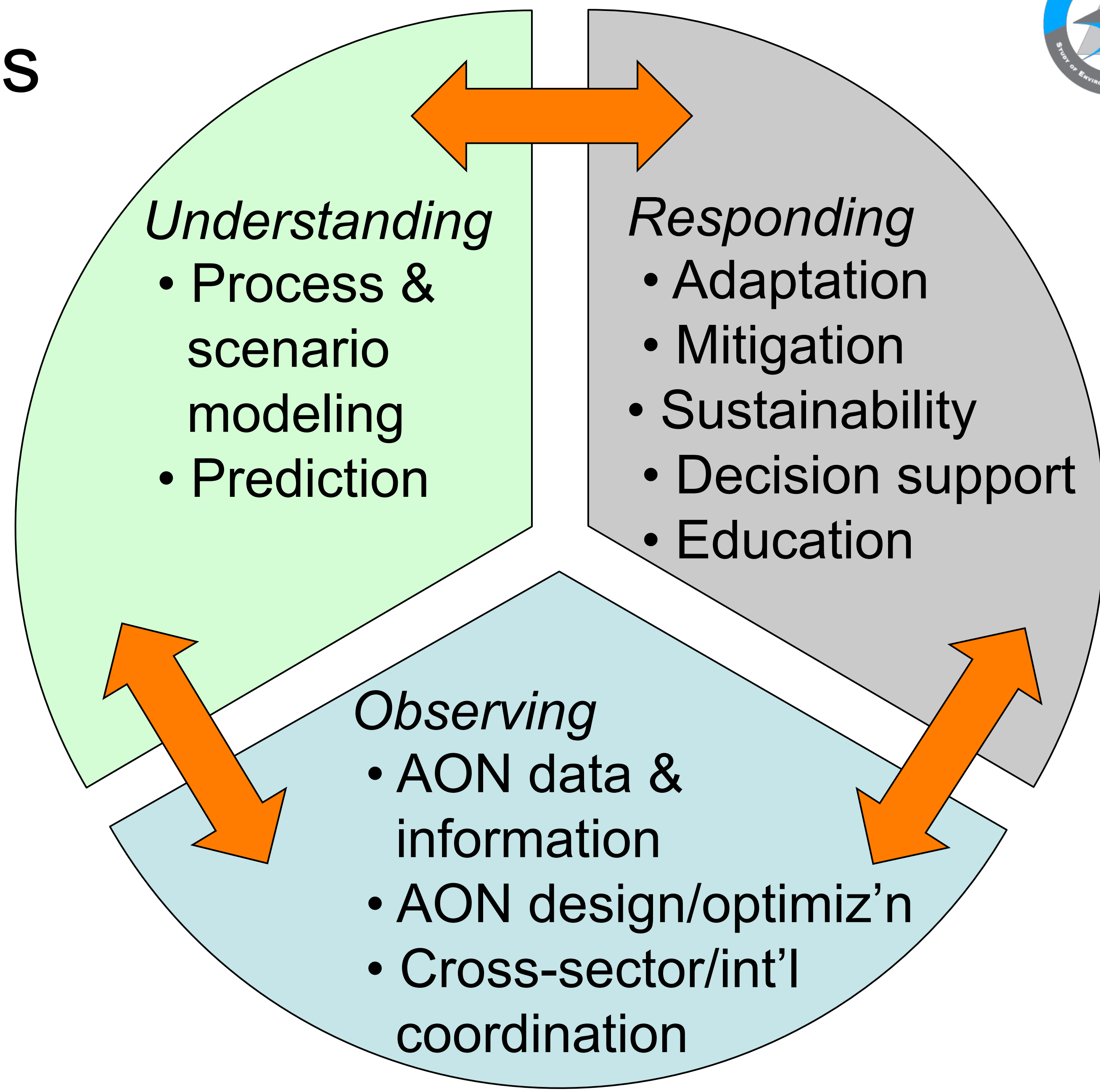
Understand the nature, extent and future development of the system-scale change presently seen in the Arctic.

SEARCH is built around three basic elements:

- **Observing Change** - Arctic Observing Network
- **Understanding Change** - Modeling & synthesis
- **Responding to Change** - Linking Arctic system science & stakeholder information needs

www.arcus.org/search/

SEARCH's Tripartite Approach to Arctic Change



What is SEARCH?

- Collaborative scientific program
- Works with academic and government agency scientists to prioritize, plan, conduct, and synthesize research focused on Arctic environmental change
- Guided by Science Steering Committee and several panels and working groups with broad representation of the research community
- ***Response of the research community Arctic change***

SEARCH
Key Documents & Milestones

- 2001 SEARCH Science Plan
- 2003 SEARCH Implementation Strategy Document
- 2005 SEARCH Implementation Workshop Report
- 2008 SEARCH/DAMOCLES Arctic Observation Integration Workshops & Report
- 2009 SEARCH State of the Arctic Observing Network (AON) Workshop & Report
- 2010 Interagency AON Working Group Meeting
- 2012 SEARCH/ARCSS Understanding Arctic Change Task Force Report
- 2012 – in press: AON Design & Implementation Task Force Report
- 2012 – in prep.: US Arctic Observing Coordination Workshop

SEARCH 5-Year Goals

Improve Understanding, Advance Prediction, and Explore Consequences of Changing Arctic Sea Ice

- Improve the understanding of atmosphere, sea-ice, and ocean system interactions through a combination of enhanced observations and process-based modeling studies
- Improve sea ice prediction from daily to decadal timescales
- Explore the breadth of consequences of a seasonally ice-free Arctic Ocean across human and natural systems
- Assess how arctic sea-ice changes interact with mid-latitude weather and climate

SEARCH 5-Year Goals

Document and Understand How Degradation of Near-Surface Permafrost Will Affect Arctic and Global Systems

