



**SEWARD PENINSULA - NULATO HILLS - KOTZEBUE
LOWLANDS
RAPID ECOREGIONAL ASSESSMENT
FINAL MEMORANDUM I-1-C**

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Executive Summary

Task 1 Objectives

The objectives of Task 1 were:

1. Define the assessment region as the ecoregion and a buffer
2. Create a conceptual ecoregion model
3. Review and assess proposed management questions
4. Review and assess proposed conservation elements (CEs)
5. Review and assess proposed change agents (CAs)
6. Conduct a review of recommendations with the Assessment Management Team (AMT)
7. Complete initial recommendations to feed into Task 2 data assessment

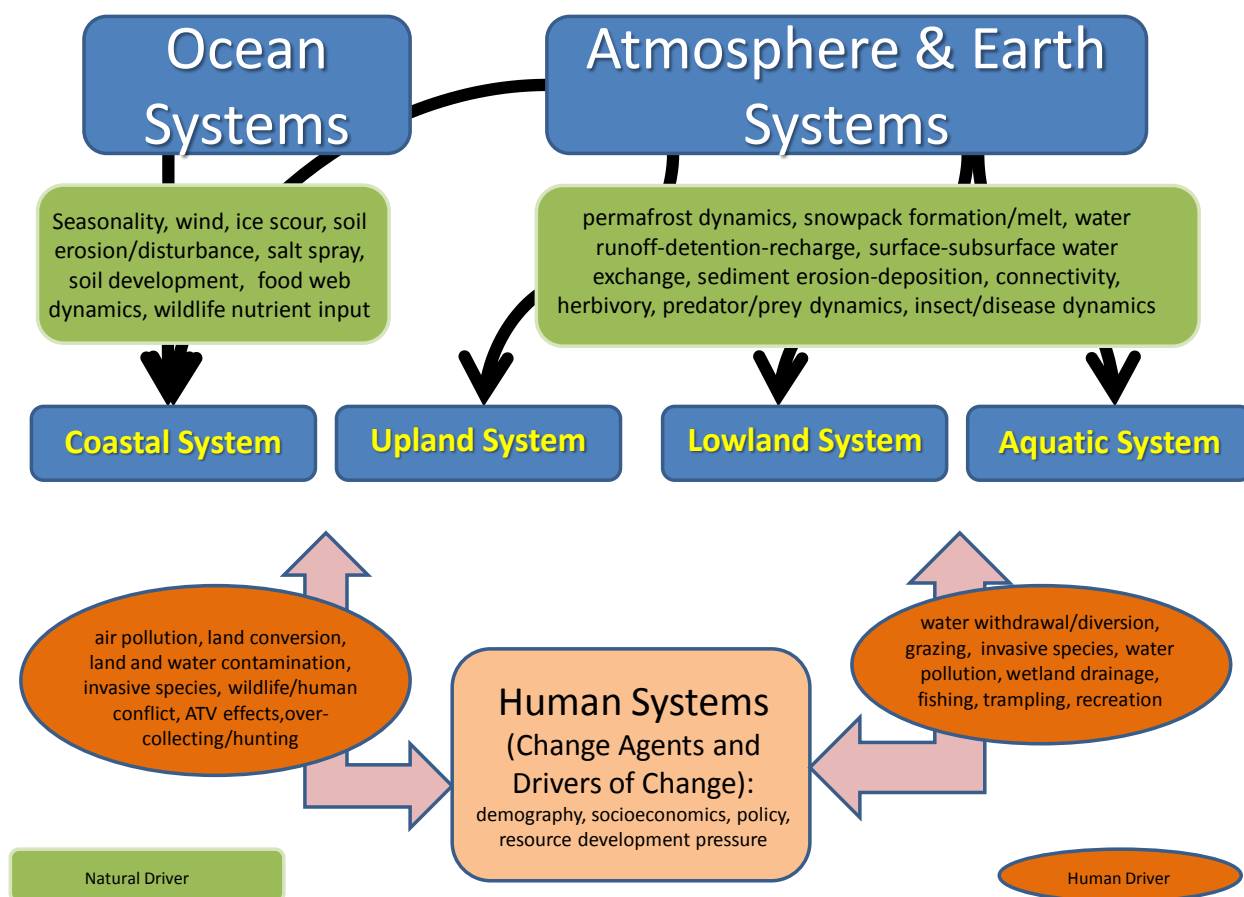
Assessment Region Boundary

We have adopted the BLM guidelines to define the region by the three component ecoregions and the 5th level hydrologic units that intersect them.

Conceptual Ecological Model for the Ecoregion

We adapted existing model concepts developed by Lawler et al. (2009), recognizing major patterns in climatic, oceanic influence, and physiography. Pervasive influences of Arctic climate regimes interact with the montane, lowland, and coastal physiography to provide overarching biophysical controls on nested ecosystems (Figure A). Affected in part by variation in solar radiation and air density, seasonal temperature and precipitation regimes vary along both latitudinal and elevational gradients. Combined, these controlling regimes set up regional patterns in coastal dynamics, wind, and dry/wet atmospheric deposition. We then define the major model components, acknowledging the interacting roles of temperature, water, and coastal dynamics in this Arctic ecoregion.

Figure A. Conceptual Model for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands Ecoregion



We first distinguish ‘Upland’ systems driven generally by extreme temperature exposure and extremely well-drained soils. Permafrost tends to be absent or discontinuous. Upland systems including sparsely vegetated bedrock, cliff, and talus or sparse tundra, and dwarf shrub lichen tundra. Taller shrublands, including predominant birch & ericaceous shrublands, are also characteristic, along with forest and woodlands dominated by spruces and hardwoods. We have provisionally included 12 major upland ecosystem types from this Rapid Ecoregional Assessment (REA) for more detailed conceptual modeling.

Lowland systems encompass the gradient from relatively moderately drained ‘moist’ uplands, typically where alluvial soils are deeper and permafrost is predominant (if not continuous) through mesic meadows and wetlands. We have provisionally identified seven major ecosystem types within this lowland category for further modeling, including Mesic-wet willow shrubland, black spruce-dwarf tree peatland, shrub-tussock tundra, and large river floodplains.

Aquatic systems encompass headwater streams, hot springs, major rivers, estuaries, and coastal lagoons, plus the various freshwater lakes that define the aquatic environments for fish and aquatic

invertebrates. We have tentatively identified nine ecosystem types within this category for subsequent conceptual modeling.

Coastal systems encompass the coastal zone with both upland to wetland vegetation. We have tentatively identified five major ecosystem types for further conceptual modeling, including tidal marsh, coastal brackish marsh, marine beach and beach meadow, coastal sedge-dwarf shrubland, and permafrost dwarf-shrub lichen tundra.

The human systems component of the conceptual model is based on work of Kofinas, Berman, and others in similar regions of the Arctic. Most people who live in the region practice subsistence resource use and rely on wildlife and plants for a large part of their diet and for cultural continuity. 'Subsistence' is a key Conservation Element (CE) and includes selected plants and animals. Change Agents (CAs) can affect subsistence practices indirectly by impacting plant communities. Some communities are in danger of disappearing because of erosion. Human activity is also a feedback mechanism in the conceptual model. People rely on healthy wildlife populations for food and non-material well-being, but human activities in turn, affect ecosystems. Settlement expansion, infrastructure development and decay, mining, energy projects, grazing, tourism, recreation, and pollution all affect plants, water, and wildlife and are thus all CAs.

Management Questions

A primary goal of AMT 1 and Task 1 is to develop a set of strong and virtually final management questions (MQs). Continued adjustments to the questions will be made throughout Phase 1 of the work, but Task 1 and the discussions during AMT1 will produce a strong penultimate set of questions. BLM provided a preliminary set of 81 MQs in 11 groups. The community meetings produced an additional set of 58 questions of interest, many of which were similar to questions BLM provided. Refinements have continued throughout Task 1, during discussions at AMT1, and in response to written comments from BLM and others on the draft Memo I-1-a and the AMT1 Summary (I-1-b). We refined this large list of preliminary MQs using seven criteria.

(1) Is each MQ stated in a clear and focused way that can be commonly understood by all participants?

(2) Is each MQ matched to and answerable with available data and planned analyses?

(3) Are there important issues or questions missing from the list of MQs?

(4) Are there MQs that are out of scope, extraneous, duplicative, or determined to be of lesser importance?

(5) Do any MQs suggest Conservation Elements or Change Agents that are missing from the target lists under development for the project?

(6) Are all candidate Conservation Elements and Change Agents addressed in at least one MQ?

(7) Are each of the MQs clearly incorporated somewhere into the ecological models under development for the project?

A large number of amendments have been made to the original questions, and subsequently in response to discussion at AMT1 and written comments to various memos. There are four broad classes of recommendations for the MQ. In some cases we can "Accept" the question as originally proposed. In other cases we have "Reframed" the question to clarify meaning or to conform to available data. Some MQs are "Deferred" to data discovery because there are doubts about the availability of suitable data. In some cases we propose that questions be dropped from the REA for one of three reasons: (1) it is

redundant with other MQ; (2) there are no data available to answer the question; or (3) it is out of the scope of the REA. For every recommendation we provide a written discussion of our reasoning. This written "paper trail" facilitates an ongoing dialogue in which questions can be revised until an actionable, widely acceptable, and useful version is found. For many questions this dialogue will continue into the data discovery and modeling tasks (Tasks 2 and 3).

It is important to note that the purpose of the set of MQs is to provide useful information to BLM in its land management decisions. In this we have relied heavily on the original set of MQ provided by BLM and the community meetings as a guide to what BLM is interested in knowing from the REA.

Based on these activities the current list of MQs to be pursued is 87 in 11 categories. The complete MQ table with discussion notes can be found in Appendix 1.

Conservation Elements

A first step in most natural resource assessments is the identification of the features to provide an effective focus for the assessment's intended purpose. Key to selection of CEs is establishing clarity of purpose. For this REA, we propose a two-track focus for assessment. One track focuses on the ecological resources of the ecoregion, supporting regional biodiversity and providing the major ecosystems services. This focus emphasizes assessment of ecological integrity of landscapes and waterscapes. These define our **Core CEs**. The second track augments the first by including additional resource values of interest to agencies and stakeholders. These define our **Desired CEs**.

To define our core CEs we utilized the "coarse filter/fine filter" approach required by BLM guidelines and used extensively for regional and local landscape assessments since the 1970s. Through analysis of existing information, we have proposed 33 upland, wetland, coastal, and aquatic 'coarse filter' units as one focus for assessment. We then evaluated available information on species of conservation concern, including criteria established by BLM in the Scope of Work. This led to an initial listing of species.

Table A provides a summary of the number of proposed CEs for the REA. Once this list is finalized, conceptual ecological models (and in many cases, spatial models) will be developed for each to state assumptions about key ecological drivers and evaluate their location and condition over time across the ecoregion. Desired conservation elements follow those listed in the scope of work, and their listing here serves as a point of departure for discussion with the AMT.

Table A. Summary of proposed Conservation Elements for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands rapid ecoregional assessment.

Conservation Element Summary	Number Proposed
Core Conservation Elements	90
Coarse Filter (total)	33
Upland	12
Lowland	7
Coastal	5
Aquatic	9
Fine Filter - Species (total)	57
Species Assemblages	6
Birds	12

Conservation Element Summary	Number Proposed
Mammals	3
Fishes	8
Plants	28
Desired Conservation Elements	22
Birds	2
Mammals	6
Fishes	11
Plants	3

Change Agents

Change agents (CAs) are those features or phenomena that have the potential to affect the size, condition and landscape context of conservation elements. CAs include broad regional agents that have landscape level impacts such as wildfire, invasive species, grazing, 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 offsite effects. CAs are also expected to act synergistically with other CAs to have increased or secondary effects. All CAs have been reviewed to determine potential impacts to conservation elements and if the impact is currently present, will remain present in the future, or is not present but considered a potential future impact. In this assessment we reviewed the list of proposed CAs from the AMT and consulted a variety of sources to:

1. Identify additional potential CAs and whether they are currently affecting the ecoregion, expected to in the future or both.
2. Characterize the ecological effects of the CA
3. Identify potential CEs that would be affected
4. Characterize potential CE impacts

Change Agent Key Recommendations

1. We found the list of candidate CAs provided by the AMT to be highly relevant and recommend inclusion of all for further assessment for data availability and quality.
2. We recommend that the Invasive Species and Insect and Disease CAs be split into two new classes “Non-Native Species” and “Nuisance Native Species and Diseases”. This decision was based on recommendations from the AMT to identify a species’ nativity with respect to organisms that have known or potential antithetical impacts to resource management goals.

Limitations and Unresolved Issues

A large number of lengthy written comments were provided after the AMT1 workshop. Many comments dealt with REA process issues rather than the content of this memo; other comments are appropriately addressed in Tasks 2 and 3. We are documenting substantive comments in an “Ongoing Issues” spreadsheet to ensure that all issues have appropriate follow up. We will work with the AMT lead to communicate with AMT members as needed to receive input on how to resolve the issues. We

endeavored to address all substantive and relevant comments, however, the volume of these may have resulted in us overlooking some that are important to individual AMT members in this memo. In such case, please communicate these to the AMT lead and we will conduct appropriate follow up.

Task 1 Refine Management Questions and Select Conservation Elements

Introduction

Rapid Ecoregional Assessments (REAs) are the first step in the Bureau of Land Management's (BLM) Landscape Approach (<http://www.blm.gov/wo/st/en/prog/more/climatechange/landscapeapproach.html>). An REA in itself is not a decision making or planning process. REAs are intended to synthesize existing knowledge and information applicable to all lands and waters within the ecoregion. This synthesis aims to inform subsequent decision making, implementation, and monitoring by BLM and partners within the ecoregion and should interact with ongoing scientific research as a foundation for science-based land management. The purpose of the REA is to answer specific management questions. Management questions typically are comprised of an interaction between conservation elements and change agents. REAs are organized into a series of phases and component tasks. Phase 1 includes tasks that clarify the scope, expected data and modeling approaches to be used; culminating in a detailed workplan for the analysis. Phase 2 completes the preparation of data, conducts agreed-upon analyses, and documents assessment results.

This memorandum summarizes the work, decisions, and remaining issues to be resolved for Task 1, Phase 1 for the Seward Peninsula - Nulato Hills - Kotzebue Lowlands (SNK) Ecoregion. Here we initiate the REA to scope the overall effort, clarify key management questions (MQs) to be answered, define the ecoregion, establish our criteria and approach for selecting and treating focal Conservation Elements (CEs), and determine the relevant Change Agents (CAs) that will be addressed. Note that all components: CEs, CAs, and MQs were provided to the contractor by the BLM through the original statement of work; thus the lists provided in this memo began with those and then were modified based on our (the contractor's) knowledge and experience along with input from four community meetings, the AMT workshop 1 and subsequent written comments. Note also that Tasks 2 and 3 will evaluate data availability and propose assessment models to answer the MQs. These tasks will further inform the final list of REA components and questions and thus those issues are not addressed here. This memorandum is the final draft (1-c) which incorporates comments on the first draft (Memorandum 1-a) provided at AMT Workshop 1 or submitted separately to BLM.

Task 1 Objectives

The objectives of Task 1 were:

1. Establish the REA Boundary
2. Create a conceptual ecoregion model
3. Review and assess proposed management questions (MQs)
4. Review and assess proposed conservation elements (CEs)
5. Review and assess proposed change agents (CAs)
6. Conduct four community meetings & generate summaries
7. Complete initial recommendations to feed into Task 2 data assessment

Introduction to Memorandum I-c

This memorandum summarizes our evaluation and recommendations for each component of the REA for the Seward Peninsula - Nulato Hills - Kotzebue Lowlands ecoregion (*from here referenced as the SNK ecoregion*) based on initial recommendations of the AMT and a rapid review of existing studies and contractor staff knowledge. The memorandum is organized according to the Task objectives above. Details are provided in tables in the appendices. From hereon we will utilize the abbreviations MQ, CE, and CA as defined above.

Task Components

Conceptual Ecoregion Model, Description, and Assessment Boundary

For Rapid Ecoregional Assessment (REA), conceptual ecological models assist with organizing current knowledge and communicating key assumptions about the environmental controls and dynamics that characterize the regional landscape. Conceptual models commonly include ‘box-and-arrow’ diagrams, tabular summaries, and textual descriptions. Here, we follow current recommended approaches (e.g., Gross 2005) to organize a conceptual model for the ecoregion. We draw upon a wealth of existing descriptive information, including conceptual models developed for the National Park Service Inventory and Monitoring programs (Lawler et al. 2009), and ecoregion descriptions of other federal agencies (Nowacki et al. 2001, NRCS 2006, McNab et al. 2007).

Assessment Boundary

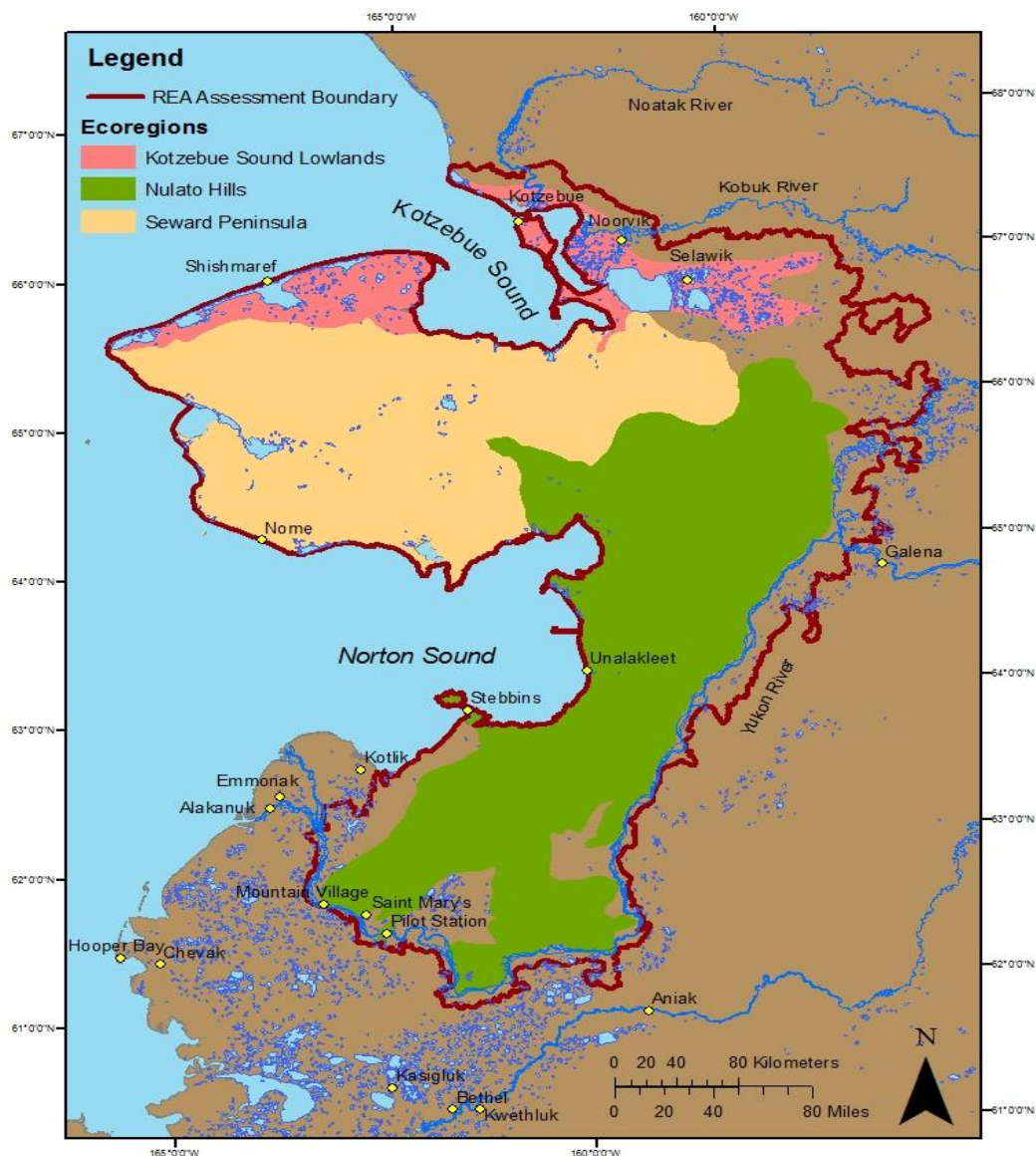
First, to define the ***spatial bounds*** of our model, we utilized the boundary provided by the BLM in the statement of work defined as the ecoregions Seward Peninsula, Nulato Hills, and Kotzebue Sound Lowlands defined by Nowacki et al. (2001) and all 5th level, 10-digit hydrologic units that overlap the ecoregion boundaries (Figure 1). The total area of the Rapid Ecoregional Assessment project boundary is approximately 60,000 miles².

The ecoregion falls within Provinces M-131 Open woodland – tundra, M-123 Tundra- meadow, and 123 – tundras, as defined by Bailey (2008). It falls into the Arctic EcoDivision as defined by NatureServe (Comer et al. 2003). It includes the northern extreme of the Western Alaska Land Resource Region (NRCS 2006) and southern extreme of the Northern Alaska region; both being Arctic in nature, extending from the Alaska Peninsula to the south up across the Alaska North Slope. The Nulato Hills subregion of this REA ecoregion falls within Western Alaska, and is defined by MRLA 240 and 230. The Seward Peninsula subregion includes portions of MRLA 240 and all of MRLA 241. The Kotzebue Lowlands subregion includes MRLA 242.

These ecoregions comprising the REA are surrounded by four other ecoregions. Due to the inclusion of the HUC units, portions of these ecoregions occur within the REA project boundary: 1) the Brooks Foothills ecoregion to the north (28 miles²), 2) the Kobuk Ridges and Valleys ecoregion to the north and east (3,798 miles²), 3) the Kuskokwim Mountains ecoregion with two small sections in the east and

southeast (79 miles²), 4) the Yukon River Lowlands ecoregion to the east (4,856 miles²), and 5) Yukon-Kuskokwim Delta ecoregion to the south (3,246 miles²). The Chukchi Sea, Bering Straits, and the Beaufort Sea abuts the western boundary of the REA project boundary. The intent of the hydrologic unit buffer is primarily to include change agent processes falling outside of the ecoregion but affecting CEs within the ecoregion. Thus, CEs peripheral to the core SNK ecoregion but falling within the buffer are not assessed in this study.

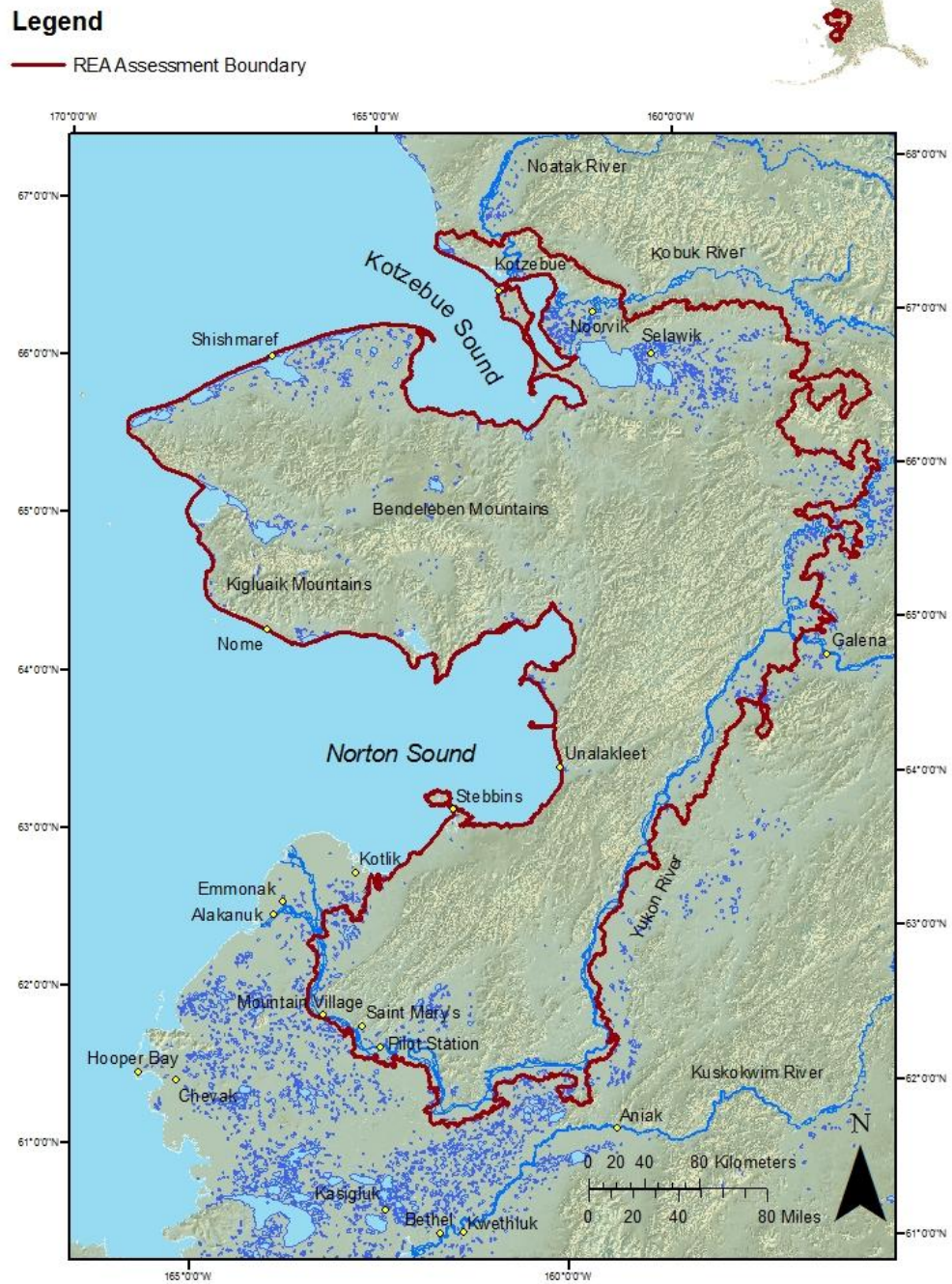
Figure 1. Location and ecological subdivisions of the Seward Peninsula-Nulato Hills-Kotzebue Lowlands Rapid Ecoregional Assessment project area.



