

North Slope

Rapid Ecoregional Assessment

Memorandum I: Management Questions, Conservation Elements, and Change Agents



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Bureau of Land Management, 222 W. 7th Avenue, Stop 13, Anchorage, Alaska 99513-7504.

Submitted by:

Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage
Scenarios Network for Alaska Planning (SNAP), University of Alaska Fairbanks, and
Institute for Social and Economic Research (ISER), University of Alaska Anchorage

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Acronyms used in this document:

ACEC	Area of Critical Environmental Concern
ADF&G	Alaska Department of Fish and Game
AKGAP	Alaska Gap Analysis Program
AKNHP	Alaska Natural Heritage Program
AMT	Assessment Management Team
BLM	Bureau of Land Management
CA	Change Agent
CE	Conservation Element
ESRI	Environmental Services Research Institute
HUC	Hydrologic Unit Code
ISER	Institute of Social and Economic Research
MQ	Management Question
NPR-A	National Petroleum Reserve-Alaska
NOS REA	North Slope Rapid Ecoregional Assessment
REA	Rapid Ecoregional Assessment
SNAP	Scenarios Network for Alaska and Arctic Planning
Tech Team	Technical Team
TEK	Traditional Ecological Knowledge
TNC	The Nature Conservancy
USGS	United States Geological Survey
UA	University of Alaska
USFWS	United States Fish and Wildlife Service
GIPL	Geophysical Institute Permafrost Lab

Introduction

Project Overview

The Bureau of Land Management (BLM) recently developed a landscape approach to enhance management of public lands. As part of this landscape approach, the BLM and collaborators are conducting Rapid Ecoregional Assessments (REAs) in the western United States, including Alaska. To address current problems and future projections at the landscape level, the REAs are designed to transcend management boundaries and synthesize existing data at the ecoregion (or in the case of Alaska, combinations of generally similar ecoregions) level. A synthesis and analysis of available data benefits the BLM, other federal and state agencies, and public stakeholders in the development of shared resources.

REAs evaluate questions of regional importance identified by land managers and statuses of regionally significant ecological resources and change agents. The resulting synthesis of regional information assists management and environmental planning efforts at multiple scales. REAs have two primary purposes:

1. To provide landscape-level information needed in developing habitat conservation strategies for regionally significant native plants, wildlife, and fish and other aquatic species; and
2. To inform subsequent land use planning, trade-off evaluation, environmental analysis, and decision-making for other interconnected public land uses and values, including development, recreation, and conservation.

Once completed, this information will provide land managers with an understanding of current resource status and the potential for future change in resource status at near-term (15 year) and long-term (50 year) intervals.

The assessment area for the North Slope REA includes three ecoregions in arctic Alaska: the Beaufort Coastal Plain, Brooks Foothills, and Brooks Range including only the section of the ecoregion north of the crest of the range.¹ The North Slope Ecoregion includes ten isolated small communities. While Prudhoe Bay, a Census Designated Place (CDP) (2010 Population 2,174), is at the northern end of the Dalton Highway, the other nine communities can only be reached by air. Barrow (2010 Pop 4,212) is the main commercial and government seat of the North Slope Borough, and is the transportation and commercial hub of the region. These ecoregions have an arctic climate, with long cold winters and brief summers. Climate varies depending primarily upon elevation and proximity to coastlines, with extreme cold at high elevations, some seasonal moderation on the coast, and slightly warmer summers in the interior Arctic. With mean annual temperatures well below freezing in most areas, permafrost is almost continuous, except in isolated locations, usually associated with waterways. The ecosystems within the ecoregions are considered to be relatively intact as compared to most ecosystems in the contiguous United

¹ Ecoregions based on Nowacki et al. 2001.

States. However, large-scale human development, primarily associated with the oil, gas, and mining industries, exists in some locations within the North Slope REA.

The Alaska Natural Heritage Program (AKNHP), Scenarios Network for Alaska and Arctic Planning (SNAP) and Institute of Social and Economic Research (ISER), collectively referred to in this document as the University of Alaska (UA) Team, will assess the current and potential future status of selected regionally significant ecological resources, referred to as Conservation Elements (CEs), at the ecoregional scale and their relationships to Change Agents (CAs), those features or phenomena that have the potential to affect the size, condition, and landscape context of the CEs. Additionally, the UA Team will address Management Questions (MQs) that were selected by state and federal land managers to inform current and ongoing management decisions.

Phase I Objectives

Phase I, the Pre-Assessment Phase of the REA, includes three tasks that are prerequisite to finalizing the components of the Work plan and continuing to Phase II, the Assessment Phase. These include:

Task 3. Selection of MQs, CEs, and CAs and the development of a Conceptual Ecoregional Model.

Task 4. Collection and evaluation of data layers necessary to conduct the assessment, and the identification of current data gaps.

Task 5. Development of an approach to analyses, including methods, models, and tools.

Memorandum I Objectives

Memorandum I provides a summary of the selection of MQs, CEs, and CAs and correlates to the results of Task 3, Phase I, as identified above. Additionally, Memorandum I provides a synopsis of the ecological and socio-economic resources present in the North Slope Ecoregion, outlines the reporting units for results, and describes the Conceptual Ecoregional Model.

The objectives of Task 3 of Phase I are:

1. Define the geographic boundaries of the assessment area.
2. Develop a Conceptual Ecoregional Model to represent to ecosystem resources, functions, and drivers present in the North Slope Ecoregion.
3. Produce a list of ecoregion-specific MQs based on questions important to land managers.
4. Identify representative biotic constituents and abiotic factors that are either regionally-significant to ecosystems, as indicated by reference in the Conceptual Ecoregional Model, or regionally-significant to land managers, as indicated by reference in the MQs, to be analyzed as a CE.
5. Identify regionally-significant disturbance factors to be analyzed as CAs.

Assessment Area

Geographic Boundary

The assessment area, referred to in this REA as the North Slope Ecoregion, consists of the Beaufort Coastal Plain, Brooks Foothills, and Brooks Range north of the crest of the range (**Error! Reference source not found.**). These ecoregions are defined by Nowacki *et al.* (2001) and represent a unified mapping approach that blends traditional approaches (Bailey et al. 1994; Omernik 1987) with regionally-specific knowledge and ecological goals. The assessment boundary, following BLM guidelines, constitutes the three component ecoregions and any 5th level hydrologic units that intersect the ecoregion boundaries.

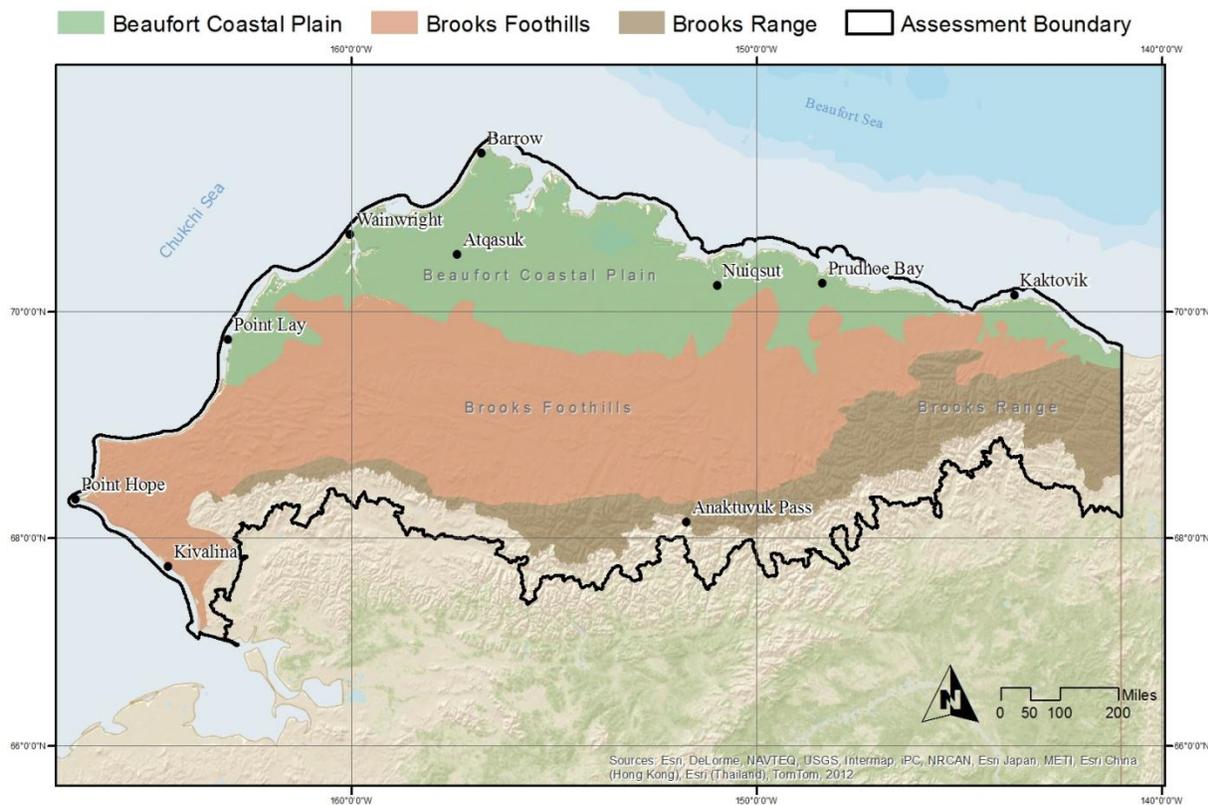


Figure 1. Ecoregions included in North Slope REA and study boundary.

Landscape Reporting Unit

As per BLM guidance, reporting units for the North Slope REA will be at the landscape level in scale and intent. For most analyses, the BLM has specified that data be reported at the 5th level 10-digit hydrologic unit code (HUC) with raw data being provided at 30 m grid cells for raster data or other native resolution as appropriate. Climate data will be provided at a resolution of 800 m grid cells and therefore any climate related questions will be answered at this scale as well. Many of the primary landscape level datasets for Alaska are also coarser than the 30 m pixel resolution recommended by the BLM (for example, the best

available resolution for Digital Elevation Model is at 60 m pixels). Thus the ultimate reporting unit of each analysis will be limited by the coarsest resolution of the data. In general, however, raw data will be provided at 60 m grid cell resolution, and results will be reported at the 5th level HUCs (Figure 2).

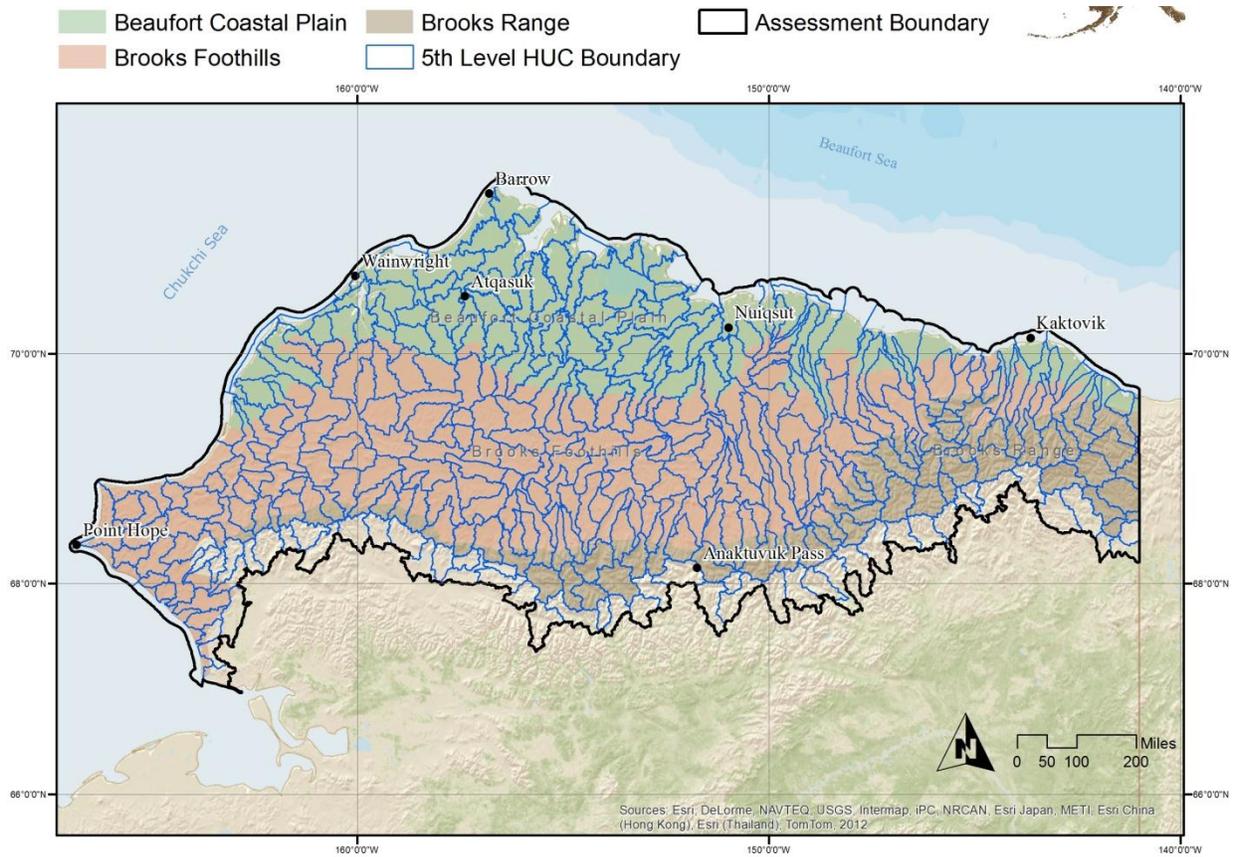


Figure 2. 5th Level HUCs within the North Slope Ecoregion.

Ecoregion Descriptions

The following narratives for each ecoregion are paraphrased from Nowacki et al. 2001. They provide general descriptions of ecosystem resources and drivers.

Coastal Plain

The Coastal Plain gradually ascends from the Arctic Ocean south to the foothills of the Brooks Range. Terrain is flat to undulating and underlain by unconsolidated deposits of marine, fluvial, glaciofluvial, and eolian origin. Climate is dry polar with short, cool summers and long, cold winters. Summers are frequently foggy because of close proximity to the Arctic Ocean. Annual precipitation is low and mostly falls as snow during the winter. Permafrost is continuous throughout the Coastal Plain except for under large rivers and thaw lakes. Permafrost and frost processes contribute to a large variety of surface features, such as pingos, ice-wedge polygons, and oriented thaw lakes. Soils are typically saturated mineral substrates and some have thick organic layers because permafrost prevents surface drainage. Thaw lakes cover up to 50% of the coastal plain and the entire region supports wetland communities. Vegetation is treeless and is dominated by wet sedge tundra, tussock tundra and sedge-dwarf shrub tundra. Low willows are abundant along well-drained riverbanks. Anadromous arctic cisco, broad whitefish, least cisco, and Dolly Varden char overwinter in the numerous large, braided rivers that originate in the Brooks Range. Smaller streams freeze completely in winter. During summer, fish migrate to nearshore waters. The coastal plain supports and serves as calving grounds for large caribou herds. Other herbivores include musk ox, lemmings, and arctic ground squirrels. Predators include gray wolves, arctic foxes, and brown bears. Polar bears den on the Coastal Plain. The region supports a wide variety of breeding shorebirds, ducks, geese, swans, and passerines. See Figure 3.



Figure 3. Photo of Coastal Plain.

Brooks Range Foothills

The Brooks Range Foothills consist of gently rolling hills and broad exposed ridges that extend along the northern flank of the Brooks Range. Narrow valleys and glacial moraines and outwash are interspersed among long, straight ridges and buttes composed of tightly-folded sedimentary rock. The surface is overlain with colluvial and eolian deposits. A dry, polar climate dominates the land, although it is slightly warmer and wetter than the Coastal Plain. Permafrost is thick and continuous. Slope related periglacial features such as solifluction lobes and stone stripes are common. Soils range from well drained mineral substrates to saturated organic horizons. The soil in the lower foothills is frequently basic while the soil in the upper foothills is often acidic. Dominant vegetation classes include expanses of shrub-sedge tussock tundra, willow thickets along rivers, and *Dryas* tundra on ridges. Calcareous areas support sedge-*Dryas* tundra. Braided streams and rivers are numerous and support large populations of arctic char and arctic grayling. Lakes are infrequent. Herbivores include caribou, musk ox, and arctic ground squirrels. Predators include gray wolves, brown bears, and peregrine falcons. See Figure 4.



Figure 4. Photo of Brooks Range Foothills.

Brooks Range

This east-west range is the northern extension of the Rocky Mountains. Accreted terranes originating from the Arctic Ocean underlie most of the range. The central portion of the range consists of steep, angular summits of sedimentary and metamorphic rock flanked by rubble and scree. Rivers and streams cut narrow ravines into the terrain. During the Pleistocene, the higher portions of the range were glaciated and remnant glaciers still remain in some cirques. Permafrost is continuous north of the crest of the range. The eastern and western portions of the range are less rugged. A dry, polar climate dominates the land. Winters are long and cold, and summers are short and cool. Temperature decreases rapidly with increasing elevation. Valleys and lower slopes north of the crest of the range are dominated by mixed shrub-sedge tussock tundra with willow thickets along rivers and streams. Higher elevation slopes and ridges are dominated by alpine tundra or are largely barren. Arctic grayling occur in groundwater-fed springs and streams.

Herbivores include dall sheep, marmots, and caribou. Predators include gray wolves and brown bears. See Figure 5.



Figure 5. Photo of Brooks Range.

