Yukon Lowlands-Kuskokwim Mountains-Lime Hills

Rapid Ecoregional Assessment Project, Alaska

Memo 1: Selection of Management Questions, Conservation Elements and Change Agents

Prepared for:

Department of the Interior
Bureau of Land Management
Rapid Ecoregional Assessments

Final Submission Date: 12 February, 2013

Submitted to:

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

Submitted by:

Alaska Natural Heritage Program (AKNHP), University of Alaska Anchorage

Scenarios Network for Alaska Planning (SNAP), University of Alaska Fairbanks, and

Institute for Social and Economic Research (ISER), University of Alaska Anchorage

Table of Contents

Figures

Tables

Introduction

The Bureau of Land Management (BLM) recognizes that landscapes and associated natural resources are changing. Climate change, development, wild fires, and invasive species are acknowledged as primary agents of change in western North America on lands managed, in part, by the BLM. Rapid Ecoregional Assessments (REAs) are an important component of BLM's landscape approach to improve understanding of existing landscape status, and how the landscapes might be altered by environmental change and development. REAs are designed to evaluate regionally significant ecological values, conditions, and trends within an ecoregion in a rapid manner using existing data. They synthesize and provide regional information to assist management and environmental planning efforts at multiple scales.

REAs begin with a set of questions from resource managers and decision-makers within the ecoregion. In general, these questions identify current or anticipated regionally significant problems or issues facing resource managers. The Yukon Lowlands, Kuskokwim Mountains and Lime Hills (YKL) REA will address a set of management questions by identifying, assembling, synthesizing, and integrating existing information about regionally significant native species, aquatic and terrestrial resources, as well as environmental change agents that are identified in the questions. Once completed, this information will provide land managers with an understanding of current resource status and the potential for resource status to change in the future (both 15 years and 50 years from the time of study) through modeling and scenarios analysis.

Rapid Ecoregional Assessments have two primary goals:

1) To provide landscape-level information needed in developing habitat conservation strategies for regionally significant native plants, wildlife, and fish and other aquatic species; and

2) To inform subsequent land use planning, trade-off evaluation, environmental analysis, and decision-making for other interconnected public land uses and values, including development, recreation, and conservation.

This, the first of four progress reports, describes the first task (pre-assessment) of the YKL REA project. This includes a description of the study area and a detailed ecoregion conceptual model. This report also presents a list of proposed Management Questions (MQs), proposed Conservation Elements (CEs), and proposed Change Agents (CAs), along with justification for their selection.

Objectives of the pre-assessment (first task):

1) Define the assessment area - ecoregions and buffer
2) Describe 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)

