Final 2014–2016 Arctic LCC Strategic Action Plan

Arctic Landscape Conservation Cooperative

Advancing Science, Understanding Change.

LANDSCAPE CONSERVATION COOPERATIVES

Contents

Introduction 2
Arctic LCC Background 2
Foundation for the Strategic Action Plan 4
Near Term Strategy 5
FY 2014 Strategy 5
FY 2015 Strategy 7
FY 2016 Strategy 8
Appendix I. Arctic LCC Mission, Scope, Goals and Objectives 10
Scope of the Arctic LCC 10
Appendix 2. Assessment of progress to date in addressing Arctic LCC Conservation Goals and Objectives 14
Appendix 3. Priority Resources for the Arctic LCC 18
Appendix 4. Anticipated Arctic LCC conservation activities for 2014-2016, and the corresponding Priority Resources that each addresses. 22
Appendix 5. List of Arctic LCC project numbers and corresponding project titles. 25
Appendix 6: Top 30 anticipated future data and information needs as indicated by stakeholders in Arctic Alaska, as reported in the Arctic LCC Future Needs Assessment project. 27

Introduction

Stretching 3000 miles east to west across the top of North America, the Arctic LCC contains 1.8 Billion-acres and nearly 78,000 miles of the most inaccessible shoreline and terrain in the northern hemisphere, with approximately 89% of the geography occurring in Canada. The Arctic LCC spans from Western Alaska across the northern section of North America east to Labrador, Canada. As such it is the northernmost, largest, and arguably most remote LCC in the 22-LCC network. Our mission is to identify and provide information needed to conserve natural and cultural resources in the face of landscape scale stressors, focusing on climate change, through a multidisciplinary program that supports coordinated actions among management agencies, conservation organizations, communities, and other stakeholders. Supporting this mission statement, we have developed four Conservation Goals and 21 Conservation Objectives (Appendix 1), and have assessed our progress to date in addressing each of these Conservation Objectives (Appendix 2).

In an agency landscape that is crowded with Arctic initiatives, it was important that, early on, we chose an operational niche that was not duplicative of others, many of which have far larger funding streams and staff capacity. We believe we have successfully defined our niche:

> We seek to generate and synthesize information on how climate change will affect ecosystems and ecosystem services in an effort to meet the expressed needs of resource managers and local communities. Our focus is on climate affects upon terrestrial, freshwater and near-shore marine habitats, and the species that depend upon these habitats. Based on the best information available we will create and apply tools useful to managers, regulators and stakeholders as they contemplate the Arctic of the future. Our policy is to make this information openly accessible to the public.

Since its inception, the Arctic LCC has recognized a set of high priority topics for which needed information was lacking. Given the short time we have been in existence, we believe we have made good progress in beginning to address these information needs. Our high priority topics are evident by reviewing our list of funded projects, technical working group reports, annual reports and meeting notes, but have not thus far been distilled into a Priority Resources list that carries the endorsement of our Steering Committee. In this document, we set forth our Priority Resources (Appendix 3), including habitats, physical processes, and a set of representative species that are likely to be affected by climate-driven changes in arctic processes. We also set forth our Conservation Priorities, outlining the activities and actions needed to provide the information important in achieving our goals (Appendix 4).

Arctic LCC Background

The Arctic LCC is embarking upon its 5th year of existence. Therefore, before we explicitly state our future strategy in pursuing our conservation goals, it is important to briefly revisit what we have accomplished to date.

Beginning with the WildREACH workshop in 2009, the Arctic LCC has sought expert opinion regarding the rapidly changing Arctic, how it is changing, the anticipated outcomes of those changes, and the information needed to better predict those outcomes. In venues from Barrow to

Anchorage, with audiences of tribal representatives, subsistence users, academics, bureaucrats, and industry and NGO representatives, we have listened as people expressed what they thought were the most important drivers and consequences of climate change in the Arctic. We listened particularly closely when they expressed a need for additional information upon which to base decisions. And we listened as other Arctic initiatives defined their niche. This input was vital in establishing the charter, mission, goals, and scope for the Arctic LCC. It served as the foundation for the formation of our initial six technical working groups that addressed coastal processes, hydrology, permafrost, climate monitoring, geospatial information needs, and species and habitats.

In 2010 and 2011, we focused on filling critical information gaps we could address with the funding available, by implementing studies across a wide spectrum of topics. In 2012, we recognized that while discrete studies can provide valuable data streams and scientific insights, the answers to many of the important questions surrounding climate effects in the arctic must be addressed in a holistic fashion. Consequently, we shifted our focus towards development of a smaller number of interdisciplinary studies that took on questions of broader scope. To this end, we provided seed money to interdisciplinary groups of scientists to develop a plan where they would work together in addressing a particular issue. The result of this effort was four completed interdisciplinary study plans (ISPs) with the following working titles:

- Biological responses to increasing water temperatures
- Climate change effects on wetlands and waterbirds
- An integrated approach to arctic aquatic habitat change
- Marine food web response to runoff

2012 was also the year in which we embarked upon design and development of our Terrestrial Environmental Observing Network (TEON), a long-term watershed-based monitoring network that had been called for by many arctic stakeholders, including USGS, NSF, SEARCH, USFWS, AON, NSSI, IARPC, and UNEP. While most every organization working in the Arctic recognizes long term monitoring as the foundation upon which we base our projections of future conditions, none have succeeded in overcoming the inherent difficulties trying to organize and fund long term monitoring efforts that span across agency boundaries. While we have quickly come to appreciate the organizational hurdles in securing funding for long term environmental monitoring, we remain committed to that goal. Finally, in 2012, we checked back in with our stakeholders to determine if our overall approach to addressing information needs in the Arctic was on-target. We did this through our Future Needs Assessment project, and were pleased to find that we had already begun to address most of the items on the resulting list of anticipated information needs.

In 2013, we developed our draft plan for TEON. We also began to fund the implementation of our ISPs. Simultaneously, we pursued development of an updated permafrost map for the North Slope, something that had not occurred since the 1970's. We continued to obtain spatial data for development of much-needed digital elevation models. And we invested in efforts to model the effects of snow on fish and wildlife and the effects of changing seasonal phenology on arctic ungulates. To date, we have provided funding to over 50 projects.

Foundation for the Strategic Action Plan

Although our institutional awareness and response to arctic climate change is less than one decade old, anthropogenic climate change has occurred at least since the dawn of the industrial age, and will continue to occur for the foreseeable future. While information is accumulating rapidly, we are in the infancy of our understanding of the nature and rate of climate change, and its effects on ecosystems. One of our challenges is to distinguish between natural variability (that occurs on annual to decadal scales) from gradual unidirectional trends occurring over the course of many decades. This is no easy task when long term data sets are absent or sparse. Our predictions of climate-associated vulnerability for species and habitats are mostly in the realm of inadequately tested hypotheses, and our models of climate change are laden with untested assumptions. While some immediate management responses to climate change may be prudent, we must also take the long view and lay a solid foundation for management responses to climate change into the next century. What is needed by managers, now and in the future, is 1) a system to gather data and use it to refine our estimates of ecological trends, 2) research that improves our understanding of the mechanisms by which climate effects priority resources, 3) modeling frameworks that incorporate the information from (1) and (2) and provide improved predictions about future resource states, and 4) an information delivery system that translates model output into actionable information for agencies and communities. An effective management response to climate change requires an adaptive cycle that includes complementary activity in all of these arenas,

The Arctic LCC Strategic Action Plan is driven most notably by the Arctic LCC Science Plan, which lays out our long term approach to achieving Arctic Landscape Conservation. The Arctic LCC also conducted a Future Needs Assessment survey after we had been operational for just over three years. The assessment report served as both a tool for use in developing our future strategy, and as an internal check to assess how well we have been addressing our customers' needs.