Climate

These ecoregions have an arctic climate, with long cold winters and brief summers. Climate varies depending primarily upon elevation and proximity to coastlines, with extreme cold at high elevations, some seasonal moderation on the coast, and slightly warmer summers in the interior Arctic. With mean annual temperatures well below freezing in most areas, permafrost is almost continuous, except in isolated locations, usually associated with waterways.

Historical weather station data for the REA study area are limited, but can be augmented with interpolated data, as shown in Table 1. Historical climate station data are available from the Alaska Climate Research Center, ACRC (<http://climate.gi.alaska.edu/>), with “Climate Normals” representing mean values for 1981-2010. Note that although winter temperatures and mean annual temperatures are warmest to the west, in Point Hope, summer temperatures are warmest inland, at Anaktuvik pass.

Table 1: Examples of measured and estimated historical mean monthly temperatures (°F). For some locations, no historical climate station date (Climate Normals for 1981-2010) are available from the Alaska Climate Research Center, ACRC (<http://climate.gi.alaska.edu/>). Sites marked with an asterisk (*) denote those for which data come from interpolated baseline climate data (1961-1990) from the Scenarios Network for Alaska and Arctic Planning (SNAP). All others are ACRC Climate Normals. Note that both data sources are included for Barrow, to serve as a comparison.

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Anaktuvik Pass*	-12.8	-15.1	-8.5	5.3	30.1	47.5	52	46.3	31.9	8.4	-5.9	-15	13.7
Barrow	-13.4	-14.2	-12.7	1.8	21.1	35.6	40.9	39	32.1	17.2	0.7	-7.8	11.7
Barrow*	-13.4	-17.7	-15	-2	19.6	34.2	39.4	37.8	30.6	13.6	-1.7	-11.2	9.5
Deadhorse*	-18.9	-18	-14	1	22	38.6	48.5	45.2	33.3	14.9	-9.7	-15	10.7
Kaktovik*	-14.8	-20.8	-16.4	-1.9	20.2	34.6	41	39.9	31.7	14.3	-1.7	-12.8	9.4
Nuiqsut	-15	-16.5	-14.9	2	23.9	43.2	49.9	45.2	35.8	18	-1.8	-9.1	13.4
Point Hope*	-2.2	-9.9	-6.3	5.9	25.9	40.1	47.2	46.7	38.8	22.6	8.2	-2.5	17.9
Wainwright	-11.8	-13.5	-13.9	2.3	23.4	39.9	46	43.6	34.8	19.5	2.2	-7.2	13.8

Historical data for precipitation are available from the Alaska Climate Research Center, ACRC (<http://climate.gi.alaska.edu/>) only for Barrow, where monthly mean precipitation (in rainfall equivalent) ranges from 0.13 inches in January to 1.05 inches in August, with an annual total of only 4.5 inches.

SNAP interpolated data also indicate dry conditions across the region, with lowest annual precipitation along the Arctic coast, and slightly higher precipitation in the mountainous regions of the Brooks Range and foothills (Figure 6).

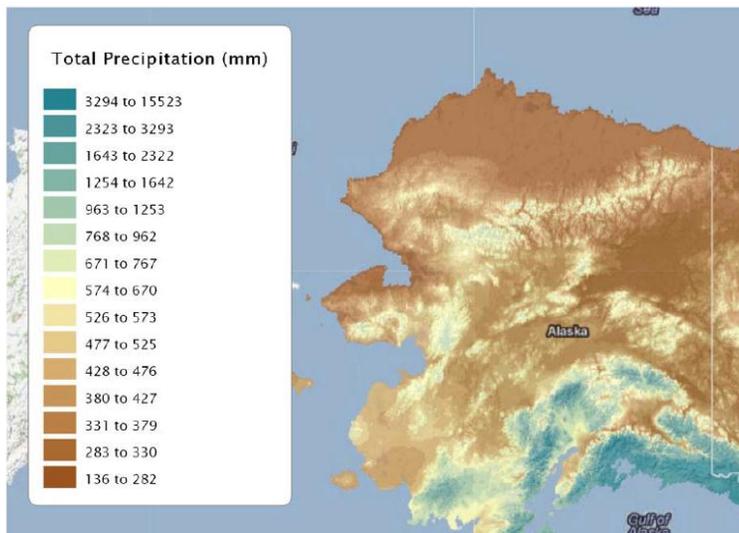


Figure 6: Total annual precipitation (rainwater equivalent). These data are based on gridded interpolated climate data, via SNAP (www.snap.uaf.edu).

Socioeconomic Description

This large region, the size of the U.S. state of Indiana, is sparsely populated with nine incorporated communities and one census designated place (CDP). Total population of the region as reported by the 2010 US Census is 9,377. Barrow is the regional transportation and service hub of the region, and the largest community with a year-round population of 4,212 (U.S. Census 2010). The second largest community in the region is Prudhoe Bay, with 2,174 people. The majority of this population are service workers associated with various oil and gas extraction and service companies. Prudhoe Bay is the northern terminus of the Dalton Highway. Point Lay is the smallest community with 189 people in 2010. Excluding Prudhoe Bay, over 70% of the population is Alaska Native. Other than Barrow and Prudhoe Bay, at least 80% of the population in all other communities is Alaska Native (Table 2). Few communities experienced a decline in their population between 2000 and 2010.

Table 2: Total population and American Indian and Alaska Native (AIAN) population by community. Source: 2010 U.S. Census.

	Total Population	AIAN Population	Percentage of AIAN Population
Anaktuvuk Pass city	324	270	83.33%
Atkasuk city	233	215	92.27%
Barrow city	4212	2577	61.18%
Kaktovik city	239	212	88.70%
Kivalina	374	360	92.6%
Nuiqsut city	402	350	96.26%
Point Hope city	674	603	87.06%
Point Lay CDP	189	167	89.47%
Prudhoe Bay CDP	2174	169	88.36%
Wainright	556	501	90.11%

The North Slope Borough is home to the largest oil field in the U.S. at Prudhoe Bay. The discovery of oil and subsequent development of the Prudhoe Bay oil fields continues to have a significant impact on the economies of the state of Alaska and the North Slope Borough. "Over half the state's oil workforce is in the North Slope Borough and nearly half of the borough's employment is in the industry (Fried & Shanks, 2013, p. 8). With 4.4% unemployment rate, the North Slope Borough has a lower unemployment rate than the rest of the state.

Despite the significant presence of the oil industry, the regional economy is a hybrid of cash and subsistence, similar to much of rural Alaska and other remote arctic indigenous communities. Oil industry's economic impact is evident in most communities, with improved infrastructure facilities. However, the impact at an individual and family level is limited. With a majority of workers in the industry being transient, a large portion of the individual income does not stay in the region. Households across the region combine wages from jobs, subsistence food harvests, and government transfers². In this region and elsewhere, households are facing increasing pressure from the high cost of living, driven by rising fuel prices.

These human interactions with aquatic and terrestrial resources have been, and will continue to be, a critical component of resource sustainability. Climate change, fire, development projects, and commercial/sport hunting and fishing can have both positive and detrimental effects on access to subsistence resources, animal and plant populations and health. This symbiotic relationship between humans and the regional flora and fauna creates a more defined link between human wellbeing and species management, beyond what is typically observed in regions outside of Alaska.

Regional Context

The ecosystems within the ecoregions are considered to be, for the most part, intact and undisturbed relative to most ecosystems at lower latitudes. This provides an opportunity to assess how systems following natural processes are likely to change under various climate and land use change scenarios. However, although development has traditionally been minimal in much of the North Slope Ecoregion outside of Prudhoe Bay, the National Petroleum Reserve – Alaska (NPR-A) has been extensively explored for potential oil and gas extraction. The potential for future oil and gas extraction has created much uncertainty with regard to natural resource management in the region. Few human settlements and current and potential oil development create uncertainties that land managers must address in regional planning efforts. As in most of the state, issues related to delivery and maintenance of power, water, and other basic resources are particularly challenging due to the vast distances and challenging topography. Additionally, subsistence harvests are a major food source for most of the communities in the North Slope Ecoregion. Thus, the North Slope Ecoregion (Brower, 2013) presents a complex system that has historic (subsistence) and contemporary (resource extraction) human activities that are directly tied to the unique and challenging environment.

Community Meetings

Community meetings are scheduled to inform the general public in the region of the activities of the REA. The purpose of these meetings is to inform the general public about the REA process, its expected outcomes, and gather stakeholder input on CEs, CAs, and MQs. Through an iterative consultation with the Assessment Management Team (AMT) and the Arctic Field Office (AFO) of the Bureau of Land Management (BLM), the North Slope Borough Planning Commission (NSB-PC) and the Subsistence

² Transfers include Supplemental Nutrition Assistance Program (SNAP), Supplemental Security Income, Social Security, unemployment assistance, and Permanent Fund dividends.

Advisory Panel for the National Petroleum Reserve – Alaska (SAP/NPR-A) were identified as most suited to disseminate information on the activities of the UA Team. Both bodies are representative, constituted by representatives from communities across the Borough. While the NSB-PC has representatives from all communities except Prudhoe Bay, SAP/NPR-A has representatives from all local communities, regional corporations, and governments, except two communities – Kaktovik and Point Hope.

In order to maintain continuity and keep the Borough population informed through the process of the REA, three consecutive meetings are planned. The UA team will present the current status of the project and solicit feedback to both bodies at three different stages of the project. Tentative meeting dates are shown in Table 3.

Table 3. Tentative community meeting schedule for the North Slope REA.

Meetings	NSP – PC	SAP – NPR-A
#1	July 25, 2013/August 29, 2013	April 3, 2013 (completed)
#2	September/October 2013	September/October 2013
#3	January/February 2014	January/February 2014

Conceptual Ecoregional Model

The Conceptual Ecoregional Model portrays an understanding of critical ecosystem components, processes, and interactions necessary for the maintenance of sustainable ecosystems. By summarizing existing information and hypotheses on the structure and function of ecosystems, the Conceptual Ecoregional Model provides the framework to assess ecological conditions and trends. The complex interactions of ecosystem resources, ecological drivers, and CAs is simplified in the Conceptual Ecoregional Model to clearly show ways in which ecosystem resources interact with one another and the relationships between ecosystem resources, CAs, and ecosystem drivers. The model provides the scientific justification for the selection of CAs and informs the selection of CEs by capturing representative ecosystem resources and their processes.

The Conceptual Ecoregional Model for the North Slope Ecoregion (Figure 7) provides a coarse-scale interpretation of key ecological resources, drivers, and CAs of the Beaufort Coastal Plain, Brooks Foothills, and Brooks Range. The model is divided into the following components:

- **Principal ecosystem resources**, including vegetation, animals, soil resources, freshwater resources, and ocean (coastal zone).
- **Ecosystem drivers**, including climate and atmospheric conditions (i.e. precipitation, temperature, cloud cover etc.) and landscape setting (i.e. geology, elevation, and proximity to ocean)
- **Anthropogenic** (land use, commercial / sport harvests, recreation) and **non-anthropogenic CAs** (climate change, fire, and invasive species).
- **Relationships between ecosystem resources** with interactions between them identifying key ecosystem processes and functions (for example, soils resources provide habitat for animals).
- **Relationships of ecosystem drivers and CAs** as external forces for ecosystem resources (for example, climate change alters composition, structure, and productivity of ecosystem resources and climatic conditions provide carbon and nitrogen setting providing essential components to the ecosystem resources).

The Conceptual Ecoregional Model will serve as a framework for measuring the cumulative impacts of all the CAs on all the CEs, providing a measure of overall current and future ecological intactness. Specific information on how this relationship will be established will be addressed in our subsequent methods memo.

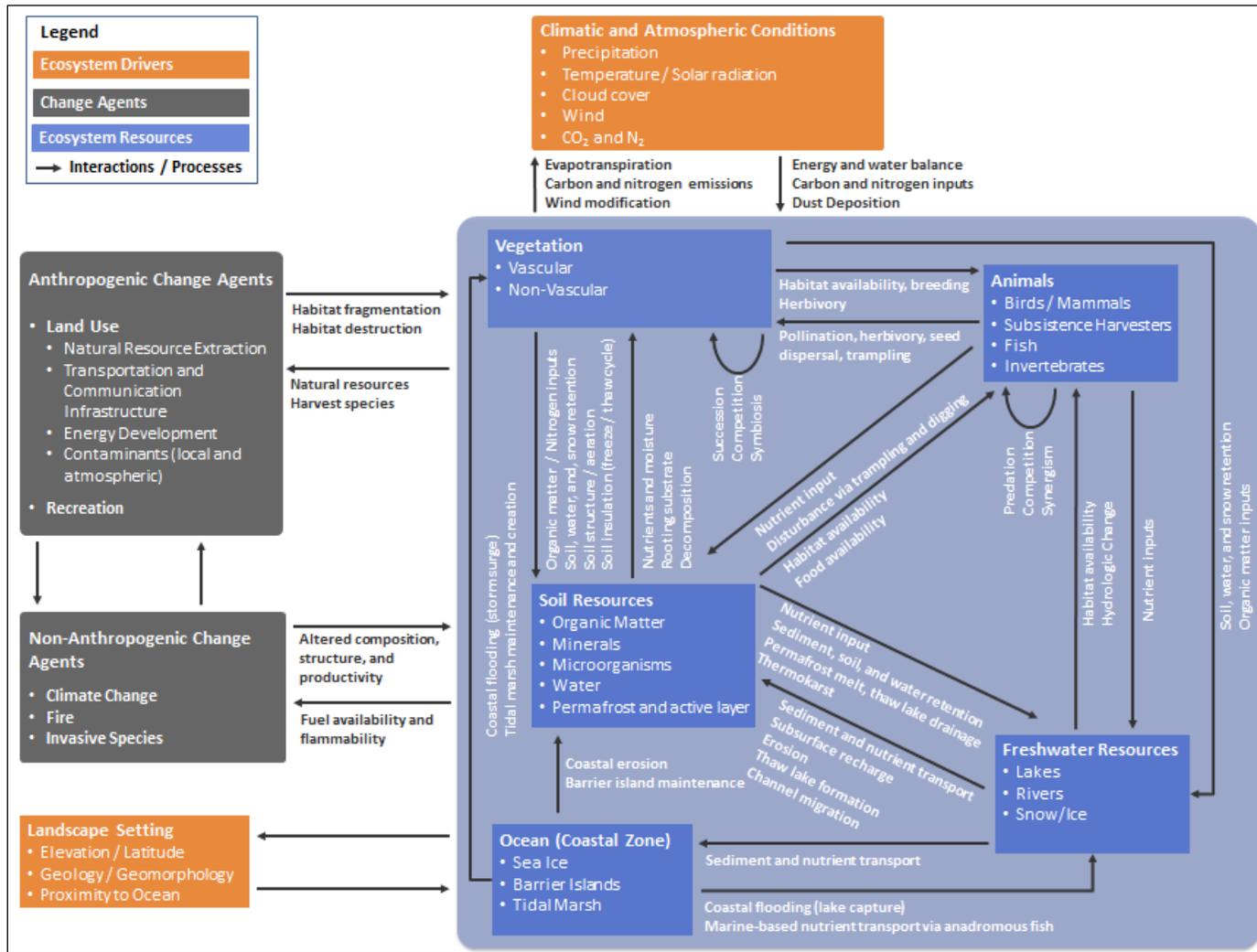


Figure 7. Conceptual Ecoregional Model for the North Slope REA.

Proposed REA Elements (CEs, CAs, and MQs)

REAs have two primary purposes:

1. To provide landscape-level information needed in developing habitat conservation strategies for regionally significant native plants, wildlife, and fish and other aquatic species; and
2. To inform subsequent land use planning, trade-off evaluation, environmental analysis, and decision-making for other interconnected public land uses and values, including development, recreation, and conservation.

To do this, REAs have three primary elements:

- Management questions (MQs) which are regionally specific questions that identify important management issues.
- Conservation Elements (CEs) which are biotic constituents of regional importance that can serve as surrogates for ecological condition across the ecoregion.
- Change Agents (CAs) which are those features or phenomena that have the potential to affect the size, condition, and landscape context of CEs.

MQs focus REAs on pertinent management and planning concerns for the region (See MQ section below). MQs are also used to create CE and CA lists by identifying critical resources and management concerns for the region. In addition to the MQs, CEs are also identified via the conceptual model (see CE section below). Although a basic list of CAs are provided by the BLM, MQs can also identify CAs used in this analysis. One of the strengths of this approach is the integration of management concerns (via the MQs) and current scientific understanding (conceptual ecoregional model) into a comprehensive assessment (Figure 8).