- Improve observation & prediction of the nature, timing, & location of permafrost thaw
- Improve prediction of how degradation of near-surface permafrost will influence arctic landscape dynamics
- Improve prediction of how permafrost degradation will influence fish, wildlife, & human communities
- Identify gaps in Arctic Observing Network datasets and the resources needed to fill those gaps
- Identify partners who can facilitate progress
- Improve delivery of information to & feedback from stakeholders

SEARCH 5-Year Goals

Improve Predictions of Future Land-ice Loss and Impacts on Sea Level

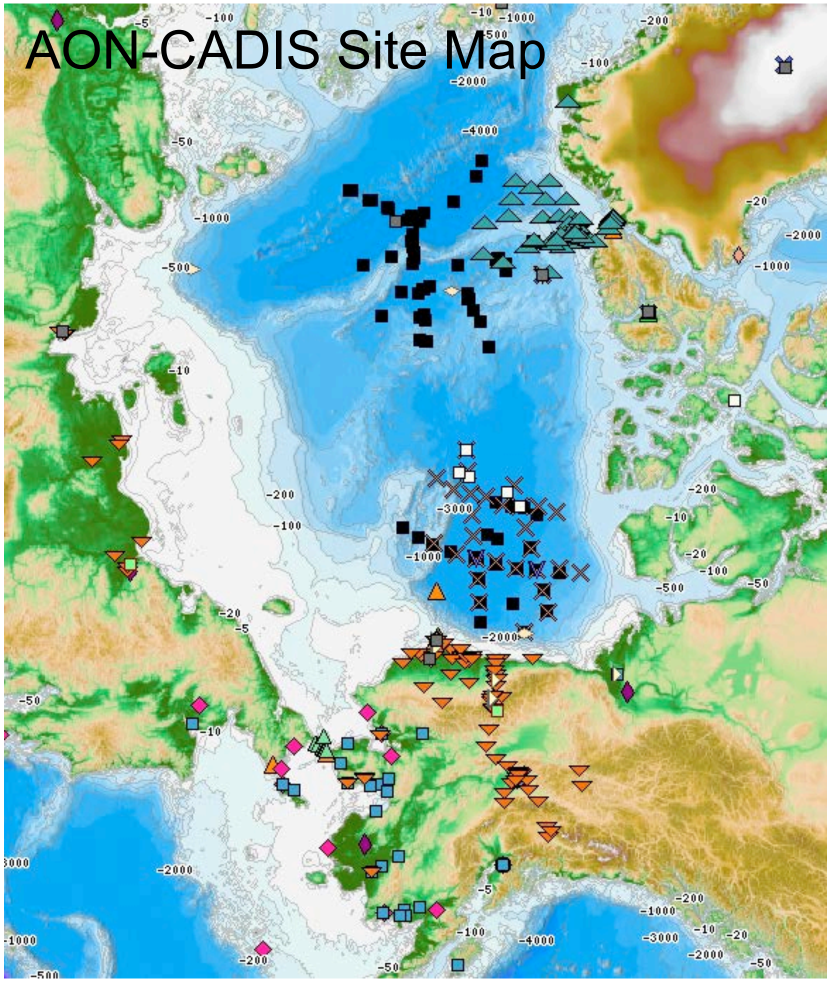
- Determine the impact of ocean waters on tidewater and outlet glaciers
- Determine the processes controlling the intra-annual and inter-annual variability of land ice discharge
- Improve predictions of pan-arctic surface precipitation and methods to accurately downscale precipitation patterns to the glacier basin scale
- Quantify the regional pattern of relative sea-level change driven by the predicted pattern of land ice loss

SEARCH 5-Year Goals

Analyze Societal and Policy Implications of Arctic Environmental Change

- Understand Arctic inhabitants' experiences and responses to environmental change, and develop methods to anticipate future adaptations
- Assess and improve public and policy perceptions and knowledge about arctic environmental issues

Arctic Observing Network (AON)



- Roughly 50 NSF-supported AON projects
- Data dissemination and archival at Coop Arctic Data & Information Service http://aoncadis.org
- State of AON:
  - Scientific community, federal/ state/local agencies, stakeholders and general public all with a vision for an Arctic observing system
  - Action toward improved networking & coordination underway

Arctic Observing Coordination Workshop Anchorage 20-22 March 2012

- Showcase projects: E.g. - From Observations to Management: Providing Scientific Information to Inform Decisions Regarding Offshore Oil and Gas Activities in the Chukchi Sea
- Local vs. pan-Arctic perspective
- Fundamental vs. applied science
- Showcase projects
- Next steps: SEARCH & DAMOCLES – ArcSEES proposal

U.S. Arctic Observing Coordination Workshop
Major Recommendations

“Showcase" projects – demonstrate effective approaches towards interagency collaboration

1. From Observations to Management: Providing Scientific Information to Inform Decisions for Offshore Oil & Gas Activities in the Chukchi Sea
2. Distributed Environmental Observatory for Terrestrial Change Detection
3. What are the Causes and Consequences of the Greening of the Arctic?
4. A Marine Distributed Biological Observatory
5. Multidisciplinary Drifting Observatory for the Study of Arctic Climate
6. Community-based Observation Network for Adaptation and Security
7. Ocean Observations to Improve Sea Ice Forecasting
8. Long-Term Sea Level Measurements along the Alaskan Chukchi and Beaufort Coasts
9. Arctic Ocean Freshwater and Heat Observing System
10. Utilizing the State of the Existing Knowledge to Guide Infrastructure Development
11. Building a Community-Based Observation Network

U.S. Arctic Observing Coordination Workshop
Major Recommendations

- Need more interaction between academic scientists and agency managers
- AON needs to be more responsive to stakeholder information needs and agency management goals – synthesized, interpreted data and information products from multiple sources – not just ‘raw observational data’
- Joint agency sponsorship of core monitoring activities (models such as the National Ocean Partnership Program)
- An arctic observations data policy
- Moving recommendations forward: SEARCH SSC will discuss with relevant groups (OCP, IPMC, IARPC, USARC)
- The biggest challenge: a productive balance between the fundamental research questions driving much of the NSF-supported AON and the data, products, and information needs of agency managers and other stakeholders