Assessment Area

Assessment Boundary

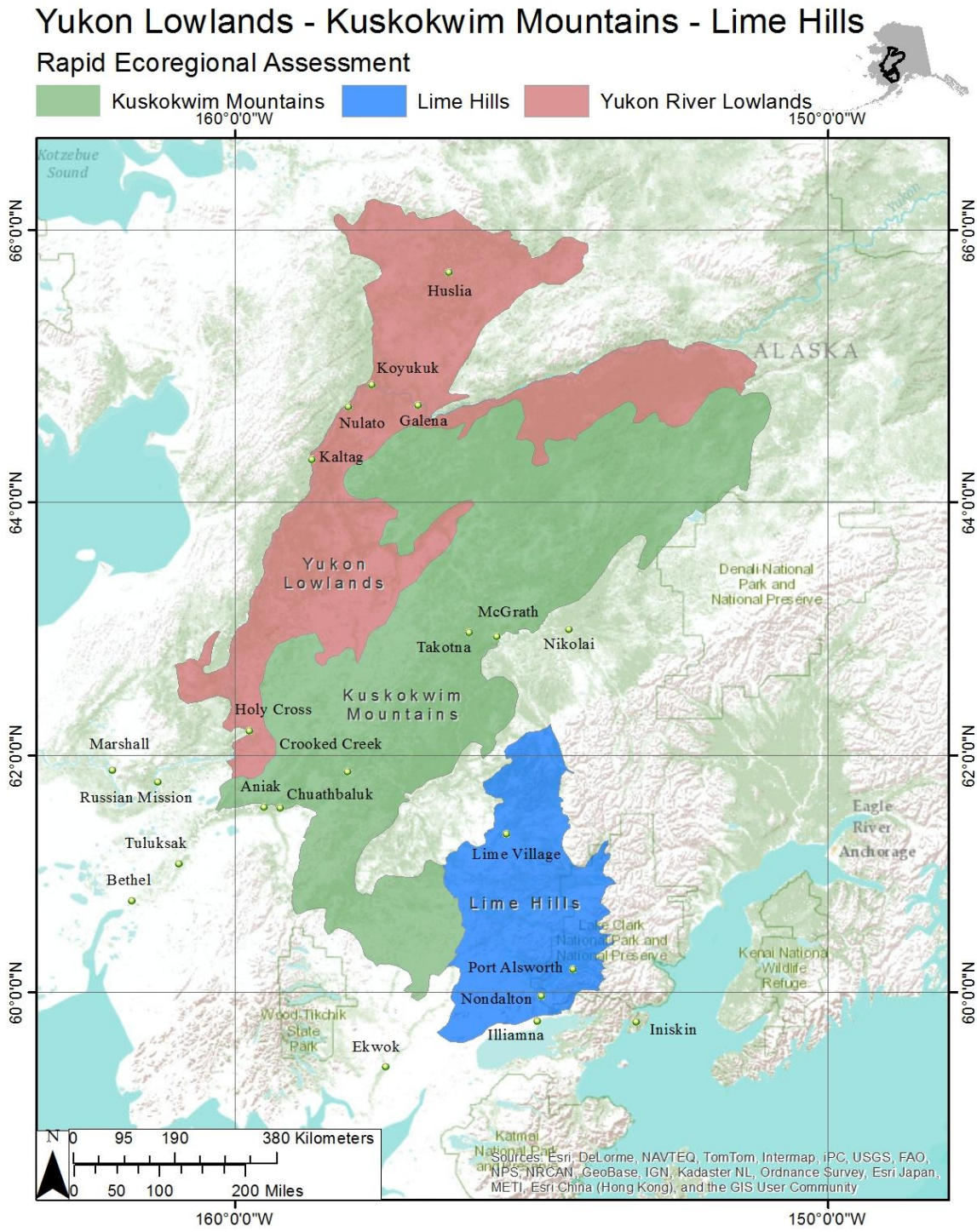


Figure 1. The Yukon Lowlands, the Kuskokwim Mountains, and the Lime Hills ecoregions.