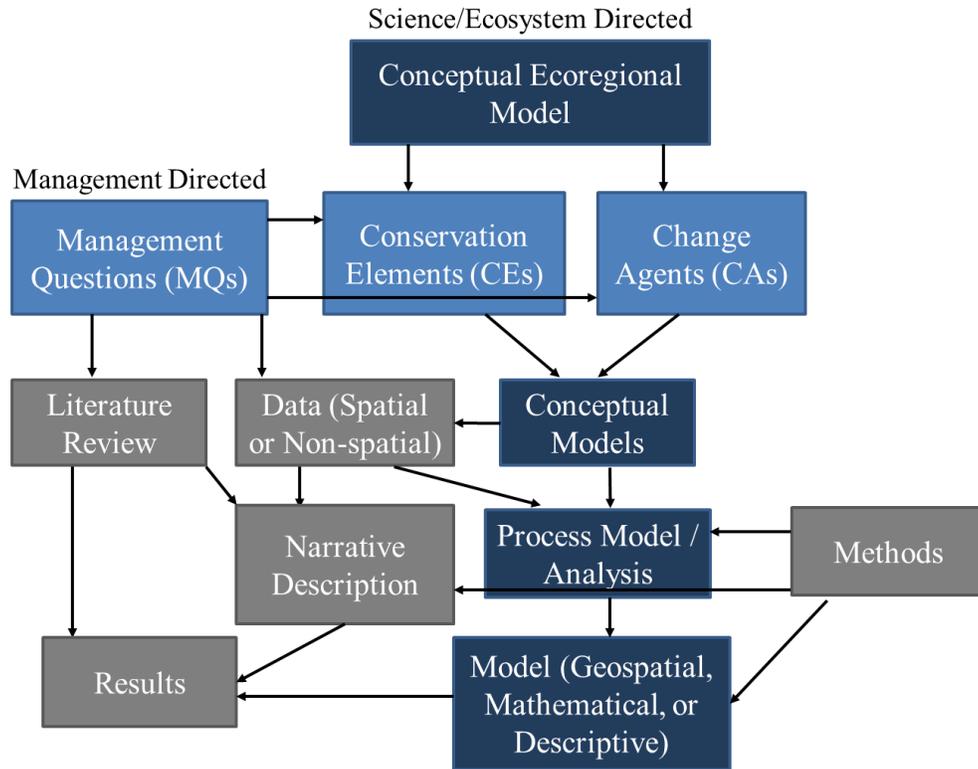


Figure 8. Diagram showing the relationship between MQs, CEs, CAs (light blue boxes) and the various models (dark blue boxes) developed as part of the REA process. Grey boxes show the interactions between the REA elements and models.

Following the two primary tracks, products from the REA can be conceptualized as two distinct deliverables:

1. Answers and responses to each MQ.
2. A series of “core” REA products that identify how the landscape is likely to change, as well as metrics of ecological intactness.

MQ findings will vary from literature reviews to spatial models, and will be related to the overall assessment, when appropriate. However, the products developed to identify and address the issues concerning CEs and CAs are considered the core REA analyses. Separate from the MQs, the core REA questions are:

1. Where are conservation elements currently?
2. Where might conservation elements be in the future?
3. Where are change agents currently?
4. How might change agents change in the future?
5. What is the overlap between conservation elements and change agents in the future?

Thus, there is substantial opportunity for overlap between the two tracks, which we have addressed in our selection of MQs, CEs and CAs.

Management Questions

Management Questions (MQs) provide regional managers the opportunity to highlight specific management concerns relevant to the larger ecoregions, and provide a tangible way in which these REA efforts can be translated into management plans. Contrary to previous REA efforts, no preliminary list of MQs were provided at the beginning of this REA. Instead, the UA Team scoured various documents that identify management and research objectives for the North Slope to create an initial list of MQs. These documents include the *Emerging Issues Summaries*,³ the research gaps identified by *Wildlife Response to Environmental Arctic Change*,⁴ and the future needs identified by the *Arctic Landscape Conservation Cooperative Future Needs Assessment*⁵. Additionally, the BLM Arctic Field Office identified MQs for the NPRA in 2011, and also provided additional questions specifically for this effort. This produced a list of approximately 275 potential MQs.

Because the REA is rapid, the BLM has mandated that only 20-40 MQs be addressed through an REA. Our list was too numerous for the BLM target, and covered topics well outside the scope of an REA. In order to reduce this list to a workable number, the UA Team refined the list by:

1. Removing questions (111 total) that were considered “out of scope” for this REA because:
 - a. They were at an inappropriate scale (i.e. asked site specific questions) – 14 questions
 - b. They asked specific policy questions – 21 questions
 - c. They were methodological questions – 33 questions
 - d. They were non-terrestrial – 37 questions
 - e. They required new data to be collected – 2 questions
 - f. They were too theoretical (i.e. ecological theory) – 2 questions
 - g. They were not appropriate for the timeframe of REA – 2 questions
2. Ranking questions (High, Medium, Low) based on:
 - a. Effort required to address the question
 - b. Whether the question fit into an REA-type analysis
 - c. Whether products developed would be useful to managers

This produced a list of 54 high ranked (recommended) MQs, 38 medium ranked MQs, and 71 low ranked MQs. This list of high, medium and low ranked questions, as well as those 111 questions considered out of scope were then given to state and field BLM offices for further review and prioritization. We received feedback from four BLM staff (1 field office, 3 state office specialists) which resulted in 72 high ranked (recommended) MQs, 35 medium ranked MQs, and 68 low ranked MQs. We then presented the 72 MQs that ranked highest priority to the AMT in June 2013, during the AMT 1 Workshop (Appendix A). The MQs ranked as medium, low, and out of scope are included for reference as an appendix (Appendix B, Appendix C, Appendix D).

³ NSSI 2009

⁴ Martin et al. 2009

⁵ Arctic LCC 2013

During the AMT1 Workshop, the UA team facilitated some discussion on the nature and scope of MQs for this type of assessment, and proposed that a Delphi survey method (Hess and King 2002; Scolozzi et al. 2012; O’Neill et al. 2008) be used to prioritize and focus our MQ list. Following the AMT workshop, we submitted the 72 MQs to the AMT and Technical Team for prioritization. We asked each member to simply rank which 20 questions were their top questions, which 20 additional questions were next priority, and which questions were of lowest priority to them. After receiving 13 responses (representing most of the AMT), we tallied the ranks for each question, reordered them based on those tallies, and sent the questions out for another ranking. The second round yielded 16 responses, which we again tallied and sorted accordingly. We then sent out the questions one last time for ranking. When we received another 13 responses, we tallied the results to assess the priorities. After that final round, we found that there were a clear set of 20 MQs that were considered the highest priority by the AMT and Technical Team (Table 4). These questions were consistently ranked the highest priority by over half of the AMT, giving confidence that these are the top issues for the region. We also identified an additional 10 MQs (Table 5) that were ranked highly by some members of the AMT, as additional questions to consider if we are forced to remove MQs due to data gaps.

Table 4: Final working list of MQs for the NOS REA. Shown is the Management Question, the associated CE or CA, and percentage of votes it received as a top MQ through the final round of the Delphi survey (n = 13).

MQ #	Management Question	CE	CA	% of total votes
AB 1	Is the fire regime changing on the North Slope and what is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire?		Abiotic	54
AB 2	How will permafrost change spatially and temporally over the next two decades?		Abiotic	54
AP 1	What physical and perceptual limitations to access to subsistence resources by local residents are caused by oil/gas activities?		Anthropogenic	77
AP 2	How are oil, gas, and mineral development on the North Slope impacting near- and far-field air quality, with particular emphasis on communities and “sensitive class 2” areas such as ANWR, Gates, Noatak?		Anthropogenic	69
AC 1	How does water withdrawal from lakes for oil and gas activities (year-round industrial and domestic use and winter operations) affect lake water quantity and water quality, outflow/stream connectivity, and down-basin stream habitat?	Aquatic-Coarse Filter	Anthropogenic	92
AC 2	How does oil and gas infrastructure (e.g. roads, pads, pipeline), both permanent and temporary, affect fish habitat, fish distribution, and fish movements?	Aquatic-Coarse Filter	Anthropogenic	92
AF 1	What are baseline characteristics and trends in fish habitat (lakes and streams), fish distribution, and fish movements?	Aquatic-Fine Filter		77

MQ #	Management Question	CE	CA	% of total votes
AF 2	What are the measurable and perceived impacts of development on subsistence harvest of fish?	Aquatic-Fine Filter	Anthropogenic	46
AT 1	What parameters can help measure impacts from anthropogenic activities independently of natural cycles and vice versa?	Aquatic and Terrestrial-All	Anthropogenic	54
AT 2	What potential impacts will oil/gas exploration and development have on CE habitat?	Aquatic and Terrestrial-Fine Filter	Anthropogenic	54
AT 3	What additional contaminants baseline data are needed for fish, birds, marine and terrestrial species, particularly those that affect the health and safety of subsistence foods?	Aquatic and Terrestrial-Fine Filter	Anthropogenic	54
TC 1	What are the impacts of oil/gas development (i.e. gravel pad and road construction; pipeline construction) on vegetation and hydrology? (Known impacts include burial, dust, saline runoff and altered soil moisture.)	Terrestrial-Coarse Filter	Anthropogenic	92
TC 2	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	Terrestrial-Coarse Filter	Abiotic	85
TC 3	How will changes in precipitation, evapotranspiration, and active layer depth alter summer surface water availability in shallow-water and mesic/wet tundra habitats and how reliable are these projections?	Terrestrial-Coarse Filter	Abiotic	77
TC 4	What are the expected changes to habitat as a result of coastal erosion and coastal salinization?	Terrestrial-Coarse Filter	Abiotic	69
TC 5	How is climate change affecting the timing of snow melt and snow onset, spring breakup and green-up, and growing season length?	Terrestrial-Coarse Filter	Abiotic	69
TF 1	What are the baseline data for the species composition, numbers of individuals, vegetation type used, and change in numbers/species composition of landbirds and their habitat over time?	Terrestrial-Fine Filter		77
TF 2	What are caribou preferences for vegetation communities? Where do these vegetation communities exist?	Terrestrial-Fine Filter		77
TF 3	What are the measurable and perceived impacts of development on subsistence harvest of caribou?	Terrestrial-Fine Filter	Anthropogenic	69
TF 4	What are caribou seasonal distribution and movement patterns and how are they related to season and weather?	Terrestrial-Fine Filter	Abiotic	69

Table 5: Second Tier MQs, based on the Delphi survey of MQs. Questions were subsequently weighted to reflect scores of high, moderate, and low priority ranks. The cumulative scores for these questions represent the next highest priority. These questions will be retained as alternatives to the high priority questions listed above (Table 4).

MQ #	Management Question	CE	CA
TC 6	How will plant species composition shift in response to long-term climate change, and what are the implications for habitat structure and quality of the prevalent available forage (i.e., digestibility, nutrient content)?	Terrestrial-Coarse Filter	Abiotic
AA 1	Have environmental changes caused people to adjust their hunting/fishing/gathering and food handling practices?		Abiotic and Anthropogenic
TF 5	What is the seasonal variation in caribou food production and availability (i.e. likelihood of increased icing events) under changing climate conditions?	Terrestrial-Fine Filter	Abiotic
AP 3	What are the appropriate social and economic indicator data that should be gathered (e.g., for historic baseline and trend data)?		Anthropogenic
AF 3	What are the expected changes in fish distribution?	Aquatic-Fine Filter	Abiotic and Anthropogenic
TC 7	Will fire intensity and burn severity change; and if it does, what will be the impacts, for example on permafrost and the active layer, vegetation and herbivores?	Terrestrial-Coarse Filter	Abiotic
AP 4	How should we integrate local and traditional knowledge into social and economic investigations of North Slope people and communities?		Anthropogenic
AP 5	Where are the locations of soils suitable/unsuitable for infrastructure development?		Anthropogenic
AA 2	How will changes in permafrost condition manifest for winter tundra travel, does an increasing depth of the active layer impact seasonal tundra travel?		Abiotic and Anthropogenic
AA 3	What industry activities are seasonally-dependent and how is climate change affecting that? (includes ice roads, breakup flooding, etc.)		Abiotic and Anthropogenic

Conservation Elements

Conservation Elements (CEs) are defined as biotic constituents (i.e. wildlife and plant species or assemblages), abiotic factors (i.e. soils) of regional importance in major ecosystems and habitats across the ecoregion, or high biodiversity priority sites (i.e. Important Bird Areas). CEs are meant to represent key resources in the ecoregion that can serve as surrogates for ecological condition across the ecoregion.

The final selection of priority conservation elements will be a limited suite of specific CEs, the conservation of which is intended to serve as a coarse-filter/fine-filter representation of the ecoregions natural resources. Most CEs are defined through the “coarse-filter / fine-filter” approach required by BLM guidelines, and used extensively for regional and local landscape assessments.⁶ This approach focuses on ecosystem representation as “coarse-filters” with a limited subset of focal species and species assemblages as “fine-filters”. The coarse-filter / fine-filter approach is closely integrated with ecoregional and CE-specific modeling exercises.⁷ However, the coarse-filter / fine-filter approach can omit important landscapes that are home to areas of high biodiversity or conservation interest (endemism). Thus, conservation places are also proposed as CEs for this analysis, as these important landscapes often have regulatory requirements that managers would have to respond to if CAs are likely to impact their persistence.

Coarse-Filter Conservation Elements

Coarse-filter CEs were identified first and include regionally significant terrestrial vegetation types and aquatic habitats representing dominant ecological patterns across the REA area. Coarse-filter CEs collectively should represent the habitat requirements of most characteristic native species, ecological functions, and ecosystem services described in the Conceptual Ecoregional Model. Ecological models (both conceptual and spatial) for each coarse-filter CEs will be fully developed later in the assessment in order to quantify the individual and cumulative impacts of CAs on the CEs.

Terrestrial Coarse-Filter Conservation Elements

Terrestrial coarse-filter CEs are regionally important vegetation classes that represent the characteristic vegetation assemblages and the dominant ecological patterns of the North Slope Ecoregion. They adequately address the habitat requirements of most characteristic native species, ecological functions, and ecosystem services.

We recommend using two landcover maps for the REA: an existing vegetation map and a Biophysical Settings (i.e. potential vegetation) map. The existing vegetation map will be used for modeling species distribution, but will not be used to identify and map coarse-filter conservation elements. For existing vegetation, we suggest using the NSSI and DU 2013 map for the Central and Western Arctic (in preparation), the Jorgenson et al. (1994) map for ANWR, and Tidal vegetation classes from the USDI

⁶ Jenkins 1976, Noss 1987.

⁷ Bryce et al. 2012.

National Wetlands Inventory map from the Arctic. The USDI National Wetlands Inventory map is more current than the Jorgenson et al. (1994) map and the DU 2013 map did not map this class.

For the terrestrial coarse-filter conservation elements, we recommend using the Biophysical Setting (i.e. potential vegetation) strata developed via the BLM Assessment Inventory and Monitoring (AIM) pilot project for NPRA (Boucher et al. 2013). A **Biophysical Setting** represents the vegetation that dominated the landscape prior to Euro-American settlement and is based on both the current biophysical environment and a natural disturbance regime (LANDFIRE <http://www.landfire.gov/>). Examples include tidal marshes, floodplains, high-centered polygons, and inland dunes (Figure 9). A Biophysical Setting (BpS) is similar to Potential Natural Vegetation (PNV), however, PNV is defined as succession without major natural disturbances or direct human activities (Kuchler 1973, Tüxen 1956, Mueller-Dombois and Ellenberg 1974).

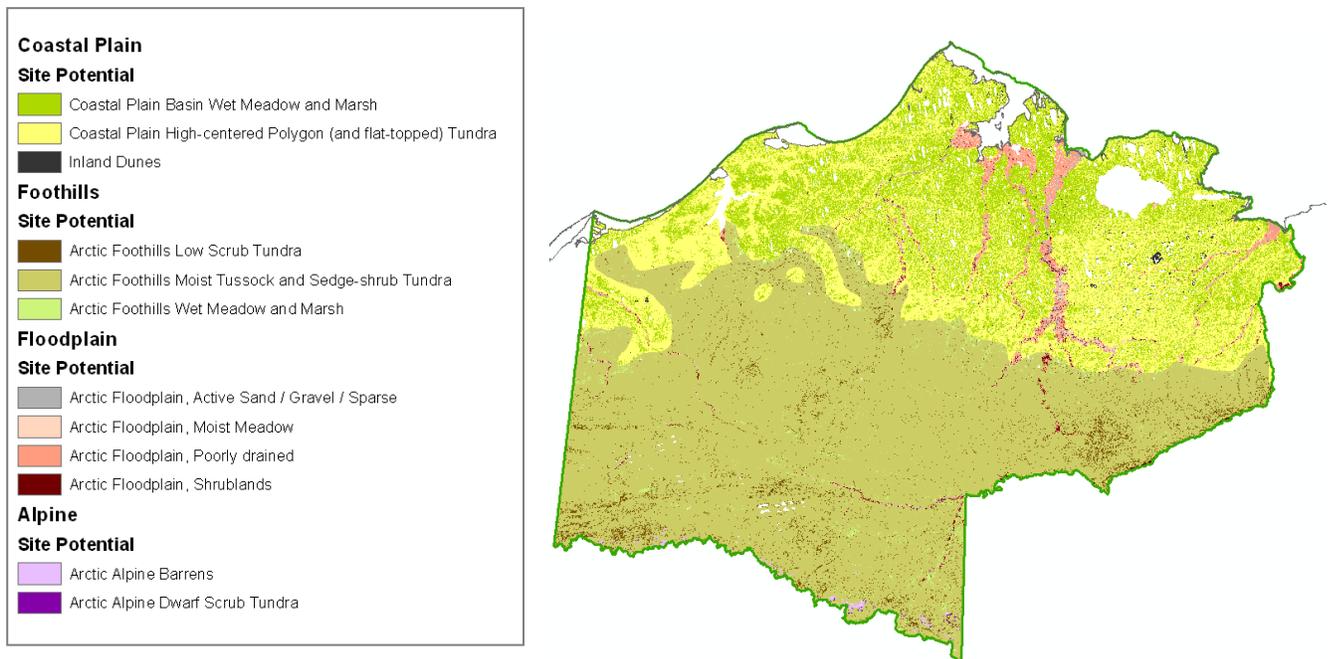


Figure 9. Map of Biophysical Settings in NPRA.

Both BpS and PNV classifications are developed the same way, using existing vegetation, successional relationships, and environmental factors (e.g., climate, geology, soil) considered together. The major difference is that BpS includes natural disturbance and PNV does not; both do not include human activity. Consequently, BpS is considered a better classification for Alaska given that most of Alaska’s natural disturbances still occur, and human infrastructure and disturbance occur in probably less than 5% of the landscape.