ADI Task Force Report

ADI Task Force Members & Key Contributors:

- S. Andelman, H. Eicken (Chair), L. Hamilton, M. Holland, C. Lee, B. Owens, M. Ramamurthy, P. Schlosser, H. Seim, M. Serreze, J. Vande Castle, C. Vörösmarty, and J. Walsh
- J. Francis, D. Nechaev, and ADI workshop participants
- Support by Olivia Lee, Helen Wiggins & Reija Shnoro, SEARCH Project Office/ARCUS
- Financial support by the National Science Foundation
- Workshops, community survey (n = 119) & proof-of-concept studies, final report in fall 2012:

http://www.arcus.org/search/aon/adi

ADI Task Force Report

- Assess the present state and near-term implementation plans of the AON and related efforts
- Synthesize lessons learned from other observing systems
- Identify and assess promising approaches and tools for design and optimization
- Offer and discuss specific design options and approaches
- Provide a summary of ADI Task Force findings and recommendations – Report released in fall 2012, :

  http://www.arcus.org/search/aon/adi

SEARCH
Study of Environmental Arctic Change

Different approaches and examples for observing system design

Qualitative and semi-quantitative evaluations

- *Integration through overarching projects, including impacts of change on human activities*
- *Retrospective analysis & review of past work*
- *Ecosystem Services*
- ***Quantitative model-based assessments***
- *Data Thinning Experiments*
- *Model-based Observing System Experiments (OSEs)*
- *Observing System Simulation Experiments (OSSEs)*

ADI Task Force Report: Conclusions & recommendations

1. Design & optimization hierarchy
2. Key science questions
3. Space and time scales
4. Prioritization
5. Design and optimization approaches
6. Metrics
7. Management structure

Lessons from other efforts

For example:

- Tropical Atmosphere Ocean Array (TAO) – science to operational (relevant for ocean and sea ice prediction; low-latitude linkages – ENSO prediction as key driver)
- Long-Term Ecological Research (LTER) – bottom-up effort that resulted in network with core set of quantities measured
- National Ecological Observing Network (NEON) – top-down effort with stringent design guidelines

Elements of AON Design and Optimization Hierarchy

AON design elements	Activity	Implementation
Problem definition	Development of science goals & definition of actionable science questions	SEARCH program, agencies, stakeholders, AON Science Steering Group
Strategy	Feedback & uncertainty analysis, metrics, model-based assessments, process studies	Working groups, funded projects, ad-hoc meetings (researchers, agencies, stakeholders)
Tactics	Target quantity definition and measurement options, model-based assessments	Synthesis forums (e.g., Sea Ice Outlook, flagship site teams), funded projects & ad-hoc meetings
Deployment scale	Sampling array design	AON projects, OSSE/OSE teams

The International Arctic Observing Summit

30 April – 2 May 2013, Vancouver, BC, Canada

C.M. Lee, M. Jakobsson, M. Murray P. Schlosser, J. Zhao

1. AOS overview
2. AOS white paper process
3. General information and timeline

AOS Overarching Goal

- To provide **community-driven, science-based** guidance for the **design, implementation, coordination** and **sustained** long-term (decades) operation of an International Network of Arctic Observing systems that serves a wide spectrum of needs
- To create a **forum** for coordination and exchange between **researchers**, **stakeholders**, and **funding agencies** involved in long-term observing activities.

Objectives, Products & Audience

Recurring, biennial forum to coordinate and optimize resource allocation for an International Network of Arctic Observing Systems.

- Engage academia, government agencies and other Arctic stakeholders (e.g. local communities, industry, non-governmental organizations).
- Assess the science basis for the Arctic observing activities.
- Provide guidance and recommendations for Arctic observing
- Synthesize Arctic science, network design options and observing priorities into recommendations for decision makers
- Identify network issues that require SAON attention.

Themes for the 2013 AOS

- **Status** of the Current Observing system.
- Observing System **Design and Coordination**
- **Stakeholder Perspectives** and Integration in Observing System Design.
- **Support and Funding** of an International Arctic Observing Systems Network.

Broad Input

- **Solicited white papers**
  - Identify critical topics associated with each of the four core themes.
  - Lead authors will be encouraged to draw together own team of co-authors and, if necessary, divide the task into multiple submissions.
  - Facilitate review and integrate public comments on White Papers
- **Community call for contributed white papers**
  - Issue a broad community call for contributed white papers according to the White Paper Protocol
  - Facilitate review and integrate public comments
- **Short Statements**
  - One-page statements.

AOS 2013: Outcomes and Products

Tangible products, recommendations for policy makers.

- Assessment of fit between stakeholder needs, science objectives and observing network.
  1. Review and **synthesis of science priorities** defined by existing observing networks.
  2. Synthesize existing reports and catalogs **(SAON inventories)** of national Arctic observing systems, expanded to asses potential longevity and organized along regional/science themes.
  3. Identify broad themes in stakeholder needs for data products.

- Recommendations for optimization and coordination of existing systems.