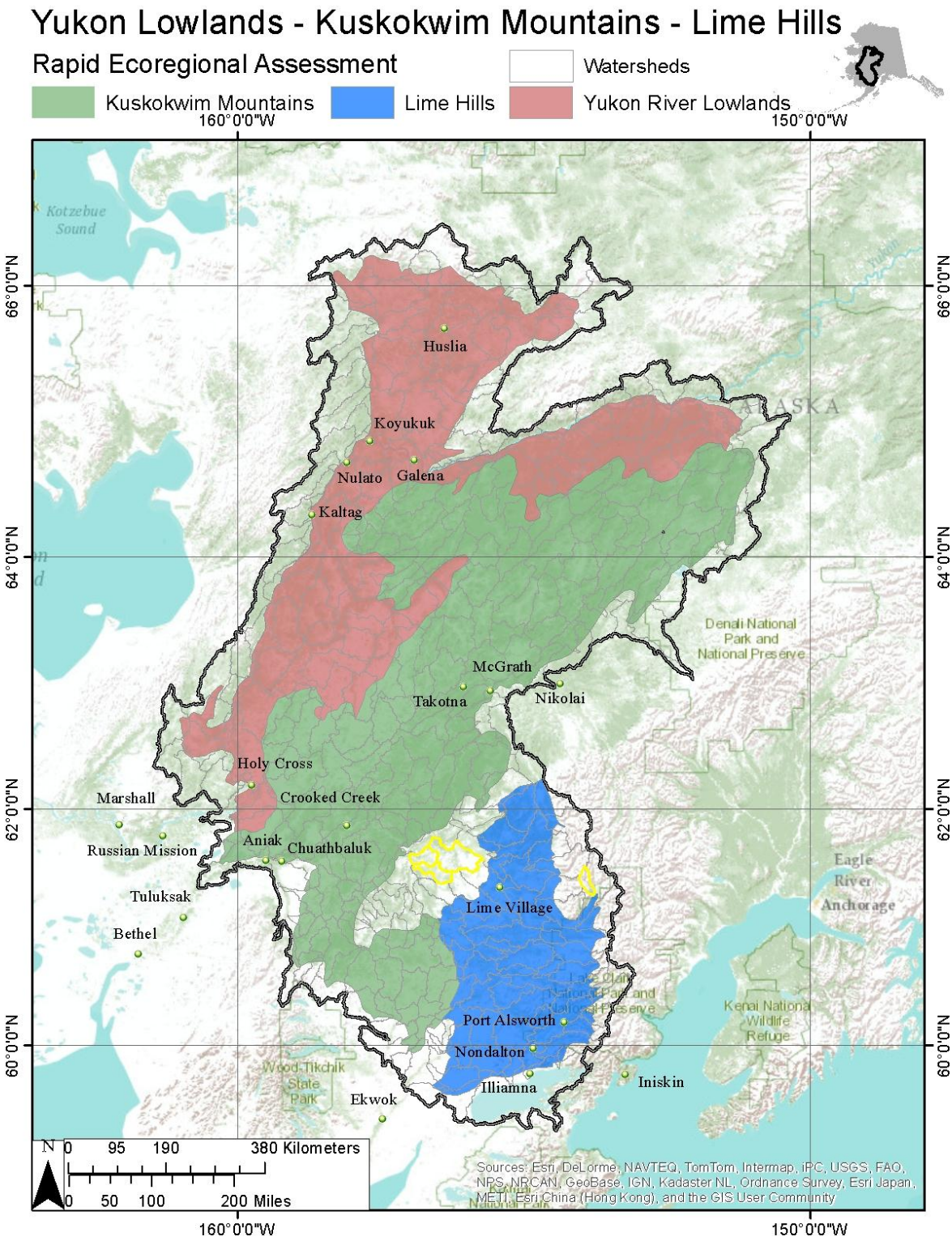


Figure 2. The study area for the Yukon Lowlands, the Kuskokwim Mountains, and the Lime Hills ecoregions. The watersheds outlined in yellow show the added HUCs for continuity.

The assessment area includes three ecoregions in interior Alaska: Yukon Lowlands, the Kuskokwim Mountains, and the Lime Hills (Error! Reference source not found.). These ecoregions are defined by Nowacki *et al*. (2001) and represent a unified mapping approach that blends traditional approaches (Bailey 1987 and Umerik 1987) with regionally-specific knowledge and ecological goals. Included in these ecoregions are two major river systems (Yukon and Kuskokwim) as well as approximately thirty small communities, all located along rivers or streams. Although none of the communities can be reached by road, Galena, McGrath, Aniak, and Illiamna serve as air-transportation hub communities for the region. The assessment boundary, following BLM guidelines, constitutes the three component ecoregions and any 5th level hydrologic units that intersect the ecoregion boundaries (**Figure 2**). Four additional 5th level hydrologic units were included in the study area to close two gaps in the boundary. This was agreed to by the BLM to facilitate seamless integration with neighboring REA efforts and to ensure that regionally important resources that may exist just outside of the ecoregion boundaries are included in the analysis.

