Western Alaska Landscape Conservation Cooperative

2011 Annual Report

INTRODUCTION FROM THE WESTERN ALASKA LANDSCAPE CONSERVATION COOPERATIVE STEERING COMMITTEE CHAIRPERSON

Dear Friends and Colleagues,

We are pleased to release the first annual report for the Western Alaska Landscape Conservation Cooperative (Western Alaska LCC or "the LCC"). This new LCC made great progress in 2011, its first official year of existence. The founding Steering Committee members, and the entities they represent, invested considerable time to ensure that the Western Alaska LCC built a strong foundation for its future. Some of the year's highlights include:

- Defining the Mission, Goals and Guiding Principles for the LCC. These help focus the LCC on previously unmet needs in delivering applied science and information to land and resource decision-makers interested in understanding and managing for climate change effects.
- Utilizing information from a wide-range of potential partners throughout western Alaska to develop the LCC's initial direction from community meetings held in late 2010.
- Establishing a Science and Traditional Ecological Knowledge community group, and a Partnership community group, to help ensure broad representation and input into the LCC's future decisions.
- Taking strategic planning steps to ensure that the LCC's science activities are directed at addressing the needs of land and resource decision-makers.
- Bringing together 150 decision-makers, researchers, and local experts to identify priority science needs linked to climate change effects on the region's geophysical and ecological processes and the key biological resources those changes may effect.
- Using those recommendations to help select 12 projects for funding in 2011, with nine focused on baseline or foundational science needs at the geophysical and landscape system levels and three projects addressing needs at the biological and human system levels.
- Working with the project principal investigators to maximize integration among their efforts and improve efficiency.
- Launching a major effort to contact all 116 Tribal Councils within the geographic area, and establishing a charter that includes seats to represent Alaska Native perspectives.

By the end of 2011, the Western Alaska LCC had established all of its primary initial governance documents and began to consider how best to move forward. Although our Science Workshop produced great recommendations to guide the LCC's activities, further prioritization is required to develop the LCC's long-range science strategy. While we do this planning the 2012 & 2013 project funds will be focused on a short-term pilot program on *Changes in Coastal Storms and their Impacts* and a "mini" pilot program on *State-wide Hydrological Discussions*. These programs will demonstrate the effectiveness of the LCC in addressing commonly-shared science needs associated with system-level climate change effects. The programs have already produced important collaborations with the Alaska Climate Science Center and other key partners.

For those of you who have actively participated in the Western Alaska LCC already, we thank you for your involvement. For those of you interested in joining the LCC partnership and working to meet its mission and goals, we look forward to the opportunity to work with. Please join our LCC Mailing list at http://www.arcus.org/western-alaska-lcc/mailing-list to stay current on the Western Alaska LCC activities and opportunities.

Sincerely,

Amy Holman
Western Alaska LCC Chairperson
NOAA Alaska Regional Coordinator

Western Alaska Landscape Conservation Cooperative

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BACKGROUND

The Western Alaska Landscape Conservation Cooperative (Western Alaska LCC) is one of five Landscape Conservation Cooperatives (LCCs) that cover the vast expanse of Alaska. The Western Alaska LCC covers the least studied, and least understood, ecological regions of Alaska (Figure 1). It spans over 750 miles from north to south, including permafrost-dominated landscapes, glacier-covered mountains, complex and massive river deltas, volcanoes, forests, tundra and low shrublands. These dynamic landscapes border three seas including the southern extent of the Chuckchi Sea; the mainland edges of the Bering Sea; and the southwestern extent of the Gulf of Alaska (part of the Pacific Ocean).

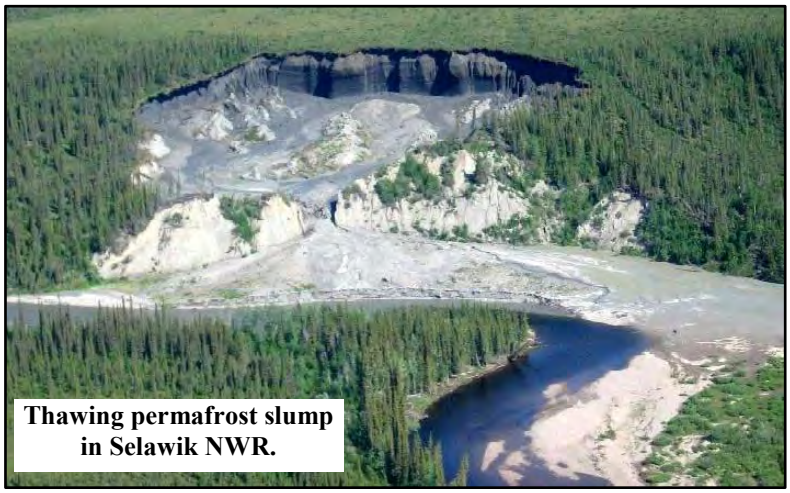
Figure 1. The Western Alaska LCC region stretches from the continuous permafrost and coastal tundra of the Kotzebue lowlands to the volcanoes of the Alaska Peninsula and the fjords of Kodiak Island.

The region contains a diverse array of plant communities, including alpine, forests, tundra and wetlands, and one of the world's most important breeding areas for migrating waterbirds (Spencer et al. 1951, Gill and Handel 1990). Western Alaska streams are home to the world's largest natural runs of Pacific salmon. These landscapes are the habitat of five herds of caribou, as well as populations of moose, brown and black bears, muskoxen and wolves. In the marine ecosystem, pollock, cod, flatfish, halibut, crab, and salmon are abundant, and these fisheries provide more than half of the seafood consumed in the U.S. While the marine system, by itself, is not the focus of the Western Alaska LCC, its linkages to the coastal and terrestrial systems are important to support both healthy terrestrial

and marine systems. Millions of seabirds from more than 30 different species breed and summer here. Tens of thousands of marine mammals, including sea otters, seals, Pacific walrus, and whales depend on this important region.

Although the Western Alaska LCC area is isolated from the major road system in Alaska, it includes 116 of the 229 federally recognized Alaska Native tribes. This reflects the area's rich natural resources and cultural history and highlights how important humans are as part of the overall natural ecosystem. Villagers throughout this LCC practice a subsistence lifestyle that depends upon the continued health of terrestrial, freshwater and marine systems.

The effects from changing climate have become a major concern in western Alaska with notable shifts in environmental conditions related to permafrost stability; the rate of coastal erosion; species distribution and behavior patterns; the expansion of trees and shrubs into tundra regions; and changes in hydrological conditions, among others changes. These changes are predicted to accelerate over the next century and represent a major challenge to residents and the land and resource managers preparing for future conditions (Appendix A).



Thawing permafrost slump in Selawik NWR.

GOVERNANCE

Landscape Conservation Cooperatives are self-directed partnerships governed by a Steering Committee which serves as the decision-making body. Alaska is unique from the rest of the country in that this 365 million-acre region has less than 700,000 permanent residents. This creates some wonderful advantages in improved coordination across partners, but also creates disadvantages related to the smaller pool of staff and experts available to dedicate time to collaborative conservation efforts. To maximize efficiency across the LCCs that occur within Alaska, the Western Alaska LCC governance is tiered off of the Alaska Climate Change Executive Roundtable (ACCER). This roundtable was established in 2007 as a forum for Federal and State science agencies in Alaska to share information about climate change. The ACCER is comprised of senior level executives and meets regularly to share information and facilitate cooperation among agencies. The ACCER appointed regional/statewide representatives to serve on a Climate Change Coordinating Committee (C4) which is tasked with ensuring coordination across the five LCCs in Alaska, the DOI Alaska Climate Science Center and the climate services programs within NOAA. More information about the ACCER can be found at: http://soa.arcus.org/abstracts/alaskas-climate-change-executive-roundtable-coordinating-federal-and-state-agency-efforts- Adjustments in

these relationships are expected with the establishment of a National Council for the LCCs and role changes for C4 currently under discussion in 2012.

Mission Statement:
The Western Alaska Landscape Conservation Cooperative promotes coordination, dissemination, and development of applied science to inform landscape level conservation, including terrestrial-marine linkages, in the face of landscape scale stressors, focusing on climate change.

The Western Alaska LCC Steering Committee is comprised of the State of Alaska, eight federal agencies, and three seats to represent Alaska Native perspectives. The Steering Committee is led by a Chair and Vice Chair positions that alternate between state and federal members of the steering committee. Most Steering Committee members hold unit or program leadership positions within their agencies/organizations (e.g. Park Superintendent, Refuge Manager etc.). The full Steering Committee Charter is posted on our website at: http://www.arcus.org/western-alaska-lcc. Appendix B provides a listing for the current Western Alaska LCC Steering Committee members. As of January 2012, the three seats to represent Alaska Native perspectives are filled by interim Steering Committee members while the LCC staff complete an intensive effort to personally contact all 116 Tribal Councils and the major Regional Native Associations and Regional Corporations within the LCC geographic area.

Universities and non-governmental organizations (NGOs) are also important partners in the Western Alaska LCC (Appendix B). It is from these groups, as well as agency staff and other conservation partnerships, where the Western Alaska LCC seeks assistance to develop important recommendations for the Steering Committee to assist them in governing the LCC. Although still early in their development, the Western Alaska LCC charter describes a "Science and Traditional Ecological Knowledge Community" and a "Partnership Community" which will eventually become the backbone of future workgroups for the Western Alaska LCC.