Biophysical Settings are similar to and often the same as other defined units within existing classifications for Alaska including BpS on the North Slope (Boucher et al. 2013 draft), Ecotypes (Jorgenson et al. 2009), Landtype Associations in the ECOMAP (1993) hierarchy, Ecological Site Types (USDA, NRCS), and other descriptions (Batten et al 1978, Boggs 2000, Carter 1988, Shephard 1995).

The spatial layers used to develop the map will be physiographic subsections (Jorgenson and Grunblatt 2013, CAVM 2003) and vegetation type (NSSI and DU 2013 map for the Central and Western Arctic, the Jorgenson et al. (2004) map for ANWR, and Tidal vegetation classes from the USDI National Wetlands Inventory map from the Arctic). A total of 12 biophysical strata were defined for NPR-A (Figure 9). Additional stratification layers will include Sand Sheet, and Pingos.

We suggest using seven BpS classes for analysis as coarse-filter terrestrial CEs. Table 6 below shows the current list of terrestrial coarse-filter CEs, the related major ecosystem functions and a dominant species per class.

Permafrost was additionally selected as a terrestrial coarse-filter CE because it is a regionally significant and has potentially fragile soil characteristics with high potential for future change, primarily as a result of climate change. While included as a coarse-filter CE, other CEs may also receive comparison with permafrost as though it were a CA (see Permafrost section under CAs).

Table 6: Terrestrial coarse-filter (Biophysical settings) conservation elements for the North Slope REA.

Terrestrial Coarse-Filter CEs (Biophysical Settings)	Ecosystem Function	Dominant Species
Tidal marsh	Rare ecosystem with high bird use	<i>Puccinellia phryganodes</i>
Marine beach/Beach meadow	Unstable spits and beaches that support unique vegetation for the North Slope and separate shallow lagoons from the deeper open ocean.	<i>Leymus mollis</i>
Coastal plain; Thaw lake cycle. Freshwater marsh stage of succession within thaw lake cycle.	Coastal plain matrix forming habitat supporting birds, mammals, and invertebrates	<i>Arctophila fulva</i>
Coastal plain; High centered polygon stage of succession	Coastal plain matrix forming habitat supporting birds, mammals, and invertebrates	<i>Eriophorum vaginatum</i>
Sand sheet; Inland dunes	Rare ecosystem supporting rare plants	<i>Deschampsia cespitosa</i>
Foothills; Tussock tundra	Foothills matrix forming habitat for birds, mammals, and invertebrates	<i>Eriophorum vaginatum</i>
Foothills and Coastal Plain; Floodplains	Supports unique associations important for insectivorous birds, ptarmigan, moose, muskox and caribou insect relief sites.	<i>Salix alaxensis</i>
Alpine; Sparsely vegetated	Mountain matrix forming habitat supporting birds, mammals, invertebrates and many rare plants	<i>Umbilicaria</i> (Lichen)
Permafrost	Sediment, soil, and water retention	

Aquatic Coarse-Filter Conservation Elements

An aquatic habitat map has not been created for the REA study area which could be used for the selection of coarse filters. The best available spatial dataset of aquatic resources is the National Hydrography Dataset (NHD), which includes streams and lakes across Alaska. The NHD has been updated for NPRA, but for the remainder of the REA study area it is outdated and lacks groundtruthing. A comparison of the NHD with a manual delineation of the stream network in the Fish Creek watershed of NPRA (Arp et al. 2012b) reveals the spatial inaccuracies of the NHD. Lake areas are expanding over time in the arctic (Arp et al. 2011) and NHD waterbodies underestimate true lake area when compared to 2002 aerial imagery (pers. comm. Ben Jones, USGS). In addition, connections between lakes and between lakes and streams are often missing, which results in a high number of isolated flow lines (pers. comm. Ben Jones, USGS and Chris Arp, UAF). Evaluation of the updated version of the NHD for NPRA (downloaded on 9/10/13) with an older version indicates that the updates are minimal and do not address the problems mentioned above.

There are additional spatial datasets that could be used to classify aquatic habitats for coarse filter selection. Synthetic aperture radar (SAR) data has been used to identify lakes with unfrozen water during the winter, which can be used to estimate potential overwintering habitat for fish. The most recent landscape analysis was conducting in April 2009. Due to spatial and temporal variability in ice thickness, this dataset must be interpreted with caution. There is large variability in ice thickness both within a site and between sites, which means that this dataset cannot be used to infer lake depths (pers. comm. Ben Jones, USGS). An analysis of the fraction of lakes with bedfast ice in a region near Barrow for the period 1991-2011 showed that 2009 had the largest deviation from the mean for April; only 20% of lakes were completely frozen (Surdu et al. 2013). A similar study comparing lakes in a coastal versus interior region of the Arctic Coastal Plain over a more recent time period (2003-2011) did not find 2009 to be particularly anomalous (Arp et al. 2012a). Both studies concluded that there is a general trend towards more lakes with floating ice regimes so using the data from 2009 may be a good proxy for current potential overwintering habitat for fish, but this is likely to change.

A list of nine aquatic habitats has been proposed as a starting point from which to select two habitats to be included as aquatic coarse filter conservation elements. These habitats were sent to BLM and USFWS fisheries biologists for their comments and additional discussion is needed before final selection of aquatic CEs. One suggestion is to consider a smaller grouping of habitat types, possibly one that matches the habitats described in USFWS WildREACH Workshop report (pers. comm. Jeff Adams, USFWS; Martin et al. 2009). A list of nine aquatic coarse filters, their corresponding WildREACH habitat types, mapping methods, and important ecological functions as they relate to fish are provided in Table 7 below.

Table 7: Aquatic coarse filter conservation elements for the North Slope REA.

Aquatic Coarse Filter CEs	WildREACH Habitat Type	Mapping Method	Ecosystem Function
Connected, deep lakes	Deep lakes	Use the flowlines and waterbody feature classes from the NHD to identify connectivity and overlay the winter water availability dataset to identify lakes that did not freeze to the bottom in 2009	Overwintering habitat for fish.
Connected, shallow lakes	Shallow lakes	Use the flowlines and waterbody feature classes from the NHD to identify connectivity and overlay the winter water availability dataset to remove lakes that did not freeze to the bottom in 2009	Summer foraging habitats.
Disconnected lakes	Deep and shallow lakes	Use the flowlines and waterbody feature classes from the NHD to identify lakes not connected to the stream network	Limited habitat opportunity for fish.
Glacial rivers	Large streams	Identify large rivers from the NHD using a combination of named stream segments and stream order. This would probably require heads-up digitizing to make sure no major rivers are missed and that the upstream starting point meets a minimum size limit, such as 4 th order. Once the rivers dataset has been defined, identify those that drain glaciers in the Brooks Range using the Randolph Glacier Inventory dataset.	High stream connectivity in the summer, source of freshwater and silt to river deltas; important spawning, rearing, and overwintering habitat.
Non-glacial mountain rivers	Large streams	Identify large rivers that initiate in the Brooks Range or foothills ecoregions that do not have glaciers in their watersheds.	Fall discharge events from rainfall at higher elevations may be important to fall migration and spawning; important spawning, rearing, and overwintering habitat.
Coastal plain rivers	Large streams	Identify large rivers that initiate in the coastal plain.	Important spawning, rearing, and overwintering habitat, but for different species than rivers draining the Brooks Range and foothills.
Mountain streams	Small streams	Identify all lower order systems from the NHD after removal of major river systems. This would only include streams that originate in the Brooks Range and foothills ecoregions.	Important habitat for Dolly Varden, export of nutrients and organic material to downstream systems.

Aquatic Coarse Filter CEs	WildREACH Habitat Type	Mapping Method	Ecosystem Function
Coastal plain streams	Small streams	Identify all lower order systems from the NHD after removal of major river systems. This would only include streams that originate in the coastal plain ecoregion.	Important migratory pathways and feeding habitats for fish in the summertime.
Estuaries	Near-shore coastal water	Research available estuary spatial datasets available for the arctic.	Important summer feeding habitats and migration corridors for anadromous fishes.

Fine-Filter Conservation Elements

Fine-filter CEs consist of regionally significant species and species assemblages that are not adequately represented by the coarse-filter CEs. Fine-filter CEs are therefore also critical to the assessment of ecological intactness.

Terrestrial Fine-Filter Conservation Elements

“Fine-filter” species provide critical ecosystem functions and services that are not adequately represented by the coarse-filter units and are critical to the assessment of ecological intactness. CEs are derived from either the ecoregional conceptual model or from management concern identified from management questions.

We propose to treat species falling within this general category into two subcategories; 1) species that will be treated individually, and 2) those that might be effectively treated as a species assemblage; i.e. their habitat and known populations co-occur sufficiently to treat them as a single unit of analysis.

To provide context to the terrestrial fine-filter CE selection process, we first produced a comprehensive list of regularly occurring vertebrate species for the North Slope REA by overlaying polygon range maps for individual taxa with the assessment boundary. This initial list consisted of over 200 birds, of which 90 are known to breed or stage regularly on the North Slope, and 28 mammals. We then attributed this list with the following criteria to further assist with the selection process:

- a. All taxa listed under Federal or State protective legislation (including listed endangered, listed threatened, candidate, and de-listed species, subspecies, or designated subpopulations).
- b. Full species with NatureServe Global or State Conservation Status ranks of G1-G3 or S1-S3.
- c. Full species or subspecies listed as BLM Special or Watchlist Status and those listed as Species of Greatest Conservation Need (SCGN) in the Alaska Wildlife Action Plan (SWAP) with habitat included in the ecoregion.
- d. Important subsistence resources to the ecoregion.
- e. Taxa considered endemic to the state and/or the ecoregion.

From this working list, a preliminary list of potential CEs was generated based on a combination of factors, including:

- Whether the CE was directly identified through a management question.
- Whether the CE was directly identified through the conceptual model. The birds and mammals selected under this category are representative of the major functional groups in arctic terrestrial ecosystems.
- Whether the species or assemblage was not adequately represented indirectly through the assessment of major “coarse-filter” ecosystem types for the ecoregion. For example, species strongly affiliated with freshwater marshes or inland dunes may be adequately treated in the REA through assessment of these surrogate coarse-filter features, and will likely not be treated as fine-filters.

The preliminary list of selected CEs then underwent revision through an iterative consultation process based on comments received back from the AMT and Technical Teams after the AMT1 Workshop (June 2013) and the CE specific webinar (August 2103). Overall, seven species or species assemblages were suggested as potential terrestrial fine-filter CEs for the REA (8). We anticipate that this list will continue to evolve as we move forward with data discovery, community meeting input, and future memo and Work plan revisions.

For each selected terrestrial fine-filter CE we intend to:

- Map their current distribution.
- Develop a species specific conceptual model.
- Identify key ecological attributes and indicators for each attribute.
- Map their current status (the overlap of current distribution with change agents and intactness).
- Assess potential for change in the near-term (2025) and long-term (2060) horizon.

Table 8: Terrestrial fine-filter conservation elements for the North Slope REA. Also included is information regarding functional group, ecosystem function, general habitats used by the CE, habitats used by the CE but not included as coarse-filter CEs, and additional selection comments.

	Taxonomic Group	Functional Group	CE Selection	Ecosystem Function	Habitats general	Habitats not included as coarse-filter CEs	Additional Selection Comments
1	Mammalia	Large herbivores	Caribou (<i>Rangifer tarandus</i>)	Important as consumers but also as prey (including carcasses) for the large and medium-sized predators. Important subsistence resource.	Tundra, bare ground, lichen	Bare ground, dwarf shrub (excluding dryas), polygonal wet-sedge	Three Management Questions related to caribou (see Table 4, TF2,3,4). Inclusive of 4 herds: Porcupine, Teshekpuk, Western and Central Arctic.
2	Mammalia	Small herbivores	Nearctic brown lemming (<i>Dicrostonyx trimucronatus</i>)	Key prey for wide spectrum of avian and mammalian predators. Soil disturbance.	Wet sedge tundra, shrub, polygonal mesic habitats; subnivalian during winter	Mesic sedge-dwarf shrub tundra, dwarf shrub, mesic herbaceous	The population dynamics of lemmings is often characterized by large inter-annual fluctuations, which in turn, has significant effects on predator populations.
3	Mammalia	Medium-sized predators	Arctic fox (<i>Vulpes lagopus</i>)	Major nest predator. Often tightly associated with human settlement.	Arctic tundra and coasts. Den in sandy soil along river banks	Developed	Litter size of Arctic fox is linked to the availability of voles and lemmings. Tied tightly to the distribution of their prey and humans.
4	Aves	Insectivores	Lapland Longspur (<i>Calcarius lapponicus</i>)	Major consumers of invertebrates and as a prey (including adult birds, eggs and chicks) for mammalian and avian predators.	Wet, hummocky, tundra meadows	Mesic herbaceous, wet sedge	Management Question regarding baseline data on landbird species (see Table 4, TF1). Lapland Longspur selected as representative landbird. Habitat and food requirements of this species overlap with some shorebirds (e.g., Ruddy Turnstone, Least and Pectoral Sandpipers).

	Taxonomic Group	Functional Group	CE Selection	Ecosystem Function	Habitats general	Habitats not included as coarse-filter CEs	Additional Selection Comments
5	Aves	Carnivores	Raptor concentration areas (assemblage including Peregrine falcon, Gyrfalcon and Rough-legged Hawk)	Top level avian predators. The falcons are largely avian predators, while the hawk is a major predator of small mammals.	Tundra, open forest, riparian bluffs and cliffs	Riparian bluffs and cliffs	Two circumpolar raptors, the Peregrine Falcon (migrant) and Gyrfalcon (resident), have been continuously monitored in terrestrial study areas across Alaska from the 1980s or earlier. Long-term datasets should be available to aid with assessment.
6	Aves	Herbivores	Willow ptarmigan (<i>Lagopus lagopus</i>)	Have diverse roles in the ecosystem as they can have a major grazing impact on habitats, make a substantial contribution to nutrient cycling, and provide a prey base to support populations of mammalian and avian predators. Important subsistence resource.	Arctic tundra in shrubby habitats in low, moist areas, wet sedge, tall and low shrubs especially alder and willow thickets	Low-tall willow, wet sedge, mesic sedge-dwarf shrub tundra, alder, birch ericaceous low shrub	Selected for importance as a subsistence resource.
7	Aves	Omnivores	Spectacled Eider (<i>Somateria fischeri</i>)	Generally, play a similar role in the ecosystem to that of insectivores and herbivores as consumers of invertebrates and plants.	Tundra lakes and ponds, wetlands including emergent marsh, wet-sedge, moss-lichen polygonal tundra	Aquatic bed, wet sedge	Selected due to conservation status - Federally listed threatened. Habitat requirements similar to Brant, an important subsistence resource.

Aquatic Fine-Filter Conservation Elements

The BLM Final Integrated Activity Plan/Environmental Impact Statement (BLM 2012) for the NPRA lists 23 freshwater fish species found in the Arctic Coastal Plain. The selection criteria used for the terrestrial CEs did not narrow the list of fish species, likely due to the lack of data on the status and trends of arctic fishes, which could be used to inform the conservation programs. None of the fish species are listed under federal or state legislation or are BLM sensitive species. Bering cisco has a state conservation status rank of S3 because it is endemic to Alaska, but none of the other species are of global or state conservation concern. In addition, no fish species were specifically targeted in the management questions or the ecoregional conceptual model.

We propose to select fish CEs that are well distributed throughout the study area since data are lacking on habitats with which to capture the common species and ecosystem functions of the aquatic resources. A list of proposed fish species to be included as aquatic fine-filter conservation elements was presented to BLM and USFWS fish biologists via email and also to AMT members present at the CE webinar on August 28th. From these discussions, we are proposing a list of four fishes, which are included with descriptions of their ecological and social importance to the REA study area below. Chum salmon were also presented as a potential CE during the webinar, but we are proposing to remove them from the list because we expect to find very little data on chum salmon specific to the REA study area and we would like to limit the number of conservation elements for the REA to around twenty.

1. Broad whitefish are an important subsistence species for communities on the Arctic Coastal Plain. In addition, they exhibit both anadromous and resident forms and utilize a diversity of lake and river habitats on the coastal plain for overwintering, rearing, and spawning.
2. Dolly Varden are utilized heavily by residents of Kaktovik and Kivalina and are well distributed throughout the stream network, especially in the eastern coastal plain and in the Brooks Range and Foothills ecoregions. They have an anadromous life history in the REA study area.
3. Arctic grayling are resident fish distributed throughout the stream network and in lake habitats across the REA study area.
4. Burbot or lake trout will be selected as a fourth species depending on information found during the data discovery task. Both are long-lived resident fish that are mostly found in deep lakes. They eat other fish, making them susceptible to bioaccumulation of contaminants and potential indicators of change in the arctic. Both are used in localized subsistence fisheries.

Conservation Places Conservation Elements

The UA team originally proposed including select Conservation Places as Conservation Elements. Conservation Places often represent areas of high biodiversity or particular conservation interest. Often these areas have regulatory requirements, making the assessment of impacts to those places a critical component of regional assessments. However, following the AMT 1 workshop and CE webinar, the AMT decided that treating Conservation Places as a CE did not make sense for the North Slope for two primary reasons. The first reason relates to the selection of the places to be assessed as a CE. Given the sensitive nature of most of the ecosystems in the arctic, and the heavy reliance upon subsistence harvest by residents in the region, that one could easily identify all of the North Slope as a Conservation Place (and in fact many non-profit conservation organizations list the entire North Slope as a priority conservation

area). Second, Conservation Places cannot be assessed to the same degree as other CEs due to the varying nature of the places. For each CE, a conceptual model with specific attributes and indicators to assess change will be developed. However, Conservation Places vary from culturally sensitive to critical habitats, and thus cannot fit into a conceptual modeling framework the same way a species or vegetation class can.