Landscape Reporting Unit

Assessment data will be summarized at the level of landscape reporting units. For most assessments the BLM has specified that data be reported at the 5th level 10-digit hydrologic unit with raw data being provided at 30 m pixels for raster data or other native resolution as appropriate. Climate data resolution is limited to 4 km^2 grid cells and therefore any climate related questions will be answered at this coarser scale. In Alaska, many of our primary landscape level datasets are also coarser than the 30 m pixel resolution recommended by the BLM (best available resolution for Digital Elevation Model is at 60 m pixels). Thus the ultimate reporting unit of each analysis will be limited by the coarsest resolution of the data.

Ecoregion Descriptions

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

Yukon River Lowlands

An expansive wetland system is associated with the lower stretches of the Yukon and Koyukuk Rivers in west-central Alaska. Although this area was unglaciated, meltwater floods deposited vast quantities of sediment within these riverine corridors during glacial retreat. As such, deep deposits of undifferentiated sediments underlie these floodplains and adjacent lowlands. A seasonally moist continental climate prevails with cool, moist summers and cold, dry winters. Permafrost is absent along the younger floodplains, but is thin, discontinuous, and relatively “warm” on the abandoned floodplains in the adjacent lowlands. Poor drainage caused by permafrost contributes to the prevalence of wet, organic-rich soils. Collapse-scar features from thawing permafrost are common. Water levels drop in the Yukon River and its tributaries in early fall during freeze-up and remain low until spring breakup when substantial ice-jam

flooding can occur. The vegetation along the major rivers is highly productive and supports vigorous stands of white spruce and balsam poplar. Active floodplains and riverbars support tall stands of alders and willows. Robust wet sedge meadows and aquatic vegetation reside in infilling sloughs and oxbow ponds. The adjacent permafrost-dominated lowlands support black spruce woodlands, and birch-ericaceous shrubs and sedge-tussock bogs. Many flat organic surfaces are pockmarked with dense concentrations of lakes and ponds. These areas support large populations of moose and black bear, the oxbow sloughs and thaw ponds support abundant waterfowl, and the lowland forests are important to furbearers. The large rivers support important runs of chinook, chum, and coho salmon.

Kuskokwim Mountains

This terrain is comprised of old, low rolling mountains that have eroded largely without the aid of recent glaciations. A continental climate prevails with seasonal moisture provided by the Bering Sea during the summer. Mountains are composed of eroded bedrock and rubble, whereas intervening valleys and lowlands are composed of undifferentiated sediments. Thin to moderately thick permafrost underlies most of the area. Boreal forests dominate, grading from white spruce, birch, and aspen on uplands to black spruce and tamarack in lowlands. Tall willow, birch, and alder shrub communities are scattered throughout, particularly where forest fires burned in the recent past. Rivers meander through this undulating landscape following fault lines and highly eroded bedrock seams. These mountains support abundant moose, bears, beavers, and scattered caribou herds.

Lime Hills

The Lime Hills are glacially dissected mountains extending from the west side of the Alaska Range. The effects of substantial glaciation are etched in the surface topography through a repeated sequence of sharp mountain ridges with steep headwalls and broad U-shaped valleys. The ridges and mountainsides are covered with colluvial rubble, while the valleys contain glacial moraines and outwash with some alluvial deposits along rivers. The continental climate is moderated somewhat by maritime influences of the Bering Sea and North Pacific Ocean. The area is underlain by isolated masses of permafrost. Vegetation is predominately tall and low shrub communities of willow, birch, and alder. Spruce forests and woodlands are confined to valley bottoms and mountain toeslopes. These habitats support moose, bears, caribou, and various furbearers.

Climate

These ecoregions have an interior climate, with cold winters and relatively warm summers, although climate patterns vary across the ecoregions based on latitude, elevation, and proximity to the coastline. With mean annual temperatures close to 32°F, permafrost is discontinuous.