The Steering Committee developed and approved a mission, guiding principles and goals document (Appendix C) of the Western Alaska LCC. The mission for the LCC states that "*The Western Alaska Landscape Conservation Cooperative promotes coordination, dissemination, and development of applied science to inform landscape scale stressors, focusing on climate change.*" The five guiding principles clearly state how the Western Alaska LCC will operate to ensure that all partner mandates and jurisdictions are respected; how we will add value, not duplicate, existing partnerships; that our focus is on solving biological, physical and sociological issues to promote adaptive management; that we respect social, political and legal limitations in our efforts to promote solutions to climate change and related stressors to benefit the western Alaska conservation community; and, that we operate with transparency and provide access to process and products.

Five goals were established for the Western Alaska LCC by the founding Steering Committee members. These goals (Appendix C) emphasize the importance of the LCC in communicating climate change effects to wide audiences; supporting coordination and collaboration amongst partners; identifying and supporting research etc. to address common information needs; enable greater synthesis of information

at broad spatial scales; and to provide applied science and technology transfer to decision makers to enhance resource management in western Alaska.

BUILDING THE LCC FOUNDATION

The Interim Steering Committee agreed upon a three-pronged approach to establishing the initial direction for the Western Alaska LCC. Variations of this process have been adopted by other LCCs around the country because it provided a deliberative and transparent approach to guiding development.

Stage One – Outreach and Scoping

In late 2010, the Western Alaska LCC Coordinator and facilitators from the Arctic Research Consortium of the United States (ARCUS) visited seven of the larger communities in western Alaska and held meetings in Fairbanks and Anchorage. These visits were designed to introduce the LCC vision to potential partners and to learn from residents in western Alaska what climate change impacts they are observing and what role they believed would best be served by the new Western Alaska LCC. Four of the meetings (Kotzebue, Nome, Bethel and Fairbanks) were co-led by the Bureau of Land Management who was simultaneously launching its Rapid Ecoregional Assessment for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands (for more information about this project see: http://www.blm.gov/wo/st/en/prog/more/climatechange/reas/seward.html), which overlapped the northern 1/3rd of the Western Alaska LCC area.

The results of these meetings are summarized in a *Synthesis Report of Local Meetings* (http://www.arcus.org/western-alaska-lcc/local-meetings). The major findings from these meetings included the identification of themes related to observed changes that are believed to be linked to changing climate. The most frequently described themes included:

CHANGES IN SPECIES AND ECOLOGICAL PROCESSES

- Changes in species abundance and migration patterns
- Changes in hydrological dynamics
- Coastal erosion
- Vegetation changes, with particular emphasis on shrub expansion into tundra systems
- Observations of new species and of new behaviors in local species

INFORMATION NEEDS

- Baseline data of species and their habitats
- Habitat and species vulnerability assessments
- Climate patterns at regional scales
- Subsistence use and trends
- Hydrological data and mapping
- Permafrost change documentation
- Geospatial baseline maps

KEY RECOMMENDATIONS TO THE WESTERN ALASKA LCC

- Integrate landscape-level observations with modeling
- Create a clearinghouse to discover, exchange and access information and data
- Improve coordination across agencies
- Collaborate on monitoring protocols and field efforts
- Fully integrate Indigenous knowledge and the participation of local residents
- Define clear roles and structure of the LCC
- Include NGOs and other non-Federal/State entities in process and structure.
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These results were fundamental in assisting the Interim Steering Committee in defining the Mission, Guiding Principles, Western Alaska LCC Goals (Appendix C), and in the development of the Charter.

Stage Two – Defining the Management Context for Applied Science

As is evident in the Western Alaska LCC mission and goals statements, this LCC is focused on increasing applied science for land and resource management with a focus on how changing climate will affect western Alaska. The Western Alaska LCC is not a decision-making body, but rather it aims to provide support in the form of data, information and science activities for the decision making agencies and entities involved in the LCC. One of the critical components in being able to achieve our mission is being able to articulate, and integrate, the needs of decision-makers with the interests of research and field scientists.

With support from the U.S. Geological Survey's (USGS) National Climate Change and Wildlife Science Center, the Western Alaska LCC brought in decision analysis experts to help the Steering Committee members identify the management context that should be the foundation for guiding the LCCs applied science activities. The two day process identified the broad types of decisions made by land and resource managers in western Alaska, and the common management or conservation outcomes that are most important to these decision makers when making those decisions. These outcomes areas are topics that the LCC science should be designed to measure, estimate, or predict.

These outcomes form the basis for very high-level objectives (e.g. *Maintain/promote/restore healthy ecosystem function)*. The first three of these outcomes are the most directly linked to the mission of the Western Alaska LCC.

Seven types of decisions commonly made by LCC partner agencies were identified during this workshop:

- ☐ Decisions about land and water use
- ☐ Decisions directly affecting habitat
- ☐ Decisions directly affecting species
- ☐ Decisions about cultural resources
- ☐ Decisions about setting quality standards
- ☐ Decisions about industry oversight
- ☐ Decisions about infrastructure and community development

The first four of these decisions represent the primary decision types for LCC focus.

Once the decision-types and the broad outcomes were identified, the Steering Committee members then identified several potential *attributes* that could be used as indicators of how well the objectives were being met. These can be thought of as measureable indicators that can be used to measure, estimate, and/or predict the impact of climate change on the high-level objectives. These attributes form the specific links between the priority science needs ultimately identified for the LCC (e.g., species composition at different trophic levels) and the

information that decision-maker truly feel they need to make better, more informed decisions (e.g., understanding ecosystem function). Identifying attributes revealed the strong connections underlying the eight outcomes.

Eight broad outcomes of management interest common to Western Alaska LCC partner agencies:

- Ecosystem function
- Habitat quality
- Population health (for individual species)
- Public health and safety
- Economic benefits
- Protection of culture
- Community stability
- Quality of outdoor experience

One of the many informative results from this workshop was a way to link the connections between themes/ issues/ science needs most strongly linked to the Western Alaska LCC's mission and how addressing those issues may also benefit decision makers for topics more closely tied to other categories of high-level objectives (e.g. public health and safety; economic benefits; protection of culture; community stability, and quality of outdoor experience). Figure 2 provides an example of these relationships. Notice how even if the LCC primarily focuses on objectives and attributes to benefit outcomes related to Ecosystem Function, Habitat Quality and Species Population and Health, other important needs within western Alaska will also benefit from the Western Alaska LCC products.

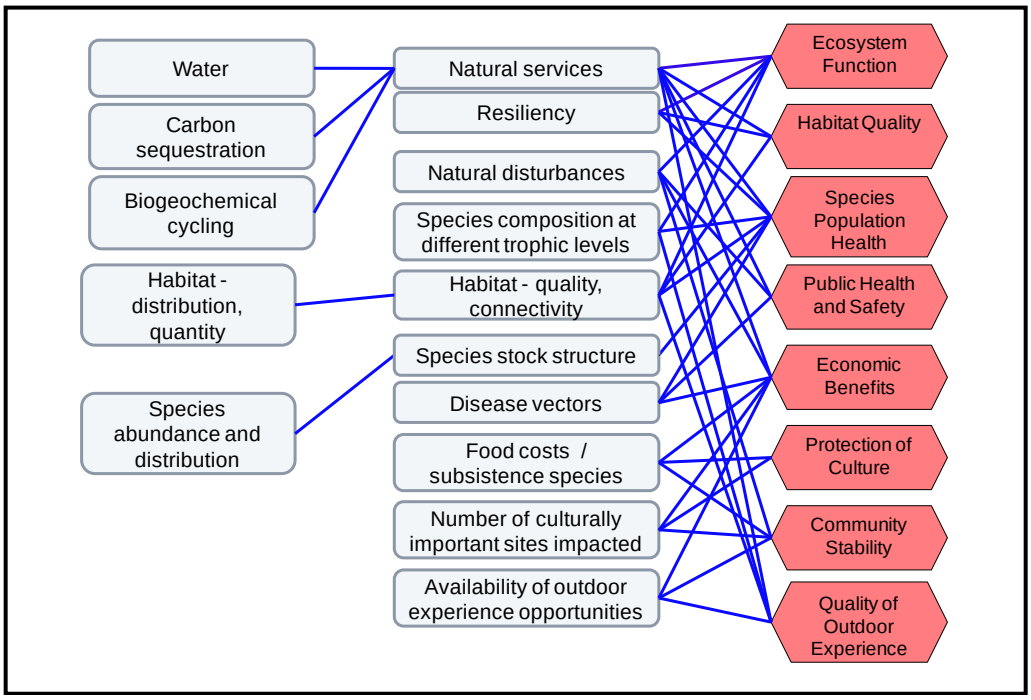


Figure 2 provides an example of the connections been decisions, attributes and objectives. More detailed information can be found in then *Decision Analysis Framing and Structuring for the Western Alaska Landscape Conservation Cooperative* (Jenni, K.E and T.L Nieman 2011. http://www.arcus.org/western-alaska-lcc).

Stage Three – The Western Alaska LCC Science Workshop

The management context workshop described above was an important step in structuring and developing the major Science Workshop we hosted in late April, 2011. Understanding and predicting the effects of climate change and other landscape-scale stressors is a complex and important problem and requires careful consideration of integrated science across multiple disciplines. Land and resource management agencies must make decisions today and in the future in the face of substantial uncertainties, and can benefit from improved understanding and better predictions. There are far more

and far greater uncertainties than there are time and resources to address them. The Western Alaska LCC is faced with deciding how best to target its limited resources and efforts in the face of near limitless information "needs." To maximize the benefit of LCC-supported science, it is important to connect potential science activities to the needs of land and resource managers and decision-makers, and then to use those decision-makers' needs to inform LCC science priorities.