For these reasons, the AMT decided not to pursue Conservation Places as a CE. However, the AMT expressed interest in understanding the impacts of the various CAs on some of the regions most important landscapes. Given that all data generated from this assessment will be publically available through the BLM National Operations Center Data Portal, each interested stakeholder will be able to assess the expected impact to their own Conservation Places. However, the UA team will be conducting a cumulative impacts assessment near the end of the project (details to be included in the Methods Memo to come out later), and could assess the impacts of the CAs on select Conservation Places as part of that effort. The UA Team will propose these options later in the assessment.

Examination of SAP Meeting Minutes

At the June 27, 2013 AMT1 Workshop, BLM's Arctic Field Office staff and the Chairperson of the AMT advised the project team to closely examine the meeting minutes of the Subsistence Advisory Panel (SAP) for the National Petroleum Reserve, Alaska (NPR-A) to identify specific species or habitats of interest to NS-REA.

The SAP is a representative body with members from eight communities/regional entities⁸ in the region, and is "instituted to advise the Bureau of Land Management (BLM) on how to minimize the possible impacts of oil and gas activities on subsistence activities." The SAP also consults with lessees/permittees about proposed operations and "review[s] and disseminate[s] information on scientific research projects" in the NPR-A. It meets at least twice a year to discuss potential developments in the region and their impacts. Therefore, discussions of the SAP involve several species and habitats important to the subsistence lifestyle of the population and larger ecological health of the region.

The Arctic Field Office staff's suggestion was to examine if any of these species or habitats – by virtue of the number of times they were mentioned; the importance assigned to them by the local populations; or the importance of the context in which they were discussed at the SAP meetings – would rise up to be included in the list of conservation elements (CEs) for the REA. The UA project team received electronic copies of transcribed meeting minutes of the SAP. The minutes covered all meetings spanning Winter 1999 through Spring 2013.

A two-phase project was designed to examine the SAP transcripts. Phase I consisted of an exploratory survey of the SAP documents for key issues and themes using frequency and co-occurrence analyses.

⁸ Two regional entities are represented on the SAP. Inupiat Community of the Arctic Slope is a federally recognized tribal entity with a Board of Directors from several communities in the North Slope. North Slope Borough is the other regional entity. Six other federally recognized tribes are represented – Naqsrugmuit Tribal Council (Anaktuvuk Pass), Native Village of Atkasuk, Native Village of Barrow, Native Village of Nuiqsut, Native Village of Point Lay, Wainwright Traditional Council.

Phase II entailed a more in-depth examination of those themes and issues identified during Phase I, in order to identify substantive knowledge components potentially useful in answering management questions.

Phase I was completed. In general, SAP meetings are structured for SAP members to be aware of the potential and current development projects that may have an impact on subsistence resources in the region. Therefore, personnel from various agencies or industry present their projects. This information is used in formulating their advise to BLM with regards to the use of land in the context of potential impact of those projects on subsistence resources. Therefore, a large portion of the 1500 pages worth of meeting minutes contains project presentations by project personnel, agency employees, scientists, and other related officials. Minutes also include personal opinions and experiences shared by attendees. Some of these shared opinions and experiences are in Inupiaq and were translated (non-verbatim) into English.

During Phase I analysis, we identified all potential conservation elements and change agents mentioned by self-identified resident subsistence users of the region. While there are several such conservation elements, most commonly mentioned species were already included in the CE list. However, among the CAs, air traffic and seismic activities were most concerning to these speakers. While both these are types of anthropogenic activities, identifying them as mentioned in the SAP meeting minutes frequently over the years calls for special attention to these activities in the analysis.

General findings from Phase I analysis are:

- 1) Individual species (with the exception of caribou) are rarely identified by subsistence users.
- 2) When species are identified, it is typically in response to reports/presentations being given by agency or industry personnel.
- 3) The SAP documents cannot provide further species/habitats for use as CEs in this REA.
- 4) Air traffic and seismic activities are the most concerning among CAs.

Looking ahead, SAP minutes, while very interesting and offer useful insights into some important aspects of interactions among subsistence users, industry representatives, and scientific community, would not offer much for an REA. This is primarily because of the distinct purposes of SAP meetings and REA projects. REAs are designed to identify, collect, and compile information (including traditional ecological knowledge) to answer specific management questions. SAP meetings are designed to appraise members of any development and land use in order for the members to advise the BLM on such land use. There is seldom any discussion or conversation elucidating the importance of a certain conservation element or impacts of any change agent on any conservation element. Most conversation during SAP meetings is in generalities. Thus, the project team proposes to abandon Phase II of SAP meeting minutes analysis. The final report on Phase I analysis will be submitted along with the next memorandum.

Change Agents

CAs are those features or phenomena that have the potential to affect the size, condition, and landscape context of CEs. CAs include broad factors that have region-wide impacts such as wildfire, invasive species, climate change, and pollution, as well as localized impacts such as development, infrastructure, and extractive energy development. CAs act differentially on individual CEs, and for some CEs, may have neutral or positive effects, but in general are expected to cause negative impacts. CAs can impact

CEs at the point of occurrence as well as through indirect effects. CAs are also expected to act synergistically with other CAs to have increased or secondary effects. Change Agents in the region can be broadly organized as:

- Climate Change
- Fire
- Invasive Species
- Anthropogenic Land Uses

Climate Change

Climate change drives multiple types of change in the REA, and is also part of feedback loops with other CAs (such as fire) and CEs (such as permafrost). Basic climate data includes mean monthly historical and projected temperature and precipitation and/or projections of autumn freeze, spring thaw, and season length based on temperature data. Comparison of historical and projected data yields data on monthly, annual, or seasonal shifts in temperature, precipitation, and/or freeze, thaw, and season length.

An assessment of climate change impacts on terrestrial habitats (with mammals and birds secondarily influenced by habitat change) is integral to the REA. This includes broad-scale assessment of potential changes in habitat (changes to coarse-filter CEs) driven by climate change, using a climate-envelope approach where such assessment is possible.

This assessment will include a qualitative discussion of the potential effects of climate change on aquatic habitats (with fish secondarily influenced). Direct modeling of water temperature will be undertaken only if pertinent data and models can be identified.

Fire

Fire is a natural feature of the landscape in this region, and part of historical and existing ecosystem processes. However, as a CA, fire can be specifically examined in terms of changing fire dynamics on the landscape, driven by a changing climate. Assessment of fire as a CA includes analysis of spatially and temporally explicit historical fire data. It also includes creation and analysis of model outputs of projected fire frequency by region, on a roughly spatial basis and/or a percentage/risk basis pixel by pixel or HUC by HUC. It does not include fire severity (for which there is no data) or exact spatial/temporal predictions of future fires, since the stochastic nature of fire starts and fire behavior is better represented via averaging outputs across multiple model runs. It also does not include historical or projected lightning, except in broadly qualitative terms based on literature review, due to lack of consistent past data and lack of reliable models for projected lightning.

Fire modeling allows for some assessment of impacts on terrestrial habitats (with mammals and birds secondarily influenced by habitat change); including fire-induced changes in broad habitat type (deciduous forest, black spruce forest, white spruce forest, grass/tundra, and snow/ice/rock) as well as in mean age (successional stage) of each cover type. It does not allow for assessment of impacts to most vegetation at the species level or at the level of fine-scale vegetation classifications used elsewhere in the project. However, the recent development of fire model parameters for three different tundra classes via

the ALFRESCO (Alaska Frame-based Ecosystem Code) model may provide useful data for this region (Rupp et al. 2006 and Rupp et al. 2001).

Fire modeling can also be coupled with analysis of fire impacts on permafrost, based on qualitative information from the literature on the influence of fire on permafrost. This analysis will not include separate fire-linked spatial predictions.

Permafrost

With mean annual temperatures well below freezing across the region, permafrost is considered continuous. However, localized thaw (complete permafrost loss) is possible in warmer areas, particularly in lake basins. Deepening of the active layer is likely region-wide. Modeling of soil thermal dynamics is crucial for this REA, since changes in these dynamics are likely to have implications for shifts in vegetation and hydrology. Permafrost is considered a CE although treated as a CA as intersections with permafrost and other CEs are crucial to projecting their future. Soil thermal dynamics are also linked to several management questions.

Invasive Species

Invasive species are included as CAs in all BLM Rapid Ecoregional Assessments due to their widespread capacity to disrupt ecological processes and degrade biological resources. In most of Alaska and particularly in this ecoregion, invasive species are not considered an immediate threat. Terrestrial invasive species, however, are documented to cause ecological and economic impacts to some areas in the state and other northern regions (see Carlson and Shephard 2007, Schwörer et al. 2011, Sanderson et al. 2012).

Examples of invasive species impacts in Alaska include extensive transformation of nutrient-rich, high productivity, forb-graminoid communities into nutrient-poor ericaceous tundra communities in the Aleutians due to seabird declines following fox and rat introductions (Croll et al. 2005). The establishment of sweetclover, which reaches high densities on stretches of the Nenana, Knik, Matanuska, and Stikine river floodplains, inhibits recruitment of native species (Spellman & Wurtz 2010); sweetclover also alters native plant-pollinator networks (Schneller & Carlson 2012). The expansion of waterweed, *Elodea*, in the Fairbanks area is associated with declines in grayling habitat (Lisuzzo 2012). In Southeast and Southcentral Alaska, reed canarygrass is rapidly invading ditches, encroaching active channels, and forming mono-specific stands in wetlands (Schrader and Hennon 2005).

At present, invasive species occurrences are largely non-existent in the North Slope ecoregion (Figure 10) and are restricted to the anthropogenically-disturbed areas along the Dalton Highway (AKEPIC 2013). However, currently benign conditions are no guarantee for future behavior. Many of the most invasive species on the continent, such as purple loosestrife and starlings, have maintained deceptively innocuous populations in anthropogenic areas before spreading (Mack 2003). A total of seven non-native plant species are known to occur within the ecoregion, none of which are considered significant threats to natural systems (Appendix E). Floodplain and wetland habitats may be most susceptible to invasion by non-native plants in the North Slope ecoregion in the future. Aquatic systems (lakes, ponds, and slow moving, clearwater streams) could be impacted by the establishment of the waterweed *Elodea*, currently known from the Tanana watershed. Presence of invasive animal species in the ecoregion is unknown.

Establishment and population increases of invasive species are likely to be accelerated due to current trajectories of climate change, increases in development, and forest fire frequency and intensity. Our understanding of the relationship of invasive species to these other change agents is limited in Alaska. Ecological impacts are largely specific to individual non-native species (see Carlson et al. 2008); the impacts may include alterations of ecological processes, such as nutrient cycling or fire regimes, as well as effects on individual native species.

Currently known non-native plant infestations will be used as a component of the ecological intactness assessment/landscape condition for the ecoregion (for example see, Unnasch et al. 2009; Dynamac 2011). The relationship of infestation occurrences to development and other factors can be used to model potential changes in patterns of infestations and therefore landscape condition relative to future scenarios. Second, one terrestrial and one aquatic invasive species will be selected for species-specific distribution modeling to identify current and future areas and resources that may be at risk. Selection of the invasive species will be based on the following criteria: 1) known in the ecoregion or expected to occur in the region, 2) expected to have the greatest impacts on the regional ecology and conservation elements.

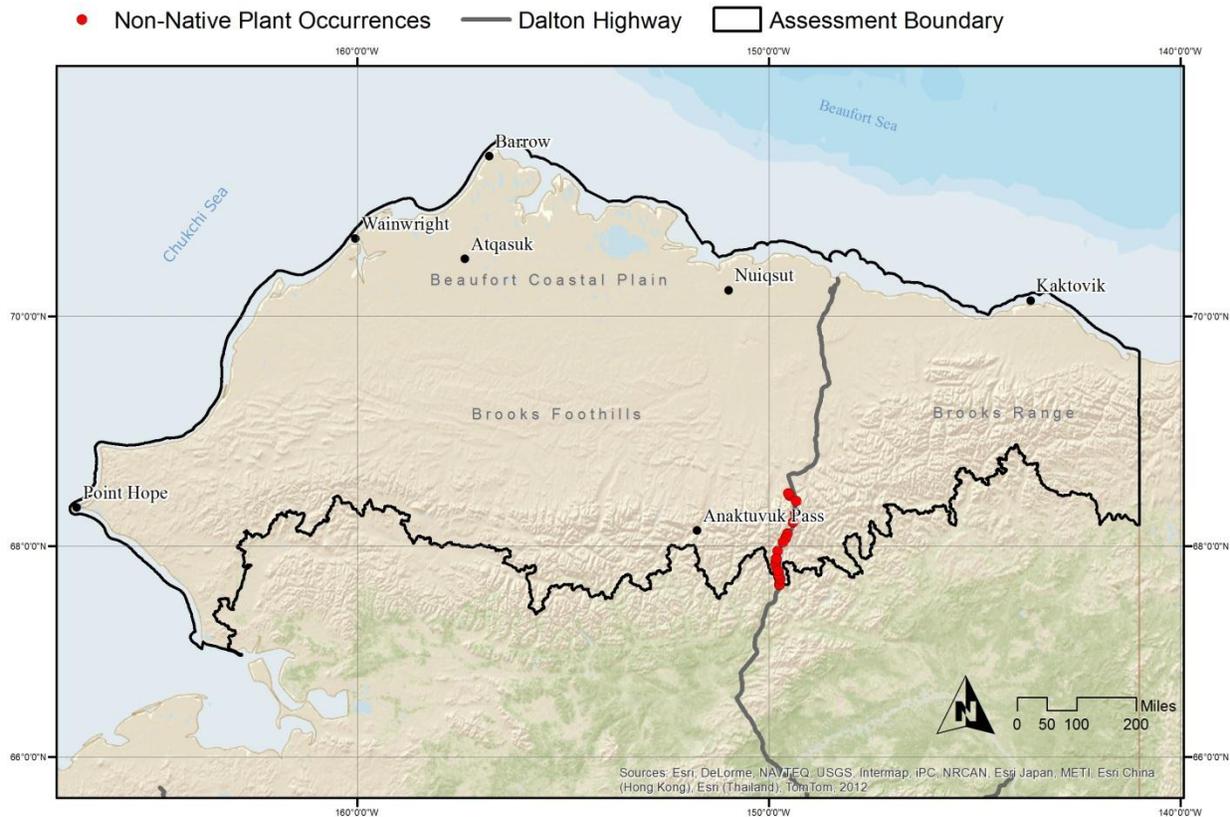


Figure 10. Non-native plant occurrences in the North Slope Ecoregion.

Anthropogenic Uses

Human use of land and other resources for purposes of development, subsistence, and other human needs are termed anthropogenic uses. Such uses can directly affect habitats as well as species. In addition to direct habitat conversion and fragmentation, anthropogenic uses can affect density of prey, which can impact subsistence hunting. Anthropogenic uses can be complementary to each other. Some uses such as development can be beneficial to local subsistence communities by providing income for equipment and fuels, and new roads that expand access to hunting areas, thus aiding and facilitating other anthropogenic uses such as subsistence. Land uses are often additive as well, as mining and energy development cannot occur without road and energy infrastructure. Thus, their impact largely depends on the complexity of the activity. Additionally, these uses have political and financial uncertainties, further adding to the complexity of measuring potential impacts.

Anthropogenic uses can also be affected by other CAs (for example, permafrost thaw and erosion). This project will provide an inventory of existing anthropogenic uses in the region and, where GIS data are available, estimated footprints will be mapped. A summary of existing data and maps for the proposed resource extraction projects – permitted or in the permitting process – will be included in the assessment. Other land uses (such as remote fly-in tourism) will rely on tabular data. The categories of anthropogenic use to be assessed are:

- **Subsistence:** All communities in the region depend on subsistence resources. Such resources are scattered throughout the region on the land and in the sea stretching from one end to the other. In addition to whales, other subsistence species harvested include various species of fish, birds, plants, and big game animals, primarily caribou. Subsistence forms a principal source of food and it is an important economic and social activity. As described above, development of any sort impacts the land available for subsistence. People in the region are constantly deal with difficult priorities in maintaining this delicate balance.
- **Natural Resource Extraction:** Prudhoe Bay is home to the largest oil field in the United States and produces approximately 40% of the oil in Alaska. This development has substantial impact on transportation infrastructure, energy supply, and impact community populations, employment and subsistence. Additional mining activities are either proposed or exist in smaller proportion.
- **Transportation and communications infrastructure:** The majority of the transportation infrastructure is related to the oil industry activities. This includes the trans-Alaska pipeline to transport crude oil across the state, winter roads to serve the oil fields, and few other proposed major connecting routes. Other transportation infrastructure –existing and planned – is small in comparison to other areas of the U.S., and located within the community footprints. Transportation infrastructure includes local roads, airports, ports, and local summer and winter trails that are used for subsistence purposes. Communication infrastructure includes broadband and cellular service towers and related infrastructure.
- **Recreation:** Recreation in the region includes visitors to remote lodges, dispersed and centralized facilities in state and national recreation areas. Visitors to this region mostly are seasonal.
- **Energy development:** Diesel generators are the main source of electricity in communities, with increased reliance on renewable sources of energy. Renewable energy projects in the region are small scale and designed to replace some of the energy produced by diesel generators. Lack of transmission infrastructure and a small customer base limit the size of these projects.