The western extent of the Brooks Range lies to the north of the Kotzebue Sound Lowlands ecoregion, with the Yukon River bordering the eastern edge of the Nulato Hills Ecoregion, and the

Yukon River Delta bordering the southern edges of the Nulato Hills Ecoregion (Figure 2). The Seward Peninsula - Nulato Hills - Kotzebue Sound Lowlands ecoregions can be distinguished from the adjacent ecoregions by the low elevations and predominately flat Kotzebue Sound Lowlands draining the Noatak and Kobuk River deltas. The Kotzebue Sound Lowlands have abundant lakes and ponds throughout the ecoregion with wet tundra dominating the poorly drained soils. The Seward Peninsula is unique with mainly tundra in the broad valleys and convex hills with scattered high elevation mountains. The Nulato Hills ecoregion drains the region from a northeast to southwest direction by a series of hills. The Nulato Hills ecoregion supports tundra at higher elevations and transitions to sub-Arctic species in the lower elevations.

Figure 2. Physiography of the Seward Peninsula-Nulato Hills-Kotzebue Lowlands Rapid Ecoregional Assessment project area.



Conceptual Ecoregion Model

The purpose of this model is to articulate key assumptions about regional landscape pattern and process that will inform our selection and analysis of CEs and CAs. This overarching description and model will provide a framework for a series of component models for the ecoregion. The **temporal bounds** of this conceptual model are intended to encompass characteristics of the past two centuries, but center on the 20th century and decade of 2001-2011. This time period reflects the climatic regimes, ecological patterns and processes, and CAs that are most applicable to this assessment. Our assessment will look to future time periods for evaluation of land use scenarios and climate-induced stress, but for conceptual modeling, our initial set of assumptions lead up to today.

Biophysical Controls

Regional Climate Regime: Climate is a major driver in determining ecosystems distributions in northwestern Alaska (Jorgenson et al. 2004). Narrative descriptions of Alaska ecoregions define the Kotzebue Sound Lowlands, Seward Peninsula, and Nulato Hills as moist polar ecoregions (Nowacki et al. 2001). Temperatures at all weather stations in northwest Alaska have similar seasonal patterns with short cool, wet summers and long cold winters with most precipitation generally falling between July and September. Strong precipitation and temperature gradients are evident, with colder mean annual air temperatures in the north and higher precipitation in the west. The coastal areas generally experience a more maritime climate with cool foggy summers and more moderate winter temperatures with a continental climate gradating further into the interior. In the winter, however, the Bering and Chukchi Sea freeze over entirely creating a pathway for cold Siberian air in the coastal areas. High winds are also common along the coastal areas and increases with winter storms. Temperatures also vary along an elevation gradient with higher elevations having cooler summers and generally warmer and windier winters. Large mountains (described in the section below on regional physiography) on the Seward Peninsula act as a moisture barrier limiting moisture from the Bering Sea, with precipitation rates twice as high south of the mountains (Jorgensen et al. 2004). Mean maximum/minimum annual temperatures range from 28.1/15.7°F at Kotzebue (1949-2010), 33.4/19.6°F at Nome (1949-1999), to 33.3/19.1°F at Unalakleet with interior temperatures of 32.2/16.7°F at Galena (1949-1993) and 37.5/21.8°F at St. Mary's (1967-2000) (WRCC 2010) although seasonal temperatures of course vary greatly. Total annual precipitation/snowfall ranges from 9.7/52.9 inches in Kotzebue, 16.0/62.2 inches in Nome, 13.0/35.3 inches in Unalakleet, 31.2/63.4 inches in Galena, and 19.1/67.8 inches in St. Mary's (WRCC 2010). Snowfall accuracy in these regions may be compromised by blowing snow and must be considered when assessing precipitation records. Surface waters generally freeze-up from early to mid-October with breakup in mid to late May (Lawler et al. 2009).

Regional Physiography: The Kotzebue Sound Lowlands (Figures 1 & 2) consists of coastal plains draining several large river systems surrounding Kotzebue Sound on the Chukchi Sea. This ecoregion is flat (<330 ft) and areas with little to no topographic relief tend to be poorly drained although areas with terraces, hills, and sand dunes are well drained. The Kotzebue Sound Lowlands has a high density of lakes, estuaries, and freshwater and contains one of the highest lake areas and densities in Alaska (Arp and Jones 2008). Lakes and ponds comprise up to 15 to 20 percent of the ecoregion and wetlands occupy 76 percent of the area (McNab and Avers 1994). The Kotzebue Sound Lowlands consist primarily of depositional features by morainal, stream, or lake deposits from material washed or blown from nearby hills and outwash plains (Karlstrom et al. 1964). Ice-related features dominate the landscape, including pingos and thaw lakes. Moraines from pre-Wisconsin glacial advances are common. The geology is predominantly marine sedimentary rocks from the Cenozoic and Cretaceous (Beikman 1980). At higher elevations igneous bedrock under volcanic soils may relate to lake development (Arp and Jones 2008).

Soils tend to be wet and shallow and are almost always saturated in the summer due to thick permafrost in areas with significant loess deposits (Jorgenson et al. 2004, Brown et al. 1997). The soils consist mainly of Histic Pergelic Cryaquepts and Pergelic Cryofibrists and are formed by silty or sand alluvial deposits, volcanic ash, or loess (USDA NRCS 1979). With standing water common in the tundra, sedge mat communities dominate. In better drained areas such as peat ridges, drainage ways, and polygonal features, woody species like white spruce, willows, alder, and paper birch occur. Grasses dominate the coastal dunes. Black spruce forests are also abundant along the Kobuk River. The floodplains receive frequent inundation through seasonal flooding.

The Seward Peninsula Ecoregion (Figure 1 and Figure 2) forms a landscape mosaic of coastal plains, extensive convex hills with scattered broad valleys, and a few isolated groups of rugged mountains. Streams and small scattered lakes occupy the larger valleys. On hillslopes and ridges soils are gravelly over weathered bedrock and in the lower elevations they tend to be formed by colluvial and alluvial sediments (Karlstrom et al. 1964). Soils include Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Typic Cryochrepts, Lithic Cryorthents, and Pergelic Cryumbrepts (USDA NRCS 1979). They are predominately poorly drained, shallow, and organic over permafrost. The permafrost is continuous, however ranges between thin to moderately thick. Permafrost features such as pingos and patterned ground are present throughout the region. The geology is complex with metamorphosed mica and calcareous schists, marbles, gneissic, and other metavolcanic rocks of the Paleozoic age (Beikman 1980). Volcanism is evident with lava flows, cinder cones, hot springs, and several large maar lakes formed by eruptions through deep permafrost (Béget et al. 1996). During the Pleistocene only the tallest mountains were glaciated with the highest peak in the region reaching 4,600 feet (Matthews 1974, Hopkins et al. 1983, Kaufman and Hopkins 1986, Kaufman et al. 1991). Remnant glacial features such as cirque lakes are found at the highest elevations. Since the Seward Peninsula was relatively ice-free it served as a migration corridor between North America and Asia, thus strong ecological similarities between the regions exist today. Tundra plant diversity is high in this ecoregion due to its past connection to Asia, occurring in a transition zone between the Arctic and sub-Arctic, and the presence of both acidic volcanic rock and limestone. Tundra vegetation dominates with alpine *Dryas*-lichen tundra and barrens at higher elevations and wet sedge-tussock tundra at lower elevations. In areas with better drainage low growing ericaceous and willow-birch shrubs persist and in river valleys willow, birch, and spruce-hardwood forest occur.

The Nulato Hills Ecoregion (Figure 2) consists of a series of low lying hills trending in a northeast-southwest direction with rivers occupying the narrow and flat-bottomed valleys, draining into Norton Sound. These hills have even-crested ridges, rounded summits, and gentle slopes and are the remnants of an ancient mountain range after extended periods of downcutting, weathering, and erosion. The bedrock is mainly Upper Cretaceous and the soils are predominately Aquepts (Beikman 1980, USDA NRCS 1979). In areas with poor drainage due to permafrost, Cryaquepts soils dominate and in well drained high ridges Cryumbrepts and Cryorthents are the main soils (USDA NRCS 1979). Due to the relatively low elevation of the Nulato Hills (elevations between 1,000-2,000 ft with a maximum elevation 4,040 ft), this ecoregion was also predominately ice-free during the Pleistocene and served as part of the Beringia migration corridor between Asia and North America. Permafrost is continuous in the entire region, but ranges from thin to moderately thick. Ice formed features such as pingos and patterned ground occur. The vegetation tends to follow an elevational gradient with *Dryas*-lichen and sedge-ericaceous shrub tundra on the hilltops, shorter to taller willow-birch-alder shrublands gradating at lower elevations, and spruce and birch woodlands at the lowest elevations.

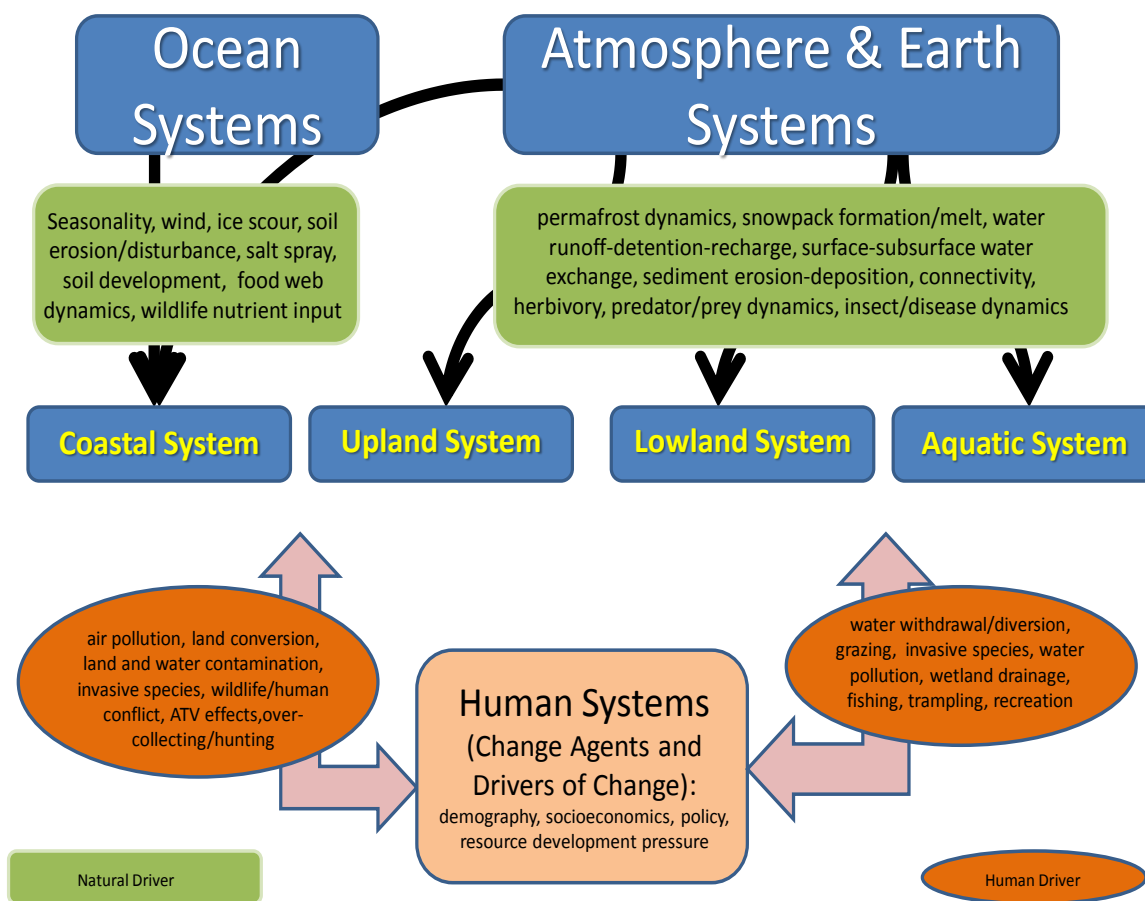
Major Systems for Conceptual Modeling

Here we adapt existing model concepts developed by Lawler et al. (2009), recognizing major patterns in climatic, oceanic influence, and physiography. Pervasive influences of Arctic climate regimes interact with the montane, lowland, and coastal physiography to provide overarching biophysical controls

on nested ecosystems (Figure 3). Affected in part by variation in solar radiation and air density, seasonal temperature and precipitation regimes vary along both latitudinal and elevational gradients. Combined, these controlling regimes set up regional patterns in coastal dynamics, wind, and dry/wet atmospheric deposition.

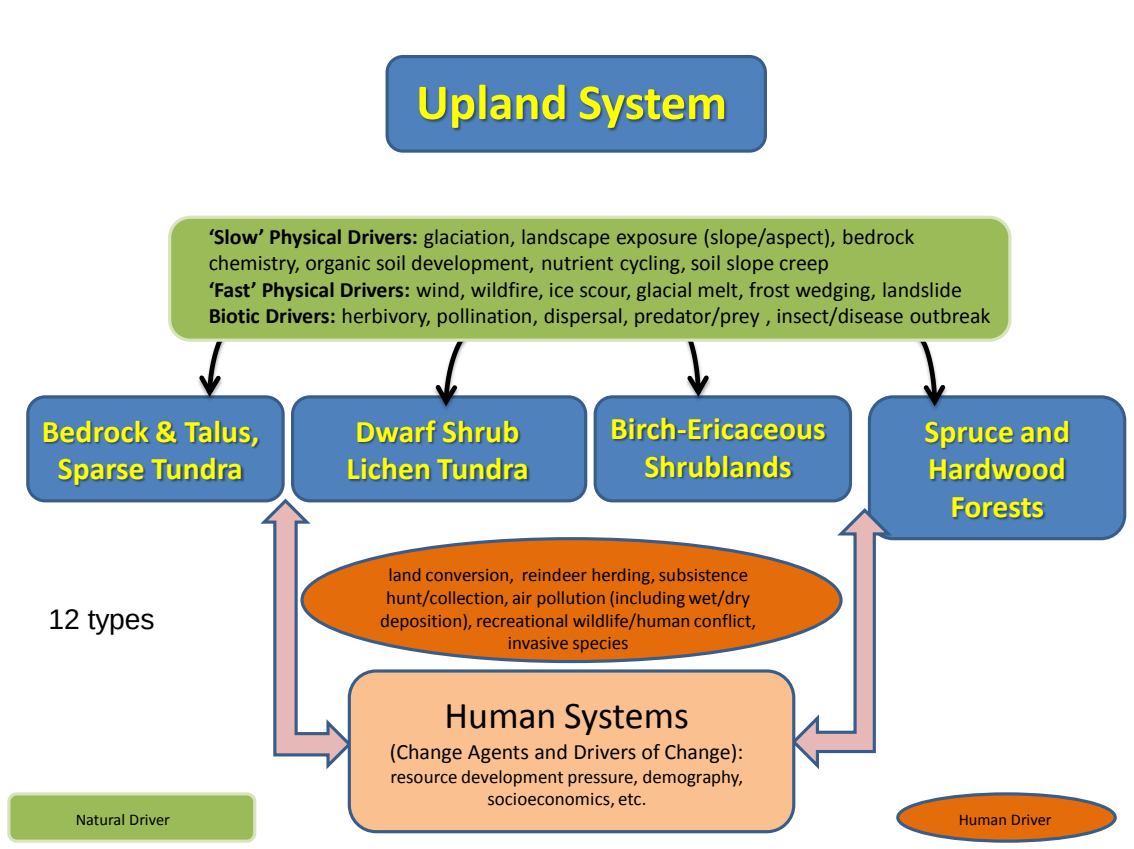
The human dimension enters as a distinct model component with socioeconomic and demographic drivers of change in land and water use and policy overlay other model components. The human dimension is addressed in several MQs as both human benefit and as a current or potential CA. Natural drivers such as herbivory and freeze-thaw dynamics are affected by locally intensified grazing, water diversions and gravel mining. Predator/prey dynamics may be influenced by patterns in hunting and collecting. Introduction of invasive plant species closely follows human land use patterns for settlements, energy development (e.g., mining, oil/gas, solar, wind farms, geothermal), or transportation infrastructure.

Figure 3. Conceptual Model for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion



We then define the major model components, acknowledging the interacting roles of temperature, and coastal dynamics in this Arctic ecoregion. We first distinguish ‘Upland’ systems driven generally by extreme temperature exposure and extreme drainage (Figure 4). At this level, we distinguish natural drivers as ‘slow’ physical drivers – those dynamics that often encompass decades to centuries for significant measurable change (e.g., glaciation, bedrock exposure and chemistry, permafrost and organic soil development, nutrient cycling, landscape exposure, or solifluction); from ‘fast’ physical drivers –

Figure 4. Upland Model Components for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion.



wind, wildfire, ice scour, glacial melt, frost wedging, landslide. These are further distinguished from biotic drivers, such as herbivory, pollination, dispersal, predator/prey dynamics, or insect/disease cycles. These natural drivers vary across major ecosystem types resulting in sparsely vegetated bedrock, cliff, and talus or sparse tundra communities, dwarf shrub lichen tundra, taller shrublands, including predominant birch & ericaceous shrublands, and woodland dominated by spruces and hardwoods. We have tentatively defined 12 major upland ecosystem types of this REA for more detailed conceptual modeling (see .

Table 1 under the

Conservation Elements (CEs) section).

Lowland systems encompass the gradient from relatively moderately drained ‘moist’ uplands, typically where alluvial soils are deeper and permafrost is predominant (if not continuous) (Figure 5). Here the ‘slow’ physical drivers include ice-wedge polygon formation, water infiltration, and peat development. ‘Fast’ physical drivers include river floodplain dynamics, thermokarst dynamics, wind, soil erosion, disturbance, and wildfire. Biotic drivers here include herbivory, dispersal, predator/prey dynamics, and insect/disease dynamics. We have tentatively identified seven major ecosystem types within this lowland category for further modeling, including mesic-wet willow shrubland, black spruce-dwarf tree peatland, shrub-tussock tundra, and large river floodplains.

Aquatic systems encompass headwater streams, hot springs, major rivers, estuaries, and coastal lagoons, plus the various freshwater lakes that define the aquatic environments for fish and aquatic invertebrates (Figure 6). We have tentatively identified nine ecosystem types within this category for subsequent conceptual modeling. ‘Slow’ physical drivers for these ecosystems include the stream drainage network and connectivity, water chemistry, permafrost development, and subsurface recharge/discharge dynamics. ‘Fast’ physical drivers relate more strongly to seasonal dynamics of snowpack formation and melt, lake turnover, rainfall, freeze/thaw dynamics, and water erosion/sediment deposition. Biotic drivers include food web dynamics, fish spawning, and other predator/prey relationships.

Figure 5. Lowland Model Components for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion.

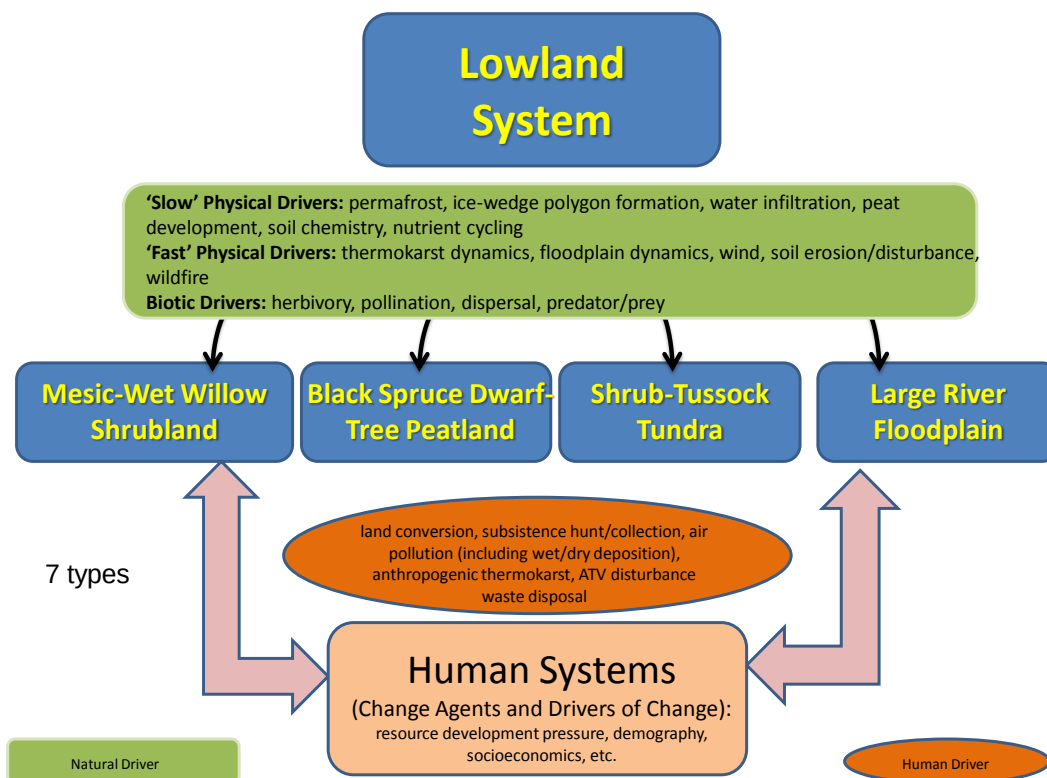
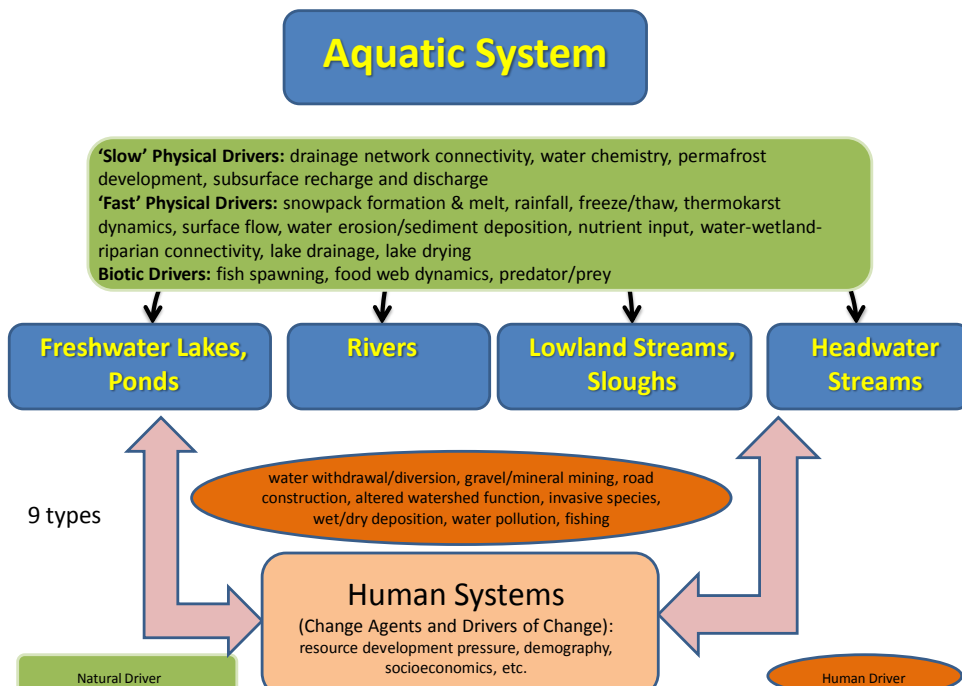


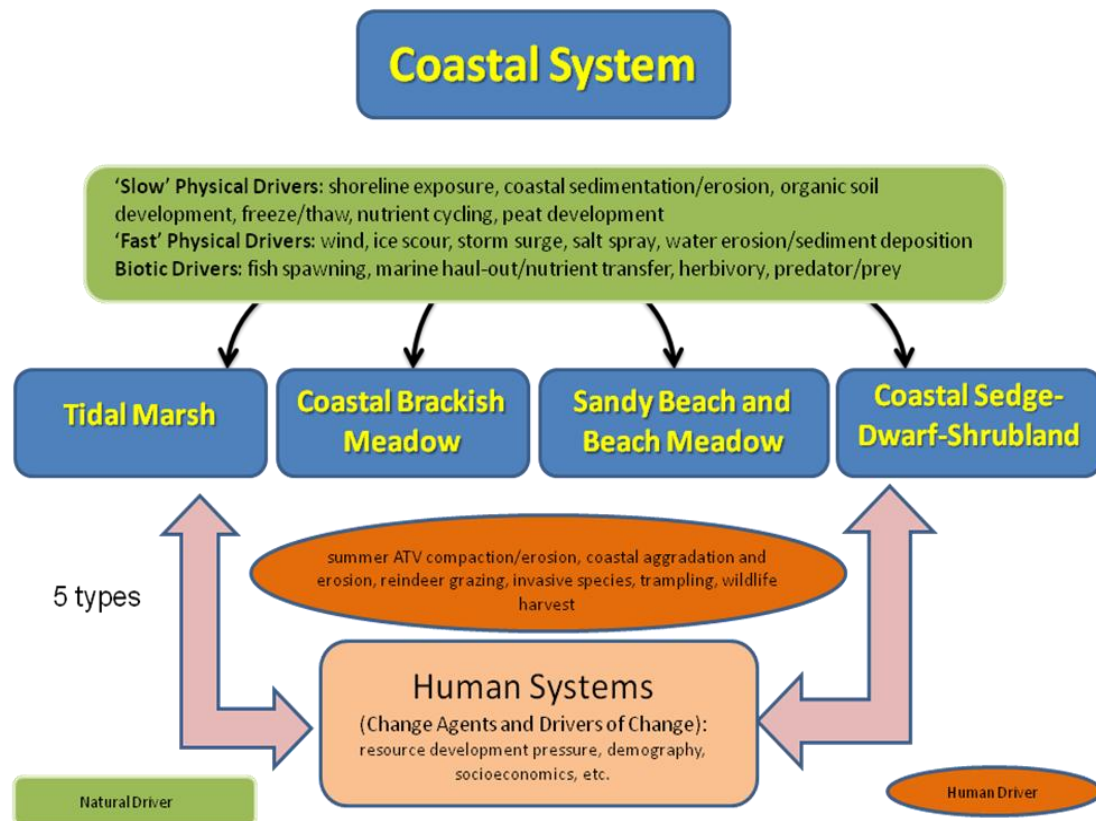
Figure 6. Aquatic Model Components for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion.