Historical weather station data for the broad region surrounding the REA study area show mean maximum/minimum annual temperatures ranging from 31.9/12.1°F at Ambler, 36.6/22.4°F at Bethel (1949-2010), 31.5/13.1°F at Bettles (1951-2010), 36.9/19.5°F at Big Delta (1937-2010), 43.7/18.3°F at Caswell (1996-1998), 36.0/21.4°F at Emmonak, 30.4/17.4°F at Teller (1949-1997), to 26.6/15.7°F at Wales (1949-1995) (WRCC 2011).

Historical data also show that total annual precipitation/snowfall ranged from 23.06/134.0 inches in Ambler, 17.32/55.1 inches in Bethel, 14.12/83.3 in Bettles, 11.38/43.8 inches in Big Delta, 23.72/120.7 inches in Caswell, 18.54/65.6 inches in Emmonak, 9.73/46.2 inches in Teller, to 11.48/38.1 inches in Wales (WRCC 2011).

Socioeconomic Description

Thirty-one small communities, ranging in size from 13 people to around 500 at Galena and Aniak, are present within the assessment area[1]. A total of more than 4000 people live in the assessment area. Approximately 76% of the population is Alaska Native. Most communities experienced a decline in their population (except for three - Iliamna, Port Alsworth, and Takotka) between 2000 and 2010 (U.S. Census Bureau, 2010).

With few year-round employment opportunities, the regional economy is a hybrid of cash and subsistence, similar to much of rural Alaska and other remote arctic indigenous communities. Households combine wages from jobs, subsistence food harvests, and government transfers[2]. In this region and elsewhere, households are facing increasing pressure from the high cost of living, driven by rising fuel prices.

Higher fuel prices push up the cost of store bought foods because transportation costs and storage costs increase. Subsistence is getting more expensive because of higher fuel costs for snow machines and four wheelers. At the same time, high food prices increase the need for subsistence as a food source. In addition to being an essential food source for communities, subsistence also helps maintain cultural continuity. Around 150 species of land and sea mammals, birds, fish, and plants have been harvested in the region (Stephen R. Braund & Associates, 2011).

> It is impossible to separate subsistence activities in Alaska from ecological relationships. These human interactions with aquatic and terrestrial resources have been and will continue to be a critical component of resource sustainability. Recognized by ANILCA (Section 810, Title VIII), federal agencies making significant resource management decisions over public lands are required to evaluate the effects of these decisions on subsistence uses and needs (BLM 2011)

Subsistence uses and needs necessitate healthy plant and animal populations as well as access to them. Climate change, fire, development projects, and commercial/sport hunting and fishing can have both

[1] Few communities straddle the border of REA regions and are counted in more than one region. Seven communities in YKL are also in the Seward Peninsula-Nulato Hills-Kotzbue Lowlands (SNK) region.

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

positive and detrimental effects on access to subsistence resources, animal and plant populations and health. This symbiotic relationship between humans and the regional flora and fauna creates a more defined link between human wellbeing and species management, beyond what is typically observed in regions outside of Alaska.

Regional Context

The ecosystems within the ecoregions are considered to be intact and undisturbed relative to most ecosystems at lower latitudes. These ecoregions represent a dramatically different model than many of the REA efforts in the lower 48 states and provides a unique opportunity to assess how systems following relatively natural patterns are likely to change under various climate and land use change scenarios. Thus, this REA effort provides a unique opportunity to develop a more detailed and ecologically-based landscape condition model that considers natural and human factors in determining ecological integrity.