Next Steps

The next step in the REA process is data discovery. Our goal with data discovery is to identify and obtain existing tabular and spatial data to assist us in answering the Management Questions, refining distribution models for both coarse-filter and fine-filter CEs, and developing the CA data layers. During this process, we will also identify areas that are data deficient. As such, data discovery will continue to help us refine our project scope. We anticipate compiling a data discovery table for review by the AMT and Technical Team by mid-October and will follow-up with a webinar in late October, at which time we will present the current status of our findings.

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Appendix A. Highest Ranked MQs provided to AMT 1 Workshop for review. Organized by theme (listed alphabetically), showing source of the question, original question, and rewrite of question (if applicable).

Theme	Source	Original Question	Rewritten Question
Air Quality	ArFO	How is oil and gas development on the North Slope impacting near- and far-field air quality?	
Air Quality	ArFO	How will oil and gas development in NPRA contribute to air quality in the future, with particular emphasis on communities and “sensitive class 2” areas such as ANWR, Gates, Noatak?	
Air Quality	ArFO	How will the evolving fire regime on the North Slope contribute to air quality in the future, with particular emphasis on communities and “sensitive class 2” areas such as ANWR, Gates, Noatak?	
Climate and Weather	Emerging Issues	How will changes in weather pattern/climate affect winter exploration seasons?	
Climate and Weather	WildREACH	How much change will occur in the timing of snow melt and snow onset?	
Climate and Weather	WildREACH	How will changes in precipitation, evapotranspiration, and active layer depth alter summer surface water availability in shallow-water and mesic/wet tundra habitats?	
Climate and Weather	WildREACH	How reliable are the projections for increasing precipitation and evapotranspiration?	
Climate and Weather	WildREACH	How will changes in precipitation, evapotranspiration, and active layer depth alter summer surface water availability in shallow-water and mesic/wet tundra habitats?	
Contaminants	Emerging Issues	What additional contaminants baseline data are needed for fish, birds, marine and terrestrial species, particularly those that affect the health and safety of subsistence foods?	Rewritten to: Have contaminated sites been mapped and what additional contaminants baseline data are needed for fish, birds, marine and terrestrial species, particularly those that affect the health and safety of subsistence foods?
Cultural Resources	ArFO MQs, NPRA AIM	What are the effects of climate change on cultural and paleontological resources?	
Erosion	Emerging Issues	What are the expected changes to habitat as a result of erosion and related redistribution of both fresh and saline water?	Rewritten to: What are the expected changes to habitat as a result of coastal erosion?

Theme	Source	Original Question	Rewritten Question
Fire Regime	Emerging Issues	How will vegetation respond given projected fire and climate regimes?	
Fire Regime	Emerging Issues	What are the current links between climate and fire, fire and vegetation, vegetation and ungulates (especially caribou)?	
Fire Regime	Emerging Issues	Given future scenarios for climate, fire, and vegetation response, how are herbivores likely to respond?	
Fire Regime	Emerging Issues	How will key forage species for caribou and other ungulates be impacted by a changing fire regime, and will this alter habitat use and migration?	
Fire Regime	Emerging Issues, NPRA AIM	What is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire on the North Slope?	Rewritten to: Is the fire regime changing on the North Slope and what is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire?
Fire Regime	Emerging Issues	Will lightning activity change in terms of frequency, location, seasonal pattern?	
Fire Regime	Emerging Issues	Will fire intensity and burn severity change; and if it does, what will be the impacts, for example on permafrost and the active layer?	
Fire Regime	NPRA AIM	What changes in permafrost and vegetation will be driven by fire and how will these effect the communities that they support?	
Fire Regime	Emerging Issues, NPRA AIM	Is there/what is the current relationship between fire, vegetation succession, and landform on the North Slope?	
Fire Regime	NPRA AIM	How will permafrost thaw affect fire regime?	
Fire Regime	Emerging Issues	What is the role of fire in tundra surface stability – e.g., will increased albedo and removal of vegetation layer increase active layer thaw and thermokarsting?	
Fish	ArFO MQs	How does oil and gas infrastructure (e.g. roads, pads, pipeline), both permanent and temporary, affect fish habitat, fish distribution, and fish movements?	
Fish	ArFO MQs	What are baseline characteristics and trends in fish habitat (lakes and streams), fish distribution, and fish movements?	

Theme	Source	Original Question	Rewritten Question
Fish	ArFO MQs	How does water withdrawal from lakes for oil and gas activities (year-round industrial and domestic use and winter operations) affect lake water quantity and water quality, outflow/stream connectivity, and down-basin stream habitat?	Rewritten to: How does water withdrawal from lakes affect down-basin stream habitat?
Invasive Species	NPRA AIM	What are the location, abundance, and trend of invasive species?	
Invasive Species	Emerging Issues	Are we likely to see new invasive species; which ones; by which pathway; how do we reduce/prevent invasion; how do we best detect and respond to invasion; and what will the effects of increased invasion be?	Rewritten to: 1. Which areas of the REA are more susceptible to invasive species establishment currently? 2. Which areas of the REA are more susceptible to invasive species establishment in the future? 3. Which CEs are most likely to be impacted by invasive species? 4. What are the potential ecological impacts of invasive species on CEs?
Invasive Species	NPRA AIM	What are the known and likely introduction vectors of invasive species and what is the current status of populations?	Rewritten to: What are the known and likely vectors for introduction of invasive species?
Migratory Birds	Emerging Issues	Is there sufficient data on rare species to credibly advise whether a specific management action is/isn't needed?	Rewritten to: Where are threatened/endangered/rare/sensitive species found?
Migratory Birds	ArFO MQs	What are the baseline data for the species composition, numbers of individuals, vegetation type used, and change in numbers/species composition of landbirds and their habitat over time?	
Migratory Birds	ArFO MQs	How has the abundance and distribution of yellow-billed loons changed over time in the NPR-A?	Rewritten to: How has the distribution of yellow-billed loons changed over time on their north slope breeding grounds?
Permafrost	Emerging Issues	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	
Permafrost	Emerging Issues	NSSI agencies' immediate need is to be able to predict how permafrost will change temporally and spatially over the next one to two decades.	Rewritten to: How will permafrost change spatially and temporally over the next two decades?
Permafrost	Emerging Issues	How will changes in permafrost condition manifest for winter tundra travel, does an increasing depth of the active layer impact seasonal tundra travel?	

Theme	Source	Original Question	Rewritten Question
Permafrost	NPRA AIM	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	
Permafrost	NPRA AIM	Is the permafrost-fire relationship driven by fire or the loss of permafrost?	
Social and Economic Structure	Emerging Issues	What may be the relevance of various existing management authorities (e.g., Executive Order 12898 [Environmental Justice], NEPA, and the OCS Lands Act) to considerations of the impacts of energy development or climate change on social and economic structure on the North Slope?	Rewritten to: What are the impacts of energy development on social and economic structure on the North Slope? This rewording is misrepresenting the original question. Recommend: "What are the different layers of regulatory control in North Slope with respect to energy development and their impact on social and economic structure in the North Slope?"
Social and Economic Structure	NPRA AIM	What are the cumulative effects of anthropogenic activities?	
Social and Economic Structure	Emerging Issues	What are the appropriate social and economic indicator data that should be gathered (e.g., for historic baseline and trend data)?	
Social and Economic Structure	Emerging Issues	How should we integrate local and traditional knowledge into social and economic investigations of North Slope people and communities?	
Social and Economic Structure	Future Needs	What are the effects of weather on construction season?	
Social and Economic Structure	Emerging Issues	What are industry activities in winter and spring (need to develop a database of industry activities for winter and spring)?	
Soils	NPRA AIM	Where are the locations of soils suitable for infrastructure development?	Rewritten to: Where are the locations of soils suitable/unsuitable for infrastructure development?
Subsistence	ArFO MQs	Is the harvest of caribou by residents of the NPRA and nearby communities affected by oil and gas activity in the NPR-A?	Rewritten to: What is the impact of development on subsistence harvest of caribou?
Subsistence	ArFO MQs	Is the harvest of fish by residents of the NPRA and nearby communities affected by oil and gas activity in the NPR-A?	Rewritten to: What is the impact of development on subsistence harvest of fish?

Theme	Source	Original Question	Rewritten Question
Subsistence	ArFO MQs	What physical and perceptual limitations to access to subsistence resources by local residents are caused by oil/gas activities?	
Subsistence	ArFO MQs	Have erosion and/or other environmental changes affected subsistence use areas and caused people to adjust their hunting/fishing/gathering practices?	
Terrestrial Wildlife	Emerging Issues	What parameters can help measure impacts from anthropogenic activities independently of natural cycles and vice versa?	
Terrestrial Wildlife	Emerging Issues	What is the winter ecology of caribou?	
Terrestrial Wildlife	Emerging Issues	What is the seasonal variation in caribou food production under changing climate conditions?	
Terrestrial Wildlife	Emerging Issues, NPRA AIM	How might changing fire regimes and fire response affect caribou distribution and the distribution of caribou food sources?	
Terrestrial Wildlife	ArFO MQs	What impacts will oil/gas exploration and development have on wildlife populations and how can we mitigate those impacts?	Rewritten to: What potential impacts will oil/gas exploration and development have on CE habitat?
Terrestrial Wildlife	ArFO MQs	What are their seasonal distribution and movement patterns?	
Terrestrial Wildlife	ArFO MQs, NPRA AIM	What are the status and trend of these communities?	Rewritten to: What are caribou preferences for vegetation communities? Where do these vegetation communities exist?
Terrestrial Wildlife	ArFO MQs	How are polar bears using the NPR-A today (pre-development) for natal denning and summer activity?	Rewritten to: Where is polar bear seasonal habitat?
Terrestrial Wildlife	Emerging Issues	What baseline measurements of caribou are needed but not yet documented?	
Terrestrial Wildlife	ArFO MQs	How are movement rates related to season and weather?	Rewritten to: How are movements related to season and weather?
Terrestrial Wildlife	ArFO MQs	How have types and levels of contaminants changed in the last 10 years for Colville River peregrine falcons?	Rewritten to: How have types and levels of contaminants changed in the last 10 years for peregrine falcons?
Terrestrial Wildlife	AK BLM State Office	How will introduction of a reindeer herding program affect caribou and vegetation?	

Theme	Source	Original Question	Rewritten Question
Vegetation	NPRA AIM	What are the condition and trend of vegetation (including rare) species and communities in natural and disturbed areas?	Rewritten to: Which rare species and vegetation communities are threatened by CAs?
Vegetation	NPRA AIM	What are the location, abundance, and pattern of vegetation (including rare) species and communities in natural and disturbed areas?	Rewritten to: Where are rare species and vegetation communities?
Vegetation	ArFO MQs	What are the impacts of oil/gas development (i.e. gravel pad and road construction; pipeline construction) on tundra vegetation? (Known impacts include burial, dust, saline runoff and altered soil moisture.)	
Vegetation	Emerging Issues	Will a changing fire regime play a role in vegetation change and should fire be used as an active tool for vegetation management?	Rewritten to: What is the impact of fire regime on vegetation
Vegetation	NPRA AIM	Where has disturbance occurred related to energy, fire, development, and insects and disease?	
Vegetation	WildREACH	How will plant species composition shift in response to long-term climate change, and what are the implications for habitat structure and quality of the prevalent available forage (i.e., digestibility, nutrient content)?	
Vegetation	Emerging Issues	Can we model the habitat effects of vegetation change (e.g., effect of vegetation change on habitat of yellow-billed loon, other species)?	
Vegetation	Emerging Issues	Can we (or do we need to) identify refugia for vegetation types and the bird species associated with them?	Rewritten to: Where are refugia for unique vegetation communities and the bird species associated with them?
Vegetation	Emerging Issues	Can we expect new ESA listings among North Slope plants species; which species are most likely?	Rewritten to: Where are rare (federally listed, BLM sensitive species) species found?
Vegetation	Emerging Issues	Do we have the baseline data needed to detect change?	
Vegetation	NPRA AIM	Do we have the baseline data needed to detect change?	
Vegetation	Combined-Emerging Issues and NPRA AIM	What should we expect in the way of range extensions? How will vegetation changes affect the food base for herbivorous species (especially caribou), and how will that in turn affect their numbers and use? How will vegetation change affect lichen fields and their recovery? How will shrub size and extent change?	Rewritten to: Where and how will shrub expansion impact caribou food availability?

Theme	Source	Original Question	Rewritten Question
Vegetation	NPRA AIM	What are the major vegetation successional pathways for the tundra vegetation classes, and how do the most common disturbance types affect those pathways?	

Appendix B: Medium Ranked Management Questions.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Climate and Weather	Emerging Issues	How will changing weather conditions affect species movements, survival, and reproduction?		Needs clarification. Qualitative assessment + literature review.
Climate and Weather	WildREACH	How will the annual precipitation input on the Coastal Plain and Foothills be allocated between winter (snow pack) and summer?		Needs clarification. SNAP data and analysis
Climate and Weather	WildREACH	How will the frequency of rain-on-snow and severe winter storm events change?		Might be estimated based on temperature predictions, but no direct model available.
Contaminants	Emerging Issues	What is needed to understand contaminant risks and impacts on human health?	What is needed to understand the impacts of contaminants on human health?	Identifying the threshold of contaminants in relation to each CE, and addressing a data gap with respect to each source of contaminant.
Contaminants	Emerging Issues	What are contaminant risks associated with energy development and is the current level of contamination well documented?	What are contaminant risks associated with development?	Identifying the threshold of contaminants in relation to each CE, and addressing a data gap with respect to each source of contaminant.
Cultural Resources	ArFO MQs	What are the effects of oil and gas activities on cultural and paleontological resources in the NPR-A?	Where could oil and gas exploration and development overlap with known cultural and paleontological sites?	Identifying cultural and paleontological resources, and assessing the impacts of resource development activities, climate change, and recreation uses are within our expertise
Cultural Resources	ArFO MQs	What are the impacts of recreational public travel through cultural and paleontological resource areas?		Identifying cultural and paleontological resources, and assessing the impacts of resource development activities, climate change, and recreation uses are within our expertise

Theme	Source	Original Question	Rewritten Question	UA Rationale
Fire Regime	Emerging Issues	Will human safety conditions change if/when fire increases; how will this affect fire suppression decisions; and how will this affect communications with villages so that they are kept in touch on fire status?	How will altered fire regime affect communities, subsistence opportunities, infrastructure, and human safety?	ISER can provide location information on infrastructure and other anthropogenic uses.
Fire Regime	Emerging Issues	What is the role of fire in tundra surface stability – e.g., will increased albedo and removal of vegetation layer increase active layer thaw and thermokarsting?		This can be partially addressed independently using our fire and permafrost models
Invertebrates	WildREACH	How will warming and changing seasonality affect abundance and peak activity periods of biting insects, and what are the bioenergetic consequences for caribou in particular?	How will warming and changing seasonality affect abundance and peak activity periods of biting insects?	Literature review plus possible spatial data for current mosquito and fly harassment areas. Recent paper by Wilson et al. 2012 addresses some of the spatial aspects of this MQ - summer resource selection for the Teshekpuk herd
Invertebrates	WildREACH	How will warming and changing seasonality affect the prevalence of parasites and disease vectors (e.g., nematode parasites of muskoxen and Dall's sheep)?		Question cannot be answered with spatial data. We have a very similar question for YKL. Literature review only.
Invertebrates	WildREACH	How does temperature affect growth and development of aquatic insects?		There are already several publications addressing this question - many from the Arctic. This can be answered in a literature review. Another AKNHP project is looking at this question across sites in coastal Alaska, but data are not yet ready for analysis.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Migratory Birds	Emerging Issues	How & where will oil spill risks to birds (from rig operation, loading/ transport, pipelines) be altered if additional energy development occurs?	What are the effects of potential energy development on migratory bird habitats?	Needs clarification. Requires information on important waterfowl areas. Other migratory species? Need clarification on species or species groups. Spatial data to map current distribution and link to habitats is likely available.
Migratory Birds	ArFO MQs	What are the possible impacts to other geese resulting from the increasing snow goose population in the NPR-A?	What are the possible impacts to other geese resulting from the increasing snow goose population	Reframe so this is a spatial assessment, not population level
Permafrost	NPRA AIM	Is the permafrost-fire relationship driven by fire or the loss of permafrost?		We can model both, but not simultaneously
Saltwater Intrusion	Emerging Issues	How will increasing salinity in near shore waters affect fish species? How will it affect fish in areas not currently saline (lower reaches of rivers, flood lakes, ...)?		Near shore waters probably considered marine, this might be out of scope. But, can try to address effects of saltwater intrusion in coastal lakes and rivers on fish species using a literature review. Review would include tolerance of fish species.
Sea Ice and Ocean Conditions	Emerging Issues	How will changes in sea ice affect the need for land-based infrastructure (e.g., barge landings)?		ISER can provide location information on infrastructure and other anthropogenic uses.
Sea Ice and Ocean Conditions	Emerging Issues	How will over land weather (precipitation, wind, snowfall) be affected by changing sea ice & how will it affect management decisions (off-road travel, water permits)?		We are limited in our ability to answer this by the assumptions built into the GCMs we will use in this REA

Theme	Source	Original Question	Rewritten Question	UA Rationale
Social and Economic Structure	Emerging Issues	Need to understand the factors that affect these social indicators – i.e., need to know how to explain what drives cause and effect in observed changes in social indicators.		Needs clarification. Depends upon the indicators of interest, and how much cause and effect is desired. This needs to be focused, but seems to fit within the capabilities of ISER.
Social and Economic Structure	Emerging Issues	What are industry activities in winter and spring (need to develop a database of industry activities for winter and spring)?		The availability of data is unknown, but this would be within our capacity.
Subsistence	ArFO MQs	Has land use by local residents changed since the 105(c) studies were conducted in the late 1970s? If so, can changes be attributed to adaptations resulting from an increased presence of oil and gas exploration activity (or in the future: development activity)?		Needs clarification
Terrestrial Wildlife	Emerging Issues	What may be the effect of changes in caribou numbers and distribution on subsistence use?	What may be the effect of changes in caribou distribution on subsistence use?	This requires seasonal use data which may not be available, but if it is then this fits within our expertise.
Terrestrial Wildlife	ArFO MQs	How do occupancy and productivity numbers for cliff-nesting raptors along the Colville River fluctuate in a pre-development environment?	What is the current distribution of cliff-nesting raptors along riparian corridors in pre-development areas?	
Terrestrial Wildlife	ArFO MQs, NPRA AIM	What habitats are most preferred by cliff-nesting raptors along the Colville River?	What habitats are most preferred by cliff-nesting raptors?	Combined with other question
Vegetation	Emerging Issues	What should we expect in the way of range extensions?		Needs clarification. This will be done, in part, during the core analysis. However, if there are specific species/communities that are of interest, then we need clarification.
Vegetation	Emerging Issues, NPRA AIM	How will vegetation changes affect the food base for herbivorous species (especially caribou), and how will that in turn affect their numbers and use?		We are addressing a similar question in the YKL REA, focused just on lichen, so this is within our capacity.