Coastal systems encompass coastal zones with both upland and wetland vegetation (Figure 7). “Slow” physical drivers include shoreline exposure and orientation relative to wind and coastal sedimentation/erosive processes, organic soil development, nutrient cycling, freeze/thaw dynamics, and peat development. “Fast” physical drivers include wind, ice scour, storm surge, salt spray, and water erosion related to freeze/thaw dynamics. We have tentatively identified five major ecosystem types for further conceptual modeling, including tidal marsh, coastal brackish marsh, beach and meadow, sedge-dwarf shrubland, and permafrost dwarf-shrub lichen tundra. Biotic drivers for these systems include fish spawning, marine haul-out & nutrient transfer, other food-web dynamics, herbivory, and predator/prey relationships.

The human system component of the model is based conceptually on work of Kofinas, Berman, and others (Berman, Nicolson, Kofinas, Tetlich, & Martin 2004; Berman & Kofinas 2010; Kofinas, Osherenko, Klein & Forbes 2000; Nicolson, Starfield, Kofinas & Kruse 2002) in similar regions of the Arctic. People who live in the region rely on wildlife and plants for a large part of their diet and to provide cultural continuity. We adopt the following definition of ‘subsistence’ that is broader than hunting and fishing.

Figure 7. Coastal Model Components for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion.



...activities that require special skills and a complex understanding of the local environment that enables people to live directly from the land. It also involves cultural values and attitudes: mutual respect, sharing, resourcefulness, and an understanding that is both conscious and mystical of the intricate interrelationships that link humans, animals, and the environment. To this array of activities and deeply embedded values we attach the word “subsistence”, recognizing that no one word can adequately encompass all these related concepts (Alaska Natives Commission 1994).

The ‘subsistence’ use of wild foods is a key CE thus any CAs that affect wildlife, fish, plants, and access to them also have an impact on subsistence activities. CAs affect communities directly as well -- three in the region are in imminent danger from erosion and are in the process of relocating. Human activity becomes a feedback mechanism in the model. People rely on healthy wildlife populations for food and non-material well-being but human activities also affect ecosystems. Settlement expansion, infrastructure development and decay, mining, energy development, grazing, tourism, and pollution all affect plants, water, and wildlife and are thus all CAs.

Management Questions

Introduction

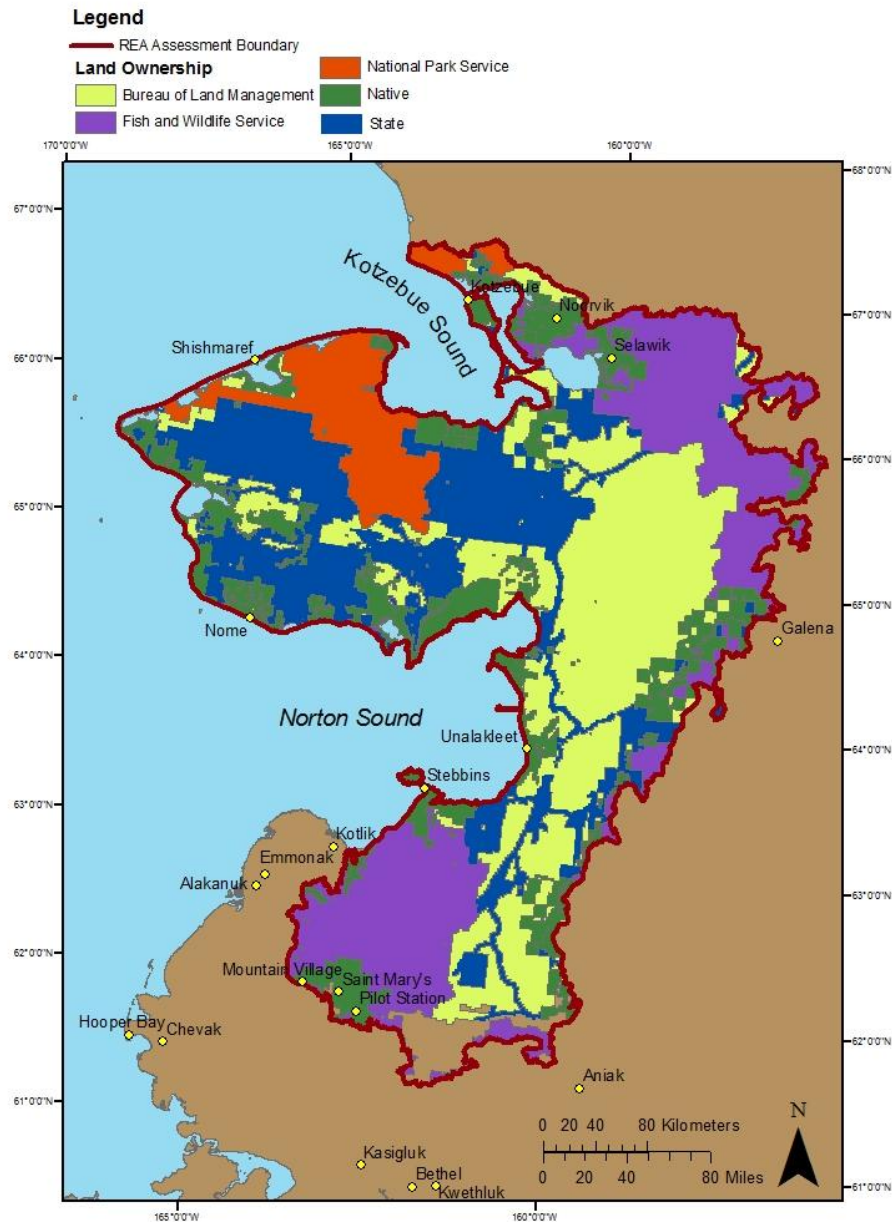
The purpose of the REA and the set of management questions (MQs) is to provide useful information to BLM for use in its land management decisions. For this purpose we have relied heavily on the original set of MQs provided by BLM and the community meetings to guide formation of the recommended MQ list (see Appendix 1. Management Questions Table). Our task as the REA contractor is to evaluate the MQ suggestions and make them actionable based on our team's knowledge of the area and ecology, data, and our interpretation of the intent of the individual MQs. Further MQ adjustments will be made through Tasks 2 and 3 as we further evaluate data availability and fit, and ability to conduct the modeling needed to answer each MQ.

The five major jurisdictions for management decisions within this ecoregion include Native Lands, the Bureau of Land Management, the U.S. Fish and Wildlife Service, National Park Service, and the State of Alaska (Figure 8). This diverse set of view-points and stakeholders must be reflected in the set of MQs.

BLM provided an initial set of 81 MQs that we assigned to 11 logical groups (Box 1). Input from the community meetings produced another 58 questions of interest. Based on the spirit of the work and our experience with other REA's, the NatureServe team proposed an additional 28 preliminary questions. One of the purposes of this Memo is to make recommendations for amendments to this MQ list. The principle focus of these amendments is on the original BLM-suggested questions. However, we also addressed each of the questions suggested during the community meetings in order to make a clear, actionable, and complete set of MQs.

The rationale for our proposed amendments is discussed in detail here as informed by AMT 1 discussions and on written comments to Draft Memo I-1-a and the AMT Summary (I-1-b). Our proposed final set of candidate MQs is presented here (these remain candidates until Tasks 2 and 3 either eliminate or accept them for actual assessment). As discussed below, effective MQs are the product of iterative increases in understanding of the ecological system, the available data, and desired outputs. Consequently, the list of MQs here at the the end of Task 1 will be a strong final draft set of questions that we, in consultation with BLM, will continue to adjust as work continues in Phase 1 of the REA. For example, for a number of the MQ in the current list there are significant doubts about the availability of data. Task 2 (data discovery) will be a critical period for reviewing such MQs.

Figure 8. Land ownership patterns in the Seward Peninsula-Nulato Hills-Kotzebue Lowlands ecoregion.



Input from Community Meetings

Four community meetings were held to provide information about the REA process and to get input from representatives of organizations that will likely use the resulting data and information. Participants

identified issues of importance to them and the communities and constituencies for which they work. The input provided by the community meeting participants also helped identify important datasets and knowledgeable contacts who live or work in the REA study area. If needed, these contacts may provide additional insights as the study is conducted. A detailed summary of the community meetings is provided in Appendix 2. Summary of Community Meetings.

The community meetings were held the first two weeks of November 2010 in Fairbanks, Kotzebue, Nome, and Anchorage. Thirty-three people attended these meetings representing a variety of federal and state agencies, university researchers, local government, and native village, and regional non and for profit organizations. A full list of participants is included in the detailed summary (Appendix 2. Summary of Community Meetings).

All but the Anchorage meeting were conducted in conjunction with a complementary initiative, the Landscape Conservation Cooperative (LCC <http://www.fws.gov/science/shc/lcc.html>). REA team members provided a brief overview after the LCC presentation to brief those participating about the purpose of the REA. The majority of the meeting time was spent reviewing and discussing draft or proposed MQs. The MQs were organized into the following themes:

- Subsistence
- Species
- Socio-Economic
- Development
- Fire
- Native Plants
- Invasive Species
- Aquatic Ecological Function and Structure
- Hydrology/Sea and River Ice/Permafrost/Weather/Soils

The community meetings brought forth several types of information, which are detailed by theme, in the full summary in Appendix 2. Summary of Community Meetings. The types of information identified and organized in the summary are:

- Additional MQs;
- Existing datasets and information resources, including specific individuals who may have certain data;
- Comments about landscape and resource changes in the REA study area;
- Comments on a variety of animals/mammals, fishes, and plants;
- Observations about subsistence use and importance;
- Socio-economic relevance of specific species and habitats;
- Comments about the SNK REA process and outcome;
- Overarching purposes of how the data derived from the REA may be used by land and resource managers; and
- Data needs beyond the scope of the REA effort.

The input from the community meetings has been incorporated into the review of the Management Questions, which are summarized in Appendix 1. Management Questions Table. The second column of the Appendix indicates if the question is a result of community meeting input. These will continue to be reviewed and discussed, in particular during the first AMT workshop.

Management Questions: A rationale for adjusting management questions

Management Questions (MQs) should be driven by three core principles (cf. Maddox et al 1999). First, participants in the process (e.g., BLM, the AMT, the Contactor) must agree to a preliminary set of MQs that directly and specifically address the needs of land managers and stakeholders. This step is satisfied with the preliminary list of MQ's provided by BLM and added to during the community meetings.

Second, questions must be narrowly focused and clearly stated so they can be efficiently and effectively answered by data-driven analyses using existing datasets. All terms used in the questions should be clear or have attached (or footnoted) definitions. MQs should be divided, if necessary, and focused into smaller, specific, and directly answerable sub-questions. We have refined the questions by suggesting language that clarifies meaning and reduces ambiguity. In some cases questions were redundant or duplicated efforts. Such questions were combined wherever possible.

Third, for the REA process, questions should be answerable by available data and methods of analyses. Questions that are not answerable by available data and analyses will be added to a "future research" list of items requiring the development of new data or tools that are beyond the scope of the REA. Questions that have no available data but are nevertheless necessary for the REA should be targets for discussion about new data acquisition or alternative approaches.

Specifically, the process we used to refine the MQs (in this document, at the AMT Workshop 1, and eventually throughout Phase 1 of this work) is driven by seven concerns.

(1) Is each MQ stated in a clear and focused way that can be commonly understood by all participants? Some MQs may need to be split into components. Others may need to be refined or edited to match the opportunities provided by and/or limitations of available data and potential analyses. Some MQs may contain terms or concepts that need definitions or conversations about meaning.

(2) Is each MQ matched to and answerable with available data and planned analyses? If not, can new data or analyses be planned or the question be modified while still remaining within the scope of the REA? If options for data or analysis are limited, then the MQ may need to be identified as a data gap and or future research need?

(3) Are there important issues or questions missing from the list of MQs (e.g., beavers as a nuisance species was not included among the preliminary set of MQ)? If so, craft needed MQs and determine the data and analyses that would be required.

(4) Are there questions that are out of scope, extraneous, duplicative, or determined to be of lesser importance? For example, in many cases questions suggested during the community meetings had

Box 1. Groups and numbers of preliminary management questions for the Seward Peninsula-Nulato Hills-Kotzebue Lowlands Ecoregion provided by BLM, the community meetings (CM), and the NatureServe team. Most questions have multiple outputs corresponding to the Conservation Elements and Change Agents.

Group	BLM	CM
Subsistence	6	6
Socioeconomic	6	9
Development	9	10
Species	19	8
Native Plant Communities	7	2
Ungulate Grazing (Reindeer)	4	1
Aquatic Ecological Function	4	5
Fire	9	6
Invasive species	6	3
Hydrology /Sea Ice / Permafrost	10	8
General Questions	11	0
TOTAL	81	58

analogues among the original BLM questions. These can perhaps be melded, dropped or deferred to focus resources elsewhere.

(5) Do any MQs suggest CEs or CAs that are missing from the target lists under development for the project?

(6) Are all CEs and CAs addressed in at least one MQ?

(7) Are each of the MQs clearly incorporated somewhere into the ecological models under development for the project? This criterion will become more clear when the conceptual models are developed during Phase 1 Task 3.

As is mentioned elsewhere in this section, development of such useful, effective, efficient, and answerable MQs will depend on iterative work of Phase 1 Tasks 1-4. Crafting good MQs critically depends on “dialog” among various steps, including (1) the AMT workshop, (2) the evolving list of critical CEs and CAs, (3) the development of conceptual ecological models that depict the relationships among CEs, processes, and CAs, and, very importantly, (4) the availability of appropriate data and analysis tools. Through this iterative process we will develop, by the end of Phase 1, a final set of MQs to be assessed. Consequently, this Memorandum is the first step in refining the list of MQs.

Develop Final Management Questions & Recommendations

Following the seven-step evaluation of BLM's preliminary set of MQs, discussions at AMT1, and written comments to the Draft Memo I-1-a and AMT1 Summary (I-1-b) we have produced a large table of comments and suggested amendments to the questions (Appendix 1. Management Questions Table). Each of the original questions has been numbered to ease tracking as they are amended. Column D ("Original Management Questions") of the Appendix reproduces the preliminary questions from BLM and the community meetings, including any that have been communicated since the beginning of the project. Column E, "Concerns/Issues," contains comments from the NatureServe team concerning the meaning of terms, difficulties of interpretation, feasibility in terms of available data (to be further vetted in Task 2) and approaches to analysis, and a brief justification for the recommendation. This is the primary “paper trail” or history to explain and justify decisions about individual MQ. Column F ("Summary Conclusion or Recommendation") contains a specific recommendation from the NatureServe team based on our experience and described input. There are four broad categories of recommendations for questions: First, “Accept” indicates we believe the MQ is actionable as originally stated. Second, many questions are “Reframed” to clarify meaning or conform to the limitation on existing data while attempting to retain the spirit of the original question. Third, some questions are “Deferred” to data discovery because there are doubts about whether sufficient data exists. Note that all MQs will be addressed during the data discovery task (Task 2). Finally, some questions have been dropped as candidates for one of several reasons: redundancy with other MQ (the redundant questions’ analogues are explicitly identified in Appendix 1); because there are no existing data to address the MQ (typically these questions are deferred to Task 2; or because they are out of scope for the REA (systematic monitoring is a primary class of work that, while important, is not in the REA’s scope).

During AMT1 all of the questions marked to be dropped were discussed individually and in several cases were restored as candidates for further evaluation. Many of the questions that are ultimately dropped will be added to a developing list of “Data Gaps” or “Needs for Research”.

Finally, in column G, we make a specific recommendation for a revised management question.

Box 2 summarizes the groups of MQ's and total recommended MQ's per group. Changes in the number of questions (compared to Box 1) reflect both additions to and subtractions from the list. A total of 87 MQs are proposed among 11 groups.

Appendix 1. Management Questions Table contains all of the preliminary questions, the proposed questions, and the "paper trail" of concerns and issues. This table will continue to be updated in Tasks 2 & 3 memos and the Task 4 REA work plan.

Box 2. Management Questions resulting from recommendations detailed in Appendix 1, summarized by the number or recommended questions in each group. Note that each of the questions has many sub-components – for example, a given management question is typically applied to many conservation elements or change agents.

Subsistence	10
Socioeconomic	10
Development	11
Species	16
Native Plant Communities	5
Reindeer Grazing	4
Aquatic Ecological Function	7
Fire	7
Invasive and Nuisance Species	9
Hydrology/Sea Ice/Weather/	
Permafrost	6
<u>General Questions</u>	<u>3</u>
TOTAL	89

Conservation Elements (CEs)

Introduction

A first step in most natural resource assessments is the identification of the features or targets of interest (Margules and Pressey 2000, Groves et al. 2002, Stoms et al. 2005). For REAs, we refer to these as “conservation elements” (CEs). These elements could include habitat for or populations of plant and animal taxa such as threatened and endangered species or ecological systems and plant communities of local interest. A list of CEs could also include other resource values such as important subsistence species, recreationally valuable species, or already designated sites of natural, historical or cultural significance.

Key to selection of CEs is establishing clarity of purpose. For this REA, we propose a two-track focus for assessment. One track focuses on the ecological resources of the ecoregion, supporting regional biodiversity and providing the major ecosystems services. This track emphasizes assessment of ecological integrity of landscapes and waterscapes (*sensu* Parrish et al. 2002, Unnasch et al. 2008, etc.). These define our **Core Conservation Elements**. The second track augments the first by including additional resources of interest to agencies and stakeholders (e.g., moose). These define our **Desired Conservation Elements**.

For our first track, we encounter the dilemma of selecting an efficient list of CEs that will help us to adequately address the complexity of natural ecosystems. We seek an effective focus to articulate our assumptions about key ecological drivers of natural systems. We will then seek to effectively gauge the relative effects of CAs on these important natural resources. Our dilemma is that we cannot practically

take a ‘species by species’ approach, hoping to account for all aspects of their individual life histories. Many thousands of species, from large-bodied carnivores, to vascular and non-vascular plants, to soil microbes occur across each ecoregion, precluding this approach. We are *always* forced to select some type of ‘surrogate’ to represent whole suites of species and the main ecological processes that define a given landscape.

Therefore, we proposed to take a “coarse filter/fine filter” approach (consistent with BLM REA guidelines) to selecting core conservation elements, and treating them in this assessment. This approach was originally proposed by scientists from The Nature Conservancy (Jenkins 1976, Noss 1987, Hunter 1990) and used extensively in a variety of forms for regional and local landscape assessments. It focuses primarily on ecosystem representation, complemented by a limited subset of focal species assemblages and individual species. ‘Coarse-filter’ focal ecological resources are identified first and typically include all of the major ecosystem types within the assessment landscape. The intent of this focus is to represent all of the predominant natural ecosystem functions and services in the ecoregion. Researchers and managers then consider whether individual species of concern - those that are in some way ‘vulnerable’ to being lost - have habitat requirements that are adequately represented by the coarse filter units. That is, we pose the question; if all major ecosystem types are managed and conserved in sufficient area and landscape configuration, which of the ‘vulnerable’ species will have sufficient habitat “swept along”? Those species that are **not** adequately addressed through ecosystem-scale conservation are included as additional foci for assessment – the “fine filter.” This approach therefore sets up a multi-level approach to define an effective focus for assessment.

Building from the framework of our ecoregional conceptual model, we first identified the major ecosystems for the ecoregion as one focus for assessment. All species of potential interest to the assessment may therefore be viewed within this “coarse filter/fine filter” framework, with specific criteria established for the selection and treatment (see below). Again, our intent is to provide an effective focus for assessment. Once this list is established, conceptual ecological models will be developed for each to state assumptions about key ecological drivers.

Selecting Core Conservation Elements

Our candidate lists reflect our interpretation of the ‘coarse filter/fine filter’ approach to identify ecosystem, species assemblages, and individual species that collectively should contribute to the assessment of ecological integrity across the regional landscape. From the established REA Scope of Work, this encompasses the listed Native Fish, Wildlife, or Plants of Conservation Concern, Regionally Important Terrestrial Ecological Features, Functions, and Services, and Regionally Important Aquatic Ecological Features, Functions and Services. We completed an initial analysis of NatureServe central databases to identify species that meet BLM stated criteria for “Other Priority Wildlife (& Plant & Aquatic) Species;” as well as all federally listed species. This generated our initial master list of species of potential conservation concern for the ecoregion.

Coarse-Filter Elements

The “coarse filter” includes 33 terrestrial and aquatic ecosystem types that express the predominant ecological pattern and dynamics of the ecoregion (Table 1). These classified units a) characterize each component of the ecoregion’s conceptual model, b) define the vast majority of this ecoregion’s lands and waters, and c) reflect described ecological types with distributions concentrated within this ecoregion. By treating these in our assessment we aim to adequately treat the habitat requirements of most characteristic native species, ecological functions, and ecosystem services. Ecological models (both conceptual and spatial) for these coarse filter elements will form a major focus for this ecoregional assessment. Existing terrestrial ecological classifications provided the basis for several existing national, regional, and local map products (e.g., NPS vegetation maps, LANDFIRE EVT & BpS, etc.) and/or may be readily

reconciled with locally-desired classification systems for plant communities (see <http://www.natureserve.org/explorer/> for more detailed descriptions of upland, lowland, and coastal ecosystem types listed in Table 1). We used NatureServe databases and existing map products to establish our proposed list of these core CEs.

Table 1. Core Terrestrial and Aquatic Coarse-Filter Conservation Elements proposed for the SNK Ecoregion REA.

• Upland Ecological Systems (12)
• White Spruce –Hardwood Forest
• Boreal Mesic Birch-Aspen Forest
• Boreal Mesic Black Spruce Forest
• Boreal Spruce-Lichen Woodland
• Black Spruce Wet-Mesic Slope Woodland
• Arctic Dwarf-Shrubland
• Arctic Scrub Birch-Ericaceous Shrubland
• Acidic Dwarf-Shrub Lichen Tundra
• Acidic Sparse Tundra
• Boreal Alpine Dwarf-Shrub Summit
• Arctic Active Inland Dunes
• Bedrock Cliff, Talus, and Block Fields
• Lowland Ecological Systems (7)
• Mesic-Wet Willow Shrubland
• Boreal Black Spruce Dwarf-Tree Peatland
• Wet Sedge-Sphagnum Peatland
• Shrub-Tussock Tundra
• Polygonal Ground Wet Sedge Tundra
• Large River Floodplain
• Boreal Freshwater Emergent Marsh
• Aquatic Ecological Systems (9)
• Headwater stream
• River
• Estuary & Lagoon
• Lowland stream and slough
• Freshwater Lake – deep, connected
• Freshwater Lake – shallow, connected
• Freshwater Lake – deep, isolated
• Freshwater Lake – shallow, isolated
• Hot Spring
• Coastal Ecological Systems (5)
• Tidal Marsh
• Coastal Brackish Meadow
• Marine Beach and Beach Meadow
• Coastal Sedge-Dwarf-Shrubland
• Permafrost Plateau Dwarf-Shrub Lichen Tundra

Fine-Filter Elements

Per above, the “fine-filter” includes species that, due to their conservation status and/or specificity in their habitat requirements, are likely vulnerable to being impacted or lost from the ecoregion unless resource management is directed toward their particular needs. We propose to treat species falling within this general category into two subcategories; a) 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, and b) those species to be treated individually.

For species to be treated in this assessment, we propose several selection criteria for inclusion and treatment in the assessment. These criteria include:

- All taxa listed under Federal or State protective legislation (including species, subspecies, varieties, or designated subpopulations)
- Full species with NatureServe Global Conservation Status rank of G1-G3¹
- Full species, subspecies, or varieties listed as BLM Special Status and those listed by the AK State Wildlife Action Plan (SWAP) with habitat included within the ecoregion

Appendix 4: Desired Terrestrial and Aquatic Fine-Filter Conservation Elements Considered for the SNK Ecoregion includes a draft list for the ecoregion for species under the first two criteria above.

Treating Core Conservation Elements in the Assessment

As previously stated, a “coarse filter/fine filter approach” intends to provide an effective focus for assessment. This applies both to criteria for selection of component elements, and to the various means of their treatment for analysis. Representative ecological types, as listed in Table 1 form our initial focus of assessment and will be treated through mapping, modeling, and various assessment methods. We then proposed and established several distinct approaches to treating species that meet established criteria for inclusion in the REA. These include:

- Species assumed to be adequately represented indirectly through the assessment of major “coarse-filter” ecosystems types of the ecoregion. For example, species strongly affiliated with estuaries and lagoons or inland dunes may be adequately treated in the REA through assessment of those surrogate coarse-filter features. Those species which will be represented through the assessment of major coarse-filter ecosystems will be further defined and clarified during Task 3 of this REA.
- Species assumed to be adequately represented indirectly as ecologically-based assemblages. That is, due to group behavior and similar habitat requirements, a recognizable species assemblage is defined and treated as the unit of analysis. Examples could include marine mammal haul-out sites. Similarly, migratory bird stopover sites or raptor nesting/foraging zones could also be treated as multi-species assemblages. These species assemblages will be further defined and clarified during Task 3 of this REA.
- Species which should be best addressed as individuals in the assessment. These include those species meeting our criteria for assessment that cannot be presumed to be included in the previous two categories. This will tend to include many major ‘landscape’ species that range over wide areas within the ecoregion and with clearly distinct habitat requirements from all other taxa of concern.

Finally, for species of concern from the latter category that have very narrow distributions (e.g., rare plants species) we will gather current locational information, but will not aim to develop conceptual models for these elements. We will continue to work with the AMT to determine appropriate means to

¹ See <http://www.natureserve.org/explorer/ranking.htm> for NatureServe Conservation Status Rank definitions
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spatially represent these elements e.g., as concentration zones of CEs, etc. Otherwise, these elements will be treated within sub-assessments subsequent to the REA consistent with BLM REA guidelines. Subsequent effort by our team, during tasks 2 and 3 of Phase I of the REA, will involve gathering input from other regional botanists and wildlife ecologists to finalize the selection and treatment of species as core conservation elements within this REA.