Arctic LCC Science Plan as a driver for the Strategic Action Plan

Our Science Plan lays out the intentions of the Arctic LCC with regards to pursuit of long-term environmental monitoring, interdisciplinary study plans, and the development of tools for resource managers to use as they contemplate the effects of climate change in shaping the future Arctic landscape.

We propose that the much called-for long-term environmental monitoring would be best accomplished by a network as described in our TEON plan. Briefly, TEON is a watershed-based network of monitoring stations and satellite nodes designed to gather data on a wide variety of baseline environmental parameters using standardized instrumentation and set protocols. TEON will collect, distribute, and synthesize long-term observational data needed to detect and forecast effects of a changing climate, hydrology, and permafrost regime on wildlife, habitat, and infrastructure in northern Alaska, with the intent to measure variation in processes sensitive to climate change.

Interdisciplinary studies are emerging in number and importance in the Arctic. However, the Arctic LCC is perhaps unique in having provided funds to multiple groups of PIs for use in simply planning their proposed study, allowing the extra time needed to accomplish the difficult

work of cross-discipline communication and coordination. Implementation of the four ISPs for which we provided planning funds is a driver for our Strategic Action Plan.

Resource managers, regulators and policy makers need tools to help them make sense of the morass of data and the complex interactions among physical processes and their associated feedback loops. We seek to create such tools and have already invested in several such tools. Most notably, we have invested heavily in the development of the Integrated Ecosystem Model (IEM) for Alaska and Northwestern Canada. This integrated model will help us understand the nature and rate of landscape change and allow for the generation of maps and other products that show how arctic and boreal landscapes may be altered by climate-driven changes to vegetation, disturbance, hydrology, and permafrost.

Arctic LCC Future Needs Assessment as a Driver for the Strategic Action Plan

The primary objective of the Future Needs Assessment is to determine how the Arctic LCC can best support and strengthen the connection between science and management in the area of climate change. The assessment will inform decisions regarding allocation of LCC funding and effort from 2013 forward and also helps illustrate the relevance of the LCC's work to date to decisions regarding land and resource management in the Arctic. The Future Needs Assessment was developed through interviews with 27 representatives of federal, state and local government agencies with management and scientific research responsibilities in the Arctic. Interviews focused on identifying scientific and other information that would be substantially useful to managers in their current work and 30 years in the future. The principle outcome of this effort was the development of a list of future science and information needs.

Of the 30 most important expressed future science and information needs, there is only one topic within our stated LCC scope (sea ice monitoring being outside of our current scope) that we have not already begun to address (Appendix 6). We find this future needs assessment report to be an affirmation that the Arctic LCC has been on a wise course for meeting the needs of Arctic stakeholders, and our future efforts require only slight adjustments to result in us addressing all anticipated future needs to some extent. We recognize, however, that we will likely never have the capacity or resources to fully address all of these future science and information needs.

Near Term Strategy

FY 2014 Strategy

The overall strategy for Arctic LCC operations in 2014 is one of further development of our TEON network and implementation of our interdisciplinary study plans. We will also continue funding other high priority efforts that we have already invested in that would suffer from our lack of continued support.

I. Implement a Terrestrial Environmental Observation Network (TEON) for Change Detection

The Arctic LCC Steering Committee has approved further development of, and investment in, TEON as an operational network. Proposed 2014 activities include:

1. Establish a Technical Work Group to assist staff with technical review and revisions to the implementation plan.
2. Complete the TEON data management plan.
3. TEON partnership development.
4. Fund existing stream gages within the TEON watersheds (Kuparuk, Putuligayak and Hulahula).
5. Consider the need for a 2014 TEON Implementation Workshop, and execute the workshop if warranted.
6. Assess the need to develop a contaminants component in TEON.
7. Link to larger scale monitoring programs as resources and capacity allow (e.g. CBPM/ CAFF Terrestrial Monitoring Program).

II. Conduct Interdisciplinary Climate Response Research

In 2013, we fully-funded implementation of the interdisciplinary study *An Integrated Approach to Arctic Aquatic Habitat Change.* In 2014 and beyond, we continue to strive for implementation of the Study Plans we have invested in.

1. Begin implementation of the 3-year project, *Biological Response to Increasing Water Temperatures.*
2. Begin Implementation of the 3-year study *Climate Change Effects on Wetlands and Waterbirds* (contingent upon PIs securing $72K in matching funds), and work with PIs to secure additional funding for Years 2 and 3.
3. Begin implementation of the 3-year project *Response of an Arctic Freshwater Ecosystem to Climate and Land Use Change.*
4. Implement *Food Web Response to Increased Runoff* (contingent upon PIs securing at least $150K in matching funds).

III. Provide Forecasts of Future Ecosystem Condition Via Spatially-Explicit Model Outputs

The Arctic LCC has joined the Alaska Climate Science Center and other Alaska LCCs to support development of the Integrated Ecosystem Model for Alaska and Northwestern Canada (IEM). We have supported, and continue to support, other spatially explicit modeling efforts.

1. Support continued development of the IEM through funding and staff participation at team meetings.
2. Issue a targeted RFP for developing a method to map thermokarst features on a broad spatial scale.
3. Work with USGS investigators to communicate results and prepare outreach materials for coastal lagoon modeling (Arey Lagoon).

IV. Data Integration and Management

1. Provide access to gridded dataset simulating historical snow conditions (spatially explicit model outputs).
2. Create historical (ca. 1980) coast line position for Beaufort and Chukchi coasts from orthorectified aerial imagery and work with USGS to analyze coastal erosion rates for additional time periods.
3. Continue to work with University of Alaska staff at IARC and GINA to make Alaska hydroclimate data accessible to the public.
4. Continue to work with ADIwg partners to develop and update metadata standards and mdTranslator application.
5. Conduct an assessment of datasets and geospatial layers that will serve as a baseline for ongoing assessment of subsistence activities and cultural resources at risk.

V. Community Involvement in Science

1. Work with USGS staff and intern from the University of Maine to present results of coastal modeling to residents of Kaktovik and identify community concerns with regard to coastal change.
2. Form a Cultural Resources Working Group to better address objectives associated with Arctic LCC Conservation Goal 2 "Better understand the impacts of environmental change on subsistence resources and users."

VI. Science Planning

1. Reconvene the Coastal Process Technical Work Group with the goal of future change in the coastal zone of northern Alaska.
2. Plan for All-Alaska LCC Conference. Planned for fall of Calendar Year 2014. Currently uncertain if this will be in FY 2014 or FY2015.

FY 2015 Strategy

The current strategy for 2015 assumes finalization of a TEON implementation plan, with protocols for data collection well in advance of the 2015 field season. It is more speculative than the 2014 strategy because of uncertainty in future funding levels.