AOS2013 Organizing Committee

Craig Lee (USA, co-chair)
Martin Jakobbsson (Sweden, co-chair)
Jinping Zhao (China, co-chair)
Leif Anderson (Sweden)
Hajo Eicken (USA)
Hiroyuki Enomoto (Japan)
Bruce Forbes (Finland)
Martin Fortier (Canada)
Jean Claude Gascard (France)
Carina Keskitalo (Sweden)
Maribeth Murray (USA)
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ISAC SAON SUSTAINING ARCTIC OBSERVING NETWORKS SEARCH STUDY OF ENVIRONMENTAL ARCTIC CHANGE ArcticNet IARC International Arctic Research Center

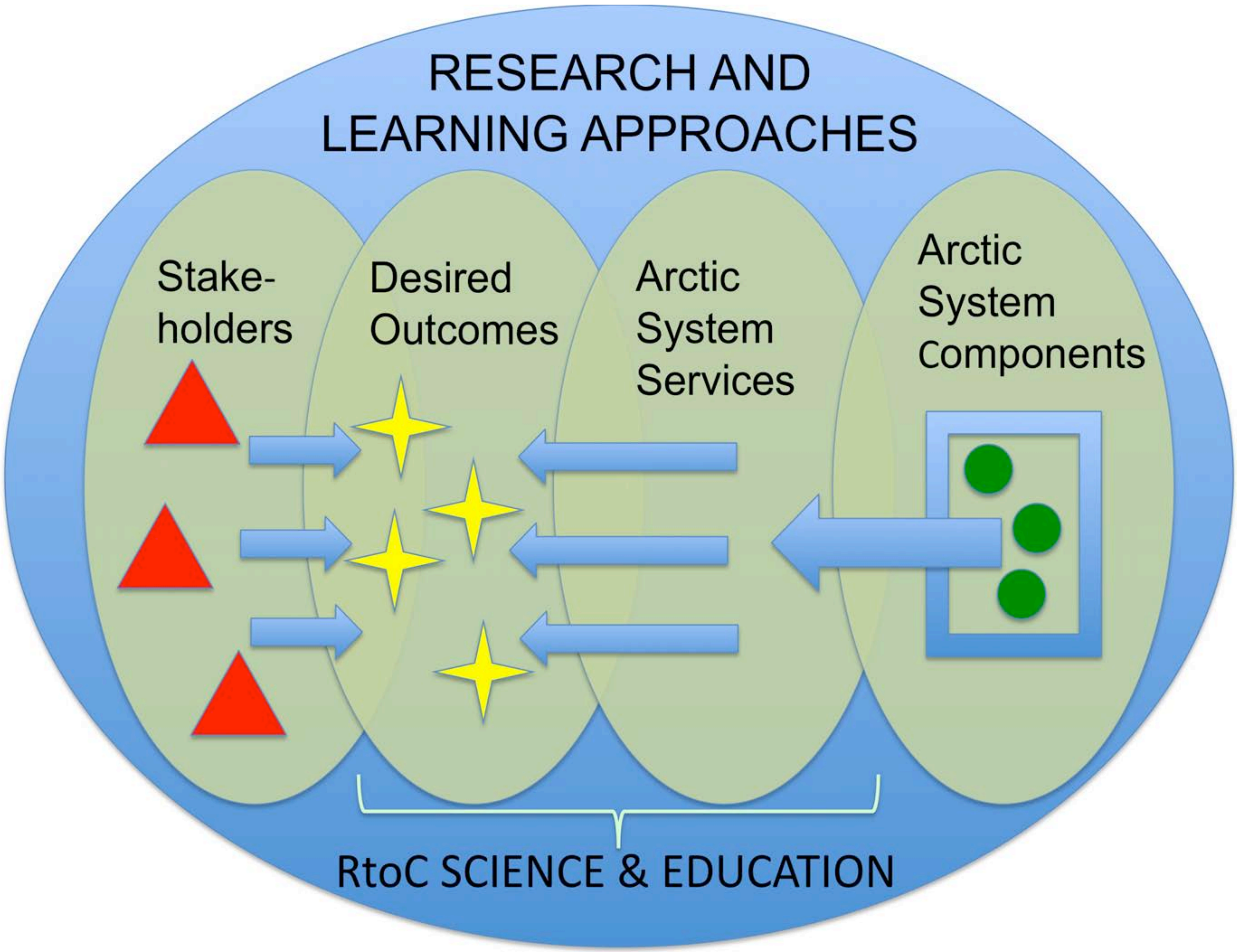
Moving SEARCH forward

- Building partnerships across agencies: IARPC, linking with USFWS Landscape Conservation Cooperatives, NPS Vital Signs program & others
- Multi-agency proposal for Arctic Sea Ice Prediction Network (Leads: J. Stroeve, C. Bitz)
- Proposal for stakeholder/agency/research linkages to NPRB for Sea Ice for Walrus Outlook
- Marine resource governance & observing systems: Joint ACCESS/SEARCH Proposal to ArcSEES (K. Pletnikoff, P. Berkman, O. Young & others)
- International linkages: WCRP, CliC, PPP, etc.
- Engagement of private sector