Desired Conservation Elements

These CEs are not less important than core CEs but while considered less critical to assessing overall ecological integrity are very important for management. Subsistence species are clearly recognized by natural resource managers in the region to be of major importance where hunting, gathering, and the general dependence on natural resources continues for most residents in the region (Ahmasuk et al. 2008). The use of subsistence species is both an economic necessity and integral to the cultural and personal identities of Alaska Natives (Alaska Native Science Commission 2005). We propose to include representative subsistence species from five functional groups: terrestrial animals, marine mammals, fishes, birds, and plants that constitute at least 5% of the subsistence diet of one or more communities in the region (see Cogner and Magdanz 1990, Ahmasuk et al. 2008, ADF&G CSIS database 2010). Reindeer were introduced into the region approximately 100 years ago and herding continues. Thus this species was proposed as a desired CE due to the number of MQs concerning it. Proposed Desired CEs are included in Appendix 3. Proposed Core and Desired (in italics) Terrestrial and Aquatic Fine-Filter Conservation Elements.

Species that are recreationally valuable were originally identified as an initial resource value in the Scope of Work. Recreationally valuable species include those encompassed by sport fishing, sport hunting, bird watching, and hiking/camping. We believe that these species largely overlap with either important subsistence species or rare species CEs and are adequately represented through major ecological systems of the ecoregion or are included in Critical Habitat CEs.

Again, we propose to complete additional expert analysis of suggested core and desired species to develop additional habitat-based assemblages for species of concern. Subsequent interaction with the AMT will clarify whether this treatment is desired and/or provide additional elements to this list. We recommend gathering locational information on Areas of High Biodiversity Significance, Specially Designated Areas of Ecological and Cultural Value but that these need not be treated as CEs. They may be effectively categorized as “reporting units.” Assessment reporting can be completed with respect to these features without treating them directly as CEs.

Summary of Recommendations for Conservation Elements

Table 2 includes a concise summary by category of conservation elements that we propose for this ecoregional assessment.

Table 2. Summary of Conservation Elements for the SNK Ecoregion

Conservation Element Summary	Number Proposed
Core Conservation Elements	90
Coarse Filter (total)	33
Upland	12
Lowland	7
Coastal	5

Conservation Element Summary	Number Proposed
Aquatic	9
Fine Filter - Species (total)	57
Species Assemblages	6
Birds	12
Mammals	3
Fishes	8
Plants	28
Desired Conservation Elements	22
Birds	2
Mammals	6
Fishes	11
Plants	3

Change agents (CAs)

CAs are those features or phenomena that have the potential to affect the size, condition, and landscape context of conservation elements. CAs include broad regional agents that have landscape level impacts such as wildfire, invasive species, grazing, climate change, and pollution as well as localized activities such as mining, infrastructure, and energy development although they do not include small site scale activities such as individual structures or small area management practices. 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 their occurrence and may also cause impacts to CEs offsite. CAs are also expected to act synergistically with each other to have cumulative and/or indirect effects. All CAs identified in the scope of work have been reviewed to determine potential impacts to CEs. CAs are included in the model if the impact is currently present and will remain present in the future, or is not present, but considered a potential future impact. In this assessment we reviewed the list of proposed CAs from the AMT and consulted a variety of sources to:

1. Identify additional potential CAs and whether they are currently affecting the ecoregion, expected to in the future or both.
2. Characterize the ecological effects of the CA
3. Identify potential CEs that would be affected
4. Characterize potential CE impacts

Change Agent Classes

Below we characterize the four classes of CAs and their major subclasses. Each class and subclass is given more detailed treatment in Appendix 5: Change Agent Assessment.

Class I Wildland Fire

1. Wildland Fire CA Class: Wildland fire is a dominant landscape scale disturbance agent in the ecoregion. Alterations to the fire regime via climate change can substantially alter vegetation structure and composition. Recent studies have provided important contributions to the

understanding of historical fire regimes in this area (Racine et al. 2004, Higuera et al. 2008, Jandt et al. 2008, Joly et al. 2009, Kasischke et al. 2010, Hu et al. 2010). This research quantifies the spatial and temporal variability of both forest and tundra fire regimes across the ecoregion. These studies along with studies of fire-climate interactions (Duffy et al. 2005, Kasischke et al. 2010) have informed simulation modeling efforts in Alaska using the landscape-fire-succession model ALFRESCO (Rupp et al. 2007, Kasischke et al. 2010). ALFRESCO provides a quantitative, spatially-explicit modeling platform that can be used to assess the impact of: changes in ignition patterns (both human and natural), climate change and emission scenarios from General Circulation Models (www.snap.uaf.edu), and impacts of changing fire regimes on flora and fauna of interest (Rupp et al. 2006). Working at more detailed thematic and spatial resolutions, we will also review and evaluate available models from the inter-agency LANDFIRE to characterize fire regimes for predominant vegetation, and then evaluate mapped outputs to determine their suitability for characterizing current and expected future conditions.

Where applicable, future climate projections will inform conceptual, tabular, and spatial models of expected future fire regime conditions, given practical assumptions of future land use configurations. The primary ecological effects of wildland fire will be on vegetation distribution and composition and associated impacts to wildlife through habitat change. For example, increased future fire activity in lichen dominated spruce forest/woodlands could impact available winter grazing habitat for caribou. Likewise, post-fire vegetation dynamics leading to increased early succession deciduous shrubs and trees will impact browsing habitat for moose. In addition, wildland fire effects via removal of the organic mat does influence hydrology and permafrost dynamics across variable temporal and spatial scales. Ultimately, changes in hydrology and permafrost will impact vegetation dynamics and associated wildlife habitat.

Class II Development

This class contains a broad variety of CAs with very different CE effects; we therefore treat them individually.

1. Community disappearance or expansion. All of the human communities in the region are remote and rural. The two largest, Nome and Kotzebue, have populations of 3500 and 3100 (Alaska Department of Labor and Workforce Development). The remaining places range in size from 80 to 650 people. A few are very small. Although some places are growing or maintaining population, over the past 10 years the region has been declining overall. In some of the smallest places there are few or no young adult women and few school age children (Howe & Martin 2010, Martin 2009). A key task is evaluate past and current patterns of population growth and composition, estimate future changes in population and its distribution, and to understand what happens to infrastructure, fuel, and remaining pollutants in the event that everyone moves away from a village.
2. Cost of living. One of the most powerful CAs threatening subsistence hunting and fishing --sharp increases in fuel prices--originates outside the region. Not only does heating and gasoline cost more than twice as much as in urban Alaska, but food prices and the cost of transportation in and out of villages increase sharply. People are forced to rely more on subsistence foods but the cost of fuel needed to get to hunting areas sometimes makes that very expensive as well. In addition, there is some evidence that the high cost of living leads to increased out-migration (Lowe 2009, FAI 2009) threatening viability of very small places.
3. Oil & Gas development: Extensive offshore oil and gas development in Northwest Alaska is under consideration, and related facilities and services could be located in the region. We use the work of Goldsmith (2010) and Minerals Management Service studies of oil development in the Arctic as a basis.
4. Alternative energy development (wind, geothermal & biomass): Communities were designed to run on diesel powered generators. Because of high fuel costs, diesel energy is unsustainable and

communities are starting to develop alternative energy. This CA can impact CEs by destroying or altering habitat, creating bird collision features, introducing invasives, causing ground water pollution or changes, and creating movement barriers. However, renewable energy can also create jobs and lower the cost of living for area residents. We will identify all current and likely future alternative energy development locations and estimate their effects on the ecoregion. The Institute of Social and Economic Research (ISER) maintains a renewable energy database. Recent developments in mini-nuclear power generators are also being considered in some communities (Galena) and could potentially be used in other places as well.

5. Mining (all minerals and materials): We will include existing and potential sites of mining development and estimate their effects on the ecoregion. The region has many placer mines. There are also exploration sites--drill holes which are filled in after exploration is complete, and have little or no adverse impact on the ecosystem (conversation with Bob Loeffler, former Director of Alaska Division of Mining on 11/2010). The two potential mines in the region are Rock Creek in Nome, which is not currently operational but could become active, and Ambler, which is still in early exploration stages. Loeffler estimates that it takes at least 10 years for a mine to move from exploration to development.
6. Recreation (sport hunting, eco-tourism.): Sport hunting competes with subsistence wildlife use. Tribal ownership of a large proportion of land in the region restricts its use and gives some protection to subsistence users (by curtailing sport hunting, most land sales, and some development). We will review hunting permit data and sport fishing data to estimate historic and recent trends in general hunting and fishing by participants, species, and pounds. Even though the eco-tourism industry is very small, it is important for community economic development and provides some cash to local households. In a recent study on the viability of businesses in rural Alaska, ISER developed and analyzed an extensive dataset on community characteristics that facilitate the quantity and diversity of business development in small non-road connected rural communities in Alaska (Haley, et al, 2007). Out of approximately 90 community characteristics variables analyzed, proximity to scenic public lands was one of the most significant factors related to business development with tourism related businesses leading the expansion. Information from the Alaska Visitor Statistics Program indicates that approximately half of visitors to Alaska are interested in visiting rural Alaska communities (Fay 2005c). We will locate current and potential tourism sites, the number of people who visit, and revenue from their activities. We will also estimate the effects of tourism activities on the wildlife, water, and land.
7. Infrastructure (airports, harbors, roads, fuel storage tanks, public buildings, historic trails): There are no year-round road connected communities in the region. Nearly all travel into the area and among communities is by air. Fuel, food, and supplies are delivered by barge or airplane. We will locate ice roads on a map and estimate changes in the ice roads (shorter season of use due to climate change) and how this may affect the region. We will also include locations of historic trails. We will use ISER's infrastructure database and locate infrastructure on a map. Combined with locational information about this CA we can estimate vulnerability of infrastructure to damage.
8. Grazing: We will follow on the work of Kofinas, caribou biologists, and owners of the Teller reindeer herd to understand the past, current, and likely seasonal migration patterns and future impacts of grazing on the land. We will provide information about the past and current population size of the herd and its foraging range.
9. Military use/expansion areas: We will provide an inventory of military sites in the area, including currently in use (Stewart River Training Area) and deactivated (such as White Alice site in Nome and the recently deactivated Port Clarence site) and estimate their effects on CEs. We will also work with the Army Corp of Engineers to locate any military hazardous waste sites.
10. Other anthropogenic effects: Subsistence users have reported abnormalities in fish and wildlife. Wind patterns, ocean currents, and extreme cold make the area highly vulnerable to Persistent

Organic Pollutants (POPs), which are highly concentrated in Arctic marine mammals. We will use harvest data as well as local knowledge to understand the effects of pollution in the area.

Class IIIa Non-Native Species

Many non-native species are recognized to cause ecological or economic harm, or harm to human health, outweighing potential benefits (i.e., “invasive” sensu Executive Order 13112, Clinton 1999). Regardless of known or perceived levels of invasiveness, non-native species in natural systems are generally regarded as antithetical to the goals of land management agencies. Terrestrial invasive species are believed to be causing large-scale ecological and economic impacts in the state and represent a major threat to the ecological integrity of the ecoregion (Carlson and Shephard 2007). At present terrestrial invasive species are primarily restricted to anthropogenically-disturbed areas in this ecoregion. The majority of the plant species are weakly invasive; however a number of species are moderately invasive (Box 3 and see Carlson et al. 2008). *Melilotus alba* is considered extremely invasive and is located just outside the REA boundary, upstream along the Yukon River in Galena (Conn et al. 2008, AKEPIC 2010). Increasingly, a greater abundance and diversity of invasive plants and animals are moving off the anthropogenic footprint across Alaska.

Unique sagebrush-graminoid steppe habitats, areas around hot springs, floodplains, and wetlands are the primary habitats likely to be invaded in the ecoregion.

Other invasive species can be categorized as follows.

→ Invasive terrestrial vertebrates and invertebrates threaten native species/systems. Three species of introduced alder-defoliating sawflies are causing extensive damage in areas southeast of this ecoregion and are likely to cause alterations to dominant woody species (Patterson 2010) affecting successional pathways and wildlife should the sawflies become established. Norway rats are well-known to cause massive seabird depredation and they cause cascading impacts on coastal ecosystems in Alaska (Krue et al. 2008). Norway and roof rats are present on the Seward Peninsula, but are currently geographically restricted.

→ Aquatic non-native species can affect ecosystems at multiple trophic levels (i.e., primary and secondary productivity) and through competitive exclusion, predation, pathogens, indirect effects, trophic cascades, etc. For example, the New Zealand mudsnail (*Potamopyrgus antipodarum*), can sequester a large fraction of available carbon away from native invertebrate production and drastically alter food web function (Hall et al. 2006). We propose to limit our efforts in this REA to the aquatic invasive taxa currently known from Alaska (see McClory and Gotthardt 2008). This includes two invasive crayfish,

Box 3. Non-native plants known from the Seward Peninsula, Kotzebue Lowlands, and Nulato Hills. Invasiveness ranks (scale of least to most invasive in natural systems = 0-100, see Carlson et al. 2008) are included in parentheses. * indicates species outside of the REA boundary, but within 200 km. † indicates species of uncertain nativity.

- *Bromus inermis* spp. *inermis** (62)
- *Capsella bursa-pastoris* (40)
- *Chenopodium album* (37)
- *Descurania sophia* (41)
- *Euphrasia nemorosa** (42)
- *Galeopsis tetrahit** (40)
- *Hordeum jubatum* † (63)
- *Leucanthemum vulgare* (61)
- *Matricaria discoidea* (32)
- *Melilotus alba** (81)
- *Plantago major* (44)
- *Poa annua* (46)
- *Poa pratensis* ssp. *irrigata* (52)
- *Polygonum aviculare* (45)
- *Stellaria media* (42)
- *Taraxacum officinale* ssp. *officinale* (58)
- *Trifolium repens* (59)
- *Tripleurospermum perforata* (48)

Procambarus clarkia (Red swamp crayfish; known from the Kenai Peninsula) and *Pacifastacus leniusculus* (Signal crayfish; known from Kodiak Island), *Myxobolus cerebralis* (the whirling disease parasite; documented from the Anchorage Bowl) (McClory and Gotthardt 2008), *Gambusia affinis* (western mosquito fish; documented in Alaska, specific location unknown), and pondweed *Elodea canadensis* (documented from Fairbanks; Larson et al. 2010).

Class IIIb Nuisance Native Species and Diseases

Native insects and diseases are well-known to cause significant alterations to habitats in Alaska (Patterson 2010). Dominant tree and shrub species across Alaska are subject to damage and increased mortality due to a variety of disease agents (wood decay and canker fungi, root disease, etc.) and native insects (aspen and willow leaf miners, spruce budworm, spruce beetle, northern engraver beetle). Large-scale mortality of dominant boreal trees in Alaska can result in cascading effects on plant communities, wildlife, and even alters salmon spawning habitats (Boggs et al. 2008). Additionally, insect and disease impacts are closely associated with climate. For example, seasonal temperatures above normal are responsible for causing outbreaks of leafminers and spruce beetles. Thus, interactions between climate change and insects and disease are particularly likely to influence CEs.

Other native species have become pests in aquatic environments. In the last several years, a native diatom, *Didymosphenia geminata* has blossomed into a nuisance species throughout portions of the U.S., and has drastically reduced native aquatic biodiversity and even altered stream hydraulics (Spaulding and Elwell 2007). *D. geminata* blooms have been observed in many streams around Alaska, primarily on streams that host guided sport fisheries for trout and salmon (D. Bogan and D. Rinella, unpublished), and it is possible that a noxious strain is being introduced by travelling anglers (see Bothwell et al. 2009). In the Kotzebue Lowlands, beavers apparently are re-establishing and have been identified as a nuisance by residents (C. Gregg pers. comm.).

We plan to include native insects and diseases that severely impact forests and that have sufficient spatially explicit data from State and Private Forestry, USFS. Second, we expect to include *D. geminata*, as this species may have impacts to aquatic resources. We will investigate options for treatment of expanding beaver populations in subsequent REA tasks.

Class IV Climate Change

This CA addresses MQs for CEs via forecast changes in climate (see Appendix 1. Management Questions Table). Climate change is already having significant effects on Alaska's species and ecosystems (Karl et al 2009) and many MQs focus on establishing current trends relative to historical norms and projecting those trends into the future. For example, insects and diseases are well-known to cause significant alterations to native habitats in Alaska (Patterson 2010). Dominant tree and shrub species across Alaska are subject to damage and increased mortality due to a variety of disease agents (wood decay and canker fungi, root disease, etc.) and native insects (aspen and willow leaf miners, spruce budworm, spruce beetle, northern engraver beetle). Large-scale mortality of dominant boreal trees in Alaska can result in cascading effects on plant communities, wildlife, and even alters salmon spawning habitats (Boggs et al. 2008).

Climate change impacts on CEs are both direct (e.g., temperature increase inhibiting species life cycles) and indirect (e.g., altered hydrology or invasive weed expansion), and these impacts are projected to increase. Using observed climate data generated by SNAP at 2 km resolution, we will first characterize the spatial and temporal distribution of recent (1990 -1999 & 2000-2009) vs. historical (1901-1989) climate change. This will help us to validate our ecoregional conceptual model, characterizing observed ranges of variation in key temperature and precipitation variables. With the high spatial resolution of the observed climate datasets, we will identify subregional landscapes that have likely experienced climate-induced stress in the 1990-2000-2010 intervals. This analysis will provide appropriate context for interpreting current conditions (e.g., correlations with wildfire increases or major insect infestations,

thermokarst, etc.), and provide a framework for projecting impacts based on future climate projections. Future climate change impacts analyses for the near term (2025) and mid-century (2060) will be based upon monthly climate variables derived from a 5 model ensemble of global circulation models run for the 4th Assessment Report of the IPCC. Model-based projections of temperature, precipitation, and derived bioclimatic variables will be used to produce spatial maps of likely climate change-induced effects. These include such effects as: a) changes in vegetation pattern (i.e., directionality and proportional shifts in predominant type and structure), b) geographic range shifts for CEs, their primary food resources, and potential disease vectors, c) the potential spread of the most noxious existing invasive species, and d) future climatic changes to hydrologic regimes affecting all aquatic CEs. Synthesis maps will identify potential locations of refugia that may continue to harbor CEs and possible climate adaptation corridors facilitating wildlife movements. In addition:

- A. We will examine relationships between climate change and subsistence, building on the work of Kofinas et al. (2010) who described how climate change affects subsistence resource use by limiting access to hunting areas. People use boats and ATVs in the summer and snow machines in the winter to reach subsistence hunting areas. Warmer temperatures mean later freeze dates and earlier thaws for rivers and shorter periods of snow cover which in turn limit snow machine travel in winter. Summer travel by boat or ATV can be affected by changing river levels.
- B. Permafrost. All of the communities in the area are susceptible to changing permafrost dynamics. We will determine variation in permafrost risk to understand the vulnerability of community infrastructure.
- C. Hydrology. Several communities within or adjacent to the study area are at high risk for coastal or river erosion. Shishmaref and Kivalina are currently in the process of relocation. We will identify other high risk communities.

Change Agent Assessment Table

Greater detail of the CA assessment is provided in the table in Appendix 5: Change Agent Assessment. Definition of fields follow:

- 1. Change agent name/type: A hierarchical list of change agents evaluated by the team
- 2. Source: This field lists sources consulted in the characterization and evaluation of the CA.
- 3. Ecological effects: In general terms, the ecological effects documented by sources.
- 4. Conservation elements affected: What are the CEs that are/may be affected by the CA? This is not an exhaustive list but draws opportunistically from literature and from the experience of the team members.
- 5. Effects Conservation elements: How are the CEs affected? As above, not an exhaustive list
- 6. Key CA synergies: Identifies strong synergies that cause the CA to occur or intensify in the presence of another CA.
- 7. Current: Identifies if the CA is currently occurring in the ecoregion (subject to further data analysis)
- 8. Future: Identifies if the CA is forecast to occur (but is not occurring currently) (subject to further data analysis and possible modeling)

Summary of Change Agent Recommendations

1. We found the list of candidate CAs provided by the AMT to be highly relevant and recommend inclusion of all for further assessment for data availability and quality.
2. We recommend that the Invasive Species and Insect and Disease CAs be split into two new classes “Non-Native Species” and “Nuisance Native Species and Diseases”. This decision was based on recommendations from the AMT to identify a species’ nativity with respect to organisms that have known or potential antithetical impacts to resource management goals.

Limitations and Unresolved Issues

A large number of lengthy written comments were provided after the AMT1 workshop. Many comments dealt with REA process issues rather than the content of this memo; other comments are appropriately addressed in Tasks 2 and 3. We are documenting substantive comments in an “Ongoing Issues” spreadsheet to ensure that all issues have appropriate follow up. We will work with the AMT lead to communicate with AMT members as needed to receive input on how to resolve the issues. We endeavored to address all substantive and relevant comments, however, the volume of these may have resulted in us overlooking some important to individual AMT members in this memo. In such case, please communicate these to the AMT lead and we will conduct appropriate follow up.

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Appendices

Appendix 1. Management Questions Table

This table is the current MQ list, plus an historical record (i.e., a "paper trail") of discussion of concerns and justification for MQ recommendations. Revisions are the products of work by the Nature Serve team, discussions at AMT1, and written comments on previous memos (I-1-a, I-1-b). The table includes the original preliminary MQs supplied by BLM and from the community meetings (column D), comments on clarifications to each of these questions and a history of discussion (column E), and a recommendation on the question (column F and G). Notes in GREEN indicate text that has received significant revision since Memos I-1-a and I-1-b. Note that while the MQ list is taking more of a "final" shape, the discussion about individual MQ will continue throughout Phase 1, and especially during data discovery (Task), when some questions may have to be dropped or amended for lack of data.

Management Questions						
Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
Subsistence (Responsible Party: ISER)						
1	CM	Subsistence	What data is needed for managers to make sound decisions about ensuring 1) abundance of harvestable resources, 2) distribution of harvestable resources, and 3) harvester access. (Based on ANILCA Section 810 there are the three factors regularly mentioned that Federal Agencies are required to support.)	This is a general statement of need. Ensure that the MQs reflect these needs. For example, population distributions of subsistence species and other CE are explicitly address in this section and the SPECIES section. We are referring specifically to NOATAK, but should apply across the board. Aspects of this question, related to access (traditional routes vs. uses) need to be effectively addressed in other questions. Discussed at AMT1.	REDUNDANT	
2	CM	Subsistence	How will lack of sea ice impact subsistence hunting, e.g. make more dangerous / easy; increase / reduce deaths? (polar bears on land, higher waves, etc.)	This was originally considered to be a research report outside the scope of the REA. Restored at AMT1 because it has significant influence on the coastal zone. Data may be the Sea Ice Alert System. Reframed question needs to emphasize land-based hunting opportunities, no sea-based.	REFRAME	How could changes in sea mammal harvests potentially affect land based hunting and fishing?
3	CM	Subsistence	At what point should we be thinking about managing for moose rather than caribou?	This was originally considered to be a research report outside the scope of the REA. Restored at AMT1. Should be addressed as part of the modeling in Task 3, as part of the SPECIES treatments. Several MQ listed to the right need to be edited and whittled down. The data should be available from subsistence and general hunting data. NOTE that the core of the original question ("when should we start thinking about managing..." and what to manage) is a policy question outside the scope. The new MQ need to search for ways to inform this decision.	DEFER TO TASK 2 and 3	(A) How are moose populations and ranges changing? (B) What are moose harvest levels? (C) Are there reports of use conflicts among user groups?
4	CM	Subsistence	Are peoples’ subsistence needs being met? How, where, how many, etc.? and how will change affect?	Need a more narrow definition of "needs" and "met". Can this MQ be stated in purely economic terms?	REFRAME	How much have harvests (lbs.) changed over the past 20 years?
5	CM	Subsistence	Do use authorizations impact access, availability and/or distribution of harvestable resources?	Karen Murphy: Is this not out of scope? REFRAMED VERSION: How are use permits/authorizations on federal lands likely to affect subsistence species availability?	OUT OF SCOPE	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
6	CM	Subsistence	We need to know more about what the subsistence species are and their use patterns. And how is this changing? How could access to subsistence resources change?		REFRAME	Which species make up the largest share (lbs.) of subsistence harvests? How is this changing?
7	BLM	Subsistence	How will harvest regulations reflect species availability?	Current regulations or proposed future regulations? Define "availability"	REFRAME	Given current and estimates of future subsistence species populations, are harvest regulations adequate to protect subsistence species populations?
8	BLM	Subsistence	What are subsistence users' concerns of increased time, effort, and expense to meet subsistence needs?	Redundant with Q 15,16, 18. Discussed at AMT1. See MQ 16 for explicit inclusion of users' concerns. Agreed at AMT1.	REDUNDANT	
9	NS	Subsistence			NEW	How have hunting and fishing regulations affected general hunting and fishing harvests?
10	BLM	Subsistence	With climate change, what will the impacts be to subsistence spp. (specific species, habitat) and what is the time frame that villages need to be aware of regarding subsistence species that they rely upon?	This has several questions embedded in it: Impacts of specific climate related change? Impacts by species? Impacts to habitat? The key question is: What is the relevant time frame to talk to community people and hunter groups about climate change effects on subsistence? NOTE: this question is effectively addressed in the SPECIES section (subsistence species are also defined as CEs). USGS: Todd Brinkman (UAF) is doing current work with subsistence hunters in Interior and North Slope villages to assess how hunting systems may be affected by climate changes. Suggest contacting him prior to deleting this question for lack of available data. Karen Murphy: Explicitly relate the distributions of species to the locations of subsistence communities.	SPLIT into 10 and 11	What are the current ranges of subsistence species? Where are the subsistence communities?
11	NS	Subsistence		Split from MQ 10. Reframed as climate envelope analysis. Karen Murphy was concerned that this didn't capture the time component of the original question. However, all of the climate change analyses will be conducted at standard time intervals.	SPLIT from 10	In which locations are climate change events likely to affect subsistence species?
12	BLM	Subsistence	How will the changes to hydrological systems affect subsistence species?	This was originally considered to be a research report outside the scope of the REA. Restored at AMT1. Should be addressed as part of the data discovery in Task 2 and modeling in Task 3. We suspect that data will be insufficient because of a lack of hydrological data. Matt Varner: Using SNAP projections related to snowpack, seasonal precip amounts/timing, and seasonal temp changes can be utilized to project impacts to resident anadromous fish run timing	DEFER TO TASK 2 and 3	Given likely scenarios for changes in hydrological systems, what changes can be expected in subsistence species.