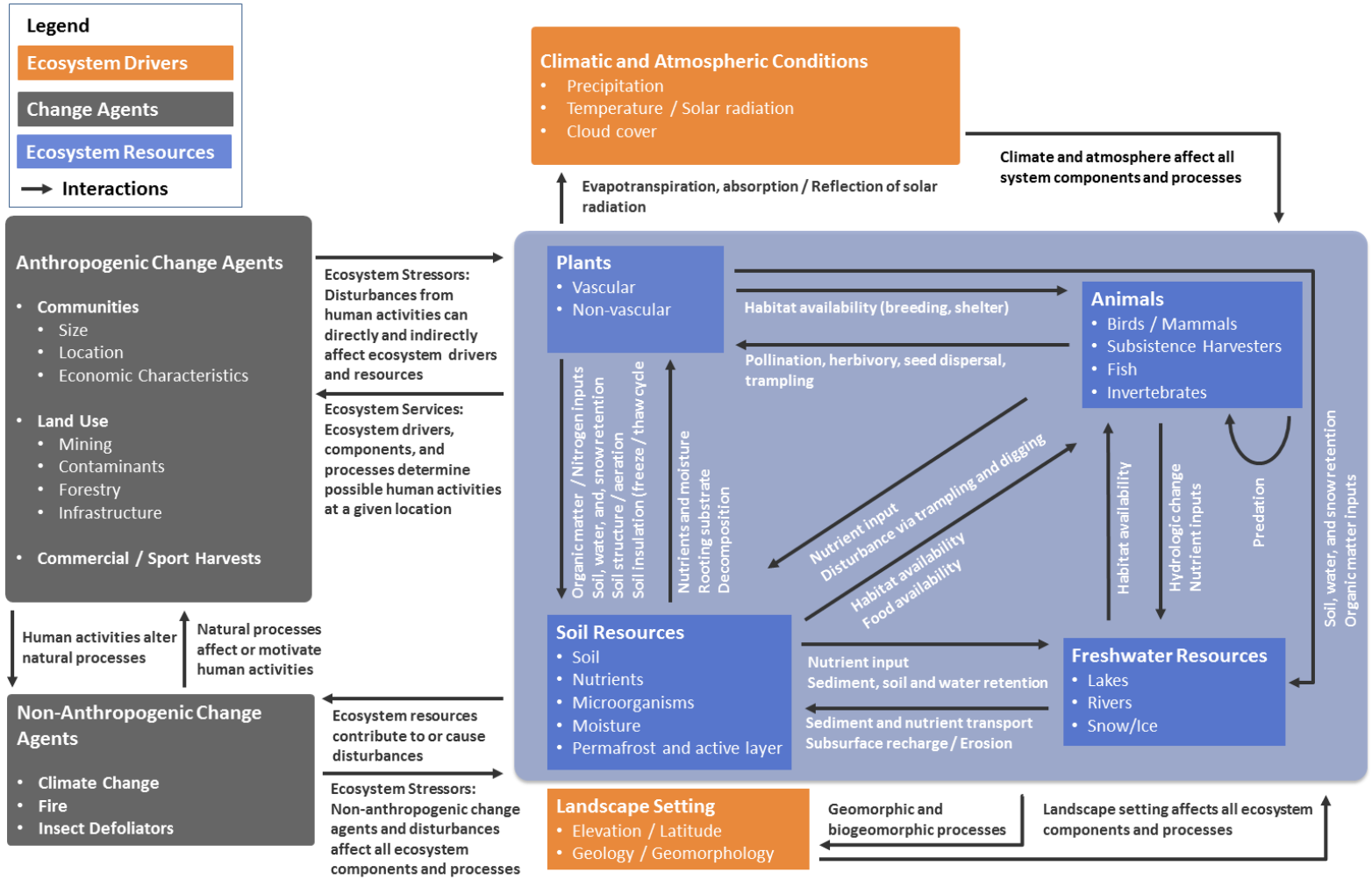
The human footprint is minimal in this region, and fire activity is driven primarily by natural factors. However sparse, human settlement still creates several uncertainties that land managers must address in regional planning efforts. Issues related to delivery and maintenance of power, water, and other basic resources are particularly challenging due to the vast distances and challenging topography. Additionally, subsistence harvests are a major food source for most of the communities in this ecoregion.