I. Implement a Terrestrial Environmental Observation Network (TEON) for Change Detection

1. Continue pursuit of partner funding to fully implement TEON.
2. Potential field implementation of TEON network sites in one or two pilot watersheds. These will most likely be sites with ongoing investigations (e.g. the Fish Creek and Kuparuk watersheds).
3. Implement management of TEON-generated data.
4. Obtain spatial information needed for development of digital elevation models and other priority spatial data layers, with a focus on TEON watersheds.

II. Conduct Interdisciplinary Climate Response Research

1. Implement Year 2 of 3-year project *Biological Response to Increasing Water Temperatures.*
2. Continued funding of the ISP *Climate Change Effects on Wetlands and Waterbirds* (Contingent upon PIs securing a 50% match for the remainder of necessary funds).
3. Implement Year 2 of the 3-year project *Response of an Arctic Freshwater Ecosystem to Climate and Land Use Change.*
4. Through an RFP, support investigations into climate effects upon subsistence harvest systems and cultural resources, with a focus on development of adaptation strategies given projected future conditions, in coordination with ANTHC, NSB and NWAB to the extent practicable.

III. Provide Forecasts of Future Ecosystem Condition Via Spatially-Explicit Model Outputs

1. Continue collaborative support for development of the IEM.
2. Support for the Coastal Process Work Group to develop a conceptual plan to integrate coastal process modeling.

IV. Data Integration and Management

1. Continue development of coastal zone spatial data layers.

V. Science Planning

1. Execute All Alaska LCC conference, where PIs gather to present results of Arctic LCC-supported studies (as well as other LCCs in Alaska).
2. Work with Arctic LCC Steering Committee to revise the Strategic Action Plan as warranted.
3. Pursue community involvement in science planning.

FY 2016 Strategy

The strategy for 2016 becomes increasingly speculative as funding levels likewise become increasingly speculative. Regardless, we will plan on further implementation of TEON and on providing funding to complete implementation of Interdisciplinary Study Plans from 2013.

I. Implement a Terrestrial Environmental Observation Network (TEON) for Change Detection

1. Continue in our pursuit of partners to fully implement TEON.
2. Field instrumentation of two additional TEON watershed.
3. Maintenance of existing instrumented TEON watersheds.
4. Implement management of TEON-generated data.
5. Continue to obtain additional spatial information needed for development of digital elevation models, with a focus on TEON watersheds.

II. Conduct Interdisciplinary Climate Response Research

1. Close out 2014 year-class ISPs, conduct RFP for new interdisciplinary study plans.
2. Continue support for investigations into climate effects upon subsistence harvest systems and cultural resources, with a focus on development of adaptation strategies given projected future conditions.

III. Provide Forecasts of Future Ecosystem Condition Via Spatially-Explicit Model Outputs

1. Continue collaborative support for development of the IEM.
2. Support the Coastal Process Work Group in development of prototype integrated coastal change model.

IV. Data Integration and Management

1. Begin development of Arctic coastline scenario projection and mapping tool based upon existing Arctic coastlines, estimates of continued retreat and accretion through time and models of processes influencing coastline change such as lake tapping (from Arctic LCC project 2010-09), and flooding forecasts (tiering off Arctic LCC project 2011-02) to project future coastal zone condition.

V. Strategic Action Plan Assessment and Modification

1. Staff reviews and assesses progress in addressing this action plan and presents results to the Steering Committee.
2. Steering Committee comes to agreement on necessary modifications to LCC strategy. Staff incorporates SC input into revised Strategic Action Plan for the following 3 years. Note that this process can take place prior to 2016.

Appendix I. Arctic LCC Mission, Scope, Goals and Objectives

The mission of the Arctic LCC is to identify and provide information needed to conserve natural and cultural resources in the face of landscape scale stressors, focusing on climate change, through a multidisciplinary program that supports coordinated actions among management agencies, conservation organizations, communities, and other stakeholders.

The Arctic LCC established conservation goals and objectives in 2010. Since that time, it has provided funding for approximately 60 studies and assessments, coordinated with dozens of organizations, participated in many arctic-centric initiatives, held workshops, meetings, and webinars, and developed over 100 spatial data products projecting potential future conditions, always seeking to address its 4 conservation goals and associated objectives.

Scope of the Arctic LCC

The Geographic scope of the Arctic LCC is defined as the Arctic Plains and Mountains Bird Conservation Region (BCR 3), and adjacent marine areas to the limits of the US and Canadian Exclusive Economic Zones adjacent to the terrestrial area of the LCC. The operational scope of the Arctic LCC is as follows (excerpted from the Arctic LCC Charter):

> The Arctic LCC will focus on terrestrial and nearshore marine systems, and will address applied science and management needs with a focus on climate change, but other landscape stressors will not be excluded. The Arctic LCC will focus on habitat and how species interact with their habitat. Initial efforts will focus on the Arctic LCC geographic area influencing management decisions in the Alaska portion of this LCC. Future focus may expand based on capacity.

Arctic LCC Conservation Goals and Objectives:

Goal 1. Better understand and predict effects of climate change and other stressors on landscape level physical and ecosystem processes.

Objectives for Goal 1: Because the Arctic is a vast and remote area, we are lacking critical information on basic physical processes (such as hydrologic and temperature regimes) that maintain habitats. For this reason the Arctic LCC should support efforts to establish observational systems to monitor key processes that create and maintain Arctic habitats and species. In addition, it should support interdisciplinary and experimental studies that examine climate-associated habitat change, especially research that supports development of predictive tools to assess likely future impacts. To that end, objectives for addressing the Arctic LCC Conservation Goal 1 are:

A. Develop criteria to select physical and ecological processes, habitats, species assemblages and individual species that merit focused attention from the LCC.
B. Identify opportunities for contributing to monitoring networks that track physical parameters and coordinate LCC partner participation in those networks.

C. Develop strategies to support the identified priority physical process research and modeling needs. In particular, seek opportunities for the LCC partners to leverage expertise and resources where appropriate, and pursue funding opportunities from other sources that typically fund geophysical and ecosystem research, many of which are expanding their Arctic research programs (such as DOE, NASA,NOAA, and NSF).
D. Establish connections/develop support for research and monitoring initiatives with similar objectives, such as Arctic Long Term Ecological Research, National Park Service I&M programs, National Wildlife Refuge I&M programs, North Slope Science Initiative, and Study of Environmental Arctic Change.
E. Identify opportunities for enhancing monitoring programs targeting priority habitats, species assemblages, and individual species; coordinate LCC partner participation in those networks.
F. Develop models that link individual and populations response to changing environmental conditions (i.e., species-habitat associations) that can inform conservation efforts for priority species.
G. Address identified but unmet science needs that support conservation of species and habitats through analysis and recommendations for methods, tools, and management practices that agencies may use to implement on-the-ground conservation actions.

Goal 2. Better understand the impacts of environmental change on subsistence and cultural resources.

Objectives for Goal 2: Although documenting changes in subsistence uses, subsistence resources, and cultural resources can be relatively straightforward, predicting future effects of climate change and other factors on these activities and resources is a complex undertaking. The LCC will help make information on effects of climate change and other factors on subsistence uses, subsistence resources, and cultural resources in the Arctic readily available for use in planning and decision making by subsistence users, resource managers, and other affected or interested parties. Objectives for addressing Arctic LCC Conservation Goal 2 are:

A. Work with stakeholder groups to identify ways to: 1) monitor changes in subsistence resource abundance and use patterns; 2) integrate traditional ecological knowledge into geospatial data systems; and 3) effectively disseminate information and findings among subsistence users.