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
13	BLM	Subsistence	What snowfall changes will occur and what affect will it have on subsistence?	Reframe explicitly as a climate change MQ. Snowfall isn't the big issue for caribou - its rain on snow that makes it so that they can't get to food.	REFRAME	How could changes in snowfall, rain and icing events potentially impact subsistence species?
14	BLM	Subsistence	How can subsistence cultures best prepare for climate change and be adaptive to the changes?	This is a research report outside the scope of the REA. We cannot address the question with the data and analysis tools available. Agreed at AMT1.	OUT OF SCOPE	
Socioeconomic and population demographics (Responsible Parties: ISER & SNAP)						
15	BLM	Socioeconomic and population demographics	What is the current ecotourism industry and what is forecast?	Divide into two MQs (current and forecast). Reframe to define relevant aspects of the industry (e.g., total \$\$, total tourists, etc.).	SPLIT into 15 and 16	What are patterns of current tourism including hunting and fishing (e.g., total revenue, total visitors, types of ecotourism)?
16	BLM	Socioeconomic and population demographics	What are the predicted socioeconomic changes in the different villages? Are shoreline communities likely to be more or less affected? Compared to villages not on the ocean shoreline?	REFRAME. Divide into separate MQs. Define in the MQ the relevant socioeconomic changes to be used in the analysis. Modeling in Task 3 can refine these issues. Explicitly add users' concerns (originally MQ 8).	REFRAME	(A) What is the current socio-economic profile for each community (including hunting and tourism)? (B) How are they likely to change under development and climate scenarios? (C) What are subsistence users' concerns?
17	BLM	Socioeconomic and population demographics	What will community economic profiles look like in 10, 25, 50 and 100 years from now due to climate change effects?	Redundant with MQ 16. Agreed at AMT1.	REDUNDANT	
18	NS	Socioeconomic and population demographics		Create a model in Task 3 of how specific elements of climate change (or other) may affect aspects of ecotourism. Use these to clarify the MQ.	SPLIT from 15	How are changes in climate likely to affect tourism destination sites, numbers of tourists and revenues?
19	CM	Socioeconomic and population demographics	What are potential increases in economic activities due to change agents?	Redundant with MQ 16. Agreed at AMT1.	REDUNDANT	
20	CM	Socioeconomic and population demographics	What are the implications for infrastructure given permafrost melt?	Is this an MQ that can be answered within the scope of this REA? To some extent redundant with MQ 159, so coordinate work. Karen Murphy also concerned that this question is Out of Scope.	REFRAME	Where will relevant infrastructure likely experience significant changes in soil thermal regime?
21	CM	Socioeconomic and population demographics	What's the viability of rural communities, given changes?	Redundant with MQ 16. This could be part of the interpretation/discussion of results in MQ16. Agreed at AMT1.	REDUNDANT	
22	CM	Socioeconomic and population demographics	How will changes in fuel prices affect subsistence, tourism/guiding/, development?	Redundant with MQ 15, 16, and 18. Agreed at AMT1.	REDUNDANT	
23	CM	Socioeconomic and population demographics	How will storm surges affect infrastructure? (Road to Council significantly eroded due o surges.)	Restored in AMT1. NOAA has been creating models for storm surge and these MAY extend sufficiently north. Need a narrowed question based on available data. Karen Murphy: "Tom Ravens at UAA is also working on this."	DEFER TO TASK 2	Based on output from storm surge models, which communities and infrastructure are most at risk for damage?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
24	CM	Socioeconomic and population demographics	How will Moonlight springs—be affected by climate change (main water supply to Nome)?	Is this an MQ that can be answered within the scope of this REA? May be redundant with MQs in the Water and Hydrology sections. Are specific data available for such an analysis?	REFRAME	How is climate change likely to affect community water supply and quality? Sewage disposal?
25	CM	Socioeconomic and population demographics	How will changes in water levels affect villages (e.g., Upper river villages are having a tougher time getting fuel barges up because the water is too low.)	No stream gauge data are available anywhere in this ecoregion. Agreed at AMT1. NOTE Varner comment: "if climatic projections indicate reduced summer flows due to poor snowpack increases in the amount of rain/snow events that accelerate run-off in spring, etc., then it is reasonable to suggest that barge traffic may be increasingly difficult"	INSUFFICIENT DATA	
26	CM	Socioeconomic and population demographics	How do sewage lagoons, wastewater systems, dumps, FUDS/Dewline, other hazardous sites, and air pollution impact species/habitats?	Is this an MQ that can be answered within the scope of this REA? May be redundant with MQs in the Water and Hydrology sections. Are specific data available for such an analysis? Consider moving this MQ to be a CA mapping Q concerning pollution sites. Discussed at AMT1.	DEFER TO TASK 2	Where are sewage lagoons and dumps? Which are at risk by climate related ecological change?
27	CM	Socioeconomic and population demographics	Where will increases or decreases in transportation corridors occur?	Redundant with 50. Agreed at AMT1.	REDUNDANT	
28	BLM	Socioeconomic and population demographics	Customary and Traditional Knowledge-elders are commenting they are no longer able to accurately predict/interpret weather, freeze /thaw dates, fire behavior, and regional temperatures – how will changes affect traditional knowledge delivery?	"Delivery of" and accuracy are different. REFRAME to clarify. Also, this seems like a research question beyond the scope of the REA.	REFRAME	What types of traditional and local knowledge data exist for the region and then how can these data be best incorporated into management decisions?
29	NS	Socioeconomic and population demographics		Check for redundancy with MQ in the Hydrology section. USGS review suggested the original "resource values" be replaced. Done here with "relevant CEs.	NEW	Among areas at risk of river erosion, which threaten relevant CEs?
30	NS	Socioeconomic and population demographics		Check for redundancy with MQ in the Hydrology section.	NEW	Where will losses of lakes/river significantly affect water supply to villages?
32	BLM	Socioeconomic and population demographics	How will permafrost melt and other hydrological changes change overland or aviation transportation routes/airstrips on a seasonal and annual basis? Trails, roads, waterways (rivers/streams), and aviation facilities and transportation routes need to be considered.	Redundant with MQ 20. Agreed at AMT1.	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
Development (Responsible Party: ISER)						
33	BLM	Development	Will the changes to permafrost and hydrological resources affect mining practices or opportunities (i.e. the NPDES permits for waste water)?	Moved from SOCIOECONOMIC. Redundant with MQ in Development and Hydrology. Data may not be available. Discussed at AMT1.	DEFER TO TASK 2	
34	CM	Development	Blueberry/ptarmigan link and lead contamination?	This is a research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
35	CM	Development	How does ocean acidification affect species?	This is a marine research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
36	CM	Development	Are we striking a good balance between development activities and habitat protection? and how do we do that?	As stated this is a policy question beyond the scope of the REA. REFRAME to simply depict where there are lands available and not available for development. Could use land use plans to clarify administrative status and allowances on current lands; e.g. from BLM lands database, which lands are open to development? Restored at AMT1.	REFRAME	Where are lands that are and are not available for development?
37	CM	Development	How is all the plastic on the beaches of Kobuk Lake (and elsewhere) affecting species?	As stated is potentially a research question beyond the scope of the REA. Plastic on the beach should be added as a CA. Then in TASK 2 look for available data. Restored at AMT1.	DEFER TO TASK 2	Where are areas that experience significant plastic on beaches?
38	CM	Development	How will water quantity and quality change with climate change?	Redundant with MQs 113, 114, 116, if related to drinking water sources 24 (note recent statewide study on water risk – see USGS/UAF). Agreed at AMT1	REDUNDANT	
39	BLM	Development	Unexplained potential anthropogenic impacts: milk production in male caribou; lesions on fish; persistent organic pollutant impacts, thickness of seagull eggshells?	Currently this isn't a question. Is a list of such phenomena desired? Defer to data discovery in Task 2, but must have a clearer sense of what information is desired, then discover whether data are available. Agreed at AMT1.	DEFER TO TASK 2	Is there evidence of contaminants in subsistence foods? In which species/locations?
40	CM	Development	What areas are or what criteria could be used to identify areas too valuable for development?	This is a policy question beyond the scope of the REA. Also redundant with MQ 36. NOTE: We could propose an analytical method to address the question (irreplaceability) Karen Murphy: "True, but you are collecting data that could be used to do a biodiversity "hot spot" map. "	REDUNDANT	
41	CM	Development	How will marine corridors, hydroelectric dams, port development, pipelines, the use of unmanned aerial vehicles, utilities impact subsistence species/habitat?	Broad overlap with MQ45, 46, 49, 50, 51, 52. Agreed in AMT1. Karen Murphy: This is a policy question beyond the scope of the REA. NOTE: We could propose an analytical method to address the question (irreplaceability) Karen Murphy: " "It seems within the REA scope to gather and provide the information for where ground disturbing construction is planned in the near future. it would be similar to your reframed questions numbers 45 and 46"	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
42	CM	Development	How will fish populations moving north along with international commercial fishing, impact subsistence species?	This is a marine research question beyond the scope of the REA. Agreed in AMT1.	OUT OF SCOPE	
43	CM	Development	How will cumulative impacts be accounted for in the REA?	An important issue that must be dealt with in the overarching interpretation and in some of the individual MQs. But this is not an MQ in and of itself. Agreed at AMT1.	NOT INCLUDED AS MQ, BUT PART OF REPORTING	
44	CM	Development	How are transporters/tourism/sport hunt and fishing affecting the migration patterns of caribou?	This may is a research question beyond the scope of the REA. However, data MAY be available. DEFER to Task 2. Traditional knowledge suggests they are affecting migration routes; BLM management plan with NW Arctic bureau to clarify effect and potentially move forward: "but if we get the data set I'll eat my hat". Agreed at AMT1.	DEFER TO TASK 2	How are transporters/tourism/sport hunt and fishing affecting the migration patterns of caribou?
45	BLM	Development	What is the extent and impact of Oil/Gas activities?	Define "impact". Separate the "where" and "impact" MQs. Including offshore?	REFRAME	Where are current and planned oil/gas activities located and where do they overlap with CEs or other relevant habitats?
46	BLM	Development	What is the current status and impacts from mining, including past mining?	Clarify "status and impacts". Perhaps REFRAME as a simple overlap of current/past mining and CW distributions.	REFRAME	Where are historic, current and potential mining activities located, and where do they overlap with CEs or other relevant habitat?
47	BLM	Development	Where are locations of mineral potential?	REDUNDANT. Redundant with 46. Agreed at AMT1.	REDUNDANT	
48	BLM	Development	What is the foreseeable potential for mineral development?	REDUNDANT. Redundant with 46. Agreed at AMT1.	REDUNDANT	
49	BLM	Development	Where the concentrated areas of recreation are and what is the forecast or potential for future areas? Impacts sport and trophy industry?	Define "concentrated". Separate the questions. Unclear what "impacts sport and trophy industry" means.	REFRAME	Where are current and potential recreational use areas located, and where do they overlap with CEs or other relevant habitat?
50	BLM	Development	Where are the travel corridors located and what are the related impacts and what is forecast?	Separate. Define travel corridors (e.g., maintained roads, ice roads, rivers, others?)	REFRAME	Where are current and planned roads located, and where do they overlap with CEs or other relevant habitat?
51	BLM	Development	What is the current status and impacts if any from military lands and what is forecast?	Separate and reframe. Define relevant impacts (to what?). Include closed sites?	REFRAME	Where are historic, current and planned military sites located, and where do they overlap with CEs?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
52	BLM	Development	Will there be a change in renewable energy opportunities? For example: Biomass, geothermal, wind farms, etc. And to what extent and where are these areas?		REFRAME	Where potential renewable energy sites located and where do they overlap with CEs or other relevant habitats?
Species (Responsible Party: AKNHP)						
54	CM	Species	Where are current locations of high priority species and habitat?	Redundant with 60. Agree at AMT1.	REDUNDANT	
55	CM	Species	How will extreme climate/weather events affect species?	Redundant with 62 Although note that climate change data is limited in Alaska (as compared with the lower 48). Don't lose concept of extreme events in Q62 (e.g., extreme ice over snow and loss of access to lichens). Agreed at AMT1.	REDUNDANT	
56	CM	Species	Are the assumptions that we have about how we're impacting these accurate?	Unclear exactly what this means. If the question is whether the climate can be trusted, then this will be discussed in the context of the analyses of specific questions. Agreed at AMT1.	PART OF METHODS DISCUSSION	
57	CM	Species	Are our mitigation efforts going to become ineffective as a result of climate change?	This is a research question beyond the scope of the REA. But agreed at AMT1 that this is a high priority monitoring/research issue that is fundamental to the whole REA effort. Need to develop a process/tracking for such research and data gap issues.	OUT OF SCOPE	
58	CM	Species	Are our assumptions about how quickly a species will recover accurate?	This is a research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
59	CM	Species	What are the thresholds for some species?	This is a research question beyond the scope of the REA. Determining thresholds (def: points beyond which ecological processes or trends are fundamentally different) are beyond the scope, but characterizing perceived climate/topographical envelope is an important first step - Covered in MQ65. Need to develop a process/tracking for such research and data gap issues. For which species might this be an issue? Include this in the planned list of RESEARCH ISSUES	OUT OF SCOPE, PARTIALLY REDUNDANT	
60	BLM	Species	What is the current distribution of each CE?	What is the current distribution of each CE? Karen Murphy is concerned that this reframing does not include the habitat issue included in MQ54. Note, however that this concern is addressed in MQ 65.	ACCEPT	What is the current distribution of each CE?
61	NS	Species		Clarify the meaning of "survey": inventoried for the presence of a CE.	NEW	What areas have been surveyed (i.e., inventoried) for each CE and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
62	NS	Species		CA overlap. Don't lose concept of extreme events in Q62 (e.g., extreme ice over snow and loss of access to lichens). USGS NOTE: USGS review wants to ensure that ALL the species questions include "any elements of uncertainty...not just data uncertainty by environmental uncertainty". Such issues would normally be part of the interpretation of any analysis. In some cases they will also be directly evaluated in the modeling, Task 3.	REFRAME	Where do current CE distributions overlap with CA?
63	NS			Standard CE climate envelope analysis, in which the climate current experienced by CE is compared to climate projections.	REFRAME	Where will the distribution of CEs and wildlife ranges likely experience significant change in climate?
64	NS	Species			NEW	Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?
65	BLM	Species	What is the current status of occupied habitat, including seasonal habitat and specialty habitat (calving, insect relief, etc.), and movement corridors? Current status compared to historical?	REFRAME: Create a definition (perhaps CE specific) of "status". Concern that seems too big of a task to do habitat envelop modeling for all primary Cues. Does a subset of CE need to be chosen for this MQ? This MQ, even as reframed to the right, will be difficult to answer. Can it be further REFRAMED and NARROWED? NOTE this is potentially redundant with MQ 86. Karen Murphy: <i>"a component of the original question that you are missing, that seems relevant to the REA, is documenting the seasonality of distribution/habitat use. For instance, to protect sockeye salmon you need to have appropriate spawning locations, over wintering locations with deep enough water, as well as passage to the ocean. All of your questions seem to lump "habitat" into one category which isn't"</i>	REFRAME	What is the current distribution of the suitable habitats for each CE? <i>[A subset of CE to be proposed in Tasks 2 and 3]</i>
66	54	Species	Where are habitats that may be limiting species sustainability?	Restored at AMT1. Originally thought to be a research question beyond the scope of the REA. NOTE this is potentially redundant with MQ 86. There is a core problem here in defining is an actionable way "sustainability". There may be a habitat that is limiting for migratory species. Need to restate – (TH) Are there aspects (or different components) of their habitats or use of habitats where there will be choke points? Need to investigate each species habitats and model which habitat components might be limiting. NOTE: CE distribution includes all major habitat components	REFRAME	What habitats are critical for species sustainability?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
67	CM	Species	Are species and habitats adequately monitored to assess climate change in the study area?	Monitoring is beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
68	BLM	Species	Where are change agents affecting this habitat and movement corridors?	Concern that seems too big of a task to do habitat envelop modeling for all primary Cues. Does a subset of CE need to be chosen for this MQ? USGS: "How many CEs will this apply to? Data? Seems only a few may have data available that are on BLM lands but are currently not on your core CE list (caribou and muskoxen)."	REFRAME	What CE populations and movement corridors overlap with CA? [<i>Propose subset of CE?</i>]
69	CM	Species	What CE populations and movement corridors are potentially affected by climate change?	Redundant with 68, 70, 71. Agreed at AMT1.	REDUNDANT	
70	BLM	Species	What are climate change impacts to wildlife habitat?	Redundant with 62, 64. Agreed at AMT1.	REDUNDANT	
71	BLM	Species	Is there expected loss of winter forage for caribou and reindeer? To what extent, where and what are the predicted trends?	Redundant with 72. Agreed at AMT1.	REDUNDANT	
72	BLM	Species	What are the predicted effects to moose habitat, specifically willow browse and what are the predicted trends?	We can't really address questions in moose browse, only potentially the general habitat associated with it. PK: Consider a similar question that is NOT restricted to climate change, but rather directed at other ecological (and social?) changes.	REFRAME	Where are moose, caribou and musk ox habitats likely to experience significant changes due to climate change?
73	BLM	Species	Is there a predicted increase in mosquito/insect populations and how will this affect the wildlife resources (insect relief areas)?	Provisionally restored at AMT1. Unclear how this would be addressed - are insect relief areas mapped? Possibly. It may be more tractable than it appears. An abstract of such a paper seemed to have pretty clearly identified the veg types and topographic position of such areas so perhaps we need to determine if the veg type (prostrate shrub) will be displaced and if expected future caribou distribution will still overlap it? Pose question to wildlife veterinarians	DEFER TO TASK 2	Is there a predicted increase in mosquito/insect populations and how will this affect the wildlife resources (insect relief areas)?
74	BLM	Species	Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?	Provisionally restored at AMT1. Delete or reframe as a report on existing publications. This may be a research question beyond the scope of the REA. Perhaps there is a straightforward way of addressing this but AMT would have to live with a pretty simplistic treatment.	DEFER TO TASK 2	Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
75	BLM	Species	What snowfall changes will occur and what affect will it have on wildlife (mobility, predation, habitat shifts)?	USGS: Suggests moving this MQ to Hydrology. Provisionally restored at AMT1. Delete or reframe as a report on existing publications. This may be a research question beyond the scope of the REA. Perhaps there is a straightforward way of addressing this but AMT would have to live with a pretty simplistic treatment. Karen Murphy: " <i>this is okay as long as you are including more than just snow depth. Icing events are important in winter mortality for many species. Not sure that there is enough information to get at either variable at this time.</i> "	REFRAME	What areas are predicted to experience significant changes in snowfall?
76	BLM	Species	What snowfall changes will occur and what affect will it have on subsistence	Redundant with 75. Agreed at AMT1.	REDUNDANT	
77	BLM	Species	What will be the effects of potential changes in nutrient availability on productivity for species?	This is very broad. It would require either speculation, or new data collection/extensive modeling. Also, impacts are likely to be species specific and impossible to generalize. Can it be stated in a more focused way? If not, delete for lack of data. Agreed at AMT1. Include this in the planned list of RESEARCH ISSUES	INSUFFICIENT DATA	
78	NS	Species	Where are potential areas to restore connectivity?	This will depend on modeling in Task 3 to define the relevant CE to focus on, and what to measure.	REFRAME	Which CE's are likely to be more vulnerable due to dispersal barriers?
79	BLM	Species	Where are potential habitat restoration areas?	Difficulty in defining what constitutes "potential" for restoration. Also, can this be narrowed to a subset of habitats (e.g., mining areas)? See also MQ 140 and coordinate analysis.	REFRAME	Given current and anticipated future locations of change agents, where will potential habitat enhancement/restoration locations likely occur?
80	BLM	Species	How will icing events affect habitat availability?	Provisionally restored at AMT1. Are icing event events predictable with current climate model? Papers may exist on this topic. DEFER to data discovery in Task 2. Where are increases in icing events predicted? Subsume with other extreme events issues, capture in conceptual models, and pursue as far as possible with any spatial modeling. Or look within the weather section. Include this in the planned list of RESEARCH ISSUES	DEFER TO TASK 2	Where are increases in icing events predicted?
81	BLM	Species	What are the highest priority species.	REDUNDANT. This is simply the CE list. Agreed at AMT1.	REDUNDANT	
82	BLM	Species	Where are species populations at risk?	Redundant with 62 and 63. Agreed at AMT1.	REDUNDANT	
83	BLM	Species	What/where is the potential for future change to species and populations?	Redundant with 62 and 63. Agreed at AMT1.	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
84	BLM	Species	How will these changes affect caribou and reindeer populations/migration patterns that rely on the lichens for winter habitat? With recent science concluding that musk ox are eating lichens now, how is this going to affect winter range availability for reindeer and caribou?	Reframe as a report on existing publications. This may be a research question beyond the scope of the REA. Narrow to Musk Ox and Reindeer, as discussed at AMT1. What would the potential effects be on reindeer and caribou where they overlap? PK: <i>"this question is lost – very much a non-vascular issue. This question is specifically related to the WACH caribou (and any reindeer) population and migration patterns tied to specific winter lichen habitat. Track and/or split"</i>	REFRAME	With recent science concluding that musk ox are eating lichens now, how is this going to affect winter range availability for reindeer and caribou?
85	BLM	Species	Are increased musk ox numbers the result of vegetation changes due to climate change or just lack of population management?	REDUNDANT or reframe as a report on existing publications. This is a research question beyond the scope of the REA. Agreed at AMT1. Include this in the planned list of RESEARCH ISSUES	OUT OF SCOPE	
Native Plant Communities (Responsible Party: AKNHP)						
86	NS	Native Plant Communities		We reduced most of the Native Plant Community questions down to the following primary questions, followed by the data sets needed to answer the question.	NEW	Primary MQ-1: What habitats support terrestrial species of concern (rare plants, rare animals, and subsistence species)?
87	NS	Native Plant Communities		We reduced most of the Native Plant Community questions down to the following primary questions, followed by the data sets needed to answer the question.	NEW	Primary MQ-2: How will these habitats likely change due to disturbance or climate change over the next 15 and 50 years?
88	NS	Native Plant Communities		We reduced most of the Native Plant Community questions down to the following primary questions, followed by the data sets needed to answer the question.	NEW	Primary MQ-3: Evaluate whether all species and ecosystems can be conserved within the conservation network of the study area over the next 15 and 50 years given climate change. This requires a standard GAP analysis.
89	NS	Native Plant Communities		Primary MQ-4: The monitoring of ecosystems and species are required for understanding their long-term conservation and ability to adjust to climate change. Agreed at AMT1.	OUT OF SCOPE	
90	BLM	Native Plant Communities	Where are intact CE vegetative communities located?	Need a working definition of "intact".	REFRAME	Where are high priority native plant associations? (i.e. rare associations or associations that support species of concern)
91	CM	Native Plant Communities	Develop baseline data to monitor habitat change (e.g., drying wetlands).	The deliverables may be able to serve as a collection of baseline data but collecting new baseline data is out of scope. Agreed at AMT1.	OUT OF SCOPE	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
92	BLM	Native Plant Communities	How are the lichens changing? Species, growth rates, acreage, location? How will Lichen communities or specific species adapt in relation to having long reestablishment timelines?	Redundant with MQ86 and 90. Also, the question as posed here seem to be research questions beyond the scope of the REA. However, a literature synthesis can be produced on this topic. PK: <i>could this not be performed with CA affects (as defined by particularly climate change) on the CE (as defined by native –non-vascular plant association) ??</i> " Include this in the planned list of RESEARCH ISSUES	REDUNDANT	
93	NS	Native Plant Communities	Where are the locations that most likely include the highest-integrity examples of each major terrestrial ecological system?	The entire area is largely untouched and so are mostly high-integrity. Agreed at AMT1 to be unnecessary.	AGREED TO BE UNNECESSARY	
94	BLM	Native Plant Communities	What is the location/distribution of sites/areas identified or designated for conservation?	Addressed in MQ 88	REDUNDANT	
95	CM	Native Plant Communities	When should plant communities be allowed to change as a result of climate change? Is there an acceptable rate of change?	This is a policy decision and out of scope of the REA.	OUT OF SCOPE	
96	BLM	Native Plant Communities	With respect to rate of change, will there be thresholds projected or tipping points that will occur for extensive vegetative shifts?	Redundant with MQ 100 (noticed by USGS in their remarks)	REDUNDANT	
97	BLM	Native Plant Communities	What/where is the potential for future change to these sites?	REDUNDANT. Addressed in MQ 88	REDUNDANT	
98	NS	Native Plant Communities	Where are intact CE vegetative communities located?	Redundant with 86 or 90.	REDUNDANT	
99	BLM	Native Plant Communities	Can tipping points be predicted?	REDUNDANT. This is part of 96. Community specific tipping are research projects beyond the scope of the REA.	REDUNDANT	
100	BLM	Native Plant Communities	How will the distribution of native flora and fauna communities change with climate change (shrub habitat replacing sedge/lichen communities, extent of anadromy, diversity, areas with highest potential to change)?	REFRAME as climate envelope analysis. Coordinate analysis with MQ 104.	REFRAME	Which native plant communities will likely experience climate completely outside their normal range?
101	NS	Native Plant Communities	Given anticipated climate shifts and the direction shifts in distributions, where are areas of potential habitat fragmentation?	Not applicable in these relatively undisturbed habitats. Agreed at AMT1 to be unnecessary. However, PK concerned that such process may affect corridors of movement.	AGREED TO BE UNNECESSARY	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
Reindeer Grazing						
102	BLM	Livestock	Where are the current populations of Reindeer?		ACCEPT	Where are the current populations of Reindeer? What is the current and historic herd size?
103	CM	Livestock	Will Reindeer grazing grow if caribou decline due to climate and other change agents?	Restored at AMT1. This is a research question beyond the scope of the REA. Can this be reframed somehow as an analysis of suitable Reindeer habitat in the absence of Caribou? DEFER to Tasks 2 and 3.	REFRAME and DEFER TO TASK 2	Will suitable habitat for Reindeer and caribou be available with climate change and how will these populations interact?
104	BLM	Livestock	With climate change, what may affect the reindeer grazing viability?	REFRAME Unclear what is meant by "grazing viability". USGS suggests that this is redundant with MQ100, but it will be retained here to explicitly include the grazing areas. Note however that the analysis should be done in tandem.	REFRAME	Where will current Reindeer grazing areas experience climate completely outside their normal range?
105	NS	Livestock			NEW	Where will current populations of Reindeer experience overlap with Change Agents?
106	BLM	Livestock	What are the impacts on the ecoregion from reindeer grazing (ecosystem, socioeconomic,)?	REFRAME. This MQ is too broad. How can it be narrowed, reframed, or separated into component parts? The focus should be on climate affects to reindeer not reindeer on grazing. A ton of work has been done on the Western Arctic Herd, by Brad Griffiths, et al. We need to synthesize it and figure out what to use here. Make sure the distinctions among the big grazers are clear. Karen Murphy: " <i>what about habitat changes (i.e. shrubification)?</i> " PK: " <i>Disagree – the question refers to the “ecological integrity” of the region and how the current reindeer grazing is affecting such. Could be redundant with 107 (there really is not that much grazing going on – there are real world MQs that have to be addressed with one area in particular that is currently being overgrazed) although the question as stated (106) looks at the entire system (integrity).</i> "	REFRAME	What are the impacts on ecosystem health from reindeer grazing?
107	BLM	Livestock	Are the impacts of overgrazing in certain areas accelerating the changes more than in areas that are not overgrazed? If so, what are these changes and how will they affect the health of the land and subsistence resources?	Can this question be addressed with current data? USGS comment questions whether it can be. The REA area is relatively undisturbed--no areas are significantly overgrazed currently. At AMT1 it was agreed that this MQ is unnecessary.	AGREED TO BE UNNECESSARY	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
Aquatic Ecological Function and Structure (Responsible Party: AKNHP)						
108	CM	Aquatic ecological function and structure	How will climate change affect our accessibility to these resources?	Redundant with 116-118	REDUNDANT	
109	CM	Aquatic ecological function and structure	How may this affect barge transportation to rural villages?	This is a research question beyond the scope of the REA. No data. PK wants the lack of data confirmed.	REFRAME and DEFER TO TASK 2	How may climate change affect barge transportation to rural villages?
110	CM	Aquatic ecological function and structure	Will climate change lead to different background levels for water quality?	This is a research question beyond the scope of the REA	OUT OF SCOPE	
111	CM	Aquatic ecological function and structure	Where are hazardous waste sites and how will climate change exacerbate pollution entering the environment?	The second half of this is a research question beyond the scope of the REA	REFRAME	Where are hazardous waste sites?
112	CM	Aquatic ecological function and structure	Will there be positive impacts of new fisheries / waterfowl moving into an area?	This is a speculative research question beyond the scope of the REA. OR, can it be addressed with existing data?	OUT OF SCOPE	
113	BLM	Aquatic ecological function and structure	Where are the regionally important aquatic values?	Need confirmation: Values = specific resources or locations?	REFRAME	Where are the important aquatic resources, such as spawning grounds and other fish habitats? (herring spawning grounds and areas used by waterfowl?)
114	BLM	Aquatic ecological function and structure	What is the condition of these various aquatic systems?	Create a definition of "condition" that is specific to the measurements/data that are available. KarenMurphy: <i>"which various aquatic systems? All of them? I don't think you can define condition in a meaningful way and score all aquatic systems in the time available. What about flipping this around and identify aquatic systems that have been altered by humans and assign a condition score related to naturalness?"</i>	ACCEPT	What is the condition of these various aquatic systems?
115	BLM	Aquatic ecological function and structure	Where are aquatic systems degraded (e.g., water quality)?	This is a subset of 114	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
116	NS	Aquatic ecological function and structure	Where are aquatic resources that will likely experience significant and abrupt deviations from normal flow regime or mean water levels?	No data are available. PK would like this confirmed in Task 2.	DEFER TO TASK 2	Where are aquatic resources that will likely experience significant and abrupt deviations from normal flow regime or mean water levels?
117	NS	Aquatic ecological function and structure		Is this MQ answerable with data in AK? Is it, in a practical sense, different from 116?	NEW	Where will aquatic resources likely experience significant and abrupt deviations from normal temperature regime?
118	BLM	Aquatic ecological function and structure	Essential Fish Habitat - How will these areas be affected by the predicted changes, and within what timeframes?	Who defines Essential Fish Habitat? Is this the same as "regionally important aquatic resources" from 113?	REFRAME	Where will Essential Fish Habitat likely experience significant and abrupt deviations from normal temperature regime?
Fire (Responsible Party: SNAP)						
119	CM	Fire	Is climate change going to change the periodicity of the fire regime?	Redundant with 129. Agreed at AMT1.	REDUNDANT	
120	CM	Fire	How will fires impact the permafrost?	This may be a research question beyond the scope of the REA. However, can answer in general terms with reference to the literature. DEFER to data discovery in Task 2 and modeling in Task 3. Restored at AMT1. USGS also wanted it restored.	DEFER TO TASK 2	How will fires impact the permafrost?
121	CM	Fire	What can be predicted about the severity of fires?	Can severity be predicted with available data? Redundant with 129. Agreed at AMT1.	REDUNDANT	
122	CM	Fire	How will fires affect sedimentation into nearby rivers?	This is a research question beyond the scope of the REA. Process that will be discussed in the future fire regime analysis. Data does not exist right now. Where will future increase probability of fire intersect with rivers? PK: <i>"This is a realistic reframed management question – data exists and analysis with river systems would be simple."</i>	DEFER TO TASK 2	Where will future increases in fire probability intersect with rivers?
123	CM	Fire	How will climate change affect fire suppression strategy? What impact will these changes (when looking at existing data) have on fire policies?	This is a policy and research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
124	CM	Fire	Will it change the volatility of future fires? How does this interact with permafrost structure and severity?	Redundant with 129. Agreed at AMT1.	REDUNDANT	
125	BLM	Fire	What are the specific vegetative (tundra) fire regimes within the ecoregion and what is the paleo fire history?	Redundant with 129 and 129.5. Agreed at AMT1.	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
126	BLM	Fire	What is the change in lightening strike frequency and distribution and subsequent ignition?	Suspect there is no existing analysis or publication. Lightning data is collected, but we aren't certain the extent of these data in space and time. Perhaps change the Q to say what is the relationship between strikes, ignition and something else. Rewrite is there a correlation between fire strike frequency and temperature –or – are we seeing an increase in lightning strikes? Restored at AMT1.	DEFER TO TASK 2	What is the known lightening strike frequency in the ecoregion? Do these data show a significant trend over time?
127	BLM	Fire	What is the effect from smoldering tundra fires?	This is a research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
128	NS	Fire	In places that have experienced fire, with and without permafrost, where does the resulting vegetative structure and composition differ from the desired state, and what changes with permafrost melt? (relates to tundra fires vs. wood)	SNAP: Right now, these data are not available. There may be past work done in the ecoregion on a very local scale (Lloyd & Fastie or Jorgenson). Agreed at AMT1.	INSUFFICIENT DATA	
129	BLM	Fire	Fire Potential – where are the areas of highest potential to change from historic and/or predicted wildfire patterns?	Paired with 129.5 Include both tundra and forest fires in this MQ. For the forested areas, SNAP can also project changes in coniferous vs. deciduous forests (e.g. early vs. late successional) and the changing age class distribution of the forest. Analysis includes severity. Karen Murphy: <i>"you lost the "high potential" component of the original question."</i> Scott Rupp: <i>"We've stated we will quantitatively compare historic and potential (as this is modeled data) future fire regimes. This analysis by definition will identify areas of highest change."</i>	REFRAME	What is the known fire history of the ecoregion and what is the potential future fire regime? What are the implications for vegetation?
129.5	NS	Fire		Paired with 129	SPLIT	What does the paleorecord reveal about fire history within the ecoregion?
130	BLM	Fire	Where are the areas with highest risks to caribou habitat? Calving sites/wintering range for caribou/musk ox/moose	This is essentially the question Kyle Joly aims to address in his PhD work. If BLM has maps of calving sites & caribou habitats, we could crudely assess the answer to this question by a simple overlay of projected fire regime & caribou habitat. We may also want to REDUNDANT this question because it is essentially a research question that will eventually be answered by Joly.	REFRAME	Where are areas of predicted high future fire risk associated with current caribou habitat, winter range, and calving sites?
131	BLM	Fire	What is the relationship with wildfire – especially forecasting habitat shift(s) related to changed fire regime ? Changes in burn severity.....	Redundant with 129. Agreed at AMT1.	REDUNDANT	
132	BLM	Fire	What is the risk to communities for wildfire and smoke?	REFRAME to relate proximity of communities to future fire risk. We will have to devise a working definition of "near existing communities" but this question can be answered using the ALFRESCO fire regime model.	REFRAME	What is the probability of fire, based on model scenarios, near existing communities?
133	BLM	Fire	Will the changes in fire regime and intensity result in rapid landform change (i.e. mass wasting)?	This question needs to be narrowed. As stated it is a research question beyond the scope of the REA.	OUT OF SCOPE	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
Invasive and Nuisance Species (Responsible Party: AKNHP)						
134	BLM	Invasive species	What affect will beetle populations have on fire regime and vice versa?	Moved from FIRE. This question needs to be narrowed. As stated it is a research question beyond the scope of the REA. Move to invasive species; where have recent beetle outbreaks occurred? Overlap with fire regimes. Restored at AMT1 as a narrower question.	REFRAME	Where have recent beetle outbreaks occurred?
135	CM	Invasive species	How is climate change going to affect invasive species?	Redundant with 138 and 139. Speices will be analyzed in this way if they are are CE or CA. It was agreed at AMT1 that it is impractical to speculate on all of the species that could potentially arrive in Alaska.	REDUNDANT	
136	CM	Invasive species	What will be the vegetational shift in invasive species?	This is a research question beyond the scope of the REA	OUT OF SCOPE	
137	CM	Invasive species	What is the current distribution of invasive species and what are the ecological affects in these areas? (mentioned: alder sawflies, a lot of zoonatics are becoming more prevalent (giardia, trichinosis, brucellosis, etc.)	Redundant with 138 and 139	REDUNDANT	
138	BLM	Invasive species	What is the extent of specific introduced and/or invasive species and what are the expected trends and forecast for invasive plant occurrence?	Separate current and future MQs. There are many potential invasive species; make sure the ones that are included as CAs are a tight list.	REFRAME	What is the current distribution of invasive species included as CAs?
139	NS	Invasive species		This needs to be a narrow and targeted list. It is easy to analyze non-natives known in the region, but which species might move into the region? There are infinite possibilities. Define a relevant list for analysis. Include the developing list in the list of RESEARCH ISSUES	NEW	Given current patterns of occurrence, what is the potential future distribution of invasive species included as CAs? [From narrow list of species that are CA.]
139.5	NS	Invasive species			NEW	Which CE's are likely to be most affected by invasive species
140	NS	Invasive species		Redundant with 79. Coordinate with analysis of that MQ. Requires working definition of "restoration potential. There should be specific definitions for each invasive species under consideration. We don't believe there are many, not to mention that "restoration" is most likely to introduce invasives. This can folded into the discussion during the writing stage.	REDUNDANT	What areas (significantly affected by invasives) have restoration potential?
141	BLM	Invasive species	Where are the areas of highest potential to change?	REDUNDANT or REFRAME Change in what? The resources that the invasive species affect? Also redundant with 139	REDUNDANT	
142	BLM	Invasive species	How will climate change affect invasive species-plants and insects?	Redundant with 139	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
143	BLM	Invasive species	What is the current status and forecast of invasives via straw and other use including river drainages? Subsequent impacts to moose wintering habitat	It is unclear what the MQ addresses. Can it be REFRAMED? Seems redundant with 139.	REFRAME	What are the known and likely introduction vectors of invasive species?
144	BLM	Invasive species	What is the risk for changing populations?	REDUNDANT. This MQ is accomplished in other MQ directed at CE and CA. There is no data on population parameters for most taxa.	REDUNDANT	
145	BLM	Invasive species	Eelgrass, weevils, native species range expansion or shifts due to changing conditions	REDUNDANT. These are not invasion species-related. Are the changing conditions referred to here climate change or invasive species? The specific taxa mentioned here can be included as CA or CE, so this question may be redundant.	REDUNDANT	
146	NS	Invasive species		REDUNDANT. This question is accomplished in the Species X CA overlap analyses.	REDUNDANT	
146.3	AMT1	Invasive species		AMT1 and USGS included discussion of beaver as nuisance species. Propose a MQ related to expansion of beaver and their potential effects.	NEW, DEFER TO TASK 2	What is the historic and current range of beaver?
146.4	AMT1	Invasive species		AMT1 and USGS included discussion of beaver as nuisance species. Propose a MQ related to expansion of beaver and their potential effects.	NEW, DEFER TO TASK 2	What are the potential impacts of beaver establishment on CEs, including subsistence species??
146.6	USGS	Invasive species		USGS comments included discussion of coyote as nuisance species. Propose a MQ related to expansion of coyote and their potential effects.	NEW, DEFER TO TASK 2	What is the historic and current range of coyotes?
146.7	USGS	Invasive species		USGS comments included discussion of coyote as nuisance species. Propose a MQ related to expansion of coyote and their potential effects.	NEW, DEFER TO TASK 2	What are the potential impacts of coyotes on CEs, including subsistence species?
Hydrology - Sea Ice - Weather - Permafrost -Soils (Responsible Party: SNAP)						
147	NS	Hydrology, Sea Ice, Weather, Permafrost, Soils		NOTE: SNAP cannot easily answer wintertime liquid precip with existing data sets. We do have monthly time step water equivalency estimates and can make crude estimates based on temperature - but would need daily averages of temperature NOT monthly. Discussed at AMT1.	NEW	What are the potential future climate scenarios in the ecoregion for temperature and precipitation?
148	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What is the annual extent of sea ice and changes in proximity to shore by date and how is this changing?	From SNAP's perspective, this question is un-answerable for the specific ecoregion given the available models/data. We may be able to address the question in a more general sense from a literature review. At AMT1 agreed to address the possibilities during Task 2.	DEFER TO TASK 2	What is the annual extent of sea ice and how is this predicted to change across the circumpolar north?
149	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	Where and how will river volumes change due to changes in climate?	This is analysis possible with existing data? From SNAP's perspective, this is an un-answerable question. Models/Data are not available. Agreed at AMT1.	INSUFFICIENT DATA	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
150	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What is the likelihood of increased liquid precipitation in winter?	Redundant with 147. SNAP cannot easily answer with existing data sets. We do have monthly time step water equivalency estimates and can make crude estimates based on temperature - but would need daily averages of temperature NOT monthly. Agreed at AMT1.	REDUNDANT	
151	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What areas will experience significant “decreases” (change to “departures from normal”) in precipitation? evapotranspiration? How does precipitation link to conservation element?	This is redundant with a various of other MQ, e.g., 147	REDUNDANT	
152	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What affect will salt water intrusion into fresh water have?	This is a research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
153	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	Monitor permafrost.	Monitoring is outside the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
154	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	How would the villages/communities deal with the effects of coastal erosion – what areas are in high risk for coastal erosion and sea level rise and what are the effects to coastal communities?	Separate "what areas at risk" from "how would they deal with". The second of these may be beyond the scope of the REA, or may depend on modeling in Task 3. How to deal with coastal erosion seems beyond the scope of the REA. From SNAP's perspective this is an un-answerable question as stated. Could maybe ask, "What is the likelihood coastal erosion will increase?" Can only ask in a general sense for the region.	DEFER TO TASK 2	What is the likelihood coastal erosion will increase within the ecoregion?
155	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	Drought – water balance issues?	As stated this is not a question. It is also redundant with a various of other MQ (e.g., 147) related to changes in precipitation. Agreed at AMT1.	REDUNDANT	
156	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What is the depth and extent of permafrost and how is this changing?	The data the Permafrost Lab at UAF have is likely restricted to borehole data which is only locally applicable. GIPL model scenario outputs are soil thermal regime (soil temperature and active layer depth) and not specifically permafrost dynamics (similar to MQ #20).	REFRAME	What are the current soil thermal regime dynamics for the ecoregion and how are these predicted to change in the future?
157	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	How will permafrost degradation and function affect vegetative and aquatic communities and to what extent? What will be permeability changes effects on water quality?	Separate and Reframe. As above and MQ #20. We can make crude assessments of future soil thermal regimes and ask what their association is with veg and aquatic communities - but this doesn't answer the question as stated.	REFRAME	Where are predicted changes in soil thermal regimes associated with important vegetative and aquatic communities?