With logistical and technical support from ARCUS and the USGS Alaska Climate Science Center-sponsored decision analysts, the LCC Science Workshop brought together approximately 150 scientists, managers and local experts, from a variety of disciplines and organizations that have been working in the Western Alaska LCC region, to identify climate change-related science information needs for land and resource managers in western Alaska. Given the LCC's focus on decision-relevant science, 'science needs' were defined as information that would reduce key uncertainties regarding the outcomes of interest to decision-makers. By addressing these shared needs, the Western Alaska LCC would help improve the ability of decision-makers to identify preferred management actions.

The workshop goal was to identify what is known and not known about the physical and biological processes that determine how alternative management actions affect the outcomes of interest, and to highlight what is known and not known about how landscape-level stressors such as climate change affect those processes. Emphasizing the connection between these potential information gaps or science needs and management decisions focused the discussions around *decision-relevant* uncertainties, and minimized detours into questions of keen interest to the participating scientists but not of much importance for actual land and resource management decision-making.

Specifically, the workshop participants were asked to identify the: i) entities (both *biotic* and *abiotic* and processes expected to change in ways that are *most important* to the shared management objectives (ecosystem function, habitat/species health) and ii) key uncertainties regarding these most important entities, and processes, and their expected responses to the predicted changes from changing climate. After focusing on geophysical and ecological processes, workshop participants were then asked to identify the most informative species and assemblages with respect to monitoring and predicting changes in the species of common management interest (in each taxa) arising due to changes in climate. The participants then identified the largest uncertainties regarding how these species/assemblages would respond to changes in climate.

The final workshop report will be available in late March, 2012, though the workshop materials and plenary presentations are available at http://www.arcus.org/western-alaska-lcc/spring-workshop-2011. Overall, the workshop participants winnowed over 150 identified science needs down to 47 common key science and information needs. These science needs clustered into three broad categories – data

collection; data integration and analysis; and data management, sharing and archiving (Appendix D). Eight of the top ten 'most important process changes' identified were associated with aspects of *hydrology* or *coastal processes*, the exceptions being *vegetation change* and *permafrost change.* In addition, each "taxa" breakout group identified approximately 10 priority species/assemblages or key habitats that should be considered by the Western Alaska LCC.

ADDRESSING SCIENCE/INFORMATION NEEDS

The results from the LCC Science workshop were immediately used for selecting projects to fund in 2011. The late Federal Budget cycle meant the Western Alaska LCC did not know it would receive funding support until April 2011. Nevertheless, in February the Western Alaska LCC Steering Committee advertised a broad Request for Proposals (RFP), contingent on the availability of funds, via our website and on www.grants.gov. The deadline was early April.

Seventy-nine proposals were received. The Steering Committee reviewed and evaluated them in April then met the week after the Science Workshop to select projects for funding. Although the Science Workshop results were not available to influence the RFP language, the project selection clearly reflects the influence of the priority needs identified and discussed at the Workshop. In all, 12 projects were funded totaling 1.3 million dollars (note: additional project support funding was provided by the U.S. Fish and Wildlife Service). These investments leveraged an additional 1.7 million dollars in matching contributions from partners.

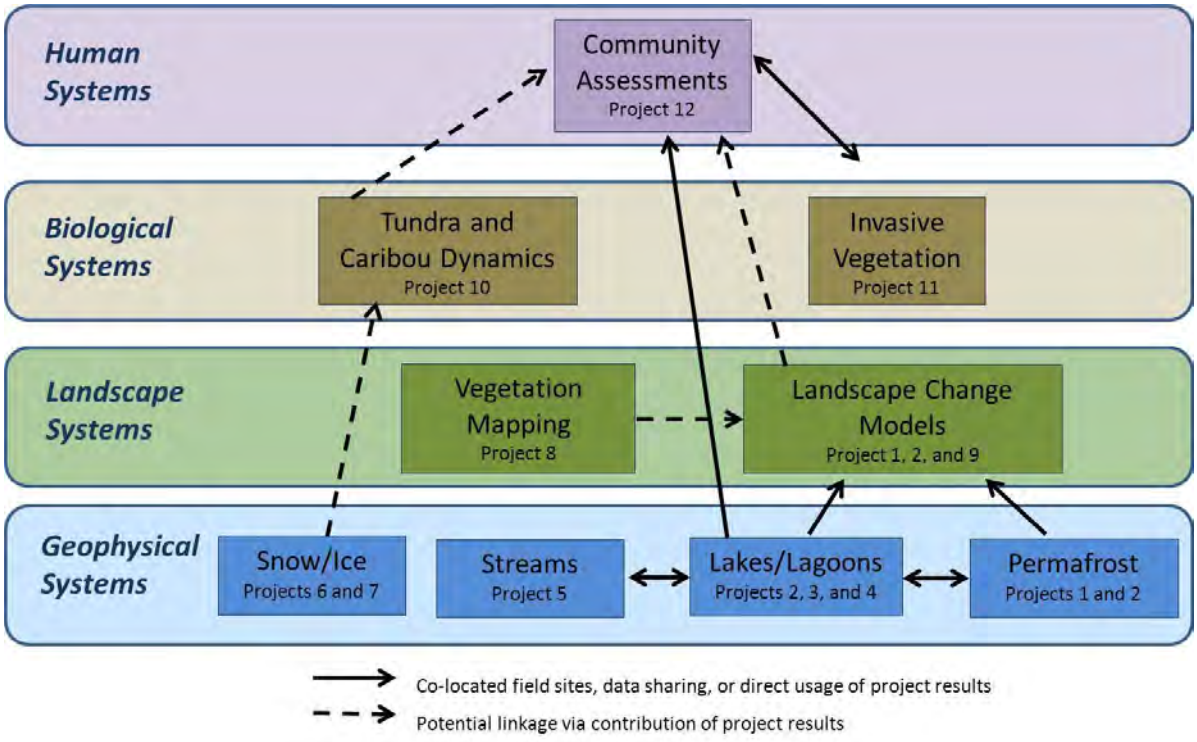


Figure 3: Relationships among projects funded by the Western Alaska LCC in 2011. Each box represents a major topic, and the project numbers linked to that topic.

The workshop results made clear the need for integrated science that will enable decision makers to consider how western Alaska *systems* are responding to climate change. As a result, the project funding decisions were largely focused on fundamental geophysical and landscape systems, with additional projects addressing key science needs in biological and human systems levels (Figure 3). The selected projects are described, very briefly, in Appendix E and in greater detail on our website (see the "Projects" tab). Figure 3 also shows the level of integration that was made in the selection of projects. The Principal Investigators associated with all of the projects linked by solid arrows in the graphic agreed to share data and or field activities to increase efficiency and integration of results. Most of the projects were initiated in October 2011; however, a few began earlier and interim results are expected from these in late 2012.

COLLABORATION WITH THE DOI ALASKA CLIMATE SCIENCE CENTER

The Alaska Climate Science Center (Alaska CSC) was established almost simultaneously with the establishment of the Western Alaska LCC and the two entities have collaborated closely since their inception. The Director of the Alaska CSC participates at all Steering Committee meetings, and the LCC staff provides feedback and coordination with Alaska CSC activities. Some highlights of this collaboration in 2011 include:

- **SHARED FUNDING** – In addition to supporting the Management Context and LCC Science Workshops, we also coordinated, through shared contracting, in host a Climate Downscaling Workshop that immediately followed the LCC Science Workshop and included some of the same participants. Along with the Arctic LCC, all three entities co-funded a major undertaking through the University of Alaska Fairbanks to integrate three independent predictive models into one functionally integrated model that will be more useful for managers. This is an on-going effort and is described as project #9 in Appendix E.
- **SUPPORTING PROJECTS** – The Alaska CSC coordinated with the LCC staff in Alaska to help identify projects to recommend for funding through USGS's LCC project support dollars. This resulted in funding a project to improve modeling of disturbance and vegetation change in tundra systems and a study to assess the potential for boreal bird species to expand into arctic and western Alaska. This information will help resource managers understand how community composition may change so they can anticipate potential effects.
- **SCIENCE PLANNING** – The initial and current annual science plans for the Alaska CSC strongly reflect the priorities and needs emerging through the Western Alaska LCC (as well as the other LCCs in Alaska). This is particularly true for the 2012 plan which is designed, in part, to help address the Western Alaska LCC pilot program goals.

SETTING THE STAGE FOR A MORE EFFICIENT AND EFFECTIVE WESTERN ALASKA LCC

Many of the formative tasks for the Western Alaska LCC were completed by August 2011: e.g. governance documents, identifying shared goals, shared science needs, gathering recommendations for priorities, etc.. This enabled the Steering Committee to begin making decisions about the long term management and science strategy for the LCC. Recognizing both

the desire for a more focused RFP for FY2012 and the time required to prioritize amongst the many needs identified at the LCC Science Workshop, the Steering Committee decided to concentrate 2012 and 2013 funding on two Pilot Programs designed to demonstrate how the LCC can add value to existing efforts in western Alaska by helping partners address shared science needs.

Pilot Program topics were solicited through the Steering Committee agencies/organizations. The Steering Committee then reviewed the topic suggestions in light of the priority needs identified at the LCC Science Workshop. They decided that the major focus of the FY12-13 Pilot Program would be on *Changes in Coastal Processes* with a "mini-Pilot Program" focused on *Hydrological Processes*. These were two of the three most important areas of uncertainty identified at the Workshop, and were priority needs for almost every taxonomic group.