B. Focus monitoring, research and modeling activities of the Arctic LCC on species and habitats important for subsistence use. Information generated from these efforts will be made accessible to all stakeholders to inform conservation of subsistence resources.

C. Conduct an assessment of datasets and geospatial layers that will serve as a baseline for ongoing assessment of subsistence activities and cultural resources at risk.

D. Convene a Work Group to define the role of LCCs with respect to stewardship of cultural resources. Work with social scientists and cultural specialists to identify mutually beneficial areas of collaboration.

Goal 3. Provide support for resource conservation planning.

Objectives for Goal 3: As Arctic land-use planning is becoming increasingly complex and dynamic, managers would benefit from access to support tools developed for a landscape-scale decision framework. The LCC will facilitate near-term (2-5 year) conservation actions by providing decision-makers better information about current conditions of natural and cultural resources. The LCC will also support longer-term (multi-decadal) conservation design with predictive tools that allow evaluation of alternative management options in the context of a changing landscape resulting from the cumulative impacts of natural and anthropogenic change. Objectives for addressing Arctic LCC conservation Goal 3 are:

A. Conduct a needs assessment for datasets and geospatial layers that will inform near-term conservation and management actions and serve as a baseline for ongoing planning and environmental assessment.
B. Assemble and make accessible information and geospatial planning tools pertaining to fish, wildlife and cultural resources.
C. Support research and monitoring activities that reflect the needs of the LCC partners relative to near-term management issues, and use that information to update geospatial databases and refine predictive models.
D. Support the development, testing, and application of tools that allow managers to explore the outcome of alternative management strategies under varying climate scenarios and landscape forecasts.
E. Provide syntheses of pertinent research and monitoring results for resource managers.

Goal 4. Contribute to improved data management and integration.

Objectives for Goal 4: Ready access to natural resource information about the Arctic (both current and future data) was repeatedly identified as a practical planning and management need by the LCC partners. The Arctic LCC envisions an information system that will allow sharing among the LCC partnership and geospatial applications for visualizing complex information over the landscape-level conservation framework. This information management system will bring together historic data, current-condition data, and new data generated from monitoring and research programs. It will also provide results of modeling exercises for use in constructing future scenarios. The LCC will benefit from a data system that encourages information sharing within the partnership, across all LCCs, and with stakeholders outside the partnership. Building and maintaining such a system is a complex undertaking; the Arctic LCC can contribute by assisting members with data management and stewardship, and ensuring compatibility with larger data integration and dissemination initiatives. Objectives for addressing Arctic LCC Conservation Goal 4 are:

A. Work with the Alaska Climate Change Executive Roundtable (ACCER) Data Integration Workgroup and other partners to implement data integration strategies.
B. The LCC data manager will undertake the responsibility for coordination with other data systems as described above. The data manager will ensure compliance with established standards for managing LCC-generated data and for synthesizing existing data in a manner that is compatible with existing and developing information systems.

C. The LCC geospatial specialist will help coordinate data acquisition among agencies, identify priority geospatial data needs, and work with subject area experts to develop plans for developing or acquiring needed data.
D. The data manager and geospatial specialist will ensure on-line access to data, via existing or newly developed platforms.

Appendix 2. Assessment of progress to date in addressing Arctic LCC Conservation Goals and Objectives

Arctic LCC Progress Towards Conservation Objectives[1]			
Conservation Goal	**Objective**	**Measure of Progress[2]**	**Justification of Progress[3]**
Conservation Goal 1 Better understand and predict effects of climate change and other stressors on landscape level physical and ecosystem processes.	A. Develop criteria to select physical and ecological processes, habitats, species assemblages and individual species that merit focused attention from the LCC.	2	WildREACH report, Species and Habitat Working Group report, Steering Committee establishment of priority resources and conservation priorities
	B. Identify opportunities for contributing to monitoring networks that track physical parameters and coordinate LCC partner participation in those networks.	2	Development of TEON plan and pursuit of TEON implementation
	C. Develop strategies to support the identified priority physical process research and modeling needs. In particular, seek opportunities for the LCC partners to leverage expertise and resources where appropriate, and pursue funding opportunities from other sources that typically fund geophysical and ecosystem research, many of which are expanding their Arctic research programs (such as DOE, NASA,NOAA, and NSF).	2	External project support for Arctic LCC projects has been leveraged by a ratio of 2.4 ($5.0 Million in FWS project funds leveraging $12.2 million in partner contributions). We are coordinating with all LCC participating agencies, CSC, AON, NSF, NFWF, NASA, NSSI and others to address Arctic LCC priorities.
	D. Establish connections/develop support for research and monitoring initiatives with similar objectives, such as Arctic Long Term Ecological Research, National Park Service I&M programs, National Wildlife Refuge I&M programs, North Slope Science Initiative, and Study of Environmental Arctic Change.	2	We have developed connections and communicate regularly with all the entities mentioned in this objective, and others not mentioned, but development of support for research and monitoring has been greatly hampered by government funding cuts.
	E. Identify opportunities for enhancing monitoring programs targeting priority habitats, species assemblages, and individual species; coordinate LCC partner participation in those networks.	2	TEON is the vehicle through which we are identifying opportunities for enhancing appropriate monitoring programs and through which we seek to coordinate LCC partner participation in a

			comprehensive monitoring network. Support for the monitoring network has been greatly hampered by government funding cuts.
	F. Develop models that link individual and population response to changing environmental conditions (i.e., species-habitat associations) that can inform conservation efforts for priority species.	2	We have funded several studies seeking to establish population or species response to changing environmental conditions, including the following Arctic LCC projects: 2010-02, 2010-06, 2010-11, 2011-01, 2011-08, 2011-09, 2011-11, 2011-16, 2011-21, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12, 2013-02.
	G. Address identified but unmet science needs that support conservation of species and habitats through analysis and recommendations for methods, tools, and management practices that agencies may use to implement on-the-ground conservation actions.	3	Most of the science-based projects the Arctic LCC has supported are directly addressing identified but unmet science needs that support conservation as stated in this objective. (e.g. 2010-01, 2010-02, 2010-03, 2010-04, 2010-05, 2010-06, 2010-07, 2010-08, 2010-09, 2010-10, 2010-11, 2011-01, 2011-02, 2011-03, 2011-05, 2011-06, 2011-07, 2011-08, 2011-09, 2011-10, 2011-11, 2011-14, 2011-15, 2011-16, 2011-18, 2011-19, 2011-21, 2012-01, 2012-02, 2012-03, 2012-04, 2012-05, 2012-06, 2012-07, 2012-08, 2012-09, 2012-10, 2012-11, 2012-15, 2013-01, 2013-02, 2013-04, 2013-05, 2013-06, 2013-08
Conservation Goal 2 Better understand the impacts of environmental change on subsistence and cultural resources.	A. Work with stakeholder groups to identify ways to: 1) monitor changes in subsistence resource abundance and use patterns; 2) integrate traditional ecological knowledge into geospatial data systems; and 3) effectively disseminate information and findings among subsistence users.	1	Species and Habitat Work Group report, 2011-07 and 2011-22
	B. Focus monitoring, research and modeling activities of the Arctic LCC on species and habitats important for subsistence use. Information generated from these efforts will be made accessible to all stakeholders to inform conservation of subsistence resources.	2	2010-01, 2010-03, 2010-05, 2010-06, 2011-01, 2011-02, 2011-07, 2011-10, 2011-11, 2011-14, 2011-15, 2011-16, 2011-21, 2011-22, 2012-01, 2012-02, 2012-04, 2012-05, 2012-06, 2012-07, 2012-08, 2012-09, 2012-10, 2012-11, 2012-12, 2013-01, 2013-02, 2013-05, 2013-06,
	C. Conduct an assessment of datasets and geospatial	0	