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
158	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	How will permafrost degradation affect aquatic communities and to what extent?	To some extent this is a research Q beyond the scope. Also redundant with 157. Agreed at AMT1.	OUT OF SCOPE, PARTIALLY REDUNDANT	
159	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What communities/villages are at risk from permafrost melt?	Needs a definition (statistical or otherwise) of risk and what functional elements are at risk in the communities. To some extent redundant with MQ 20 so coordinate work.	REFRAME	Where are predicted changes in soil thermal regimes associated with communities/villages?
160	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What is the timeframe forecast for loss of land on the shoreline and hydrological resources in communities/villages, specific to each community as a result of permafrost melt?	This MQ is addressed separately in a variety of more specific MQ, e.g.. 156	REDUNDANT	
161	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What percent of lakes/ponds are expected to disappear with permafrost melt, and where are these changes expected? How will these hydrological changes affect water supply to villages and to wildlife?	Is this MQ answerable with data in AK? From SNAP's perspective - No. Agreed at AMT1.	INSUFFICIENT DATA	
162	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	What are the areas at high risk from river erosion? What are the effects of river erosion on resource values?	Is this MQ answerable with data in AK? From SNAP's perspective - No. Agreed at AMT1.	INSUFFICIENT DATA	
163	NS	Hydrology, Sea Ice, Weather, Permafrost, Soils	How will permafrost degradation affect water quality?	This is a research question beyond the scope of the REA. Agreed at AMT1.	OUT OF SCOPE	
164	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	YK Delta FWS. Data on contaminants in fish and marine mammals is needed (e.g., beluga is an important subsistence species for coastal communities).	This is a data gap, not an MQ. Also out of scope as a marine issue. Agreed at AMT1.	OUT OF SCOPE	
165	CM	Hydrology, Sea Ice, Weather, Permafrost, Soils	How will these hydrological and permafrost change affect water supply to villages?	Hydrological models are the 'holy grail' of the ecosystem studies. This question is un-answerable given the available models/data. Agreed at AMT1.	INSUFFICIENT DATA	
166	BLM	Hydrology, Sea Ice, Weather, Permafrost, Soils	How will the hydrology (ground water connectivity, permafrost, lake dehydration, change in precipitation quantity and season) be affected?	As stated this is a research question. Aspects of the MQ are redundant with a various of other MQ in this section related to changes in precipitation, e.g.. 17. Agreed at AMT1.	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
General Questions or Applicable to Several MQs (Responsible Party: Nature Serve)						
167	BLM	General questions or applicable to several MQs	What resource values are regionally important - Why are these values important?	REDUNDANT. Accomplished as part of CE distribution analyses in SPECIES, COMMUNITIES, and SUBSISTENCE sections	REDUNDANT	
168	BLM	General questions or applicable to several MQs	Where are these regionally important values located?	REDUNDANT. Accomplished as part of CE distribution analyses in SPECIES, COMMUNITIES, and SUBSISTENCE sections	REDUNDANT	
169	BLM	General questions or applicable to several MQs	What is their current status? Current status compared to historical?	REDUNDANT. Accomplished as part of CE distribution analyses in SPECIES, COMMUNITIES, and SUBSISTENCE sections	REDUNDANT	
170	BLM	General questions or applicable to several MQs	What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)?		ACCEPT	What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)?
171	BLM	General questions or applicable to several MQs	What is the status of populations and communities, and their dynamics and connectivity?	REDUNDANT. Accomplished as part of CE distribution analyses in DEVELOPMENT and SUBSISTENCE sections	REDUNDANT	
172	BLM	General questions or applicable to several MQs	What are the attributes and indicators of status?	This is a task for the modeling in Task 3.	DEFER TO TASK 3	What are the attributes and indicators of status?
173	BLM	General questions or applicable to several MQs	Where are regionally important aquatic ecological features, functions, and services?	REDUNDANT. See MQ 108-118	REDUNDANT	
174	BLM	General questions or applicable to several MQs	What/where is the potential for future change to habitats/communities/landscapes/ecological	REDUNDANT. See MQ in FIRE, NATIVE COMMUNITIES, various sections include climate change MQ.	REDUNDANT	
175	BLM	General questions or applicable to several MQs	What/where is the potential for future change in status of resource values from change agents?	REDUNDANT. See MQ in various specific sections.	REDUNDANT	

Number	Source	Group	Original Management Question (from Source)	Concerns/Issues	Summary Conclusion or Recommendation	Proposed Management Question
176	BLM	General questions or applicable to several MQs	What are the information/data gaps? What are the science needs?	This is not a MQ, but will be discussed in reports and memos.Create a running list of DATA GAPS and important RESEARCH ISSUES.	REFRAME	What are the information/data gaps? What are the science needs? What are important research issues?
177	BLM	General questions or applicable to several MQs	How will these areas be affected by the predicted changes, and within what timeframes?	REDUNDANT.See climate change MQ in many sections	REDUNDANT	

Appendix 2. Summary of Community Meetings

Seward Peninsula Rapid Ecoregional Assessment Community Meetings Detailed Summary

Organization of Summary

A general overview of the community meetings structure is presented on this page. The second section is input by theme, which is the bulk of this summary. Next is input about concerns and considerations on the Rapid Ecoregional Assessment (REA) research project. A list of the community participants is found at the end of this Appendix. Handouts provided at the community meetings included an overview of the project, a map of the study area, and a listing of conservation elements and other items that provide the organizational structure for this study.

Community Meetings Structure

Four community meetings were held to provide information about the REA process and get input from various organizational representatives that potentially will use the data and information resulting from the REA. The REA is structured as a collaborative effort to compile already existing data into new information sets and then to model possible changes land managers will need to consider for the future.

Participants

The community meetings were held the first two weeks of November 2010 in Fairbanks, Kotzebue, Nome and Anchorage. Thirty three people attended these meetings ranging from various federal and state agency representatives, university researchers, local government and native village, regional non and for profit organizations. A full list of participants is included at the end of this report.

Community Meeting Format

All but the Anchorage meeting were conducted in conjunction with a complementary initiative, the Landscape Conservation Cooperative (LCC). The REA provided a brief overview after the LCC presentation and discussion, to familiarize those participating about the purpose of the REA. The vast majority of the meeting time was spent reviewing draft or proposed management questions the Assessment Management Team (AMT) should address. The management questions were organized into the following categories:

- Subsistence
- Species
- Socio-Economic
- Development
- Fire
- Native Plants
- Invasive Species
- Aquatic Ecological Function and Structure
- Hydrology/Sea and River Ice/Permafrost/Weather/Soils

REA DETAILED NOTES BY THEME

Discussion on the proposed questions included additional questions that should be considered, input on data sources were identified, and discussion about gaps and baseline needs. For those who have color monitors or printers the color code used throughout this document is:

Black are MQ's presented by REA Team

Nome - Green

Fairbanks - Red

Anchorage - Purple

Kotzebue- Blue

Purpose of Management Questions

At the first community meeting in Fairbanks, those participating identified a need to connect the Proposed Management Questions with land managers' roles and their decision making purview. They identified proposed purposes for the management questions for each theme/category, which are also included in this summary.

Consultant's Comments about some of the proposed purposes are also included in the tables in an effort to help clarify what is within the scope of the Seward Peninsula REA and what isn't.

SUBSISTENCE

Data Sources/Comments

Fairbanks

- Project Jukebox developed/managed by UAF is a possible data source.
- Data will be difficult to obtain.

Kotzebue

- SNWR has been flying and documenting beaver activity.
- Cape Krusenstern (NPS) did a lot of research on fishing in that area, including fish behavior, migration patterns, local uses, etc.
- There was a big thaw slump near the sheefish spawning areas. SNWR has been monitoring spawning populations for a long time.
- NW Arctic Borough has their zoning plan on line, which may be a good data source.
- NANA might have some maps and information on line too.
- Bob Uhl would be a good source to learn more about white fish and local use.

Nome

- Fish and marine mammals are king for subsistence species; land mammal resources seem really important, but it's a small part - surveys show only 12% from land mammals.
- Community subsistence surveys have been conducted by subsistence unit at ADF&G.
- Blueberries are important.
- The desire for musk ox and moose in the community exceeds its availability. 150 of the 175 harvested musk ox are for subsistence—25 are permit draws.
- Stakeholder groups have recognized the importance of TEK related to the NW Arctic caribou herd, but data collection and use is in its infancy.
- Cultural can mean two things with the NPS: Anthropology and TEK

Anchorage

- Some subsistence data has been collected in communities; contact Jim Simon (Fbks ADF&G regional manager)
- Harvest use - ADF&G would be a good source.
- Clarify the term subsistence, from the Alaska standpoint.
- Subsistence data and collection should be one of the themes of the State-of-the-Science meeting.

General Observations/Comments on Climate Change

Fairbanks

- Ice on snow surface affects caribou ability to eat.

Kotzebue

Animals:

- Beaver are expanding; considered invasive by locals. Giardia, affect fishing—dams possibly preventing fish from getting to their spawning grounds.
- Bears are becoming more numerous and create problems. Black bears and 2 yr old grizzlies are sometimes taken for subsistence. Polar bears are coming into villages.
- Most important subsistence species: Caribou, moose, fish, birds, sourdock, berries, telocki (tea).
- Coyotes have just shown up recently and should be viewed as pests.
- Wood bison are not recognized as food; we put up with musk ox—they were not introduced for subsistence.
- Moose probably got harvested more this year because of the late (and different) caribou migration.

Fish:

- 4th of July is usually when we fish for whitefish, but they came in the middle of June this year.
- Salmon were late. Also fish for sheefish and trout. Sheefish were late this year.
- Fishing occurs all year long, including pike, smelts, herring, grayling.

Utilization of Subsistence Species:

- Animals and plants that are used for clothing; e.g., furbearers, beachgrass for basket weaving.