Theme	Source	Original Question	Rewritten Question	UA Rationale
				Could be a core question if lichen becomes a CE.
Vegetation	Emerging Issues	How will vegetation change affect lichen fields and their recovery?		Could be core question if lichen is a CE. This is something within our capacity.
Vegetation	Emerging Issues, NPRA AIM	How will shrub size and extent change?		The first part of this question is out of scope for the REA, but the second part could be considered a core analysis if shrubs are chosen as a CE or CA.
Vegetation	Emerging Issues	For change detection, which species or habitat types should be measured and at what scale; which sites should be used and how do we ensure comparability?		This is within our expertise, but again would require major work effort. Part of it will be identified through the core analyses.
Air Quality	Lon Kelly	How will oil and gas exploration and development, industry in northern Europe and Asia, research projects, changing climate, and environmental regulation impact air quality on the North Slope in aggregate, and how can these activities be controlled by land managers to minimize negative impacts?		We need clarification on regional impacts (northern Europe and Asia outside of ecoregion). Outside of our expertise, but would be able to find sources to help address the question.
Fire Regime	Emerging Issues	What is the nature of the link between fire regime and hydrology and will a change in this link have cascading effects on fish, birds, and other species?		This is an advanced modeling exercise that could be outside the scope of an REA. We can model some of these things independently, but this really represents a much larger research agenda.
Saltwater Intrusion	Emerging Issues	How will the use of saltwater for ice roads impact vegetation over time?		As stated now, this isn't a landscape-wide issue, and if included, will likely just be a

Theme	Source	Original Question	Rewritten Question	UA Rationale
				literature review
Social and Economic Structure	Emerging Issues	We need objective measures for thresholds to identify what constitutes a significant change.	What threshold constitutes significant social or economic change?	Needs clarification. This is very vague and is likely out of scope for an REA
Vegetation	Emerging Issues	Will vegetation change affect active layer depth?		This is likely limited to a literature review at this scale and timeframe.

Appendix C. Low Ranked Management Questions.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Climate and Weather	Emerging Issues	How will changes in weather pattern/climate affect coastal erosion?		Can be addressed via SNAP models linked to permafrost models from GIPL, but shore-fast ice and storms can only be addressed via the literature.
Climate and Weather	Emerging Issues	What information is needed to understand coupling (or de-coupling) of changes in benthic and water column characteristics with changes in weather?		lit review? No SNAP data available
Climate and Weather	Emerging Issues	What will be potential effects of changing weather conditions on lake depth (re: winter water removal and fish habitat)?	How will lake depth be affected by changing weather conditions, especially with regards to winter water removal and fish habitat?	Needs clarification. This can be addressed via permafrost modeling and perhaps via P-PET models, but results will be regionally generalized rather than site specific.
Climate and Weather	Emerging Issues	There seems to be a similar set of concerns with weather stations as with hydrological gauging stations (cost, maintenance, proper placement, ...); can we learn anything from our knowledge of hydrological gauging stations to help deal with these challenges for weather stations?	What is the number, distribution, seasonal use, and short- or long-term placement of hydrological gauging stations on the North Slope and how do these compare with weather stations?	lit review? No SNAP data available
Climate and Weather	NPRA AIM	What is the carbon sequestration potential of BLM-managed lands?		SNAP does not have any data to address this. Lit review might turn up something, but I doubt it. Doing calculations from scratch is probably out of scope.
Climate and Weather	WildREACH	What are the expected changes in snowpack characteristics (depth, density, presence of ice layers), and how might these vary on a regional and local scale?		This is more specific than what our models at SNAP offer. We can offer qualitative discussion, but not spatially explicit analysis.
Climate and Weather	WildREACH	Will increased fogginess/cloudiness exert a negative or positive feedback effect on air temperature in the coastal zone, and what is the expected spatial extent of this effect?		We do not have data at SNAP on fog and clouds
Contaminants	Emerging Issues	Effective regulation of local industry requires a baseline of contaminants present prior to industry in order to best assess what, and how much, contaminants local industry adds to the environments. What is our current knowledge of such a baseline?		Needs clarification. Depends upon the contaminant, but this would largely be left to a literature review.
Erosion	Emerging Issues	What are the erosion risks to communities and to subsistence opportunities and access?	What are the risks of erosion to communities, cultural sites, and subsistence opportunities?	ISER can provide location information on infrastructure and other anthropogenic uses. The UA Team does not currently have anyone that specializes in erosion, or hydrology in general, so

Theme	Source	Original Question	Rewritten Question	UA Feedback
				some of these may have to be addressed more qualitatively than quantitatively
Erosion	Emerging Issues	What are the links between coastal or riverine erosion and contaminant risk and where is the overlap between erosion and contamination?		ISER can provide location information on infrastructure and other anthropogenic uses. The UA Team does not currently have anyone that specializes in erosion, or hydrology in general, so some of these may have to be addressed more qualitatively than quantitatively
Erosion	Emerging Issues	What are the links between coastal and riverine erosion and changing permafrost conditions?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Erosion	Emerging Issues	What are the impacts to water quality (sediment load, dissolved oxygen, conductivity, etc.) in the fresh water and near shore environments?	What are the impacts of erosion on water quality, including sediment load, dissolved oxygen, and conductivity, in fresh water and near shore environments?	The UA Team does not currently have a hydrologist, so this would be limited to literature review
Erosion	Emerging Issues	How will erosion patterns change with the changing patterns in weather, sea ice, wave climate, and sea level changes and how do we plan for this in the future?	How will erosion patterns change with the changing patterns in weather, sea ice, wave climate, and sea level change?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Erosion	WildREACH	Will higher water temperatures, sea level rise, and retreat of summer sea ice cause degradation of the barrier island systems of the Beaufort and Chukchi seas?		Needs clarification, are we including barrier island systems in study area? This could be out of scope.
Erosion	WildREACH	Will alluvial deltas continue to build or will rising sea levels outpace potential increases in sedimentation rates?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Erosion	WildREACH	How quickly will shoreline retreat result in newly breached lake basins?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Erosion	WildREACH	To what extent will coastal erosion, in combination with sea level rise, cause salinization of low-lying coastal areas?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Erosion	WildREACH	Will coastal wet sedge meadows establish at a rate equal to loss of this habitat through erosion and inundation?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Fire Regime	Emerging Issues	How will a changing fire regime affect air quality?		This will likely be literature review only.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Fire Regime	Emerging Issues	What is the nature of the link between fire regime and hydrology and will a change in this link have cascading effects on fish, birds, and other species?		This is an advanced modeling exercise that could be outside the scope of an REA. We can model some of these things independently, but this really represents a much larger research agenda.
Fire Regime	Emerging Issues	Will a changing fire regime alter carbon flux and/or CO2 emissions?		We lack expertise in emission modeling
Fish	Emerging Issues	How important are ephemeral streams to fish passage?		This will probably be a difficult question to answer - there is some research on beaded streams, but linking their importance to fish movements would require tagging.
Hydrology	Emerging Issues	Hydrologic data, including storage and transport, are lacking for individually small stream/lake systems, but might these systems be collectively very important?		Needs clarification. Out of expertise.
Hydrology	ArFO MQs	Are permitted water withdrawals from lakes causing temporary or permanent changes in aquatic habitat, and are they consistent with water availability?		Needs clarification. Changes to aquatic habitat can only be determined if data are available. I don't understand the second part - are they asking if withdrawals are greater than inputs?
Hydrology	ArFO MQs	What impacts will oil/gas exploration and development have on water resources and water quality?		ISER can provide location information on infrastructure and other anthropogenic uses. The UA Team does not currently have anyone that specializes in erosion, or hydrology in general, so some of these may have to be addressed more qualitatively than quantitatively
Hydrology	ArFO MQs	Are adequate stream flow and climate data available from areas most likely to be developed for oil and gas exploration and production?	How might oil and gas exploration and production affect stream flow?	ISER can provide location information on infrastructure and other anthropogenic uses. There are many questions about the current level of monitoring that needs to be vetted through the AMT as to whether that is an appropriate use of REA resources.
Hydrology	Emerging Issues	Is the hydrologic cycle undergoing significant and rapid change in response to climate change; is it well understood how this will affect cycle complexity, high/low flows, etc.?	Is the hydrologic cycle undergoing significant and rapid change in response to climate change?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	How can we measure and model duration of outflow of lakes? This is needed to define "full" for lake recharge.		Needs clarification. The UA Team does not currently have a hydrologist
Hydrology	Emerging Issues	How does snow water equivalent vary on a local scale? How do we determine how much water is available? How accurate are	How does snow water equivalent vary on a local scale? How do we determine how much water is available?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions

Theme	Source	Original Question	Rewritten Question	UA Feedback
		current methods of determining basin storage?		
Hydrology	Emerging Issues	How do the coastal plain and foothills differ in water availability?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	ArFO MQs	Is adequate hydrologic information available to determine whether development is occurring within the 100-year floodplain?	Is there current and potential development within different levels of floodplains?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	How will changing patterns of seasonal runoff affect stream flow?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	What is the contribution of groundwater in various systems, and is it sufficient to maintain yearround flow?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	Will drought conditions and changes in drainage patterns decrease water body connectivity?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	Which Coastal Plain lakes are susceptible to tapping (rapid drainage) and on what time scale?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	To what extent and rate is lake drying occurring now and can we predict or model for the future? What is the geographic variation?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	Are there characteristics of lakes (e.g. basin shape, soils/substrate, vegetation, etc.) that are more/less prone to drying?	What are the mechanisms (e.g., changes in active layer, precipitation, evaporation, etc.) that lead to lake drying, and what lake characteristics increase or decrease potential for drying?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	Is there evidence of lake expansion, or formation of new lakes, that would offset lake drying? What are the rates and patterns of this phenomenon?	What are the rates and patterns of lake expansion or formation and will expansion and formation offset drying?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Invasive Species	NPRA AIM	What are the known and likely introduction vectors of invasive species and what is the current status of populations?	What are the known and likely vectors for introduction of invasive species?	This question will likely only be addressed through a literature review.
Invertebrates	WildREACH	How does earlier spring thaw affect timing of life cycle events and peak availability to predators?		Phenological question - cannot be answered with spatial data. Literature review only.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Migratory Birds	NPRA AIM	What changes in habitat are driving changes in the distribution and abundance of migratory birds?		Needs clarification. Question at the least needs to be reframed to address what are the potential/expected changes in habitat and how could those influence the distribution of migratory birds. Abundance part of question is out of scope.
Migratory Birds	Emerging Issues	Are there likely to be shifts in species composition and how will this affect subsistence use patterns?		Needs clarification. Question could be reframed to include more specific habitat types that species area associated with.
Migratory Birds	ArFO MQs, NPRA AIM	How has the abundance and distribution of spectacled eiders changed over time in the NPR-A and what is driving this change?	How has the distribution of spectacled eiders changed over time on the north slope? What is driving this change?	Although abundance questions are generally considered out of scope, the USWFS does have density estimates for Steller's Eider across N. Slope which they have developed into a GIS coverage as birds/km2. However, we are more concerned with current and future distribution than past changes.
Migratory Birds	ArFO MQs	What are current population estimates and productivity of spectacled eiders in the NPRA?	What are current population estimates and productivity of spectacled eiders?	Population estimates, unless the already exist, are outside the scope of an REA.
Migratory Birds	ArFO MQs	What is the current population estimate for yellow-billed loons in the NPR-A?	What is the current population estimate for yellow-billed loons?	Population estimates, unless the already exist, are outside the scope of an REA.
Saltwater Intrusion	Emerging Issues	What species of fish and fish predators are more/less tolerant of salt intrusion?		Duplicate of another question, but could be addressed through a literature review
Saltwater Intrusion	Emerging Issues	To what extent may ice road construction need to rely on the use of saltwater?		ISER can provide location information on infrastructure and other anthropogenic uses, but this is mostly non-spatial.
Saltwater Intrusion	Emerging Issues	How will the use of saltwater for ice roads impact vegetation over time?		As stated now, this isn't a landscape-wide issue, and if included, will likely just be a literature review
Saltwater Intrusion	Emerging Issues	What is currently known about the level of saltwater intrusion on the North Slope; who's measuring it; where; is it being measured adequately?	What is the level of saltwater intrusion?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Saltwater Intrusion	Emerging Issues	To what extent is saltwater intrusion occurring now and can we predict or model it for the future? What is the geographic variability?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Sea Ice and Ocean Conditions	Emerging Issues	How will a changing ice edge affect specific species?		Needs clarification. We lack expertise in sea ice modeling
Sea Ice and Ocean Conditions	Emerging Issues	How will sea ice changes affect species' onshore vs. offshore distributions?		Needs clarification. Likely considered out of scope based on time limitations.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Sea Ice and Ocean Conditions	Emerging Issues	What will be the effect on wave regime and how will that relate to erosion patterns?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Sea Ice and Ocean Conditions	Emerging Issues	Will diminished sea ice affect fire regime?		Needs clarification. We lack the capacity to model sea-ice extent
Social and Economic Structure	Emerging Issues	We need objective measures for thresholds to identify what constitutes a significant change.	What threshold constitutes significant social or economic change?	Needs clarification. This is very vague and is likely out of scope for an REA
Social and Economic Structure	Emerging Issues	Many studies are a “snapshot” in time, without follow up to detect change. Need to synthesize existing studies, predictions, recommendations for social and economic impacts of energy development and climate change.		Needs clarification. In part, this is what an REA will do. If there is a more specific question, then we can assess it independently
Social and Economic Structure	Future Needs	What are the effects of weather on infrastructure and communities?		Needs clarification. We cannot model weather, but we do address this partially with climate change impacts. Otherwise, this would be limited to a literature review.
Subsistence	ArFO MQs	Have subsistence cabins and camping areas been impacted by scientific research projects in the NPR-A, and if so, how?	Have subsistence cabins and camping areas been impacted by scientific research projects, and if so, how?	Data is likely to be lacking, but if available we could do this.
Terrestrial Wildlife	Emerging Issues	Need to review the appropriateness of stipulations and their value to caribou		Needs clarification
Terrestrial Wildlife	Emerging Issues	What may be the response of naïve caribou herds to oil and gas exploration?		Needs clarification
Terrestrial Wildlife	WREMSS	What are the condition and trends of wildlife habitat in basins emphasized in the Energy Policy and Conservation Act (EPCA) report?		Needs clarification
Terrestrial Wildlife	WREMSS	What are the stressors or drivers of change that affect wildlife habitat in basins emphasized in the EPCA report?		Needs clarification. Stressors (CA's) and drivers are addressed in each species conceptual model - so to some degree will be addressed for each CE. However, this assessment is not specific to basins? What role to basins play on the NOS? Requires clarification.
Terrestrial Wildlife	Emerging Issues	What are unique traits, threats, and uses for each caribou herd?		Not appropriate scale for REA
Terrestrial Wildlife	ArFO MQs	What are pre-development numbers of caribou?		We are not certain about the availability of pre-development caribou data.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Terrestrial Wildlife	ArFO MQs	What impacts will oil/gas activity have on populations of ground-nesting birds through effects on predator populations?		Population estimates, unless they already exist, are outside the scope of an REA. The REA timescale is insufficient to link changes in population to oil/gas development.
Vegetation	Emerging Issues	Will we see the loss of unique vegetation types and how will this affect the life histories of other species?	1. Where are habitats for rare species expected to be in the future? 2. Which rare species appear vulnerable to reductions or changes in future habitats	This can be addressed spatially, but question below makes it a little easier to focus on specific species.
Vegetation	NPRA AIM	What is the correlation to predict the types and distribution of vegetative communities and habitats over time?		Needs clarification
Vegetation	NPRA AIM	What are the location and trend of rare species or communities?	What are the population trends of rare species?	We are comfortable with this, but it is a duplicate of another question. Also, there is no known demographic studies of rare plants that we know of.
Vegetation	WildREACH	How will changes in the seasonality of stream discharge and occurrence of flood events influence development of riparian vegetation communities?		This would be limited to a literature review.
Vegetation	Emerging Issues	Will vegetation change affect active layer depth?		This is likely limited to a literature review at this scale and timeframe.
Vegetation	WildREACH	What is the time scale of expected shrub increase, and how will this vary by species/growth form (low vs. tall shrub) and ecoregion?		This is largely out of our expertise and the timescale of an REA.