	layers that will serve as a baseline for ongoing assessment of subsistence activities and cultural resources at risk.		
	D. Convene a Work Group to define the role of LCCs with respect to stewardship of cultural resources. Work with social scientists and cultural specialists to identify mutually beneficial areas of collaboration.	0	On 12/16/13, the Arctic LCC Steering Committee convened the core of a Cultural Resources working group to address this objective.
Conservation Goal 3 Provide support for Arctic resource conservation planning	A. Conduct a needs assessment for datasets and geospatial layers that will inform near-term conservation and management actions and serve as a baseline for ongoing planning and environmental assessment.	3	WildREACH report, ALCC Future Needs Assessment, Species and Habitat Working Group report
	B. Assemble and make accessible information and geospatial planning tools pertaining to fish, wildlife and cultural resources.	3	Imiq, Biom/Cliome maps, SNAP maps and animations based on multiple emissions scenarios, all served on Arcticlcc.org
	C. Support research and monitoring activities that reflect the needs of the LCC partners relative to near-term management issues, and use that information to update geospatial databases and refine predictive models.	3	2010-02, 2010-03, 2010-04, 2010-05, 2010-06, 2010-08, 2010-09, 2010-10, 2010-12, 2010-13, 2011-01, 2011-05, 2011-07, 2011-10, 2011-14, 2011-15, 2012-01, 2012-02, 2012-04, 2012-05, 2012-11, 2012-12, 2012-13, 2013-01, 2013-02, 2013-06, 2013-08
	D. Support the development, testing, and application of tools that allow managers to explore the outcome of alternative management strategies under varying climate scenarios and landscape forecasts.	3	2010-01, 2010-05, 2010-09, 2010-10, 2011-01, 2011-02, 2011-05, 2011-07, 2011-10, 2011-11, 2011-14, 2011-15, 2011-16, 2012-01, 2012-02, 2012-04, 2012-05, 2012-11, 2013-06
	E. Provide syntheses of pertinent research and monitoring results for resource managers.	3	2010-03, 2010-04, 2010-05, 2010-10, 2011-03, 2011-06, 2011-11, 2011-15, 2012-02, 2013-01, 2013-08
Conservation Goal 4 Contribute to improved data management and integration.	A. Work with the Alaska Climate Change Executive Roundtable (ACCER) Data Integration Workgroup and other partners to implement data integration strategies.	3	Data Manager working with ADIwg, and developing a metadata translator to allow users to convert ADIwg metadata to multiple formats, including the ISO 19115 standards. Data manager coordinates with other LCCs via the Data Management Working Group.
	B. The LCC data manager will undertake the	3	Data Manager ensures compliance with established

	responsibility for coordination with other data systems as described above. The data manager will ensure compliance with established standards for managing LCC-generated data and for synthesizing existing data in a manner that is compatible with existing and developing information systems.		standards. All LCC data sets are publicly available and documentation meets appropriate metadata standards.
	C. The LCC geospatial specialist will help coordinate data acquisition among agencies, identify priority geospatial data needs, and work with subject area experts to develop plans for developing or acquiring needed data.	3	2012 exercise in which the geospatial and coastal TWG were allocated a portion of the LCC budget to use in acquiring the most needed spatial data that their budget would allow. Effort was well coordinated and resulted in high return on investment. Partnering on acquisition of MODIS, LIDAR and other forms of spatial data is an ongoing effort, with collaboration between the LCC, CSC, USGS, NASA, BLM and others.
	D. The data manager and geospatial specialist will ensure on-line access to data, via existing or newly developed platforms[4].	4	On-line access to data occurs routinely as soon as the data and metadata are made available to us and meet quality control standards. Metadata are deposited with multiple repositories to enhance discoverability, including Data.gov and GINA.

[1]The vast majority of our projects remain works in progress or have only recently-released information products or tools. In future iterations of this plan, we will address how our initiatives are known to be influencing or incorporated into management decisions and adaptation actions.

[2]Progress is classified as none (0), little (1), moderate (2), great (3), or completed (4). For conservation Goal 4, a progress score of 4 implies that we are fully operational in terms of the objective, but does not imply that there is not additional work to be done on the objective as additional information is gathered.

[3]Refer to Appendix 5 for an index of project numbers and project titles. Web content for each project can be accessed at arcticlcc.org following the url protocol: arcticlcc.org/projects/alcc<project-number> (e.g. arcticlcc.org/projects/alcc2010-05).

[4]A comment was made by a Steering Committee member to include development of data visualization tools as an objective under this goal. This comment suggests there may be a need to revisit our objectives.

Appendix 3. Priority Resources for the Arctic LCC

Priority resources are defined by the combination of processes (Column 1) interacting within landscape units (Column 2) and affecting biota represented by the species in Column 3. The number in Column 4 is for identification purposes only, not intended to represent order of importance. This compilation of Priority Resources for the Arctic LCC is not intended to imply that member agencies/entities have adopted these as their own agency/entity priority resources.

Ecosystem Processes, Features, and Services[1]	Landscape Features	Representative Species[2,3,4]	Priority Resource ID
Hydrologic processes (including all water balance components), permafrost dynamics, thermokarst, nutrient and sediment input from terrestrial systems • Sufficient runoff to recharge surface water storage for habitat and human needs. • Stream and lake connectivity • Overwintering habitat availability • Water quality within optimal range for sustaining water-dependent fish and wildlife populations. • Temperature • Chemistry (nutrients, carbon) • Aquatic invertebrate productivity and phenology	Rivers, streams, other fluvial systems	• Grayling – widespread species across ecoregions and relatively well studied • Dolly Varden – important subsistence species and characteristic of mountain-origin systems east of the Colville River and on Chukchi coast • Broad whitefish – important subsistence species and characteristic of connected lake-stream systems in the coastal plain;	1

Ecosystem Processes, Features, and Services[1]	Landscape Features	Representative Species[2,3,4]	Priority Resource ID
Hydrologic processes (including all water balance components), permafrost dynamics, thermokarst, nutrient and sediment input from terrestrial systems • Runoff sufficient to recharge surface water storage for habitat and human needs. • Snow pack insulative layer • Stream and lake connectivity • Overwintering habitat availability • Water quality within optimal range for sustaining water-dependent fish and wildlife populations. • Temperature • Chemistry (nutrients, carbon) • Aquatic invertebrate productivity and phenology	Lakes, Ponds	• Broad whitefish – see above • Grayling – see above, dependent on lakes for overwintering • Lake trout – representative of resident species in deeper lakes (foothills, Brooks mountains), sensitive to warming temperatures (growth rates) • Least cisco – broadly distributed on coastal plain, subsistence use, important forage species • Yellow-billed loon and spectacled eider – listed or candidate species that are lake-dependent. • King eiders and other diving ducks – lake dependent and harvested for sport and/or subsistence	2
Hydrologic processes (including all water balance components), permafrost dynamics, thermokarst , nutrient cycling • Snow melt timing and quantity • Water temperature • Aquatic invertebrate productivity and phenology	Wetlands/wet sedge meadow	• Shorebirds – Most abundant species group in the arctic, habitat preferences arrayed along a wetness gradient (e.g., phalaropes in wet meadows, dunlins and semipalmated sandpipers in mesic , plovers prefer dry) • Greater white-fronted goose – dependent on nutrient-rich vegetation, sport and subsistence harvest	3