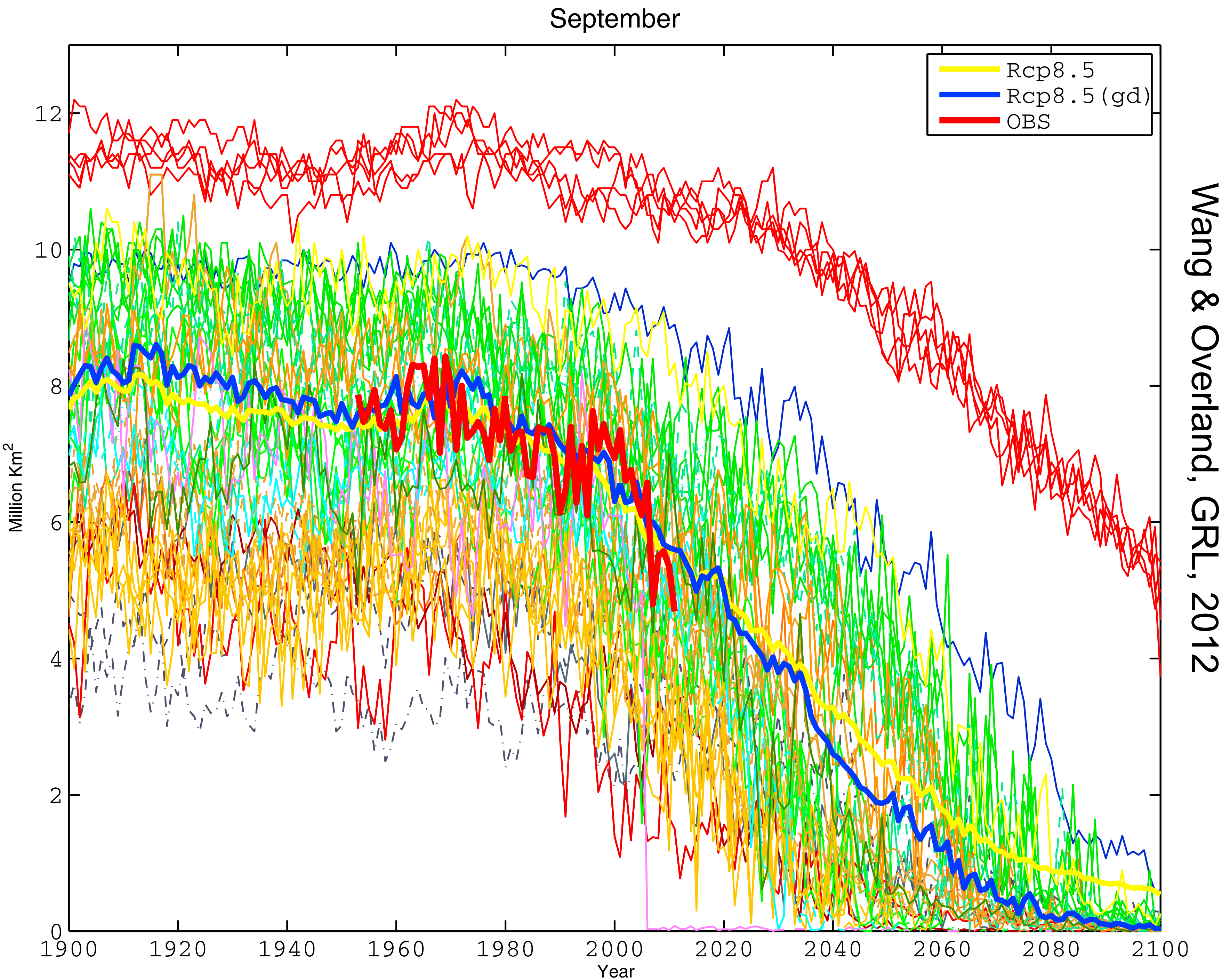
Responding to Arctic Change

- Studying & anticipating responses of the Arctic system to social-environmental change
- Linking Arctic system science & stakeholder information needs