Subsistence/Purposed Purpose: Provide data for managers to make sound decisions about ensuring 1) abundance of harvestable resources, 2) distribution of harvestable resources, and 3) harvester access. (Based on ANILCA Section 810 these are the three factors regularly mentioned that Federal Agencies are required to support.)

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Questions from REA Team

- What is the current distribution of subsistence species?
- How will climate change affect their range?
- How will range and use change?

Additional Comments and Questions from Fairbanks

- Comment: There's high variability and may not be easy to identify.
- Are peoples' subsistence needs being met? How, where, how many, etc.? and how will change affect?
- How do we adequately provide for subsistence needs (e.g. with Special seasons, restrictions)?
- Do use authorizations impact access, availability and/or distribution of harvestable resources?
- Comment: Assumes climate change will affect their range.

Additional Questions from Anchorage

- We need to know more about what the species are and their use patterns. And how is this changing? How could **access** to subsistence resources change?

SPECIES

General Observations/Comments on Climate Change

Fairbanks

- In Nulato Hills more shrubs have been seen.
- Ice on snow surface is affecting caribou's ability to eat.
- In Selawik and Arctic Refuges - sightings of polar bears along the coast are more frequent.
- Fish runs are a concern.

Kotzebue

- One potential indicator of change is that hunters have found seal blubber in walrus stomachs.

Nome

- An extreme event that has big impacts is rain on snow. Impacts caribou, ptarmigan--starvation. These events are happening more frequently. What will the impacts be on nesting birds?
- Shrub invasion is poorly documented. Increasing shrubs could increase fire frequency which would decrease caribou forage. Need to find a flagship species or iconic images or concepts in the beginning of the process that highlights the importance and urgency of the issue.

Data Sources/Comments

Kotzebue

- Western Arctic Caribou Herd Working Group is a credible source for data
- TEK projects concerning whitefish; Alex should have this type of community harvest data with a 3-year harvest survey. This is about implementing TK, not gathering TK; practical application of TK is what we try to focus on.

Nome

- Charlie Lee works for Norton Sound and would have good information on the fish resources here/Nome.
- Dave Ryland at F&G would have information on perched culverts.
- NPS Arctic Inventory and Monitoring is coming up with a protocol for lagoon (bird) monitoring.
- Peter Bente has data for birds of prey and use of area.
- ADF&G has a lot of data, but may not be available electronically, e.g. caribou telemetry.

Species: Questions and Comments

Nome

- Burbot, sheefish, smelts, pike are other important subsistence fish.
- Ice edge location and timing can significantly affect the timing of migratory birds; fish are spawning limited.
- MaKays Buntings are showing up at restoration projects where reseeding has been done.
- Higher insect numbers (mosquitos, gnats) are being observed.
- We know the least about predators (wolves) and how they relate to prey species.
- Brown bear numbers and harvests have increased over the years. Density reports are mostly anecdotal.
- Microtines are important and easy to monitor, but the larger megafauna gets all the attention.
- Rough-legged hawks have been surveyed and over the years there have been three events where their numbers dropped, but it was not investigated as to why.
- In 2009, short-eared owls (species of concern) were radio-tagged, and high number of microtines led to a high density of owls.
- Moose weren't present on the Seward Peninsula 50-60 yrs ago. Within the last 10 yrs both moose and musk ox have been recognized as good subsistence food.
- Cottonwood trees at Serpentine Hot Springs weren't there before; also increasing beaver activity has been noted.
- Migratory birds would be a good flagship species as would fish or marine mammals.
- Better knowledge of use by the NW Arctic Caribou Herd and habitat change would be helpful information to have. Caribou populations run in cycles. There is a concept that caribou populations are like the tides in the oceans, there is nothing we can do about it.

Beyond Scope of REA

Kotzebue Comments

- Western Arctic Caribou Herd – there is disagreement about how human impacts affect the caribou herd. Need better information about behavior/migration from Traditional Knowledge. Need to take a social network approach – caribou are different, they communicate with each other, some are better feeders, etc. Do the better feeders know something about rangeland that we don't? Social Network Analysis needs to be done.
- Need a clearinghouse/coordinator for community research. Community's involvement in research efforts is very important. SNWR has been inundated with climate researchers recently. Coordination

at the local level needs to be more systematic. (This might be best through the Borough, or a local organization.)

Anchorage Comments

- Health concerns of subsistence foods; How adaptive species are, and Ecosystem services are all beyond the scope of the REA.

Species/Purposed Purpose: (these are also applicable to the Development theme) - Provide data so managers can make sound decisions about whether or not STIPs and normal mitigation measures will be effective given anticipated changes - whether from climate or other change agents. - Provide data so managers can make sound decisions about harvesting for subsistence, sport and commercial uses, enabling managers to continue to provide the same level of opportunity. <i>REA Team Comment: the second item above is likely outside the scope of their contract as it appears to be a short-term focus.</i>
Proposed Management Questions - Additions and Comments Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple
<u>Management Questions from REA Team</u> - What is the current distribution and habitat of each conservation element? (should be available soon from USGS) <u>Additional Questions from Fairbanks</u> - Are the assumptions that we have about how we're impacting these accurate? - Are our mitigation efforts going to become ineffective as a result of climate change? - Are we striking a good balance between development activities and habitat protection? And how do we do that?
<u>Management Question from REA Team</u> - How will species adapt to changing environments?
<u>Management Questions from REA Team</u> - Where are change agents affecting their habitat and movement corridors? - Where are potential habitat restoration areas? (Are there any? - presumes there are.) - Where are habitats that may be limiting species sustainability? - Where will critical wildlife habitat experience climate completely outside its normal range? Specifically, calving areas, wetlands, migratory stopover, etc. <u>Additional Question from Fairbanks</u> - Are our assumptions about how quickly a species will come back accurate? <u>Additional Question from Kotzebue</u> - What are the thresholds for some species?
<u>Management Questions from REA Team</u> - How will climate change affect conservation element ranges? - What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region and where are data gaps? <u>Additional Question from Fairbanks</u> - How will extreme climate/weather events affect species? (Rain on snow)

Additional Questions from Kotzebue

Pollution:

- Blueberry/ptarmigan link and lead contamination?
- How does ocean acidification affect species?
- How is all the plastic on the beaches of Kobuk Lake (and elsewhere) affecting?

Management Questions from REA Team

- How does water quantity and quality change?

SOCIOECONOMIC

Anchorage Comment

- This theme isn't broad enough/emphasized enough for the changes that population demographics can bring.

Data Sources/Comments

Fairbanks

- UAF: Working on models that will link climate to permafrost – not complete yet – many uncertainties. They have model with a 2x2km res. on SNAP. Ground ice information is very limited.
- UAF: Recreational Sciences in SLARM maybe a good data source.
- Looks right now like disappearance of lakes under a warming scenario will outweigh increased lakes with disappearing permafrost.

Kotzebue

- NOAA
- is currently looking into coastal erosion.
- NANA has community maps that may show sewage lagoons/dump sites; Village Safe Water; ANTHC possibly; DEC-Contaminated Sites should have FUDS sites mapped.
- Selawik Lake harmful (toxic) plankton blooms; Alex at the Borough collected samples and had them identified.
- Alternative Energy: NANA, Matt Bergan, Sonny Adams, Brad Reeves (KEA), and Rich Seifert (UAF Coop Extension) who it was believed has a demonstration home in Kotzebue.

Nome

- 2 GAO reports regarding coastal erosion affecting Unalakleet, Shaktoolik, Golovin, Shishmaref are available.
- DCCED/DCRA and Office of Homeland Security have coastal erosion reports.
ervin.petty@alaska.gov
- Remote sensing work may be able to show the extent of water level changes in lakes.
- Each village gets their water in different ways; Village Safe Water would be a good source of info.
- If the Coast Guard comes here there may be a housing shortage.

Anchorage

- L. Alessa (UAA) and Peter Schwietzer at UAF have been collecting information on water use in villages. (mainly perception data)

General Observations/Comments on Climate Change

Fairbanks

- Permafrost loss – need more information; lack data.
- Very small scientific community studying permafrost. Permafrost changes are locally specific. There is a lot of permafrost data in the North, not so much in the South for the Seward Pen region. Big data gaps regarding permafrost. Local knowledge will be very important.
- Patterns of resource use will change as conditions dry, etc. Incorporating social science is going to be key. You (already) can fly and 4-wheel to places you haven't been able to in the past.
- Hydrology around the villages—melting permafrost and associated increasing motorized access will also be important.

Kotzebue

- The land upriver from Noorvik is being eroded by the Kobuk River.
- Two lakes behind Noorvik have dried up recently, but it's hard to see other changes because they're happening slowly.
- Algae growth on fish in nets.
- Selawik Lake has had some harmful (toxic) plankton blooms.
- There used to be reindeer herders in the area, but they are all gone now. Some of the reindeer have shorter legs, and some people think they are better to eat.

Nome

- Through survey data they see evidence of drying lakes.
- Lakes across the landscape vary in clarity.

Socio Economic Links to Species/Habitat

Nome

- Birding is an emerging tourism industry. The first cruise ship that came through the NW passage docked here.
- Sea wall and port will have to be developed to have the coast guard here. This is the deepest port this far north.
- Harbor reconstruction efforts are underway, which affected the Sanke River estuary.
- Iditarod is a big tourism boost for the community.
- Biking, camping, and other tours are also increasing—people who spend more time and possibly \$
- The reindeer industry is in a steep decline, but is cyclical.

Beyond Scope of REA

Kotzebue

Need for local ownership of resources and permits, some voiced the need for income and job data for tourism; leakage is high for tourism jobs.

Socioeconomic/Proposed Purpose: Provide data so managers can make sound decisions about balancing habitat protection with anthropomorphic activities, given climate and other change agents.

REA Team Comment: it would be useful to know what types of activities and decisions.

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Additional Question from Kotzebue

- How will changes in fuel prices affect subsistence, tourism, guiding, development?

<u>Management Questions from REA Team</u> - What are patterns of current tourism/guiding/angling (e.g., total revenue, total visitors, types of tourism)? - Where will the tourism industry experience significant (and relevant) changes in climate?
<u>Additional Questions from Fairbanks</u> - Will there be positive impacts due to climate change? - What are potential increases in economic activities due to change agents?
<u>Additional Question from Kotzebue</u> - What's the possibility of other salmon moving into the area as a draw for increased tourism?
<u>Additional Question from Anchorage</u> - What are current/projected population demographics?
<u>Management Questions from REA Team</u> - What areas will experience significant coastal and river erosion, and which of these will threaten villages? - Increase or decrease to transportation corridors?
<u>Additional Question from Nome</u> - How will storm surges affect infrastructure? (Road to Council significantly eroded due to surges.)
<u>Management Question from REA Team</u> - Which communities/villages will experience significant permafrost melt? Over what timeframes?
<u>Additional Questions from Fairbanks</u> - What are the implications for infrastructure given permafrost melt? - What's the viability of rural communities, given changes?
<u>Management Question from REA Team</u> - Where are lakes/ponds expected to disappear as a result of permafrost melt? (likely can't answer - p/ V. Romanovsky)
<u>Management Question from REA Team</u> - Where will losses of lakes/rivers significantly affect water supply to villages?
<u>Additional Question from Nome</u> - How will Moonlight springs—be affected by climate change (main water supply to Nome)?
<u>Additional Question from Kotzebue</u> - How will changes in water levels affect villages (e.g., Upper river villages are having a tougher time getting fuel barges up because the water is too low.)
<u>Management Question from REA Team</u> - Where will losses of lakes/rivers significantly affect important wildlife and other conservation elements?

Management Questions from REA Team

- Where are the current populations of Reindeer? (data available soon/only species need a permit for grazing)
- Where are areas of current overgrazing by Reindeer? (Anchorage comment: Overgrazing not an issue; perhaps What are/ will be grazing needs?)
- Where are areas of current overgrazing because of the existence of other change agents, causing the potential for accelerated change?
- Where will current populations of Reindeer experience significant effects of change agents, including climate change, that are completely outside their normal range?

Additional Question from Fairbanks

- Will Reindeer grazing grow if caribou decline due to climate and other change agents?

Additional Questions from Kotzebue

- How do sewage lagoons, wastewater systems, dumps, FUDS/dewline, other hazardous sites, and air pollution impact species/habitats?

DEVELOPMENT

Comments on REA Model/Research

Fairbanks

- It's important to cross management boundaries to address changes.

Kotzebue

- We need to keep and consider subsistence within the context/definition of ANILCA, the Tribes and the Federal government's definition.

Data Sources/Comments

Kotzebue

- Land Use Plans for the agencies should indicate plans for future development.
- Unmanned aerial vehicles will soon be used to manage wildlife population, then keep an eye on my hunting practices. They are using them for fires and BP is using them to monitor species on the North Slope.

Nome

- Data layers from DNR are available; transportation - DOT may have.
- The open season for the Nome port is getting earlier in the spring and later in the fall.

Subsistence Comments

Kotzebue

- We're the only place in the country that has a truly subsistence lifestyle; and guides and transporters are given priority, shutting out the local interests.
- We don't want to be involved in the industry of bringing outsiders to help harvest their subsistence resources.

FIRE

General Observations/Comments on Climate Change

Fairbanks

- Fire frequency and severity has changed over the recent years. Nulato Hills has seen more shrub.

Nome

- 6000 acres burned in NPS this year.

Data Sources/Comments

Nome

- Kyle Joly at Gates of the Arctic would be a good source on tundra fire histories.

Anchorage

- Fire management report will be coming out looking at data for the Nulato Hills

Fire/Proposed Purpose: Provide data so managers can make sound decisions about how much fire over a defined period of time can be tolerated without having intolerable impacts to habitats, e.g., caribou habitat. This should include data about extreme fires and the severity of that impact.

REA Team Comment: This seems short-term focused and likely outside the scope of the contract.

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Question from REA Team

- What areas have experienced significant (1000+ acres as defined by availability from earlier records) fire?
- What areas have high fire potential?

Management Question from REA Team

- Based on climate models, what areas will have increased or decreased fire danger?

Additional Questions from Fairbanks

- Is climate change going to change the periodicity of the fire regime?
- How will fires impact the permafrost?
- What can be predicted about the severity of fires?
- How will fires affect sedimentation into nearby rivers?

- Where do areas of high future risk for fire overlap with current caribou habitat and calving sites?

Additional Questions from Fairbanks

- Are there areas / issues with increased sedimentation?
- At what point should we be thinking about managing for moose rather than out caribou?

Management Question from REA Team with additions from Fairbanks

- Which villages are near predicted areas of future fire risk?
- In places that have experienced fire, with and without permafrost, where does the resulting vegetative structure and composition differ from the desired state, and what changes with permafrost melt? (relates to tundra fires vs wood)

Additional Questions from Fairbanks

- How will climate change affect fire suppression strategy? (added by Anchorage: What impact will these changes - when looking at existing data - have on fire policies?)
- Will it change the volatility of future fires? How does this interact with permafrost structure and severity?

NATIVE PLANT COMMUNITIES

Climate Change/Comments

Nome

- There's not much we can do—what happens happens; except for fire suppression, but that is expensive.
- When should we use fire suppression to protect habitat?

Native Plants/Proposed Purpose: Provide data so managers can make sound decisions about conservation and adaptation strategies so they can be developed based on predicted changes due to climate and other change agents.

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Questions from REA Team

- For areas designated for conservation (National Parks, Wilderness, etc.), how well do they represent all species and ecosystems for the Ecoregion?
- How will climate change affect the conservation areas' ability to support all species and ecosystems within the Ecoregion?

Additional Questions from Fairbanks

- What will be the vegetational shift in communities?
- When should plant communities be allowed to change as a result of climate change? Is there a rate of acceptable change?

Management Questions from REA Team

- What's the value of a plant community?

INVASIVE SPECIES

Data Sources/Comments

- Kotzebue: Check with Alex Whiting (Native Village of Kotzebue) he wrote paper on coyotes.
- Beavers were identified by both Kotzebue and Nome community participants as invasive.
- Nome: Need to differentiate between new invasive species and where no survey was done for invasive species.

Anchorage:

- Need to clarify invasive vs range expansion.
- State & Private Forestry has useful data.

Comments

- Kotzebue: If new port is developed, ballast water may be a vector. Rats could also be introduced.

Invasive Species/Proposed Purpose: Provide data so managers can make sound decisions about how invasives access habitat communities, which will provide information about what procedures could prevent their introduction. *REA Team Comment: This would be a research project outside the scope of the contract.*

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Question from REA Team

- What is the current distribution of invasive species and what are the ecological affects in these areas? (Kotzebue mentioned: alder sawflies, a lot of zoonotics are becoming more prevalent (giardia, trichinosis, brucellosis, etc.))

Management Questions from REA Team

- Given current patterns of occurrence and expansion, what is the potential future distribution of invasive species?
- What are the known and likely introduction vectors of invasive species?
Additional questions from Fairbanks
- How is climate change going to affect rare and invasive species?
- What will be the vegetational shift in species?
- When should plant species be allowed to change as a result of climate change? Is there a rate of acceptable change?
- Will our revegetation /mitigation strategies need to change?

AQUATIC ECOLOGICAL FUNCTION AND STRUCTURE

Data Sources/Comments

- Anchorage: ADF&G just published a document that addresses first question in second row.

Aquatic Ecological Function and Structure/Proposed Purpose: Provide data so managers can make sound decisions about changes or extensions of anadromous ranges, given “new normal.” *REA Team Comment: Don’t know if identifying extensions is feasible outside of a detailed research project.*

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Questions from REA Team

- Where are the important aquatic resources, such as spawning grounds and other fish habitats?
(Kotzebue added: herring spawning grounds and areas used by waterfowl?)

Additional question from Anchorage

- Will there be positive impacts of new fisheries / waterfowl moving into an area?

Management Questions from REA Team

- Where will climate change affect these important aquatic resources?

Additional questions from Fairbanks

- How will climate change affect our accessibility to these resources?
- Are the extremes in the ranges likely to change?

Management Questions from REA Team

- How will climate change affect these important aquatic resources? Water temperature, flow rates, etc.

Additional questions from Fairbanks

- How may this affect barge transportation to rural villages?
- Will climate change lead to different background levels for water quality?
- Where are hazardous waste sites and how climate change exacerbate pollution entering the environment?

HYDROLOGY - SEA ICE - WEATHER - PERMAFROST - SOILS

Data Sources/Comments

Fairbanks

- UAF Permafrost Lab is working on models that will link climate to permafrost – not complete yet – many uncertainties. They have model with a 2x2km res. on SNAP.
- Ground ice information is very limited.
- Looks right now like disappearance of lakes under a warming scenario will outweigh increased lakes with disappearing permafrost.
- Three of the lowest minimum ice years have been in the last four years.

Kotzebue

- Data Needs: SNWR is looking at the extent of the permafrost in this region. Having a better understanding of this would be useful.
- Good information on topography (like LIDAR) would help attract researchers to do more work up here.
- Sea level change modeling.

Nome

- Baseline information exists about the success of fertilization in Salmon Lake. Lorna Wilson's thesis; Charlie and Jim Minard also have access to the info.
- GINA will have fish data access soon.
- AWC is on-line and Joe Buckwalter is a contact at F&G for that.
- A big data gap is spacial data—Nome is a complicated landscape with land ownership.
- No baseline—big concern about coastal marshes/lagoons are changing. We've missed the chance to capture the baseline.

General Observations/Comments on Climate Change

Fairbanks

- Hydrology will change because of permafrost loss.
- Climate and weather data is much easier to obtain compared to permafrost. Local knowledge will be very important.
- What are the gaps/needs for climate data? (NOAA)
- Changes in hydrology in relation to fish habitat are a concern. Also, hydrology around the villages—melting permafrost and associated increasing motorized access. (ADF&G)
- NOAA terminology usage: "Climate" is used for anything over 14 days; anything less than that is "weather".

Kotzebue

- Hunting on sea ice—have adapted to hunting on rotten ice (Blossom).
- There were ice jams in Buckland this year that caused a lot of damage.
- Rain on snow can really harm caribou and musk ox.
- More extreme events are predicted which are lost in the SNAP predictions which just use averages.
- Some communities, like Kotz, with water supply lakes, could be in trouble if melting permafrost causes water supply lakes to drain.
- Melting sea ice is a big problem for walrus.
- River ice could be important for a number of reasons. Anything from travel, to flooding at ice out.

Nome

- Changing thawing patterns and flushing events can have an impact of the fish ecology (grayling, salmonids)

- Changing climate can also create habitat that is suitable habitat for other salmon species.
- There isn't a stream near Nome that hasn't been affected by mining, but the Nome River has shown signs of recovery, at least in places.
- Changing temperature profiles in the lakes could change salmonid development dramatically.

Hydrology - Sea Ice -River Ice- Weather - Permafrost-Soils/Proposed Purpose: Provide data so managers can make sound decisions about changes from "normal". "Normal" needs to be defined. + include soils.

Proposed Management Questions - Additions and Comments

Fairbanks Red, Kotzebue Blue, Nome Green, Anchorage Purple

Management Questions from REA Team

- What areas will experience significant "decreases" in precipitation?
- Fairbanks comment: Change "decreases" to "departures from normal"

Additional questions from Anchorage

- Add: and evapotranspiration after precipitation
- How does precipitation link to conservation element?

Management Questions from REA Team

- Where will important aquatic communities experience significant (change) degradation due to permafrost change?

Management Questions from REA Team

- Where will changes (delete: in permeability potential) affect water quality?

Management Questions from REA Team

- What is the annual extent of sea ice and changes in proximity to shore by date, and how is this changing?

Additional question from Fairbanks

- Where and how will river volumes change due to changes in river and sea ice?
- How will lack of sea ice impact subsistence hunting, e.g. make more dangerous / easy; increase / reduce deaths? (polar bears on land, higher waves, etc.)

Additional question from Fairbanks

- What is the likelihood of increased liquid precipitation in winter?

Management Questions from REA Team

- What affect will salt water intrusion into fresh water have?

Concerns and Considerations about the REA Model/Research Project

The following are concerns expressed by participants at the meetings for the overall project.

Colored text is used to provide a flavor of the conversation in each location:

Fairbanks Red, Kotzebue Blue, Nome Green, and Anchorage Purple

Fairbanks Comments

- 1) AMT should prioritize Proposed MQ's based on Management Decisions agencies are responsible for.

Consultant's comment: Agree, but need to distinguish between short term management questions vs long term which is more about strategies and RMP activities, not seasonal plans.

- 2) It's important to get others' input as these questions have come mostly from BLM.

REA Team Comment: Purpose of community meetings and a multi-agency Assessment Management Team, who will made the final decisions about the specific focus for the data compilation and modeling for future scenarios.

- 3) Need to bound, define terms in MQ's; e.g., timeframe, species, geographic area.

REA Team Comment: Geographic area was defined in the RFP/contract, as was the timeframe (2060) and species.

- 4) How will this project take into consideration change that has occurred vs change that is predicted?

- 5) In general, the MQ's assume change will occur; and infer that change will not be good.

REA Team Comment: The project is about predicting changes and assessing effects. Is this a concern that the MQ wording sounds loaded? If so, should talk about.

- 6) The group should find common ground and work from there.

- 7) Climate change is going to bring about more extreme events, how do the MQ's address this?

REA Team Comment: Extreme events are fairly impossible to predict.

- 8) Climate change will impact other change agents - need to account for this.

REA Team Comment: Need examples, but this is true and also nearly impossible to predict.

- 9) Are the MQ's/primary focus of the REA for terrestrial or aquatic?

REA Team Comment: This is identified in the scope of work.

- 10) Are there new tools, e.g., information technologies/models, to help predict changes and impacts?

- 11) NPS and BLM have completed recent land use plans - they maybe useful + TNC plans/data.

REA Team Comment: Yes those should be assessed as scenarios.

- 12) May get better information from others, e.g., native organizations may have subsistence data they are willing to share.

Kotzebue Comments

- 1) Can NatureServe's vulnerability index be applied to the concern about plastics in habitats?

- 2) Focus on the really critical elements of the model to get at future distributions.

- 3) Agencies in the lower 48 paradigms take root up here inappropriately. Managers make decisions that have bad repercussions for subsistence users. Need to reinvent the wheel when it comes to managing subsistence needs.

Nome Comments

- 1) An indicator species approach or an index approach have much less data gaps (e.g. Caribou, moose, musk ox), much more gaps in other species. Why not focus on these indicator species and try to get a handle on the vast amount of information that is available. You get better efficiency out of your effort with this approach.

- 2) Monitoring a number of related species and how they are related might make more sense than monitoring single species by themselves.

Anchorage Comments

- 1) There are some broad assumptions in models—how things will change—models should also focus on how adaptive a species may be; this should be built into the process. A management question is: *How will species adapt to changing environments?* A good example is walrus—walruses will probably adapt by moving onto shore. A lot of the modeling focuses on vulnerability, but don't take into

account adaptability of species. We should keep in mind, this may go beyond the scope of REA. Maybe getting clarity on the research questions related to this would be something that the REA could inform.

- 2) Restoration - How you define the goal (protecting things as they are now, v. protecting healthy ecosystems) is important. Is it adaptation, status quo, function?
- 3) Managing for healthy ecosystems is the important goal.
- 4) What about function (ecosystem services?) been a consideration here? A: Not in REA
- 5) How caribou populations would be impacted would be tough to model, with such high variability.
- 6) We need to be clear about certainty/uncertainty.
- 7) How can/should TEK be used?
- 8) 50 years out is too far; need to focus nearer term -15 years
- 9) Differences between the work in the lower 48 and here—many offices down there are a smaller part of a larger ecoregion—opposite in Alaska.
- 10) Need to make sure that socio-economic and demographics are given enough emphasis as a change element.
- 11) Climate change studies may eclipse the socio-economic / development aspects of the future, that could have just as significant impacts.

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Appendix 3. Proposed Core and Desired (in italics) Terrestrial and Aquatic Fine-Filter Conservation Elements.

Conservation status (NatureServe Global and State Ranks, State, and Federal), identification of the conservation element in the original scope of work (SOW), habitat associated with the elements, and notes are included.