Ecosystem Processes, Features, and Services[1]	Landscape Features	Representative Species[2,3,4]	Priority Resource ID
Hydrologic processes (including all water balance components), permafrost dynamics, thermokarst, succession , nutrient cycling • Forage quantity and quality to sustain herbivorous wildlife • Phenology • Biomass, nutrient composition • Structure (shrub vs. meadow) • Snow pack characteristics	Upland tundra/moist sedge meadow	• Caribou (see above) • Ptarmigans (willow and rock) – dependent on willow shrub, sport and subsistence harvest • Greater white-fronted goose (see above) • Lemmings (brown and Greenland) – keystone species, important prey species, population cycles may be sensitive to climate change • Arctic fox - important predator, potentially sensitive to climate change (range contraction) , commercial and subsistence harvest	4
Coastal erosion, wave climates, flooding, sediment transport. • Coastal habitat availability and quality sufficient to sustain coastal-dependent species. • Intact barrier island system • Water quality and temperature • Nutrient/carbon/sediment input from terrestrial sources	Lagoons	• Arctic cisco – dependent on nearshore zone for migration corridor, subsistence/commercial fishery, sensitive to temperature (growth rates) • Long-tailed duck – large population dependent on lagoons for undisturbed molting habitat	5
Coastal erosion, wave climates, flooding, sediment transport. • Intact barrier island system	Barrier Islands	• Common eider – dependent on islands for nesting, subsistence harvest	6
Coastal erosion, wave climates, flooding, sediment transport. • Periodic salt water flooding	Coastal sedge meadow ("salt marsh")	• Black brant – preferential use of coastal sedge meadow for brood-rearing molting, staging; sport and subsistence harvest • Snow goose – preferential use of coastal sedge meadow for brood-rearing molting,	7

Ecosystem Processes, Features, and Services[1]	Landscape Features	Representative Species[2,3,4]	Priority Resource ID
		staging; subsistence harvest; sport and subsistence harvest	
Cultural resources, food security, village and subsistence infrastructure • Village flooding and erosion • Air and ground temperatures suitable for food storage • Seasonality of securely frozen and ice-free waterways for travel • Seasonality of frozen and snow-covered tundra for travel • Hydrology and thermokarst relative to drinking water and sewage • Runoff sufficient to recharge surface water storage for habitat and human needs.	Villages, subsistence camps, travel corridors and use areas, archeological sites	• Grayling • Dolly Varden • Chum salmon • Broad whitefish • Lake trout • Eiders • Greater white-fronted goose • Black brant • Ptarmigan • Long-tailed duck • Caribou • Sheefish • Beaver	8

[1]Processes important to maintaining the value of the landscape feature to support fish and wildlife populations are listed at the top of each cell, followed by a list of features and services that are intrinsic to maintaining habitat and cultural value.

[2]Representative species are selected because they are: 1) judged to be responsive to changes in the key processes/features listed in the first column, and associated with the habitats listed in the second column, and/or 2) important to human users or their role in the ecosystem. Text indicates reasons for selection.

[3]The Arctic LCC recognizes that there are a number of marine mammal species that utilize habitats that occur within our geography, some of which are highly important to subsistence. Given that the Arctic LCC has chosen "terrestrial and nearshore marine systems" as its focus, we have chosen to not include marine mammals among our representative species at this time, though retain the option to do so in the future. As we learn more and questions change, different species may be selected.

[4] The Arctic LCC has not subjected our Representative Species to the proposed FWS surrogate species evaluation process. As such, the representative species listed for each priority resource is not intended to be used as a list of surrogate species.

Appendix 4. Anticipated Arctic LCC conservation activities for 2014-2016, and the corresponding Priority Resources that each addresses.

Activity Components of the Near-Term Arctic LCC Strategy	Priority Resources Addressed (noted by Priority Resource ID from Appendix 3)
FY 2014	
Technical review and revisions to the TEON sampling plan	1, 2, 3, 4
Completing the TEON data management plan	
TEON partnership development	
Funding of existing stream gages within the TEON watersheds (Kuparuk, Putuligayak and Hulahula)	
Consider the need for a 2014 TEON Implementation Workshop, and execute the workshop if warranted	
Assess the need to develop a contaminants component in TEON	
Begin implementation of the 3-year project, *Biological Response to Increasing Water Temperatures*	2, 3, 4
Begin Implementation of the 3-year study *Climate Change Effects on Wetlands and Waterbirds* (contingent upon PIs securing $72K in matching funds), and work with PIs to secure additional funding for Years 2 and 3.	2, 3, 4
Begin implementation of the 3-year project *Response of an Arctic Freshwater Ecosystem to Climate and Land Use Change.*	
Implementation of the ISP *Food Web Response to Increased Runoff* (contingent upon PIs securing at least $150K in matching funds)	1, 2, 3, 4, 5, 7, 8
Support continued development of the IEM through funding and staff participation at team meetings.	1, 2, 3, 4, 7, 8
Issue a targeted RFP for developing a method to map thermokarst features on a broad spatial scale.	
Work with USGS investigators to communicate results and prepare outreach materials for coastal lagoon modeling (Arey Lagoon).	2, 5, 6, 7, 8
Further develop the coastal component for our Science Plan, enlisting the aid of an intern from the U. Maine IGERT Program, tiering off of the unfinished work of our unfinished work of our Coastal Processes Technical Working Group	
Provide access to gridded dataset simulating historical snow conditions (spatially explicit model outputs).	1, 2, 3, 4, 7, 8
Create historical (ca. 1980) coast line position for Beaufort and Chukchi coasts from orthorectified aerial imagery and work with USGS to analyze coastal erosion rates for additional time periods.	2, 5, 6, 7, 8
Continue to work with University of Alaska staff at IARC and	1, 2, 3, 4, 7, 8

Activity Components of the Near-Term Arctic LCC Strategy	Priority Resources Addressed (noted by Priority Resource ID from Appendix 3)
GINA to make Alaska hydroclimate data accessible to the public.	
Continue to work with ADIwg partners to develop and update metadata standards and mdTranslator application.	1, 2, 3, 4, 5, 6, 7, 8
Conduct an assessment of datasets and geospatial layers that will serve as a baseline for ongoing assessment of subsistence activities and cultural resources at risk.	
Work with USGS staff and intern from the University of Maine to present results of coastal modeling to residents of Kaktovik and identify community concerns with regard to coastal change.	5, 6, 7, 8
Form a Cultural Resources Working Group to better address objectives associated with Arctic LCC Conservation Goal 2	8
Reconvene the Coastal Process Technical Work Group with the goal of future change in the coastal zone of northern Alaska.	5, 6, 7
Plan for All-Alaska LCC Conference for fall of Calendar Year 2014.	1, 2, 3, 4, 5, 6, 7, 8
FY 2015	
Continue in our pursuit of partners to fully implement TEON	1, 2, 3, 4, 5, 7, 8
Potential field implementation of TEON network sites in one or two pilot watersheds. These will most likely be sites with ongoing investigations (e.g. the Fish Creek and Kuparuk watersheds)	
Implement management of TEON-generated data	
Obtain spatial information needed for development of digital elevation models and other priority spatial data layers, with a focus on TEON watersheds	
Continued funding of the ISP *Climate Change Effects on Wetlands and Waterbirds* (Contingent upon PIs securing a 50% match for the remainder of necessary funds)	2, 3, 4
Implement Year 2 of the 3-year project *Response of an Arctic Freshwater Ecosystem to Climate and Land Use Change*	
Through an RFP, support investigations into climate effects upon subsistence harvest systems and cultural resources, with a focus on development of adaptation strategies given projected future conditions, in coordination with ANTHC, NSB and NWAB to the extent practicable	8
Begin planning for an Arctic LCC conference, where PIs gather to present results of Arctic LCC-supported studies and, with the assistance of the Arctic LCC Steering Committee, begin to develop a revised Strategic Action Plan for 2017 and beyond	1, 2, 3, 4, 5, 6, 7, 8,
Continue collaborative support for development of the IEM.	1, 2, 3, 4, 7, 8