The Arctic of 2050



ISAC Responding to Change Workshop; Murray et al., 2012



September
Rcp8.5
Rcp8.5(gd)
OBS
Million Km^2
Year
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12
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1960
1980
2000
2020
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2060
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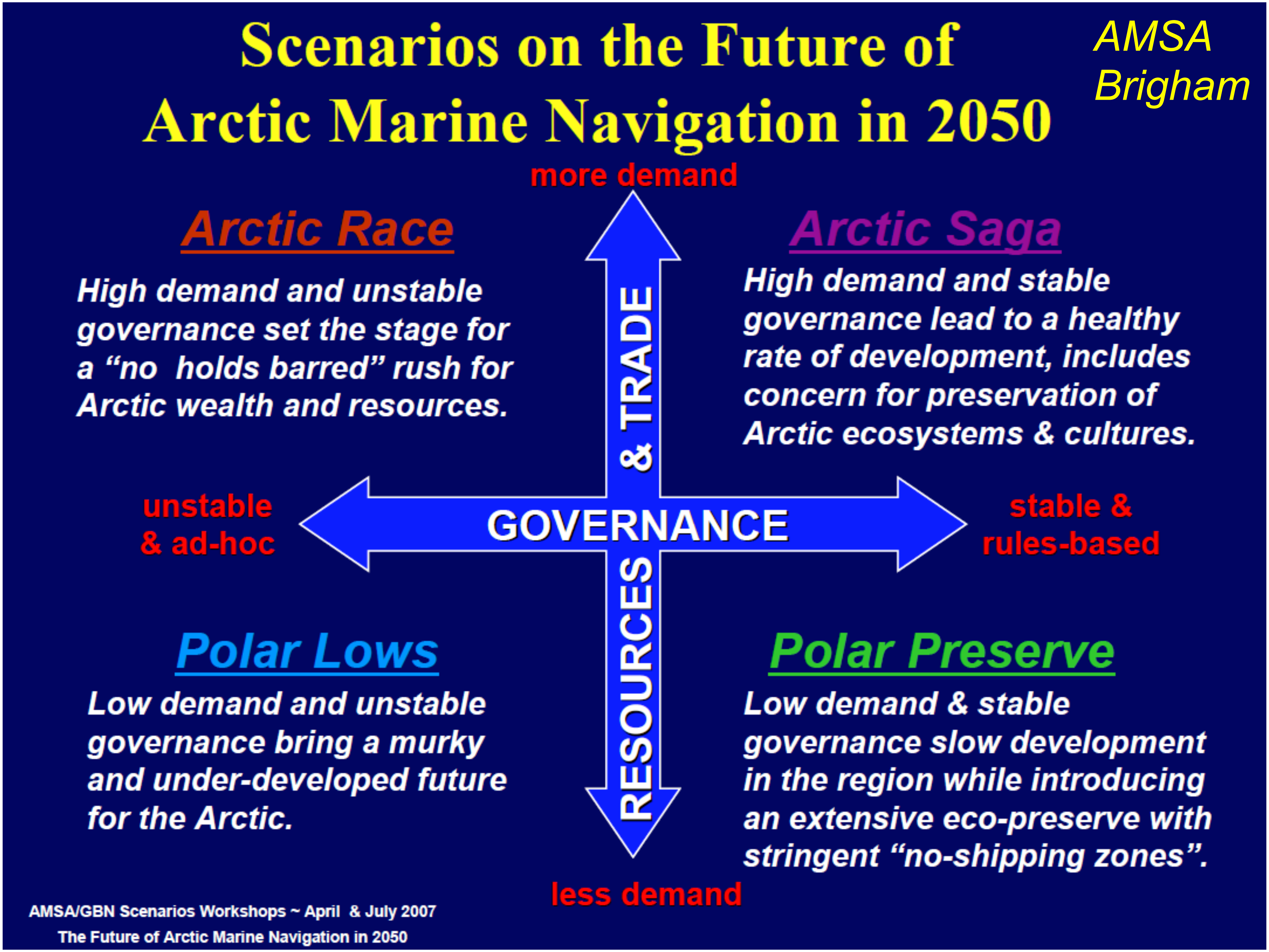
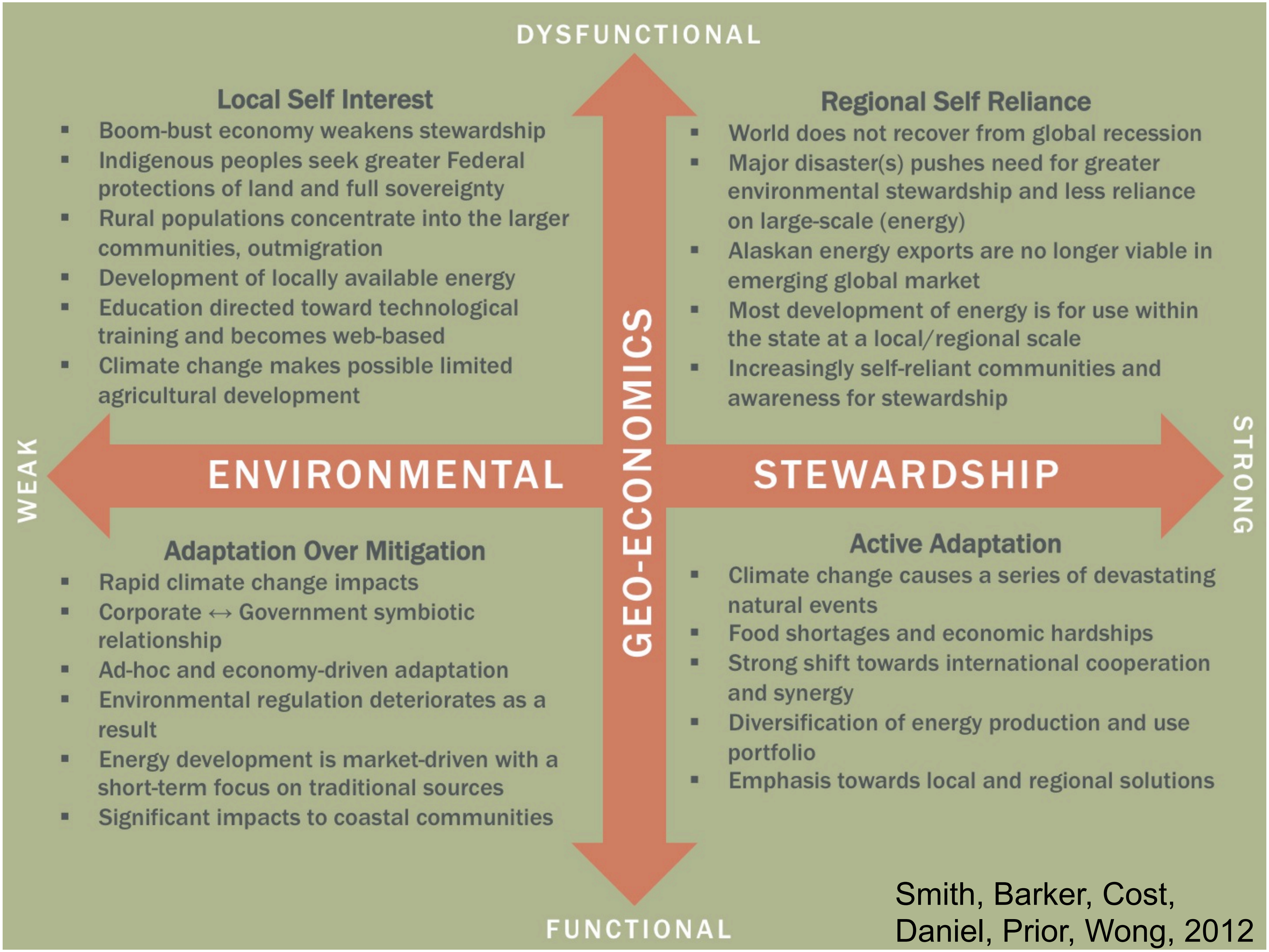
2100
Wang & Overland, GRL, 2012


Scenarios on the Future of
Arctic Marine Navigation in 2050
AMSA
Brigham
more demand
Arctic Race
High demand and unstable governance set the stage for a “no holds barred” rush for Arctic wealth and resources.
Arctic Saga
High demand and stable governance lead to a healthy rate of development, includes concern for preservation of Arctic ecosystems & cultures.
RESOURCES & TRADE
unstable & ad-hoc
GOVERNANCE
stable & rules-based
Polar Lows
Low demand and unstable governance bring a murky and under-developed future for the Arctic.
Polar Preserve
Low demand & stable governance slow development in the region while introducing an extensive eco-preserve with stringent “no-shipping zones”.
less demand
AMSA/GBN Scenarios Workshops ~ April & July 2007
The Future of Arctic Marine Navigation in 2050