Changes in Coastal Processes is a broad topic, so the Steering Committee convened an organizing team of 21 scientists, managers and local experts familiar with the region and the topic to refine program objectives, and identify key components, strategies and opportunities for leveraging. The team discussed the many ways changes in climate may cause changes in the physical drivers of coastal processes (i.e., storms, sea level rise, nearshore ice, tides, freshwater hydrology inputs, etc.) and potentially impact subsistence and other coastal resources. Ultimately, the team recommended focusing on *Changes in Coastal Storms and their Impacts*. Large changes in coastal storm characteristics (frequency, intensity etc.) are expected due to climate change. Storms have a wide range of impacts on local, regional, and national decisions and there is limited coordination occurring across a wide range of stakeholders, providing real opportunities to promote partner engagement, leveraging, collaboration and synthesis.

Six areas of emphasis were recommended for the first year of the Program on *Changes in Coastal Storms and their Impacts*: inventorying current activities; developing a conceptual model to help identify key uncertainties; improving understanding of coastal storm effects on important biological resources and how these may change under changing climate; promoting community based monitoring to enhance priority data collection; improving understanding of Shorefast Ice characteristics and dynamics (timing, duration, solidity etc.); leveraging opportunities to improve baseline data on key coastal processes. These recommendations were adopted by the Steering Committee and are the basis of the RFP released in January, 2012.

Hydrological Processes is similarly a broad and diverse topic. The primary focus of the "mini-Pilot Program" in 2012 will be stream and lake temperature data collection, monitoring and management. There is a high level of interest in sponsoring work that would improve understanding of how these parameters may change with climate, and the corresponding changes that may occur for the species dependent on these systems. However, these are topics of state-wide interest and therefore need to be addressed at that level, which poses a number of challenges. The Steering Committee felt that initiating the state-wide dialogue would better enable them to understand how the Western Alaska LCC can best assist in advancing science in this important topic. We will work with the Alaska CSC and through ACCER to begin this dialogue, with the hope that in 2013 we can support some strategic projects in western Alaska that will produce state-wide benefits.

FUTURE CHALLENGES

The Western Alaska LCC is poised to make significant progress in 2012. The new *Changes in Coastal Storms and their Impacts* pilot program is already leading towards new collaborative synergies amongst the LCC partnership as we look to develop the strongest, most integrated, program possible. The initiation of state-wide discussions involving five LCCs (and all the entities forming the LCCs), the Alaska CSC and several Universities on hydrological issues may well establish a pattern for addressing science needs that require an even broader level of coordination than already undertaken by an individual LCC.

In addition to the above opportunities, the Western Alaska LCC will further refine its priority science needs from those identified at the Science Workshop and select the most effective strategies for addressing them. This will occur as part of the LCC's long-term science and operational planning, making 2012 calendar year another important year in establishing the LCC. We recognize that challenges will arise as we explore options with a wide partnership of differing mandates and motivations.

There are immense challenges to overcome within western Alaska to assist resource managers in understanding and addressing the complex changes that will likely occur as the climate continues to warm. The LCC area has at least three regions driven by very different ecological processes (from permafrost in the north, to deltaic and discontinuous permafrost in the central region, to volcanic and glaciated systems in the south) with very sparse instrumentation and data to establish baseline conditions or document changes. The remote conditions (no road system) and logistical complexities of working in this region increase project costs significantly. These challenges are magnified in this time of declining budgets, both for all partner entities and the LCC.

In spite of these challenges, we feel confident of success given the LCC's progress so far and the partnership's shared concerns for the environment and common interests in efficiency and effectiveness. As we continue to see evidence of the effects of climate change across the landscape, the collaborative nature of the LCC will become increasingly important.

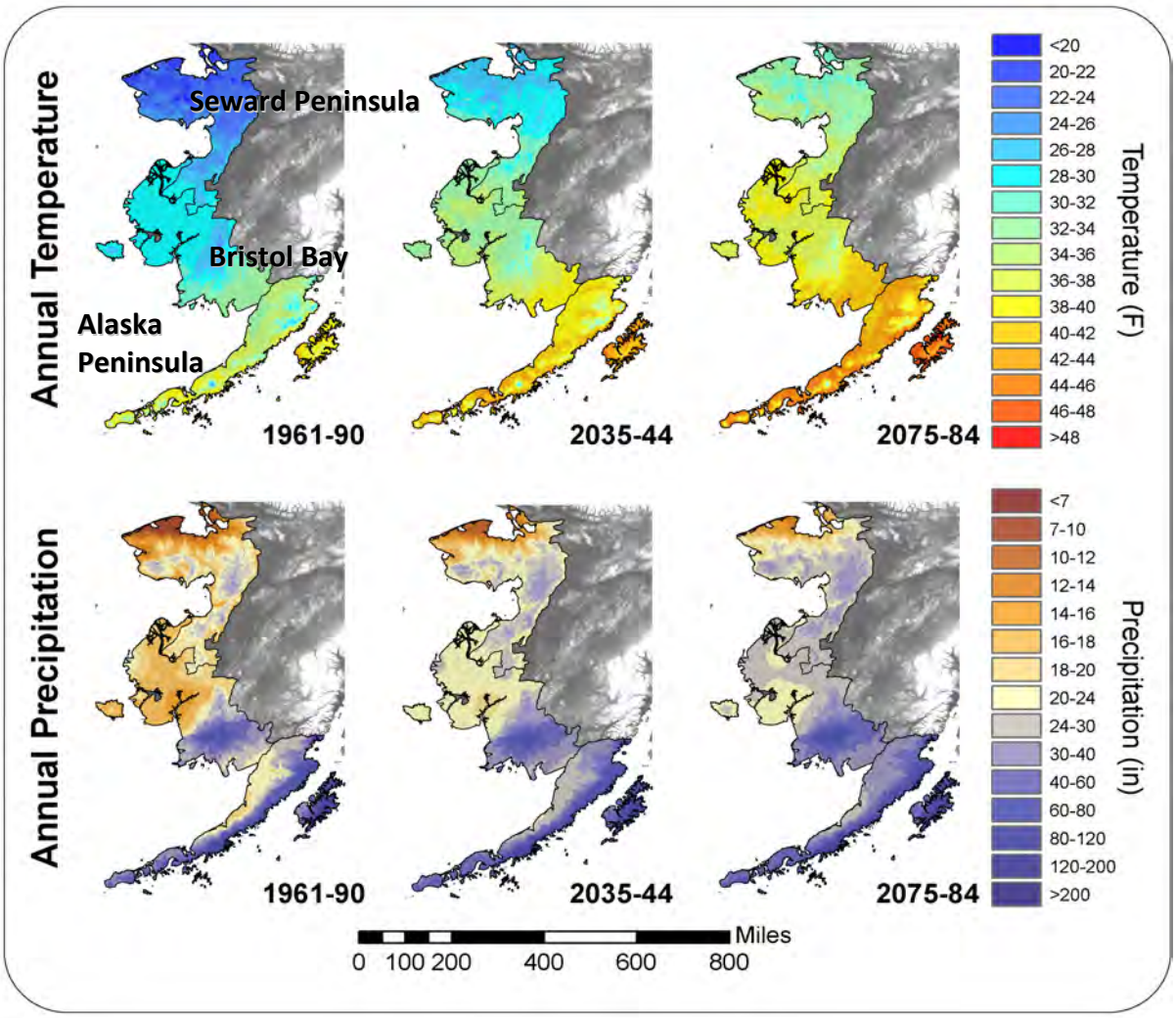
To stay current on the activities and opportunities within the Western Alaska LCC, please join our mailing list at our LCC website: http://www.arcus.org/western-alaska-lcc/mailing-list.

APPENDIX A

Provided courtesy of
The Wilderness Society and
the Scenarios Network for Alaska Planning (SNAP), University of Alaska, Fairbanks

Projected Climate Change:

Western Alaska Landscape Conservation Cooperative



	Temperature (°F)					Precipitation (in)				
	Average			Change		Average			Change	
	1960-90	2035-44	2075-84	2035-44	2075-84	1960-90	2035-44	2075-84	2035-44	2075-84
Annual										
Seward Peninsula	24	29	34	+5.5	+9.8	19	23	25	+4(19%)	+6(33%)
Bristol Bay	30	35	39	+5.1	+9.0	26	30	33	+5(18%)	+8(30%)
Alaska Peninsula	36	40	43	+4.3	+7.4	49	55	58	+6(12%)	+9(18%)
Winter										
Seward Peninsula	8	15	21	+7.6	+13.1	8	10	12	+2(24%)	+4(48%)
Bristol Bay	16	23	28	+7.0	+11.6	11	14	16	+3(24%)	+5(44%)
Alaska Peninsula	27	33	36	+5.6	+9.0	29	33	35	+4(14%)	+7(23%)
Summer										
Seward Peninsula	47	49	52	+2.5	+5.2	11	13	14	+2(16%)	+3(23%)
Bristol Bay	48	51	54	+2.4	+5.3	14	16	17	+2(14%)	+3(19%)
Alaska Peninsula	48	51	54	+2.5	+5.2	20	22	23	+2(10%)	+3(12%)

Climate Change Implications for the Western Alaska LCC

Many areas in Alaska are already showing signs of climate change. Scientists have reported observations of wetland drying, glacial and polar sea ice recession, spruce-bark beetle infestations, and an increase in fire frequency and intensity throughout the state. A better understanding of where and when such changes could continue to occur is needed to help decision makers identify how Alaska's ecosystems may respond in the future.