Activity Components of the Near-Term Arctic LCC Strategy	Priority Resources Addressed (noted by Priority Resource ID from Appendix 3)
Support for the Coastal Process Work Group to develop a conceptual plan to integrate coastal process modeling.	1, 2, 5, 6, 7, 8
Continue development of coastal zone spatial data layers.	2, 4, 5, 6, 7, 8
Execute All Alaska LCC conference, where PIs gather to present results of Arctic LCC-supported studies (as well as other LCCs in Alaska).	1, 2, 3, 4, 5, 6, 7, 8
Work with Arctic LCC Steering Committee to revise the Strategic Action Plan as warranted.	
Pursue Community Involvement in Science Planning	
FY 2016	
Continue in our pursuit of partners to fully implement TEON	1, 2, 3, 4, 5, 7, 8
Field instrumentation of two additional TEON watersheds	
Maintenance of existing instrumented TEON watersheds	
Implement management of TEON-generated data	
Continue to obtain additional spatial information needed for development of digital elevation models, with a focus on TEON watersheds.	
Close out 2014 year-class ISPs, conduct RFP for new interdisciplinary study plans	1, 2, 3, 4, 5, 6, 7, 8
Continue support for investigations into climate effects upon subsistence harvest systems and cultural resources, with a focus on development of adaptation strategies given projected future conditions	8
Continue collaborative support for development of the IEM.	1, 2, 3, 4, 7, 8
Support the Coastal Process Work Group in development of prototype integrated coastal change model.	1, 2, 5, 6, 7, 8
Begin development of Arctic coastline scenario projection and mapping tool based upon existing Arctic coastlines, estimates of continued retreat and accretion through time and models of processes influencing coastline change such as), lake tapping (from Arctic LCC project 2010-09), and flooding forecasts (tiering off Arctic LCC project 2011-02) to project future coastal zone condition.	

Appendix 5. List of Arctic LCC project numbers and corresponding project titles.

Web content for most projects can be accessed at arcticlcc.org following the URL protocol: arcticlcc.org/projects/ALCC<project-number> (e.g. "arcticlcc.org/projects/ALCC2010-05")

Project ID	Project Title
2010-01	Predicting Future Potential Biomes for Alaska
2010-02	Modeling Shorebird Distribution on the North Slope
2010-03	Expanding the North Slope Fish Distribution and Water Quality Geodatabase
2010-04	Hydroclimatological Data Rescue, Data Inventory, Network Analysis, and Data Distribution
2010-05	Integrated Ecosystem Model (AIEM) for Alaska
2010-06	Linking North Slope Climate, Hydrology, and Fish Migration
2010-07	Long-term Monitoring of the Impacts of Climage Change on the Glaciers and Rivers in the Arctic National Wildlife Refuge
2010-08	Streamflow Monitoring on Upper Kuparuk and Putuligayuk Rivers
2010-09	Thermokarst lake drainage - vulnerability to climate change and prediction of future lake habitat distribution on the North Slope
2010-10	Threatened Eider Geodatabase for Northern Alaska
2010-11	ASDN: a Network of Sites to Evaluate How Climate-mediated Change in the Arctic Ecosystem are Affecting Shorebird Distribution, Ecology, and Demography
2010-12	Streamflow monitoring on the Canning and Tamayariak rivers.
2010-13	Hydrologic Monitoring of Glacier-Influenced Watersheds (Hulahula Gage)
2011-01	Mapping Suitable Snow Habitat for Polar Bear Denning Along the Beaufort Coast of Alaska
2011-02	Modeling Barrier Island Lagoon System Response to Projected Arctic Warming
2011-03	Reconciling precipitation trends in Alaska: Comparison of trends in gridded precipitation products and station records
2011-05	Fish Creek Watershed Hydrology Monitoring
2011-06	Understanding Arctic Ecosystems: Ecological Mapping and Mapping Field Plot Database for the North Slope
2011-07	RAMP: Develop the Rural Alaska Monitoring Program
2011-08	Climate effects on Arctic Food Resources: Modeling the Timing and Duration of Aquatic Insect Emergence from Tundra Ponds
2011-09	Shorebirds and Invertebrate Distribution on Delta Mudflats along the Beaufort Sea
2011-10	Anaktuvuk River Fire Monitoring
2011-11	Climate Change Vulnerability of Migrating Bird Species Breeding in Arctic Alaska
2011-13	Fostering Collaboration Across North America's Arctic
2011-14	Alaska LiDAR Data Processing - Colville to Staines River
2011-15	North Slope Land Cover
2011-16	Modeling avifaunal responses to climate change in North America's boreal-Arctic transition zone
2011-18	Integrating studies of glacier dynamics and estuarine chemistry in the context of landscape change in the Arctic Refuge
2011-19	Secure Data Services - Improved Data Sharing Through Accountability
2011-21	Changing Seasonality of Invertebrate Food Resources across the Arctic Coastal Plain
2011-22	BioMap Alaska - Citizen Science for Alaska's Oceans

Project ID	Project Title
2012-01	WEAR ShoreZone and ShoreStation Surveys NPS
2012-02	SNOWDATA: Snow Datasets for Arctic Terrestrial Applications (Alaska Arctic LCC Distributed Snow Property Datasets)
2012-03	Arctic LCC Facilitation for Current and Future Resource Management and Science Needs
2012-04	ShoreZone Program on the North Slope of Alaska
2012-05	North Slope Alaska Admiralty Bay LiDAR
2012-06	Biological Responses to Increasing Water Temperatures in Lakes of the Barrow/Atqasuk Focus Watershed
2012-07	Interdisciplinary Study of How Climate Change May Affect Wetland Habitats and the Associated Waterbirds
2012-08	Towards an Integrated Study Plan Focusing on Aquatic and Wetland Habitat and Biological Responses to Climate Variability and Change
2012-09	How Will Marine Food Webs in the Coastal Arctic Respond to Increased Runoff Associated With Permafrost Melt?
2012-10	Permafrost Database Development, Characterization, and Mapping for Northern Alaska
2012-11	Historical Orthomosaic, Digital Surface Model, and Shoreline Position for the Northern Alaska Coastline
2012-12	Evaluating the 'Bottom Up' Effects of Changing Habitats: Climate Changes, Vegetative Phenology, and the Nutrient Dynamics of Ungulate Forages
2012-13	Streamflow Monitoring on Upper Kuparuk and Putuligayuk Rivers
2012-15	Thermokarst Monitoring at the Landscape Level: a Feasibility Study
2012-1001	Arctic LCC Project Tracking System
2013-01	Terrestrial Environmental Observation Network
2013-02	Response of an Arctic Freshwater Ecosystem to Climate and Land-use Change
2013-03	North Slope Coastal Imagery Initiative
2013-04	Arctic Coastal Impressions
2013-05	A Sense of Place: Inupiat Knowledge of the Coast using Aerial Imagery
2013-06	St. Lawrence Island ShoreZone Mapping
2013-07	Implementation of the Coastal Vulnerability Module for the North Slope Shore Zone Mapping
2013-08	Imiq - Hydro/Climate Database: Migration to Open Source Platform and Creation of Map Service Interfaces and Displays

Appendix 6: Top 30 anticipated future data and information needs as indicated by stakeholders in Arctic Alaska, as reported in the Arctic LCC Future Needs Assessment project.