DYSFUNCTIONAL
Local Self Interest
▪ Boom-bust economy weakens stewardship
▪ Indigenous peoples seek greater Federal protections of land and full sovereignty
▪ Rural populations concentrate into the larger communities, outmigration
▪ Development of locally available energy
▪ Education directed toward technological training and becomes web-based
▪ Climate change makes possible limited agricultural development
Regional Self Reliance
▪ World does not recover from global recession
▪ Major disaster(s) pushes need for greater environmental stewardship and less reliance on large-scale (energy)
▪ Alaskan energy exports are no longer viable in emerging global market
▪ Most development of energy is for use within the state at a local/regional scale
▪ Increasingly self-reliant communities and awareness for stewardship
WEAK
ENVIRONMENTAL
GEO-ECONOMICS
STEWARDSHIP
STRONG
Adaptation Over Mitigation
▪ Rapid climate change impacts
▪ Corporate ↔ Government symbiotic relationship
▪ Ad-hoc and economy-driven adaptation
▪ Environmental regulation deteriorates as a result
▪ Energy development is market-driven with a short-term focus on traditional sources
▪ Significant impacts to coastal communities
Active Adaptation
▪ Climate change causes a series of devastating natural events
▪ Food shortages and economic hardships
▪ Strong shift towards international cooperation and synergy
▪ Diversification of energy production and use portfolio
▪ Emphasis towards local and regional solutions
FUNCTIONAL
Smith, Barker, Cost, Daniel, Prior, Wong, 2012

Climate Change Rapid / Geo-economics Dysfunctional

- Rapid climate change occurs in the north and other regions of the global ecosystem, transitions are fast
- “Meaner” levels of resource and economy growth
- Governments look to private sector for solutions (economic and social)
- Demand for fish and water increases significantly
- Methane releases occur, methane becomes a fuel source
- Community and local response provide education and social services
- Powerful economies do better
- Division between “haves: and “have-not's” widens
- Periods of global recession
- Development of north is boom and bust
- Governance fails
- Human migration to Northern urban centres
- Governments cannot deliver
- Rise of corporate power – major corporate economies become drivers of Northern development
- Some Northern regions are difficult to access, impacting development potential
- Many people in the world are hungry
- International collaboration decreases
- Capital exists in the accounts of those who retained earnings from previous activities
- Failure of existing infrastructure
- High degrees of conflict

Climate Change Rapid / Geo-economics Functional

- Regulated banking system
- Migration to subarctic regions
- Food production systems suitable for Northern latitudes
- International cooperation to deliver social programs (education, healthcare) and research
- Emergence of a new economic model that recognizes climate change (distributed models)
- Change in personal values, decline in consumerism
- Public policy is enabling
- Insurance systems no longer cover loss due to natural causes
- Economic development is a rush causing negative impacts on climate and environment
- Resource extraction requires community development
- Growth of regional centres
- Significant investments in digital communications technology
- High speed, rapid change
- Highly uncertain future
- Climate change creates losers as does rapidly changing social and economic situations
- Winners will be those who have high degree of resiliency and adaptability and are proactive