In order to understand what these changes may be like, data from a composite of five down-scaled global circulation models was used to estimate decadal averages of future temperature and precipitation values within the LCC's domain. These models assume a steady increase in carbon dioxide (CO_2) emissions from fossil fuel combustion over the first several decades of the 21st century, followed by a gradual decline in emissions as several kinds of low-emission energy alternatives become more prevalent. This emissions regime is considered a "moderate" estimate[1]. Several other scenarios have evaluated higher emission rates, and scientists have since determined current levels[2] are significantly greater than even the most extreme concentrations previously analyzed by the International Panel on Climate Change. Higher emissions rates will likely accelerate changes in climate and lead to more severe ecosystem impacts.

Temperature changes

Temperatures are projected to increase over the coming decades at an average rate of 1°F per decade. Average annual temperature is expected to rise by about 5°F by 2040 and nearly 10°F by 2080, with more extreme warming in the northern section of the LCC.

Considering the natural variation in temperatures across the LCC, this is likely to result in a transition from average annual temperatures below freezing (~24-30°F), to temperatures near or above the freezing point (~34 -39°F) for the Seward Peninsula and Bristol Bay regions. In the Alaska Peninsula, mean winter temperatures are also projected to move above the freezing point, increasing from ~ 27°F to ~36°F. A likely outcome of these changes is a lengthening of the growing season, a change that could have profound effects on wildlife mating cycles, plant growth and flowering, water availability in soil and rivers, and hunting and fishing.

Precipitation changes

Precipitation is projected to increase across the study area. Although summer rainfall is expected to rise by ~ 18-33%, this increase may not be enough to offset an increase in evapotranspiration caused by warmer temperatures and a longer growing season. Winter precipitation may increase by 25-50% and could fall in the form of snow, ice, or rain, depending on the temperature. Ultimately, the timing and intensity of precipitation will determine how these changes affect the landscape and hydrology across the LCC.

Uncertainty of findings

It is important to note that projecting changes in environmental variables is difficult, especially in Alaska where historical climate monitoring data is sparse. In general, there is greater confidence in modeling future temperatures than precipitation. In addition, accurately measuring precipitation, especially snow, is challenging in remote, windy parts of Alaska, so it might be more difficult to monitor and detect changes in precipitation.

In this analysis we have summarized 10-year averages of data from an ensemble of five models as an estimate of future conditions. The variation between models is sometimes as large as the mean, and so actual changes could be smaller or greater. Our analyses do not convey the impacts of extremes, which may have a greater ecological impact than the general trends of increasing temperature and precipitation shown here.

These results can be viewed as a plausible hypothesis of future climatic conditions, and can be used to guide plan research and monitoring programs that will measure and quantify the changes that are occurring across ecosystems within the Western Alaska LCC.

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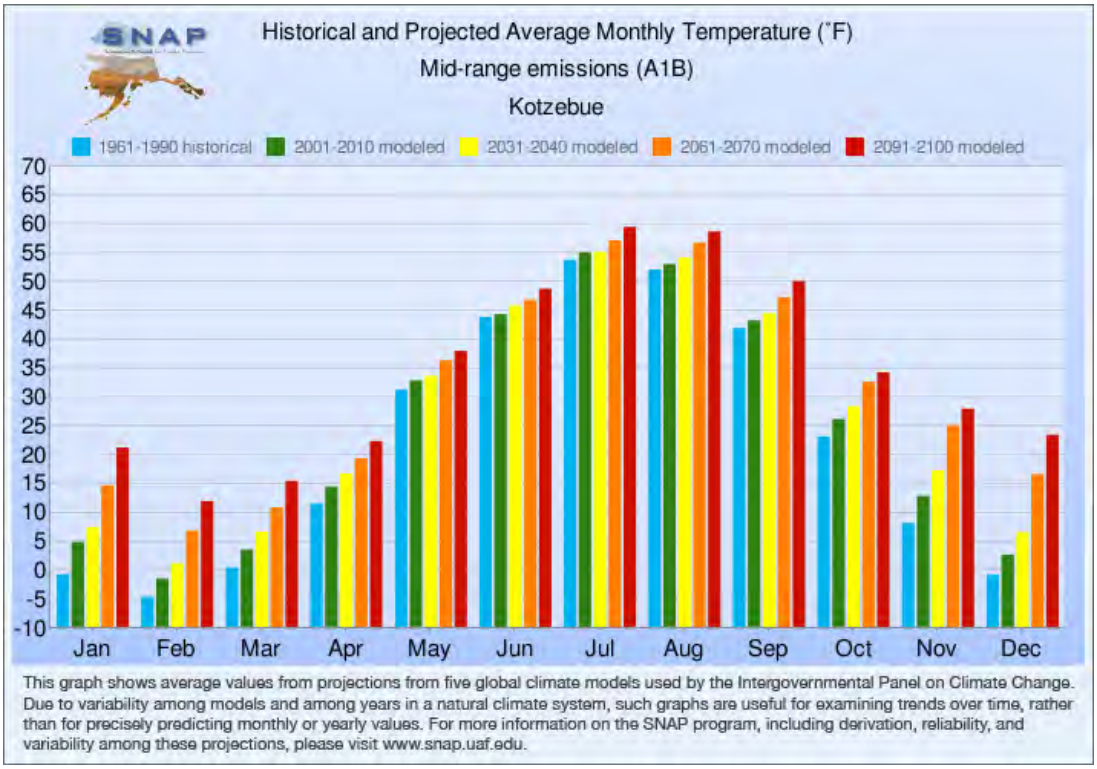
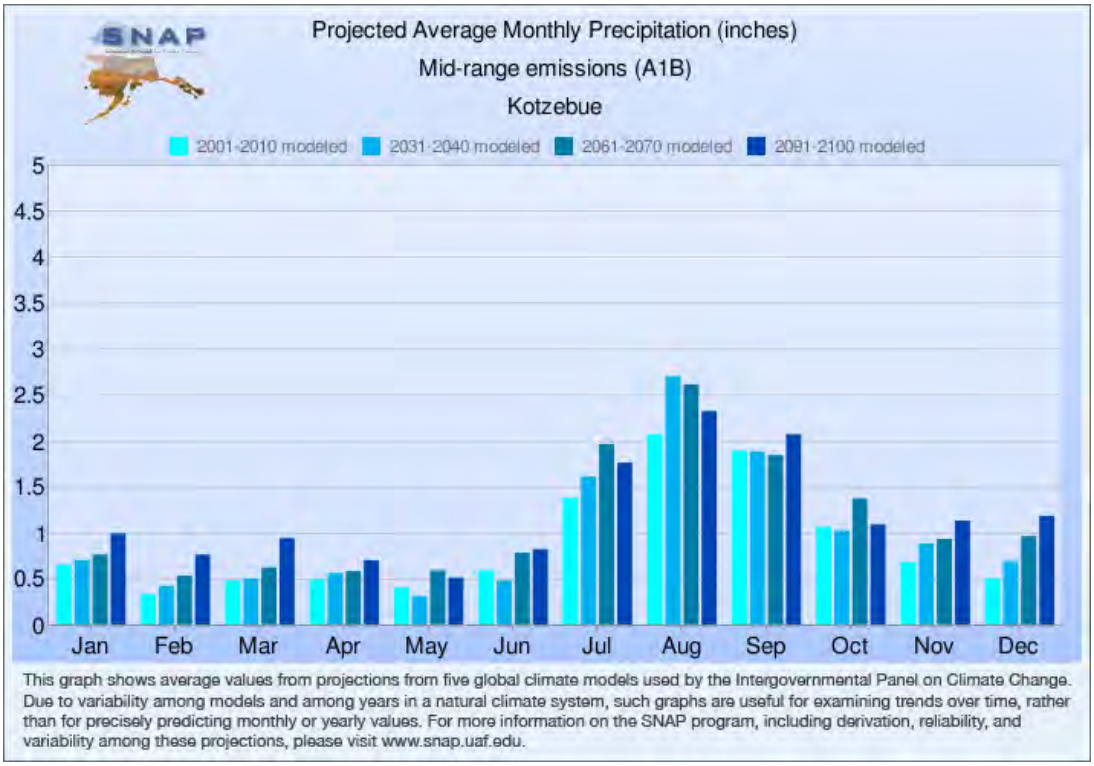
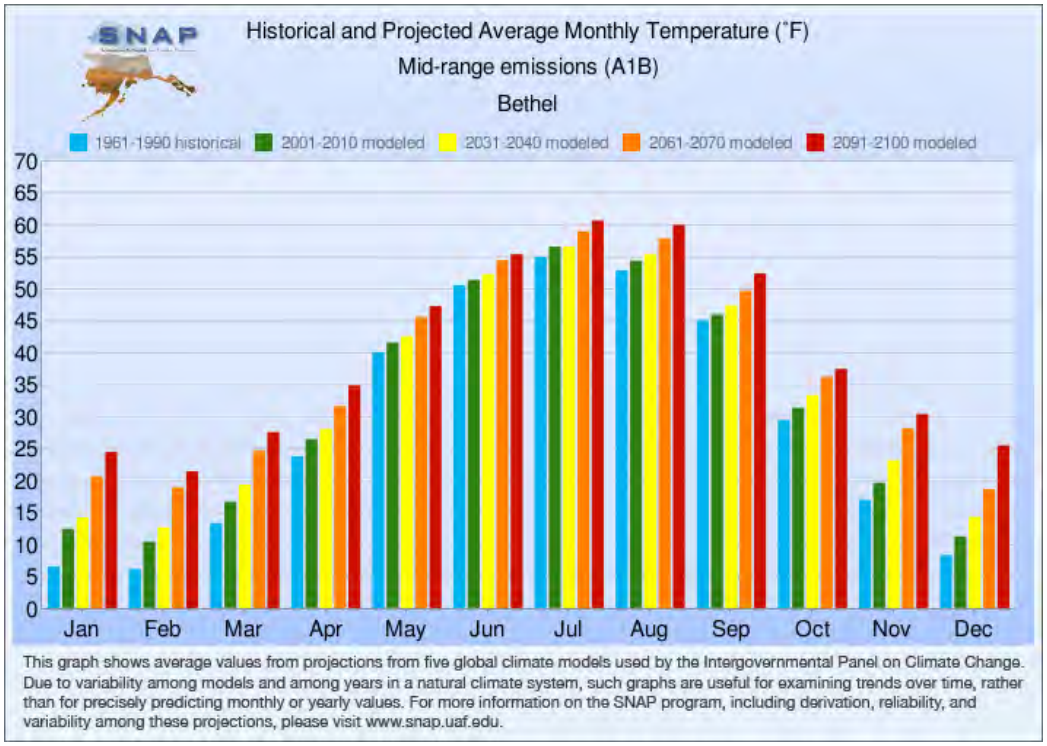
[1] *The emissions outlook is the A1B scenario from the International Panel on Climate Change (IPCC) Special Report on Emissions Scenarios published in 200; model projections are from the Fourth Assessment, published in 2007. The models used in this analysis included ECHAM5, GFDL-CM2.1, MIROC3.2 medium resolution, HadCM3, and CCCMA-CGCM3.1.*