	Top 30 anticipated future data and information needs	Rank index[1]	Arctic LCC projects and efforts that address anticipated information and data needs
1	Fish and wildlife - effects of environmental change on fish and wildlife habitat use patterns	4.42	2010-01, 2010-02, 2010-03, 2010-04, 2010-05, 2010-06, 2010-08, 2010-09, 2010-11, 2011-01, 2011-02, 2011-03, 2011-05, 2011-07, 2011-08, 2011-09, 2011-10, 2011-11, 2011-16, 2011-21, 2012-02, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12
2	Hydrology / Hydrography - baseline mapping of surface & groundwater dynamics & distribution; modeling, forecasting	4.30	2010-03, 2010-04, 2010-05, 2010-06, 2010-07, 2010-08, 2010-09, 2010-12, 2010-13, 2011-03, 2011-05, 2011-15, 2011-18, 2012-02, 2012-10, 2012-13, 2012-15, 2013-01, 2013-08
3	Coastal erosion - mapping, modeling, forecasting	4.10	2010-09, 2011-02, 2011-14, 2012-01, 2012-04, 2012-05, 2012-10, 2012-11, 2012-15
4	Community subsistence harvest - systems, change	4.05	2011-07, 2011-22, 2012-12
5	Permafrost (and soils) - mapping, modeling, forecasting	4.03	2010-05, 2010-09, 2012-10, 2012-15, 2013-01
6	Season length - freeze-up, breakup, green-up date	4.02	2010-01, 2010-05, 2010-06, 2010-08, 2010-09, 2010-12, 2010-13, 2011-05, 2011-08, 2011-21, 2012-02, 2012-06, 2012-07, 2012-08, 2012-12, 2012-13, 2013-01, 2013-02, 2013-08
7	Sea level rise / coastal flooding	3.90	2011-02, 2011-09, 2011-14, 2012-01, 2012-04, 2012-05, 2012-11, 2013-06
8	Plant communities - predicted shifts in distribution and composition	3.88	2010-01, 2010-05, 2010-09, 2011-06, 2011-15, 2012-10, 2012-12, 2012-15, 2013-01
9	Outreach - policymakers, public	3.87	2011-07, 2011-13, 2011-22, 2012-03, 2013-04, 2013-05, contributions to Integrated Arctic Management report and NFWPCAS[1], Interior Arctic Coordination Group
10	Explore and describe linkages between physical drivers and biological responses	3.78	2010-02, 2010-05, 2010-06, 2010-11, 2011-01, 2011-08, 2011-09, 2011-16, 2011-21, 2012-02, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12, 2013-01, 2013-02
11	Human dimensions of change - effects on residents of the Arctic (demographics, community locations, areas of human use & activity)	3.78	2010-05, 2010-06, 2010-07, 2010-09, 2010-13, 2011-02, 2011-07, 2012-04, 2012-06, 2013-05
12	Contaminants - baseline levels, risk	3.77	2011-07, 2012-08, 2013-01, 2013-02
13	Weather - trends, storms, waves, extremes	3.75	2011-02, 2011-03, 2012-02, 2013-01
14	Temperature - baselines, change, modeling, forecasting	3.63	2010-01, 2010-05, 2010-06, 2010-07, 2010-09, 2011-08, 2011-21, 2012-02, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12, 2013-01, 2013-02,

	Top 30 anticipated future data and information needs	Rank index[1]	Arctic LCC projects and efforts that address anticipated information and data needs
			2013-08
15	Trend analysis - to support decisions/stipulations/mitigation & monitoring that are adaptive to expected changes	3.56	2010-01, 2010-05, 2010-06, 2010-07, 2010-10, 2011-03, 2011-10, 2011-21, 2012-02, 2012-10, 2012-11, 2012-15, 2013-01, 2013-02
16	Modeling & forecasting; evaluation of the predictions over time	3.55	2010-01, 2010-02, 2010-05, 2010-09, 2011-01, 2011-02, 2011-08, 2011-16, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12
17	Fish and Wildlife - status and trends for specific species	3.46	2010-02, 2010-03, 2010-06, 2010-10, 2010-11, 2011-07, 2011-08, 2011-11, 2011-16, 2011-21, 2012-12, 2013-02
18	Coastal / nearshore ecosystem ecology	3.45	2011-02, 2011-09, 2012-09
19	Downscaled modeling - Models at sub-region or local area scale	3.45	2010-01, 2010-02, 2010-05, 2010-09, 2011-01, 2011-02, 2011-08, 2011-16, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12
20	Cultural Resources - Identify & expand inventory of high risk cultural resource areas	3.39	Not yet addressed
21	Sea ice - mapping, trend analysis, forecasting (and conversely, open water)	3.22	Outside LCC scope
22	Invasive species	3.21	2011-22
23	Precipitation	3.18	2010-01, 2010-04, 2010-05, 2011-03, 2013-01
24	Planning tools (for communities) that address climate change issues and effects	3.13	2010-01, 2010-05, 2010-06, 2010-09, 2011-01, 2011-02, 2011-07, 2012-11
25	Snow pack - depth, seasonality	3.12	2010-05, 2012-02
26	Data portal - integrated, cross-agency data storage and access	3.11	2010-10, 2011-19, LCC projects entered into NSSI data catalog and Data.gov.
27	Fish and wildlife - changes in behavior, phenology	3.05	2010-02, 2010-06, 2010-11, 2011-07, 2011-08, 2011-11, 2011-16, 2011-21, 2011-22, 2012-06, 2012-07, 2012-08, 2012-09, 2012-12, 2013-02
28	Fish assemblages	3.03	2010-03, 2010-06, 2010-07, 2011-02, 2013-02
29	Water quality	2.93	2010-04, 2011-18, 2012-07, 2012-08, 2012-09, 2013-02, 2013-08
30	Adaptation actions - Scenario planning to inform future adaptation actions (related to biological resources)	2.92	2010-01, 2010-05, 2010-09, 2011-01, 2011-02, 2012-02

[1]Rank index is a function of how responsive the Future Data and Information Need relates to the following topics: Arctic LCC mission/goals, applicability, scope, eco-cultural, timeliness, contribution, feasibility. See the Arctic LCC Future Needs Assessment Report for additional details regarding these parameters and the stakeholder interview process.

[2]National Fish, Wildlife and Plant Climate Adaptation Strategy