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
SPECIES ASSEMBLAGES							
<i>Critical Fish Habitats</i>					SOW		<i>Subsistence importance -Likely unidentifiable</i>
<i>Marine Mammal Haul-Out Sites</i>					SOW		<i>Subsistence importance</i>
<i>Migratory Bird Habitats</i>					SOW		<i>Important for rare species</i>
<i>Raptor Concentrations</i>					SOW		
<i>Seabird colony sites</i>					SOW		<i>Important for rare species. Habitat for example, coastal cliffs at Cape Deceit</i>
ANIMALS							
Birds							
Aleutin Tern	G4	S3B	Nominee Species			Estuary & Lagoon; in sea bird colonies	Uncommon breeder on Seward Peninsula; declining
Arctic Peregrine Falcon	G4T2	S3B	Nominee Species			Alaska Arctic Bedrock and Talus, Major River	
Bar-tailed Godwit	G5*	S3B	Nominee Species			Alaska Arctic Polygonal Ground Wet Sedge Tundra, Alaska Arctic Dwarf-Shrubland	Common breeder in the region; declining *Global status debated.
Black Scoters	G5	S3S4B SCS4 N					USGS suggests declining population, furthest north nesting population, suggested by USGS

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
							reviewer to be included
Bristle-thighed Curlew	G2	G2, S2B	Nominee Species		Sensitive Species	Alaska Arctic Shrub-Tussock Tundra	Small population, 40% global pop. Breeds on Seward Peninsula
Common Eiders	G5	S3S4B S3N					FWS species of concern, unique habitats at Espenburg; suggested by USGS reviewer to be included
Emperor Goose	G3G4	S3S4			Sensitive Species	Alaska Arctic Tidal Marsh	Uncommon breeder on Seward Peninsula, populations depressed
Hudsonian Godwit	G4	S2S3B	Nominee Species		Watch List	Alaska Arctic Wet Sedge-Sphagnum Peatland	Rare breeder on Seward Peninsula; AK pop is small, and genetically distinct.
King Eider	G5	S3B, S3N	Nominee Species			Western North American Boreal Freshwater Emergent Marsh	
Kittlitz's Murrelet	G2	S2B, S2N	Nominee Species	Candidate for Listing	Sensitive Species	Alaska Arctic Bedrock and Talus	Relict population in Seward Peninsula, declining
McKay's Bunting	G3	S3	Nominee Species		Sensitive Species	Alaska Arctic Tidal Marsh, Alaska Arctic Marine Beach and Beach Meadow	One of NA's rarest birds, AK endemic; winters on Seward Peninsula.
Red Knot	G5*	S2S3B	Nominee Species		Sensitive Species	alpine tundra, bare ground	Subspecies <i>roselaari</i> declining; breeds on Seward Peninsula *Global status debated
Spectacled Eider	G2	S2B	Nominee Species	Listed as Threatened		Lowland stream, Alaska Arctic Coastal Brackish Meadow,	rare local breeder
Yellow-billed Loon	G4	S2S3B, S3N	Nominee Species	Candidate for Listing	Sensitive Species	Lentic – shallow, closed basin, Alaska Arctic Polygonal Ground Wet Sedge Tundra	Candidate species for listing based on low populations and potentially declining trend; status on the Seward Peninsula is unknown.
<i>Canada geese</i>	G5	S5B				<i>Estuary & Lagoon, Western North American Boreal Freshwater Emergent Marsh, Alaska Arctic Coastal Brackish Meadow</i>	<i>Subsistence importance</i>

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
<i>Willow ptarmigan</i>	G5	S5				<i>Alaska Arctic Mesic-Wet Willow Shrubland</i>	<i>Subsistence importance</i>
Mammals							
Alaskan hare	G3G4	S3S4	Nominee Species		Sensitive Species	Alaska Arctic Mesic-Wet Willow Shrubland	potentially declining
Pacific walrus	G4	S3	Nominee Species			rocky shores, islands, beaches, coastal headlands - captured within sea mammal haul-out sites	
Polar Bear	G3	S3		Listed as Threatened			
<i>Beavers</i>	G5	S5			SOW	<i>River, Headwater Stream, Slough/Pond, Freshwater Lakes</i>	<i>Ecologically important - range appears to be expanding</i>
<i>Black Bear</i>	G5	S5			SOW	<i>Forested ecological systems</i>	<i>Subsistence species in Nulato Hills region.</i>
<i>Brown Bear</i>	G4	S5			SOW		<i>Subsistence species.</i>
<i>Moose</i>	G5	S5			SOW	<i>Alaska Arctic Mesic-Wet Willow Shrubland, Western North American Boreal Deciduous Shrub Swamp</i>	<i>One of the most used terrestrial mammals for subsistence, growing sport hunting in the region, charismatic species</i>
<i>Muskox</i>	G4	S4			SOW	<i>Alaska Arctic Shrub-Tussock Tundra, Alaska Arctic Polygonal Ground Wet Sedge Tundra</i>	<i>Rarely used subsistence species. Sport hunting occurs.</i>
<i>Western Arctic Caribou</i>					SOW	<i>Alaska Arctic Acidic Dwarf-Shrub Lichen Tundra, Alaska Arctic Shrub-Tussock Tundra, Alaska Arctic Acidic Sparse Tundra??</i>	<i>One of the most used terrestrial mammals for subsistence, growing sport hunting in the region.</i>
Fishes							
<i>Alaska Blackfish (Dallia pectoralis)</i>	G5	S5	Nominee Species			Lowland stream, Major river, Lentic - deep or shallow,	

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
						open basin	
Arctic lamprey (<i>Lampetra japonica</i>)	G4	S4	Nominee Species			Major river	
Pacific lamprey (<i>Lampetra tridentata</i>)	G5	S4S5	Nominee Species				
Broad whitefish (<i>Coregonus nasus</i>)	G5	S4S5	Nominee Species			Major river, Estuary and Lagoon, Lentic - shallow and deep	
Humpback whitefish (<i>Coregonus pidschian</i>)	G5	S5	Nominee Species			Major river	
Round whitefish (<i>Prosopium cylindraceum</i>)	G5	S4	Nominee Species			Major river	
Bering cisco (<i>Coregonus laurettae</i>)	G4	S4	Nominee Species			Estuary & Lagoon	
Rainbow smelt (<i>Osmerus mordax</i>)	G5	S3S5	Nominee Species			Lentic - shallow, estuary and lagoon, major river	
Arctic char of Kigluaik Mountain Lakes	SNR	SNR			SOW	Lakes	
Arctic grayling (<i>Thymallus Arcticus</i>)	G5	S5			SOW	Major river	There is some sportfishing for grayling
Pink salmon	G5	S5			SOW	Major river	Behind marine mammals salmon are the most consumed subsistence species in the region (Pinks and Chums appear most important)
Chum salmon	G5	S5			SOW	Major river	Subsistence species
Chinook salmon	G5	S4			SOW	Major river	Subsistence species
Coho salmon	G4	S4			SOW	Major river	Subsistence species
Sockeye salmon	G5	S5			SOW	Major river	Subsistence species
Dolly Varden					SOW		Subsistence species. There is some sportfishing for dolly varden
Lake trout	G5	S5			SOW	Freshwater Lakes - Deep	
Pike (<i>Esox lucius</i>)					SOW	Freshwater Lakes, Major	There is some sportfishing for pike

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
						river	
<i>Sheefish (Stendous leucichthys)</i>	G5	S3S5			SOW	Major river	There is some sportfishing for sheefish
VASCULAR PLANTS							
<i>Artemisia globularia</i> ssp. <i>lutea</i>	G4T1T 2Q	S1S2			Sensitive Species	Bedrock and Talus	
<i>Artemisia senjavinensis</i>	G3	S2S3			Sensitive Species	Bedrock and Talus	
<i>Cardamine microphylla</i> ssp. <i>blaisdellii</i>	G4T3T 4	S3S4			Watch List	Mesic-Wet Willow Shrubland	Relatively common
<i>Carex heleonastes</i>	G4	S2S3			Watch List	Boreal Freshwater Emergent Marsh	
<i>Claytonia Arctica</i>	G3	S1			Sensitive Species	Acidic Sparse Tundra (?)	Wet graminoid-herbaceous tundra
<i>Douglasia alaskana</i>	G3	S3			Sensitive Species	Bedrock and Talus	
<i>Douglasia beringensis</i>	G2	S2			Sensitive Species	Bedrock and Talus	
<i>Gentianopsis detonsa</i> ssp. <i>detonsa</i>	G3G5T 3T5	S1			Sensitive Species	Bedrock and Talus	
<i>Lupinus kuschei</i>	G3G4	S2			Watch List	Sand dunes, glacial rivers	
<i>Oxytropis Arctica</i> var. <i>barnebyana</i>	G4?T2 Q	S2			Sensitive Species	Bedrock and Talus, Mesic-Wet Willow Shrubland	
<i>Oxytropis kokrinensis</i>	G3	S3			Watch List	Acidic Dwarf-Shrub Lichen Tundra	Specifically, "Dryas meadows"
<i>Papaver walpolei</i>	G3	S3			Sensitive Species	Bedrock and Talus	
<i>Parrya nauruaq</i>	G2	S2			Sensitive Species	Bedrock and Talus	
<i>Pedicularis hirsuta</i>	G5?	S1			Sensitive Species	Marine Beach and Beach Meadow, Coastal Sedge-Dwarf-Shrubland	Collection on Seward Peninsula is questionable
<i>Pleuropogon sabinei</i>	G4G5	S1			Sensitive	Slough/Pond	Collection on Seward Peninsula is

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
					Species		questionable
Potentilla rubricaulis	G4	S2S3			Watch List	Bedrock and Talus, Acidic Sparse Tundra	Specifically, "Alpine meadows"
Potentilla stipularis	G5	S1			Sensitive Species	Mesic-Wet Willow Shrubland	
Primula tschuktschorum	G2G3	S2S3			Sensitive Species	Wet Sedge-Sphagnum Peatland, Polygonal Ground Wet Sedge Tundra	Impacted by goose & reindeer grazing, competition with <i>P. eximia</i>
Puccinellia vahliana	G4	S2S3			Watch List	Acidic Dwarf-Shrub Lichen Tundra, Wet Sedge-Sphagnum Peatland	Specifically, "Dryas tundra, fens"
Puccinellia wrightii	G3G4	S2S3			Sensitive Species	Arctic Dwarf-Shrubland	Specifically, "Alpine Dryas"
Ranunculus auricomus	G5	S2			Watch List	Mesic-Wet Willow Shrubland	
Ranunculus chamissonis	G3G4	S2S3			Sensitive Species	Sedge-grass meadows, marshlands	
Ranunculus glacialis var. 1	G4T2	S2			Sensitive Species	Alpine scree	
Rumex krausei	G2	S2			Sensitive Species	Bedrock and Talus	
Saussurea triangulata	G1	S1			Watch List	Mesic-Wet Willow Shrubland	
Smelowskia johnsonii	G1	S1			Sensitive Species	Bedrock and Talus	
Symphyotrichum yukonense	G3	S3			Watch List	Large River Floodplain	
Taraxacum carneocoloratum	G3Q	S3			Watch List	Acidic Sparse Tundra	
Blueberry (<i>Vaccinium uliginosum</i>)	G5	SNR				Most Ecological systems	Potential inclusion as one of the regions important plant subsistence food. This species occurs on most acidic tundra and woodland habitats

Conservation Element	Conservation Status					Associated Habitats	Notes
	Global Rank	State Rank	AK State Wildlife Action Plans	Federal Listing	BLM		
<i>Cloudberry/Salmonberry (Rubus chamaemorus)</i>	G5	SNR				<i>Shrub-Tussock Tundra (peatland-dominated)</i>	<i>Potential inclusion as one of the regions most important plant subsistence food</i>
<i>Crowberry/Blackberry (Empetrum nigrum)</i>	G5	SNR				<i>Tundra Ecological Systems</i>	<i>Potential inclusion as one of the regions most important plant subsistence food</i>

Appendix 4: Desired Terrestrial and Aquatic Fine-Filter Conservation Elements Considered for the SNK Ecoregion

Conservation Element	Conservation Status					Associated Habitats	Notes
	Subsistence Importance	Recreational Importance	GRANK	SRANK	Indentified in SOW		
CRITICAL HABITATS							
Critical Fish Habitats	X	X			X		Likely unidentifiable
Marine Mammal Haul-Out Sites	X	X					
Migratory Bird Habitats	X	X			X		Important for rare species
Pollinator Habitats					X		Likely unidentifiable
Raptor Concentrations		X			X		
Seabird colony sites	X	X					Important for rare species. Habitat for example, coastal cliffs at Cape Deceit
ANIMALS							
Birds							
Canada geese	X	X	G5	S5B		Estuary & Lagoon, Western North American Boreal Freshwater Emergent Marsh, Alaska Arctic Coastal Brackish Meadow	One of the most harvested birds
Tundra Swans (?)	X	X	G5	S4B		Lentic – shallow, open basin, Lentic – shallow, closed basin	These are taken widely as important subsistence species on the YKD, I assume the hunting habits are similar on the Seward Peninsula.
Willow Ptarmigan	X	X	G5	S5		Alaska Arctic Mesic-Wet Willow Shrubland	One of the most harvested birds throughout the year
Mammals							
Beavers	X		G5	S5	X	River, Headwater Stream, Slough/Pond, Freshwater Lakes	Ecologically important - range appears to be expanding
Black Bear	X	X	G5	S5		Forested ecological systems	Subsistence species in Nulato Hills region. Charismatic species.
Brown Bear	X	X	G4	S5			Subsistence species. Charismatic species.
Furbearers (Arctic Fox, Coyote, Lynx, Marten, Mink, Muskrat, Northern Flying Squirrel, Red Fox, Red Squirrel, River Otter, Weasels, Wolverine)	X	X			X	Nearly all ecological systems	Consider deletion - Large group of different species, likely covered under the coarse filter
Moose	X	X	G5	S5	X	Alaska Arctic Mesic-Wet Willow Shrubland, Western North American Boreal Deciduous Shrub Swamp	One of the most used terrestrial mammals for subsistence, growing sport hunting in the region, charismatic species
Muskox	X	X	G4	S4	X	Alaska Arctic Shrub-Tussock Tundra, Alaska Arctic Polygonal Ground Wet Sedge Tundra	Rarely used subsistence species. Sport hunting occurs. Charismatic species.

Conservation Element	Conservation Status					Associated Habitats	Notes
	Subsistence Importance	Recreational Importance	GRANK	SRANK	Identified in SOW		
Western Arctic Caribou	X	X			X	Alaska Arctic Acidic Dwarf-Shrub Lichen Tundra, Alaska Arctic Shrub-Tussock Tundra, Alaska Arctic Acidic Sparse Tundra??	One of the most used terrestrial mammals for subsistence, growing sport hunting in the region, charismatic species
Wolves	X	X				Nearly all terrestrial ecological systems	Subsistence hunting/trapping. Charismatic species.
Fishes							
Arctic char of Kigluaik Mountain Lakes					X	Lakes	
Arctic grayling (<i>Thymallus Arcticus</i>)	X	X	G5	S5	X	Major river	There is some sportfishing for grayling
Pink salmon	X	X	G5	S5	X	Major river	Behind marine mammals salmon are the most consumed subsistence species in the region (Pinks and Chums appear most important?)
Chum salmon	X	X	G5	S5	X	Major river	
Chinook salmon	X	X	G5	S4	X	Major river	
Coho salmon	X	X	G4	S4	X	Major river	
Sockeye salmon	X		G5	S5	X	Major river	
Dolly Varden	X	X					There is some sportfishing for dolly varden
Lake trout	X	X	G5	S5	X	Freshwater Lakes - Deep	
Pike (<i>Esox lucius</i>)	X	X			X	Freshwater Lakes, Major river	There is some sportfishing for pike
Rainbow smelt (<i>Osmerus mordax</i>)	X		G5	S3S5		Freshwater Lake - shallow, estuary and lagoon, major river	
Rainbow trout					X		Consider deletion - Range isn't known to occur within REA assessment boundary
Sheefish (<i>Stendous leucichthys</i>)	X	X				Major river	There is some sportfishing for sheefish
Whitefish species	X				X	Major river, Estuary and Lagoon, Lentic - shallow and deep	Four species identified on Table 2 as Core CEs. Whitefish species make up a large portion of diets in the region
Invertebrates							
Crab					X		King crab? Opilio?
VASCULAR PLANTS							
Blueberry (<i>Vaccinium uliginosum</i>)	X		G5	SNR		Most Ecological systems	Potential inclusion as one of the regions important plant subsistence food. This species occurs on most acidic tundra and woodland habitats
Cloudberry/Salmonberry (<i>Rubus chamaemorus</i>)	X		G5	SNR		Shrub-Tussock Tundra (peatland-dominated)	Potential inclusion as one of the regions most important plant subsistence food
Crowberry/Blackberry (<i>Empetrum nigrum</i>)	X		G5	SNR		Tundra Ecological Systems	Potential inclusion as one of the regions most important plant subsistence food

Appendix 5: Change Agent Assessment

See text for explanation of fields. The “Include” field identifies those CAs vetted and recommended for inclusion by the AMT.

Change Agent	Notes	Source	Ecological Effects	Conservation Elements Affected	Change Agent Synergies	Current	Future
CLASS I WILDFIRE							
Change in fire frequency		Higuera et al 2008, Joly et al. 2009, Kasischke et al. 2010, Hu et 2010	Alters vegetation structure and composition, alters permafrost and hydrologic regimes	Subsistence (access to and availablity of fish and wildlife), all CEs	Climate Change, Invasive and Nuisance Species	X	X
Change in fire intensity		see above	see above	see above	see above	X	X
Change in fire size		see above	see above	see above	see above	X	X
CLASS II ANTHROPOGENIC ACTIVITIES							
Development							
Community infrastructure	Infrastructure includes airports, harbors, roads, fuel storage tanks, public buildings	Data from ISER infrastructure database, location, age, replacement cost	Destroying or altering habitat, creating bird collision features, introducing invasives, causing ground water pollution or changes, and creating movement barriers. Potential impacts to permafrost.	Vegetation, birds, fish, terrestrial animals	Climate change	X	X
Community expansion, relocation, or closure	Demographic change Small communities in the interior region are at risk of closing. Erosion forcing Kivalina and Shishmaref to move	Howe & Martin 2010, Survey of Living Conditions in the Arctic 2003, US Census, Alaska Department of Labor and Workforce Development	Pressure on subsistence species, damage to water supply, pollution from abandoned sites, changes t habitat where new communities are built.	Subsistence species, subsistence hunting and fishing	Climate change	X	X
Recreation							
ATVs and snow machines	Local transportation and subsistence	Surveyof Living Conditions in the Arctic 2003	Increased hunting and fishing pressure, damage to tundra, pollution	subsistence species, rare plants and animals, tundra	Climate Change		X
Water based	sport hunting, eco-tourism?	Fay 2005a, 2005b, 2005c; National Park Service reports	Increased hunting and fishing pressure, pollution	subsistence species	Climate Change		X
Dispersed recreation	hiking, camping, rafting	Fay 2005a, 2005b, 2005c	Potential impacts to use areas, possibilities of fire from recreational users, pollution impacts	subsistence species, rare plants and animals, tundra	Climate Change		X
Forage							
Grazing - Teller reindeer herd		CircumArctic Rangifer Monitoring and Assessment CARMA Network, ADFG	Damage to lichen tundra, hybridization with caribou	caribou, susbsistence	Climate Change	X	X
Transportation Infrastructure							
Roads, including ice roads		ISER Community databases. Larsen, et al. 2007	Habitat fragmentation, impacts to rare plant and animal populations, changes access to subsistence resources, impacts to permafrost	plants and animals, subsistence	Climate Change, Energy and mining development	X	X
Transmission corridors	There are none now. Unless we know where they will be, its premature to study this.		Habitat fragmentation, impacts to rare plant and animal populations, bird collision features	rare plants and animals, bird communities	Energy Development		X
Energy Development							

Change Agent	Notes	Source	Ecological Effects	Conservation Elements Affected	Change Agent Synergies	Current	Future
Extractive energy development							
Oil and gas	Likely to be off-shore but will affect on-shore	Minerals Management Service reports	Potential impacts to wildlife populations. Pollution and development pressures into ecosystems.	plant and animal communities, ecosystem services			X
Mining	Lots of tiny exploration holes in region. 2 possible projects	Bob Loeffler interview, publications, data from AK Department of Natural Resources	Hydrological changes, access routes, pollution, providing energy to mine could impact fish and plant habitats.	ecosystem services, fish, vegetation communities	Climate Change	X	X
Alternative energy development							
Wind		ISER renewable energy database, Fay, Keith, Schwörer 2010	Destroying or altering habitat, creating bird collision features, introducing invasives, causing ground water pollution or changes, and creating movement barriers. Could increase subsistence by making fuel more affordable.	bird communities, plant and animal communities, fish	Climate Change		X
Geothermal			Potential for pollution, impacts from access to sites and fuel transport, lower energy costs may make fuel more affordable.	plants and animals communities	Climate Change		X
Mini-nukes	Galena proposed to develop	ISER energy database, Toby Schwörer	see above	see above	Climate Change		X
Biomass	Project is starting up. We can coordinate with them.	Integrative Biofuels Research: Toward Renewable Energy for Alaska (NSF funded EPSCOR project)	see above	see above	Climate Change		X
Military Constrained Areas							
Military use areas	Historic sites could be contaminated.	Army Corp of engineers. Ak land use maps.	Impacts to habitat and species	Plant and animal communities		X	X
Pollutants							
Point source pollutants	refuse management, oil spill?	EPA reports, ADFG,	Cumulation of persistent organic pollutants in subsistence species, high concentrations are known in marine mammals.	subsistence species, rare animals		X	X
Non-point source pollutants			see above	see above		X	X
Water use							
Groundwater withdrawals	Community level varies with population		Increased groundwater withdrawals may impact fish habitat and impact subsistence species. Impacts to permafrost causing potential damage to ponds.	fish, subsistence species			X
Altered surface flow connectivity (dams, alterations to habitat that make stream reaches unsuitable for species movement)		Dept of Community and Regional Affairs	Impacts to fish habitat and subsistence species.	see above	Wildfire, Climate Change		X

Change Agent	Notes	Source	Ecological Effects	Conservation Elements Affected	Change Agent Synergies	Current	Future
Altered surface flow (flood control, diversions, spring impoundments etc)	river erosion? Difficult to document?		see above	see above	Wildfire, Climate Change		X
CLASS IIIa NON-NATIVE SPECIES							
Invasive terrestrial plant species		AKEIC 2010, Carlson et al. 2008, Conn et al. 2008, Villano 2008, Carlson and Shepard 2007, Carlson et al. 2005	Impacts to native species and ecosystem services, competition for limited resources	sagebrush-graminoid steppe habitats, floodplains, and wetlands	Climate Change, Anthropogenic Activities	X	X
Aquatic invasive plants	Includes the potential for the pond weed <i>Elodea canadensis</i> - Has been found in Chena Slough and Chena River near Fairbanks	Amy Larsen, NPS, in AND Dec. 1, 2010	see above	see above	see above	X	X
<i>Gambusia affinis</i> (western mosquito fish)		McClory and Gotthardt 2008	see above	see above	see above	X	X
<i>Myxobolus cerebralis</i> (the whirling disease parasite)		McClory and Gotthardt 2008	see above	see above	see above	X	X
Two invasive crayfish, <i>Procambarus clarkia</i> (Red swamp crayfish) and <i>Pacifastacus leniusculus</i> (Signal crayfish)		McClory and Gotthardt 2008	see above	see above	see above	X	X
Norway rats		McClory and Gotthardt 2008	Norway rats cause massive seabird depredation and they cause cascading impacts on coastal ecosystems in Alaska	ecosystem services, fish populations, plant and animal communities	Anthropogenic activities	X	X
Three species of introduced alder-defoliating sawflies		McClory and Gotthardt 2008	Extensive damage in areas southeast of this ecoregion and are likely to cause alterations to a dominant woody species, affecting successional pathways and wildlife if the sawflies become established.	see above	Climate Change		X
CLASS IIIb NUISANCE NATIVE SPECIES AND DISEASES							
The diatom, <i>Didymosphenia geminata</i> (Didymo, rock snot)		D. Bogan and D. Rinella, unpublished,	Aquatic ecosystems are affected at multiple trophic levels (i.e., primary and secondary productivity, competitive exclusion, predation, pathogens, indirect effects, trophic cascades, etc.).	ecosystem services, fish populations, plant and animal communities	Climate Change, Anthropogenic Activities	X	X
Disease agents		Patterson 2010	Cause significant alterations to native habitats.	see above	Climate Change	X	X

Change Agent	Notes	Source	Ecological Effects	Conservation Elements Affected	Change Agent Synergies	Current	Future
(wood decay and canker fungi, root disease, etc.)			Impacts include changes to plant communities, wildlife, and even alters salmon spawning habitats				
Native insects (aspen and willow leaf miners, spruce budworm, spruce beetle, northern engraver beetle)		Patterson 2010, Boggs et al. 2008	Cause significant alterations to native habitats. Impacts include changes to plant communities, wildlife, and even alters salmon spawning habitats	see above	Climate Change	X	X
CLASS IV CLIMATE CHANGE							
Temperature change		Hinzman et al. 2005, Kofinas et al. 2010	Temperature increases inhibit species' life cycles, alter hydrology with increased coastal river erosion, increase invasive weed expansion, alter permafrost regimes, and change disease vectors. Warmer temperatures also mean later freeze dates and earlier thaws for rivers and shorter periods of snow cover which in turn limit snow machine travel in winter, reducing access to subsistence hunting areas. Summer travel by boat or ATV is also affected by changing river levels.	All CEs		X	X
Precipitation change	SNAP future precipitation scenarios are monthly outputs of total precipitation. We can't distinguish between rain & snow, but can somewhat assume precipitation in the winter months largely falls as snow.	Hinzman et al. 2005	Precipitation changes alter hydrology, soil thermal dynamics and potential evapotranspiration. Shorter periods of snow cover limit snow machine travel in winter, reducing access to subsistence hunting areas. Summer travel by boat or ATV is also affected by changing river levels. Maybe also something here about potential affects on aquatic ecosystems?	same as above		X	X
Changes in Seasonality? - Discuss at AMT meeting	In terms of future climate scenarios, SNAP also has derived products from temperature & precipitation which include: date of freeze-up, date of thaw & growing season length. If these are of interest, we could expand this section to include these climate changes which essentially translate to changes in seasonality.						