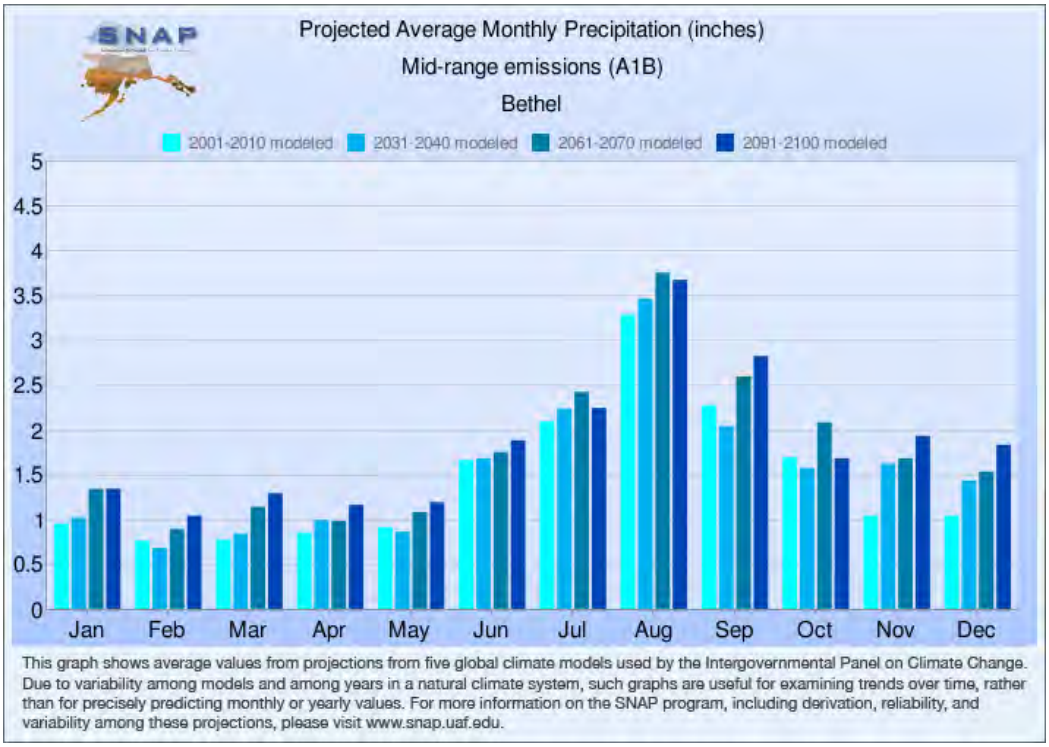
[2] *Atmospheric CO_2 levels are made available by the Carbon Dioxide Information Analysis Center (http://cdiac.esd.ornl.gov/trends/co2/contents.htm) and summarized on CO_2 Now (http://co2now.org/).*



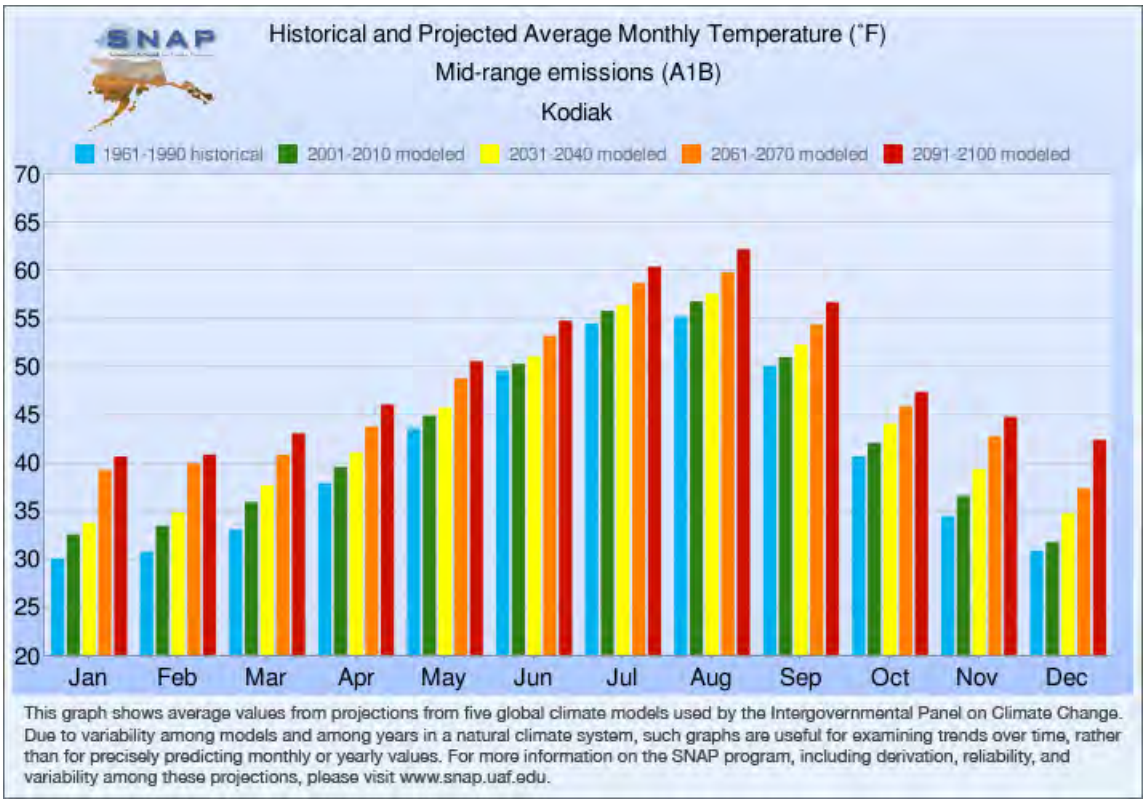


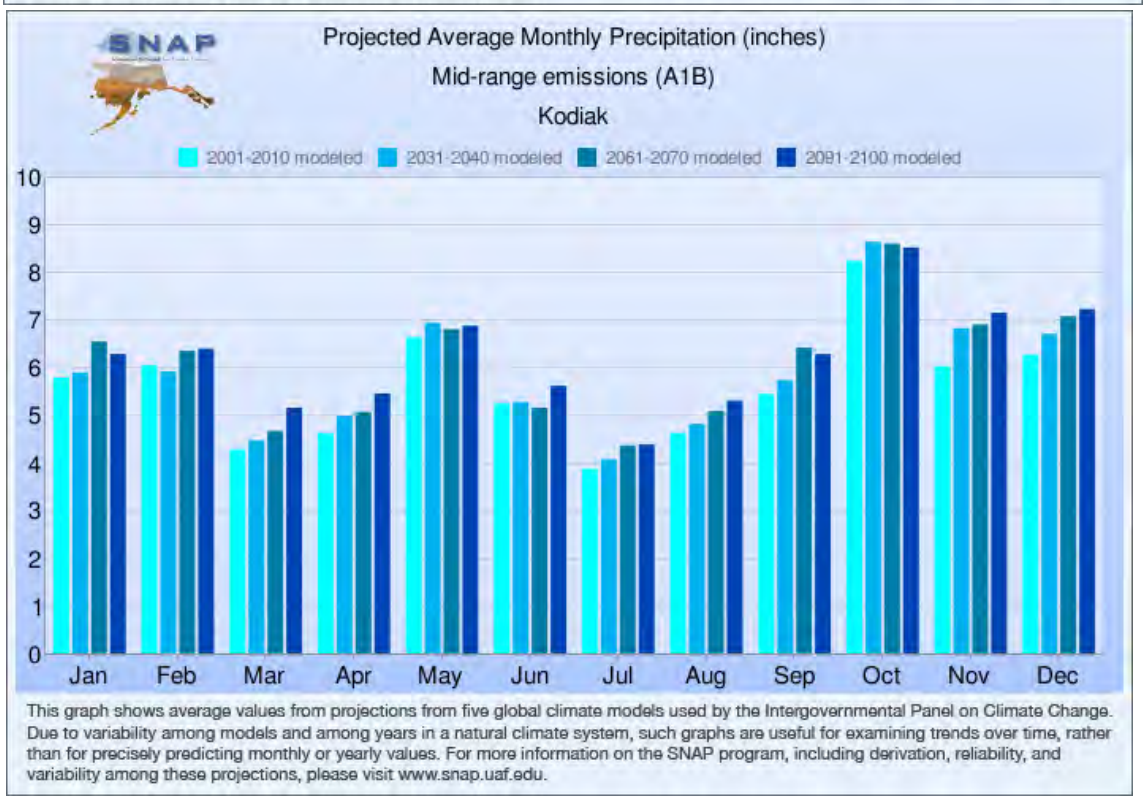
Expected changes in temperature and precipitation levels, Kotzebue, Alaska. Kotzebue is the most northern community is the Western Alaska LCC. Note the changes in temperatures in May and June and the shift from a below freezing mean temperature to one above freezing for December through March. Courtesy of SNAP, UAF.