Scenarios Created At

JIF 2011

Jasper Innovation Forum

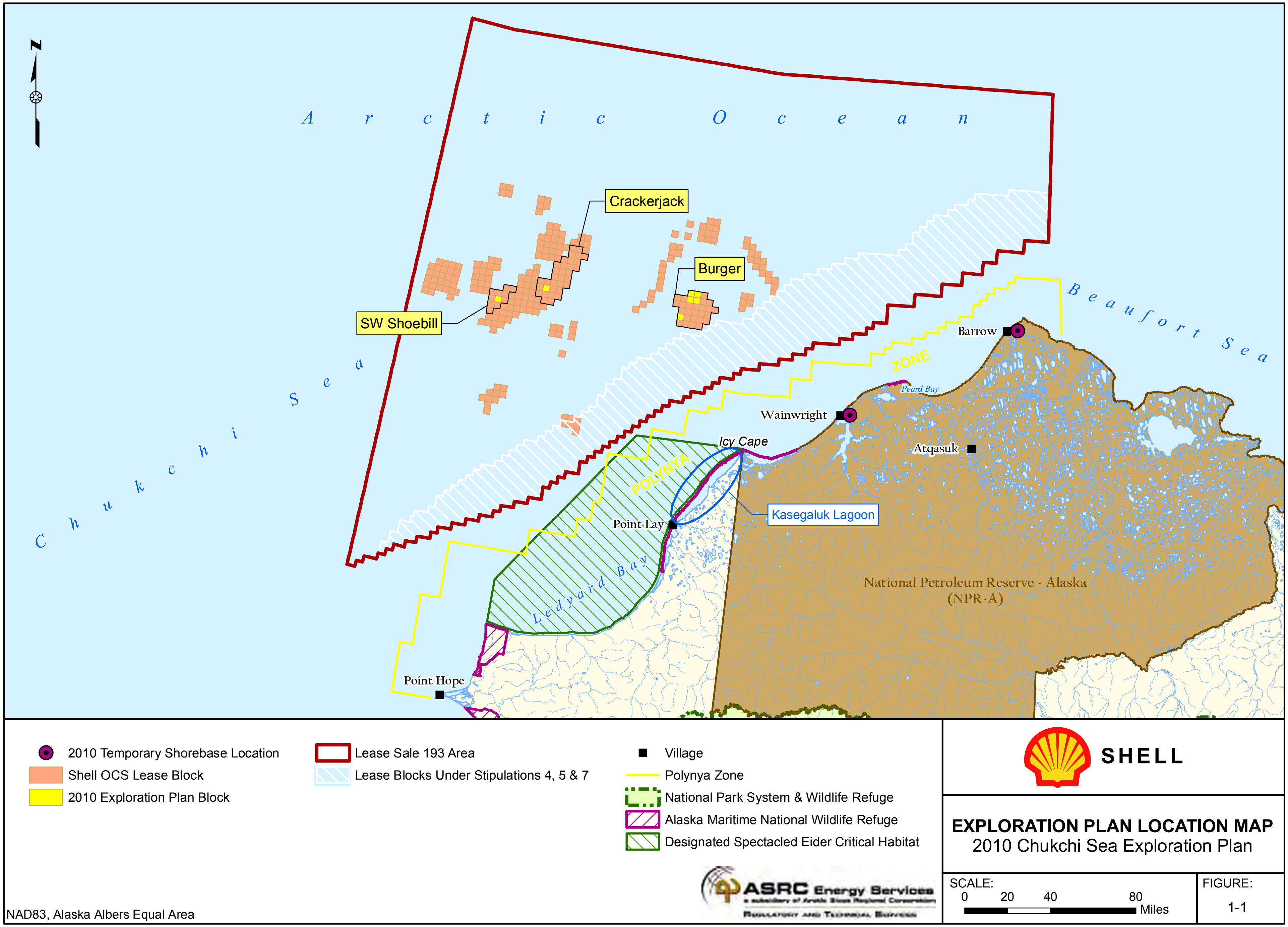
Global North 2050

Climate Change Moderate / Geo-economics Dysfunctional

- Government provision of financial support is diminished in the North
- Northern development is driven by the corporations (including the provision of social services)
- Non-government organizations gain power re-insurance companies, arctic institutes and industry associations become influential
- Communities in the North without resources do not thrive
- Emergence of local governance
- Higher allocation of resource revenues to regional and local government
- Earlier allocation of financial resources to fight climate change has killed the economy
- Growing unemployment in the North
- Northern residents do not have equal access to education and health
- Reliance on digital technologies to deliver education and health-care
- Little immigration/migration out of the North
- Senior levels of governments have difficulty financing health and education
- Aboriginal co-governance systems emerge
- Application of new pharmaceutical technologies
- Migration to South if opportunities exist
- May return to or rely on the land

Climate Change Moderate / Geo-economics Functional

- Transportation systems effective
- Strategic settlement (land rush)
- Economic, environmental issues and social issues are all given priority
- International agreements on CO_2 reduction
- Movement away from use of fossil fuels
- Expensive to do business in the Global North
- Focused, proactive movement to reduce CO_2 at an early stage
- Proactive, adaptive strategies
- Demography
- Climate change still a “future” threat
- Solid social security networks developed
- Many technological solutions found to address climate change
- Individual sacrifice for the collective good
- Advanced communication technologies support social well-being and opportunities in the North
- Carbon tax in place
- Full cost accounting drives development of alternative energy supplies
- New economic opportunities emerge in the North



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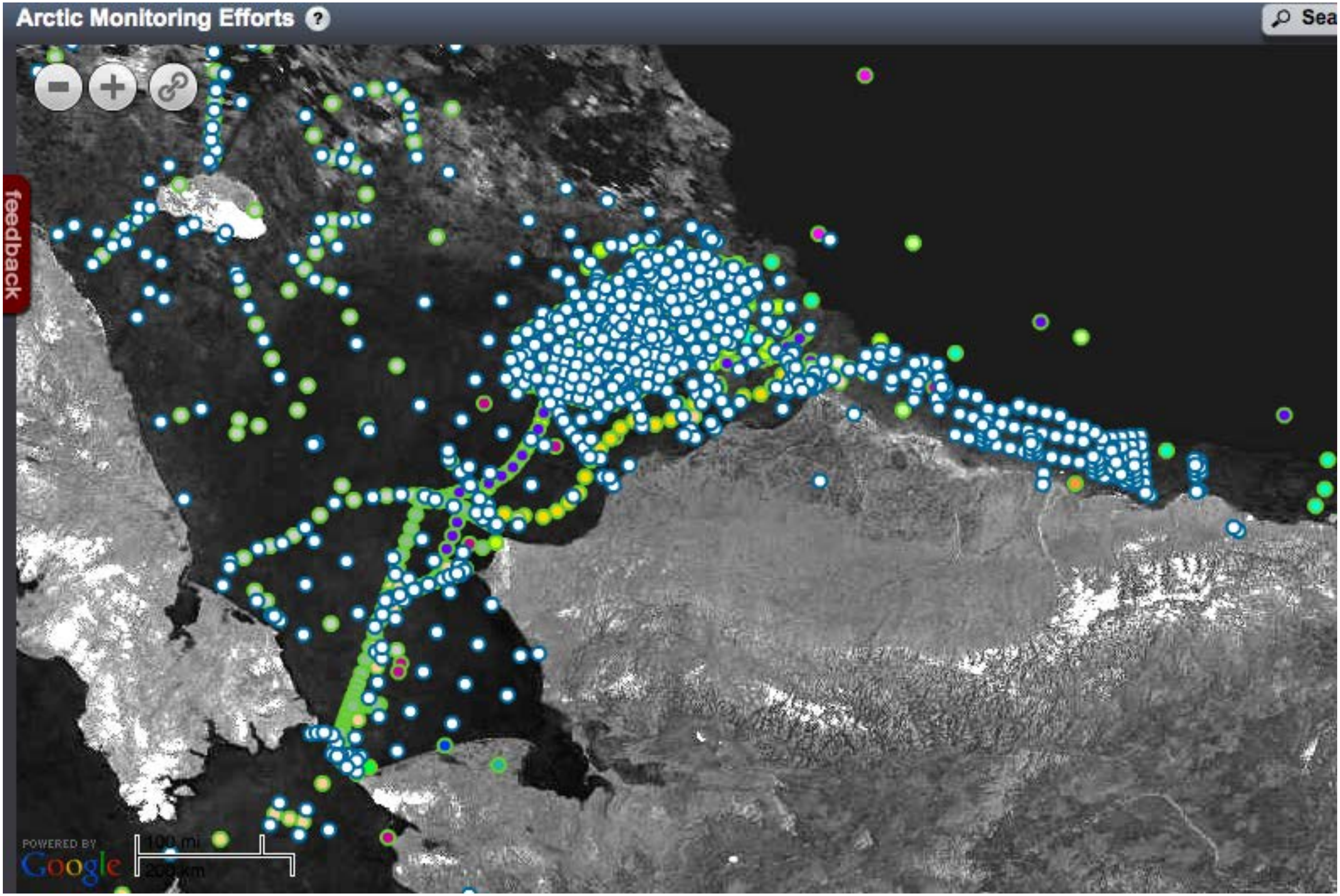

aoos.org Alaska Ocean Observing System