Appendix D. Out of Scope Management Questions.

Theme	Source	Original Question	UA Feedback
Climate and Weather	Emerging Issues	What do we know about, and can we synthesize, information on the number, distribution, seasonal use, and short- or long-term placement of meteorological stations on the North Slope?	out of scope - methods question
Climate and Weather	Emerging Issues	How will changing weather conditions affect ice movement (loss or gathering)?	Out of scope - non-terrestrial
Climate and Weather	Emerging Issues	How does weather condition correlate to oceanographic conditions and how will this affect oil spill modeling?	Out of scope - non-terrestrial
Climate and Weather	Emerging Issues	What parameters are currently being measured at North Slope weather stations and are these correct and sufficient for our analysis and modeling needs?	out of scope - methods question
Climate and Weather	Emerging Issues	Are the data being collected by different types of weather stations, e.g., RAWS and USGS, comparable?	out of scope - methods question
Climate and Weather	Emerging Issues	Is the current location of meteorological stations appropriate and sufficient, for example, for predictive capacity and fire modeling?	out of scope - methods question
Climate and Weather	Emerging Issues	What are the hurdles to facility siting (e.g., wilderness designation, cost, access)?	Out of scope - policy question
Climate and Weather	Emerging Issues	Is the data that is obtained through currently placed meteorological stations linked to any pan-arctic accessible data network; if not, should it be; how; which one?	out of scope - methods question
Climate and Weather	Emerging Issues	What is that state of access to and can we improve access to real time and historic weather data?	out of scope - methods question
Climate and Weather	Emerging Issues	Can access to weather data be facilitated through the NSSI website and can the Projects Database help to identify data gaps, compare data types, share standards, etc.?	out of scope - policy question
Climate and Weather	Emerging Issues	What should various agency roles be in gathering, funding, or accessing real time and historic weather data?	out of scope - policy question
Contaminants	Emerging Issues	Do we have sufficient information on ice, marine currents, and wind to inform spill models in a changing environment? If not, what are the priority needs and who is doing such modeling?	Out of scope - non-terrestrial
Contaminants	ArFO MQs	What are the effects of coastal and lake-shore erosion on legacy wells and other documented sites containing hazardous materials?	Out of scope - inappropriate scale
Cultural Resources	ArFO MQs, NPRA AIM	How can cultural and paleontological resources give us information on past climate change and the possible effects of climate change on the landscape in the future?	Out of scope - requires new data

Theme	Source	Original Question	UA Feedback
Cultural Resources	ArFO MQs	Has the lack of precise measuring and location of cultural and paleontological resources allowed some sites to be compromised?	Out of scope - inappropriate scale
Cultural Resources	ArFO MQs	How can oil and gas activities and BLM activities mesh to minimize or avoid compromise of cultural or paleontological resources and still allow practical means of activity and exploration?	Out of scope - policy question
Erosion	Emerging Issues	How and where is erosion being measured?	Out of scope - methods question
Erosion	Emerging Issues	How have engineering considerations responded to accelerating erosion processes for current and future infrastructure?	Out of scope - inappropriate scale
Erosion	Emerging Issues	Are there mechanisms to consider for adapting to or mitigating for erosion?	Out of scope - methods question
Fire Regime	Emerging Issues	How will estimates of changing fire regime affect development planning? For example, will a changing fire regime alter the suitability of potential facility locations, or impact development activities through air quality (leading to equipment shutdown) and the need to gear up for suppression activities?	Out of scope - policy question
Fire Regime	Emerging Issues	Would comparing burned and unburned locations and their current, historical and potential vegetation on winter range and calving habitat for ungulates help answer these questions?	Out of scope - methods question
Fire Regime	Emerging Issues	Will current fire behavior models (e.g., FlamMap, FSPRO, FARSITE) work under changing climate conditions? Need to be sure to model under differing climate scenarios, not just the most probable scenario. For example, the maps that LandFire produces should be evaluated under different climate scenarios in order to feed appropriate information into the fire behavior models.	Out of scope - methods question
Fire Regime	Emerging Issues	Might the presence of coal deposits affect management strategies for fires?	Out of scope - policy question
Fire Regime	Emerging Issues	May need to update/influence changes in the National Fire Plan re: wildland fire decision support system, village fire protection planning, access to funding for fire response. Can this be done via the State of Alaska's Immediate Action Working Group?	Out of scope - policy question
Fire Regime	Emerging Issues	Will a changing fire regime require the land managers (BLM, DNR, USFWS, NPS) to change their management strategies for fire on the North Slope (full protection status for villages?). Are we set up to do so?	Out of scope - policy question

Theme	Source	Original Question	UA Feedback
Hydrology	Emerging Issues	What kind of network of long term gauging stations is needed?	Out of scope - methods question
Hydrology	Emerging Issues	Are there means (experimental or known) that can enhance the ability of energy exploration and development to move forward in water challenged environments?	Out of scope - methods question
Hydrology	ArFO MQs	What differences exist in climate and river flow responses between the coastal plain, foothills, and upland areas in NPR-A, and how might that affect design of oil and gas infrastructure?	Out of scope - policy question
Hydrology	ArFO MQs	Are temporary and permanent stream crossing structures adequately designed and monitored to minimize channel disruption, erosion and sedimentation?	Out of scope - inappropriate scale
Hydrology	Emerging Issues	Do we currently have remote sensing capability for monitoring lakes?	Out of scope - methods question
Hydrology	Emerging Issues	Are current data sets (3-7 years) adequate for estimates of peak, mean and low flows or do we need a minimum of >10 years of data?	Out of scope - methods question
Hydrology	Emerging Issues	Are alternative technologies being investigated and if so, will they lead to alternative criteria (regulatory requirements) versus science requirements?	Out of scope - methods question
Hydrology	Emerging Issues	Is there a significant data gap in relating annual surface runoff to annual precipitation and what will it take to fill this data gap?	Out of scope - methods question
Invertebrates	WildREACH	What climate-related changes are likely in community composition of macroinvertebrates in stream, lake, and saturated soil environments?	Out of scope - inappropriate scale
Invertebrates	WildREACH	How will changes in the distribution and quality of surface waters and shifts from pelagic to benthic productivity in deep lakes affect availability of macroinvertebrates to fish and wildlife?	Out of scope - inappropriate scale
Marine Activity	Emerging Issues	In what ways will increased access enable increased development?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Will increased activity cause more bird strikes?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	What are the Law of the Sea implications?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	We will need even greater fed/state/local coordination to avoid regulatory uncertainty for activity management.	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	How will infrastructure expand to serve development and what may be the effect of this expansion?	Out of scope - non-terrestrial

Theme	Source	Original Question	UA Feedback
Marine Activity	Emerging Issues	What are, and how will we measure, the cumulative effects of increases in various marine activities?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Baseline information is lacking for many categories of information (species, habitats, water quality, ...); to the extent it exists, is there adequate access to the data?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Will the spread of invasive species increase? If so, which species and which pathways will be important? How can the spread of invasive species be reduced?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	How will the acoustic ecology change and what is the comparability of prior studies (Gulf of Mexico vs. Arctic)?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	How will shipping and other marine operations interfere with species and their pursuit by subsistence hunters (e.g., will whale migrations be deflected and whaling access thus be altered)?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	To what degree will increased marine discharges of pollutants affect water quality (e.g., for prey species)?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	What are the risks from the increasing presence of non-ice-hardened cruise ships?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How do we differentiate and assess the separate and combined effects of climate change and development on various species and their interaction?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	What will be the metric of successful management in the future (for example, under ESA)?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How might a shift in species distribution from sea to land (e.g., polar bears, walrus) affect land management?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How may this shift affect predator/prey relations on land and/or in marine waters?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Will changes in ocean currents affect species distribution and recruitment (e.g., nearshore currents and larval drift)?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Can prey species shifts in distribution and abundance be better modeled; how and with what precision?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	What will be the ecosystem level effects of shifts in the distribution and abundance of fish and other species?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	If fish species shift north, will fishing (incl. commercial fishing) patterns change and what will the effect be on management options, on non-target species, ...?	Out of scope - non-terrestrial

Theme	Source	Original Question	UA Feedback
Marine Mammals	Emerging Issues	Will shipping affect whale migration and hunter access?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Can we identify species/habitat conservation refugia?	Out of scope - non-terrestrial
Migratory Birds	Emerging Issues	Are current breeding bird surveys sufficient to meet management needs in a changing environment?	Out of scope - methods question
Migratory Birds	Emerging Issues	How will any changes in migratory waterfowl numbers or distribution alter risks to aircraft from bird strikes?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs, NPRA AIM	What are pre-development numbers, distribution, and survival rate of molting geese in the Teshekpuk Lake area (TLSA)?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs, NPRA AIM	How has distribution and abundance of molting geese in the TLSA changed over the last 20 years and what is driving this change?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	How has the abundance and distribution of Steller's eider changed over time in the Barrow Triangle and what is driving this change?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	What are current population estimates and productivity of Steller's eiders in the Barrow Triangle?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	What is the trend in population estimates of nesting snow geese on the Ikpikpuk River delta?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	How are the snow geese impacting the nesting and brood-rearing habitat on the Ikpikpuk River delta?	Out of scope - inappropriate scale
Migratory Birds	Emerging Issues	Will the nature of ice edges as locations of food gathering and/or resting places change, and what will be the effect of this change on species' bioenergetics?	Out of scope - non-terrestrial
Migratory Birds	Emerging Issues	What changes may be in store for ice leads as habitat and what may be the effect of any changes in oil spill risks on the likely function/value of ice leads?	Out of scope - non-terrestrial
Permafrost	Emerging Issues	How and where is permafrost being measured; is it adequate; and is the data accessible?	Out of scope - methods question
Permafrost	Emerging Issues	What is the impact of changing permafrost to traditional ice cellars?	Out of scope - inappropriate scale
Permafrost	Emerging Issues	Are current measurement techniques sufficiently precise (e.g., to address subsidence)?	Out of scope - methods question
Permafrost	Emerging Issues	What are the restoration methods for such structures as VSMS in a changing environment?	Out of scope - methods question

Theme	Source	Original Question	UA Feedback
Permafrost	Emerging Issues	Is seabed permafrost adequately mapped and what is the interaction between seabed permafrost and permafrost in coastal areas as exploratory drilling and off-shore to on-shore infrastructure is developed?	Out of scope - non-terrestrial
Permafrost	Emerging Issues	What is the impact on seabed permafrost from noise generated by exploration and production drilling in the marine environment, and how can it be mitigated?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	How will changing oceanographic conditions alter marine ecosystems (e.g., ability to produce prey)?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	Will (has) ice melt cause(d) a pulse of contaminants?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	What will the effects of ocean acidification be, for example on marine food chains, and how does it relate to nearshore discharge?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	Will ocean current patterns change; how?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	What is the time span & validity of historic data on temporal and spatial changes in sea ice?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	How do the timing, duration, and distribution of slush or broken sea ice affect oil spill response?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	Is the function of sea ice as habitat changing & what do the models project for the long term (50 yrs out)?	Out of scope - non-terrestrial
Sea Ice and Ocean Conditions	Emerging Issues	Is the role of sea ice as a hunting platform for subsistence harvesters changing?	Out of scope - non-terrestrial
Social and Economic Structure	Emerging Issues	What are the institutional arrangements needed to assess the impacts of energy development and climate change on the social and economic structure of the North Slope?	Out of scope - policy question
Social and Economic Structure	Emerging Issues	How do we measure the effects of various management practices on the social structure of villages and people of the North Slope?	Out of scope - methods and policy question
Social and Economic Structure	Emerging Issues	What is the appropriate human health risk assessment data that should be gathered, e.g., to assess the effects of dietary shifts associated with energy development or climate change?	Out of scope - methods question
Social and Economic Structure	Emerging Issues	How do we structure social and economic studies so that they consider both Inupiaq and non-Inupiaq residents of the North Slope?	Out of scope - methods question

Theme	Source	Original Question	UA Feedback
Social and Economic Structure	Emerging Issues	Under NEPA, how do we assess the impacts of oil and gas development on the social and economic structure of North Slope communities, and how does climate change effect that assessment process?	Out of scope - Policy question
Social and Economic Structure	Emerging Issues	How can we achieve a common/standardized set of key social indicators so that socioeconomic data are transferable over time and between studies and locations?	out of scope - methods question
Social and Economic Structure	NPRA AIM	What percentage of IAP decisions is being achieved?	Out of scope - Policy question
Social and Economic Structure	Emerging Issues	Might the North Slope Borough play a role as a “1-stop” (or “first stop”) shop for coordination of social and economic studies on the North Slope?	Out of scope - policy question
Social and Economic Structure	Emerging Issues	NSSI coordination across agencies and membership could lead to less duplication of effort (via Projects Database?), better communication, better understanding of information, and facilitate incorporation of traditional and local knowledge.	Out of scope - policy question
Social and Economic Structure	Emerging Issues	How can we best avoid undue burden on North Slope people and communities in the implementation of multiple studies and surveys?	Out of scope - methods question
Social and Economic Structure	Emerging Issues	What might the communities themselves want from surveys and studies?	Out of scope - methods question
Social and Economic Structure	Emerging Issues	How do we involve local people and communities in social and economic studies in a meaningful way?	Out of scope - methods question
Social and Economic Structure	Emerging Issues	If there is to be remuneration, how do we set a fair standard?	Out of scope - methods question
Social and Economic Structure	Emerging Issues	Can NSSI facilitate the development of standards (e.g., minimum data standards) for social and economic studies on the North Slope? If so, how can we best ensure that Principal Investigators will access and follow such standards – for example, and can such standards be posted via the NSSI website and/or linked to the Projects Database?	Out of scope - methods question
Terrestrial Wildlife	Emerging Issues	Is there a better technology for gathering consistent census data across the Slope?	out of scope - methods question

Theme	Source	Original Question	UA Feedback
Terrestrial Wildlife	NPRA AIM	What changes in habitat are driving changes in the distribution and abundance of wildlife – specifically caribou?	Out of scope - time limitation
Terrestrial Wildlife	WREMSS	Are applied mitigation and best management practices for habitat and human disturbance related to energy development effective in the conservation of wildlife habitat?	Out of scope - policy question
Terrestrial Wildlife	WREMSS	Are reclamation activities related to energy development accomplishing wildlife and associated habitat objectives as stated in the activity plans and/or land use plans?	Out of scope - policy question
Terrestrial Wildlife	Emerging Issues	Need to establish a network to share caribou information between and among herd managers and researchers	Out of scope - policy question
Terrestrial Wildlife	Emerging Issues	Better reporting of subsistence and sport harvest data would aid in determining relationship with impacts from exploration and development activities	Out of scope - policy question
Vegetation	Emerging Issues	What other cumulative food web effects may occur with vegetation change?	Out of scope - theoretical
Vegetation	Emerging Issues	Can vegetation change serve as an indicator of cumulative impact?	Out of scope - policy question
Vegetation	Emerging Issues	What form(s) of sampling and protocol will be needed to detect change?	Out of scope - methods question
Vegetation	Emerging Issues	How does/should vegetation change model outputs affect management decisions and timing (e.g., can/should we manage for plant species that favor certain herbivores)?	Out of scope - policy question
Vegetation	NPRA AIM	What are the vegetation impacts from development activities versus background “natural” changes?	Out of scope - methods question
Vegetation	Emerging Issues	Can we differentiate ‘natural’ change from human-induced change?	Out of scope - methods question
Vegetation	WildREACH	How will changes in the length and timing of the growing season influence plant phenology, including seasonal changes in nutritional quality?	Out of scope - this is a research question.
Vegetation	WildREACH	What is the likelihood of widespread conversion from sedge and sedge-shrub meadow to bog meadow (paludification) and how would this affect herbivore and detritus-based trophic systems?	Out of scope - time limitation
Vegetation	Emerging Issues	Are there good vegetation change models for the North Slope and if not, what can we do to help develop them?	Out of scope - methods question

Theme	Source	Original Question	UA Feedback
Vegetation	Emerging Issues	What rate of vegetation change is 'normal' (are there previous change estimates?) and how will its definition affect interpretation of future change rates?	Out of scope - theoretical

Appendix E: List of non-native plant occurrences in the North Slope Ecoregion

List of non-native plant occurrences in the North Slope Ecoregion. The total area infested with non-native plants in the North Slope Ecoregion is 6 acres. Data are extracted from the University of Alaska's Alaska Exotic Plant Information Clearinghouse (<http://aknhp.uaa.alaska.edu/maps/akepic/>). * Rank indicates Invasiveness Rank (see Carlson et al. 2008 and Nawrocki et al. 2011).

Scientific Name	Common Name	Family	Rank*	Total Infested Acres
<i>Chenopodium album</i> L.	lambsquarters	Chenopodiaceae	37	0.01
<i>Descurainia sophia</i> (L.) Webb ex Prantl	herb sophia	Brassicaceae	41	1
<i>Hordeum jubatum</i> L. ⁹	foxtail barley	Poaceae	63	16.63
<i>Matricaria discoidea</i> DC	pineappleweed	Asteraceae	32	1.1
<i>Plantago major</i> L.	common plantain	Plantaginaceae	44	1.52
<i>Polygonum aviculare</i> L.	prostrate knotweed	Polygonaceae	45	1.01
<i>Taraxacum officinale</i> F.H. Wigg.	common dandelion	Asteraceae	58	1
Total:				22.27

⁹ *Hordeum jubatum* is a nuisance weed of questionable nativity; it is likely native to eastern Interior Alaska.