Expected changes in temperature and precipitation levels, Bethel, Alaska. Bethel is a community within the delta of the Yukon-Kuskokwim Rivers, part of the 'central' region of the Western Alaska LCC. Note the changes in temperatures in May and June. Courtesy of SNAP, UAF.





Expected changes in temperature and precipitation levels, Kodiak, Alaska. Kodiak Island is located in the southwestern corner of the Gulf of Alaska. It is part of the "southern" geographic region of this LCC. Courtesy of SNAP, UAF.

APPENDIX B

Steering Committee Entities (contact names provided on website):

National Oceanic and Atmospheric Administration (Chair in FY12)
Alaska Department of Fish and Game (FY11 Co-Chair; FY12 Vice-Chair)
Aleutian Pribilof Islands Association (Interim member)
Association of Village Council Presidents (Interim member)
Kawerak (Interim member)
Bureau of Indian Affairs
Bureau of Land Management
Environmental Protection Agency
National Park Service
U.S. Army Corps of Engineers
U.S. Fish & Wildlife Service (Co-chair in FY11)
U.S. Geological Survey
DOI Alaska Climate Science Center (non-voting member)

Additional Participating Entities[1]:

- University of Alaska (Fairbanks and Anchorage)
- Alaska Natural Heritage Program
- ABR, Inc
- Alaska Ecoscience
- Alaska Native Science Commission
- Alaska Native Tribal Health Consortium
- Arctic Oceans Observatory System
- Audubon Alaska
- AK Department of Environmental Conservation
- Defenders of Wildlife
- Fisheries Research and Consulting
- USDA Natural Resource Conservation Service
- Northwest Arctic Borough
- Los Alamos Laboratory
- Idaho State University
- National Aeronautics and Space Administration
- University of Washington
- Alaska Department of Natural Resources
- Vienna University of Technology
- University of Nebraska-Lincoln

- U.S. Forest Service
- Colorado State University
- Alaska Association of Conservation Districts
- Pacific Coast Joint Venture
- The Nature Conservancy
- University of Nevada Reno
- The Wilderness Society
- Bristol Bay Health Corporation
- Bering Straits Native Corporation
- Calista Corporation
- Kawerak Inc
- Koniag Corporation
- Maniilaq Association
- Ekuk Tribal Council
- NANA Corporation

[1] This list continually expands.

APPENDIX C

Western Alaska
Landscape Conservation Cooperative

MISSION STATEMENT

The Western Alaska Landscape Conservation Cooperative promotes coordination, dissemination, and development of applied science to inform landscape level conservation, including terrestrial-marine linkages, in the face of landscape scale stressors, focusing on climate change.

GUIDING PRINCIPLES:

The WA LCC will operate under the following guiding principles:

- Consider and respect each participating organization's unique mandates and jurisdiction.
- Coordinate with other committees, workgroups or organizations that add mutual value, maximize capacity, avoid redundancies, and leverage resources.
- Focus on solving biological, physical, and sociological issues to promote scientifically sound, outcome-based, adaptive management.
- Respect social, political and legal limitations while promoting solutions to landscape-level stressors (climate and related) that benefit the greater Western Alaska conservation community.
- Be transparent in operations and ensure access to the Western Alaska LCC process and products.

WESTERN ALASKA LCC GOALS:

The goals are not presented in priority order.

- Promote communications to enhance understanding regarding effects of climate change in Western Alaska
- Support coordination and collaboration among partners to improve efficiencies in their common science and information activities,
- Identify and support research, and data collection, analysis, and sharing that address common information needs of land and resource management decision makers,
- Enable synthesis of information at landscape and larger spatial scales,
- Enhance resource management in western Alaska through applied science and technology transfer.

APPENDIX D

Table D1. Synthesis of identified science and information needs in the category of *Data Collection – Geophysical processes* (from the draft Western Alaska LCC Science Workshop Report). Needs are sorted by the number of groups that identified the need.

key: X - identified as priority need; / - raised in the group's report but not in final list of priorities.	Coastal Birds	Coastal Mar. Mammals	Landscape Ecology	Birds	Fish	Mammals
Maintain and expand hydrological stations (flow, water balance, temperature, etc.)	X		X	X	X	X
Expand weather stations; temperature data	X		X	X	X	
Precipitation data (establish water balance micromet stations, upgrade ppt gauges)	X		X	X	X	
Snow measurements/accumulation data; and snow timing (e.g. MODIS imagery)			X	X	X	X
Digital Elevation Models / topographic and bathymetric data (for: veg maps & models; sea level rise; landform processes): statewide, 2.5 m resolution [SPOT, etc.] (LCC should advocate for); coastal localized <1m [LIDAR]; localized <1m [LIDAR] @ high priority watersheds/ coastlines/ research sites	X		X	X		
Tide gauges / monitor sea level rise (LCC advocates for with relevant agency)	X		X	X		
Baseline conditions of water chemistry and temperature in lakes, rivers, streams	X			X	X	
(Coastal) storm monitoring (frequency, wind strength, direction, intensity)	X			X		
Permafrost distribution and changes				X	X	
Soil moisture baseline data, evapotranspiration rate data	X				X	
Sediment loads/transport by stream type (fish), in floodplains (birds)				/	X	
Wetland spatial data mapping			X	/		
Salinization extent and levels in coastal zones	X			/		
Baseline contaminants				X		
Acidification extent and levels in coastal zones	X					
Waterbody monitoring (lake drying, change in aquatic food resources)				X		
Coastal erosion / subsidence / sedimentation				X		
Soil carbon databases (can veg mapping & other efforts be linked to current C databases for modeling?)			X			
Surficial geological maps (LCC advocates for)			X			
Bedrock maps (LCC advocates for)			X			

Table D2. Synthesis of identified science and information needs in the category of *Data Collection – Biological (Species, Populations, Assemblages)* (from the draft Western Alaska LCC Science Workshop Report). Needs are sorted by the number of groups that identified the need.

key: X - identified as priority need; / - raised in the group's report but not in final list of priorities.	Coastal Birds	Coastal Mar. Mammals	Landscape Ecology	Birds	Fish	Mammals
Vegetation maps / fish habitat maps			X	X	X	
Baseline information on important species (seasonal distribution, abundance, etc.)	X			X		X
Other attributes of important species that could indicate climate-related changes (body condition, fat accumulation rates, health indices, disease rates, prey selection, etc.)	X	X		X		
Monitor "support species/communities" (e.g., birds - eelgrass, benthic inverts; c. mar. mam. - composition, timing, distribution of benthic inverts and zooplankton)	X	X		X		
Demographic traits of important species (survival, reproductive success, recruitment, etc.)	X	X				
Phenology (timing of nest initiation, migration, etc.)	/		X			
Surveys for invasive species			X			
Baseline species inventories			X			
Ecological site inventory (plant community, soils, hydrology, topography, etc.)			X			
Microbial species			X			
Information on beaver populations (rates of colonization, effects on different life stages of fish, etc.)					X	

Table D3. Synthesis of identified science and information needs in the category of *Data Integration and Analysis* (from the draft Western Alaska LCC Science Workshop Report). Needs are sorted by the number of groups that identified the need.

key: X - identified as priority need; / - raised in the group's report but not in final list of priorities.	**Coastal Birds**	**Coastal Mar. Mammals**	**Landscape Ecology**	**Birds**	**Fish**	**Mammals**
Linkages among physical, ecological processes, and important species **(birds:** species habitat utilization models; **fish:** species tolerance limits to water temperature & chemistry changes; **mammals**: species responses to changes in snow availability and cover; **c. marine mammals**: understanding dependence of important species on sea ice conditions)	X	X	X	X	X	X
Data Synthesis: analyze long-term population data (pop dynamics), migration data, distributions across landscapes; **data mining**: shrub encroachment via historic photos, tree ring analyses, etc.	X	X	X	X	X	X
Gap analysis for data on important species and/or physical/climate data	X	X	X	X	X	
Projections of climate-related changes in physical processes (hydrology, permafrost, erosion, storms, snow, contaminants release, fire regimes, etc.)	X			X	X	X
Projections of climate-related changes in vegetation			/	X	X	X
Assess & rank vulnerability of important species, including subsistence harvested species and vegetation communities, to projected climate changes (e.g., vulnerability, resiliency, adaptability, disease susceptibility and incidence)	/	X		X		X
Understand hydrological cycle changes and hydrological models	X			X	X	
Develop standard hierarchical vegetation classification for the region based on analyses of field vegetation data (in conjunction w/ Arctic LCC)			X			
Understand how changes in precipitation will impact steams (ground: surface water budget changes, timing, etc.)					X	
Understanding of how aquatic temperature/chemistry affected by air temperature and local conditions of geology, for lakes, rivers, streams (e.g., vulnerability analysis of fish habitat to climate changes)					X	
Successional models for poorly understood ecosystems			X			

Table D4. Synthesis of identified science and information needs in the category of *Data Management, Stewardship, and Access* (from the draft Western Alaska LCC Science Workshop Report). Needs are sorted by the number of groups that identified the need.

key: X - identified as priority need; / - raised in the group's report but not in final list of priorities.	Coastal Birds	Coastal Mar. Mammals	Landscape Ecology	Birds	Fish	Mammals
Improved data management, stewardship and serving (data sharing policies, better access, easier discovery of historic data, standardization, GIS interfaces, etc.)	X	X	X	X	X	X
Develop decision-support tools			X		X	/
Assess data quality and usability	X					
Mechanisms for collecting and disseminating local knowledge						X

Table D5. Synthesis of science strategy recommendations (from the draft Western Alaska LCC Science Workshop Report). Recommendations are sorted by the number of groups that identified the need.

key: X - identified as recommendation or need; / - raised in the group's report but not in final list of priorities.	Coastal Birds	Coastal Mar. Mammals	Landscape Ecology	Birds	Fish	Mammals
Expand collaborations with local residents		X	/	X		X
Collection and Use of Local and Traditional Ecological Knowledge		X	/	X		X
Long-term monitoring stations / sites / programs			X	X	X	
Clarify Information & Science needs of: decision makers; landscape change modelers; conduct formalized structured decision making to link management needs to monitoring and research data collection; develop conceptual models linking processes, species, and decision maker information needs	X			X		X
Improve collaborations between disciplines, agencies/entities to better leverage skills, funds, and resources	X	X		X		
Better utilize data from and build on existing data collection programs (process data from LTER, NEON, NSF; ADF&G, etc.)			X		X	
Better use of historic and paleo data	X	X				
Develop remote sensing tools			X		X	
Public outreach/communication regarding priorities, plans, projected changes, etc.				X		
Prevent introduction of invasives					X	
Study of species at edges of current ranges						X
Encourage external funded research at sites w/in LCC			/			

APPENDIX E

Collaborative projects funded by the Western Alaska LCC in 2011

Please see the Project Summary document that is posted on our website for a more complete description as well as an identification of the many partners involved in these projects.

1) Establishing a Distributed Permafrost Observatory in Western Alaska

Lead: Vladimir Romanovsky, Geophysical Institute, University of Alaska Fairbanks

Documenting changes in permafrost temperature and stability over time is essential for understanding ecological dynamics in the western Alaska permafrost zone. This project will establish a network of permafrost observatories within the Western Alaska LCC region, in the continuous/discontinuous permafrost boundary area. Active layer and permafrost temperature records will be used to produce a reliable high-resolution model of the present thermal state of permafrost and potentially its past and future changes within western Alaska.

2) Broad-Scale Lake and Permafrost Dynamics in the Western Alaska LCC Region

Lead: Guido Grosse, Geophysical Institute, University of Alaska Fairbanks

This project focuses on permafrost change and its effect on lake habitat change in major lake districts of the Western Alaska LCC. Land, resource, and wildlife managers as well as local communities in Western Alaska need spatially explicit information to determine past lake habitat changes, identify spatial patterns that could be correlated to climate, and project future habitat changes. Forecasting future changes will assist with developing habitat conservation plans and assessing the stability of freshwater resources for communities.

3) Thermal Response of Western Alaska Lakes and Lagoons to Past, Present, and Future Changes in Climate

Lead: Ben Jones, Alaska Science Center, US Geological Survey

Water temperature in lakes and lagoons play a key role in hydrology, water quality, ecosystem productivity, and suitability as habitat for aquatic organisms (salmon!) and the food webs that support many terrestrial species. The information and data products from this project will fill a fundamental data gap in western Alaska (lake and lagoon surface temperature trends and projections) and can be used by various land managers in climate change studies, habitat evaluations, and land and resource management.

4) Moored All-Season Vertical Temperature Arrays in Lakes of Kodiak, Togiak, and Alaska Peninsula/Becharof NWRs

Lead: Bill Pyle, Kodiak National Wildlife Refuge, US Fish and Wildlife Service

Water temperature monitoring is an essential part of lake management and can provide early warning signs of climate change effects using simple, low-cost techniques. The information and data products from this project will provide a framework for better understanding trend in the quality of lake environments in relation to climate change. All proposed study lakes are important and productive sockeye salmon habitat. These data feed directly into the thermal response project (Jones) described above.

5) Watershed Control of Hydrologic Sources and Thermal Conditions in SW Alaska Streams: A Framework for Forecasting Effects of Changing Climate

Lead: Daniel Schindler, School of Aquatic and Fisheries Sciences, University of Washington

A warmer and wetter climate will likely have a substantial effect on important aquatic resources in Western Alaska. This project will help provide an understanding of how current precipitation patterns (e.g., snow versus water) interact with watershed topography to control water sources to streams and,

therefore, their thermal regimes. Ultimately, it will provide a valuable and accessible model to help managers strategize for adapting to future warmer climates and to protect the aquatic resources of the region.

6) Timing and Extent of Winter Snow Thaw/Refreeze Events in Alaska 2001-2008
Lead: Ryan Wilson, The Wilderness Society, Anchorage
Mid-winter icing events have the potential to lead to population declines of grazing caribou and to some species of small mammals due to reduced survival and reproduction associated with restricted access or lack of forage. Population-level effects of icing events remain unclear partly due to limited information on icing events in Alaska. The assessment results will provide a baseline data set and remote sensing method both of which will have broad interest to a large community of users, allowing them to better understand the recent past, better link changes in ecological drivers and responses of wildlife populations, and helping them plan for the future.

7) Direct Snow Condition Monitoring at Key Ecological Sites in Remote Western Alaska
Lead: Anne Orlando, Selawik National Wildlife Refuge, US Fish and Wildlife Service
Climate change is likely to alter snow patterns and characteristics, impacting vegetation, hydrology, permafrost condition, wildlife, and the Alaskans who depend on these resources. Currently, many areas of western Alaska are lacking important data related to snowpack and snow conditions, including the prime winter range for the Western Arctic Caribou Herd (WACH). This project will help monitor snow conditions, which are vital to understanding and predicting landscape level impacts of climate change in western Alaska.

8) Develop an "Existing Vegetation" Map for the Western Alaska LCC Region
Lead: Michael Fleming, Images Unlimited, Anchorage
A consistently mapped vegetation data layer for Alaska is needed for conservation management entities across the state. This project will develop a baseline vegetation product using the same basic data and analysis methodology across the entire region. When combined with an ongoing USFS project, the majority of the state will be mapped using the same methodology. This revised data layer will provide an important tool for not only fish and wildlife management agencies but also for fire management, development projects, and climate change modeling.

9) Integrated Ecosystem Model for the Western Alaska LCC
Lead: T. Scott Rupp, Scenarios Network for Alaska Planning, University of Alaska Fairbanks
Initially funded by the Arctic LCC, this multi-year effort is integrating existing models of vegetation, disturbance, and permafrost into one complete ecosystem model for the state of Alaska. The project is supported by Arctic and Western AK LCCs, as well as the Alaska Climate Science Center. The model will integrate existing models on climate, vegetation, disturbance, hydrology, and permafrost components to improve understanding and provide accurate change projections to land managers and other groups.

10) The Tundra in Transition: Unraveling the Dynamics of Western Alaska Caribou-Tundra Ecosystems
Lead: Don Spalinger, Department of Biological Sciences, University of Alaska Anchorage
Tundra dynamics in southwestern Alaska are poorly understood, yet these systems are critical to support caribou populations. Caribou in southwest Alaska are an important subsistence resource and potentially an indicator of ecosystem function. Understanding the causes behind caribou population declines in the area needs to include an understanding of tundra dynamics and habitat quality. The five caribou herds in southwestern Alaska occupy climatically and topographically unique landscapes allowing a great

opportunity to identify habitat-limiting factors on caribou population dynamics. This project will establish baseline information of vegetation drivers and nutrient cycling that effect caribou population dynamics.

11) Assessing the Vulnerability of Western Alaska Ecosystems and Subsistence Resources to Non-Native Plant Invasion

Lead: Joan Hope, Alaska Association of Conservation Districts

To assess the vulnerability of a region to invasive plants, documentation of the presence or absence of invasive plants is necessary. This project will expand on work initiated by the EPA to identify invasive plants in rural communities in the Bristol Bay region. Between the two efforts, 26 villages will be inventoried for invasive plant species; this will provide both an essential baseline for understanding the potential impact from these plants and the opportunity to treat the existing populations before they invade new areas. The second part of the project, courtesy of a University of Alaska Fairbanks graduate student, will use these data to assess the vulnerability of important subsistence plants (blueberry and low-bush cranberry) to changes in pollination, as key insect species can be drawn to invasive plant populations.

12) Climate Change Health Assessments for Three Coastal, Riverine, and Lake System Communities

Lead: Susan Flensburg, Bristol Bay Native Association

Bristol Bay communities seek local scale information to mitigate negative climate effects and develop healthy methods for adaptation. Residents dependent on subsistence plant and wildlife species are concerned about threats to food and water resources, public safety, and infrastructure. This project will develop assessment reports about climate change issues related to the local environment for a community in each region (lake, riverine, coastal) that will help those communities address related issues, and provide information useful to neighboring communities.

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