Although development has been minimal traditionally, there are two relatively large (spatially and politically) mining efforts being proposed within this study area. The probability of either/both mines being developed is largely unknown, which has created a lot of uncertainty with regard to natural resource management in the region. Using scenario analysis, this REA will assess the potential spatial impacts of the proposed mines at the ecoregional level in an effort to quantify the uncertainty so that land use management can be more directed and focused.

Conceptual Ecoregional Model

Conceptual ecoregional models depict an understanding of how an ecosystem works, with the purpose of communicating that understanding to others. Conceptual models can often help to foster communication between managers, scientists, and the public. The following conceptual model (**Figure 3**) provides a coarse-scale interpretation of key ecological resources and drivers of the Yukon Lowlands, Kuskokwim Mountains, and Lime Hills ecoregions. We divided the model into the following components:

- Principal ecosystem resources including vegetation, animals, soil and freshwater.
- Ecosystem drivers such as climate, physical setting (i.e. geology, topography, and geomorphology), and landscape elements (i.e. lakes, forests).
- Primary change agents including fire, climate change, land use, and insect defoliators.
- Ways in which ecosystem resources interact with each other. For example, soils provide habitat for burrowing animals.



Based on: U.S. Long Term Ecological Research Network (LTER). 2007. *The Decadal Plan for LTER: Integrative Science for Society and the Environment.* LTER Network Office Publication Series No. 24, Albuquerque, New Mexico. 154 pg.

The model incorporates subsistence communities as part of the ecosystem. Subsistence communities (and other users) receive goods and services from the ecosystem: food, water, fuel, and transportation access. Ecosystem stressors are disturbances caused by human activities. Some ecosystem stressors are caused by subsistence communities, but most are larger scale disturbances caused by industrial and resource development.

Figure 3. Conceptual ecological model for the Kuskokwim Mountains, Yukon Lowlands, and Lime Hills REA.

- Ways in which climate, physical setting and change agents affect the ecosystem resources. For example, climate affects both fire and permafrost, which in turn affects vegetation.

The change agents identified in the model are used as the primary change agents in the REA. In addition, many of our conservation elements (called core CEs, see below) were derived from the pathways in which ecosystem resources interact with each other. For example, peatlands were identified as a CE from the ecosystem conceptual model because they provide significant nutrient inputs from the soil resources to the freshwater resources. This conceptual model will serve as a framework for measuring the cumulative impact of all the CAs on all the CEs, providing a measure of overall current and future ecological integrity.

Community Meetings

The University of Alaska team and BLM State and Field offices coordinated three community meetings, one each in Galena, Newhalen, and Aniak. The purpose of these meetings was to inform the general public about the REA process, its expected outcomes, and gather input on conservation elements, change agents, and management questions. Information on regional concerns gathered at these meetings resulted in eight additional proposed management questions (each of them identified in the next section), three additional conservation elements (martin, river otters, beaver), and an additional change agent (larch sawfly). Meeting highlights and a list of meeting participants are included in **Appendix A**.

Management Questions

The BLM defined a preliminary set of management questions (MQ) in the Statement of Work (SOW) for this REA. These questions were generally broad in scope, and too numerous for the BLM target of 30-50 management questions for the REA. In order to refine and shorten this list to a workable number, BLM State and Field Offices were asked to review the MQs for clarity and relevancy, and to prioritize questions. This review resulted in numerous rewording of questions, separation of compound questions, and spurring of additional questions of interest. Review of several iterations of each question resulted in a list of questions that were most relevant to land managers. All iterations of the questions were considered and, when possible, original (BLM) phrasing was retained. Questions that were ranked low priority by the BLM and were reviewed by our team as out of scope were omitted from further consideration (only nine fell under this classification). One-hundred and thirty one questions remained after this omission. This list was re-evaluated to determine if questions 1) addressed scales deemed either too fine or coarse, 2) required data known to not be available or would require substantially longer time than 18 months to collect, 3) were redundant with existing questions, or 4) were too broad or vague to answer accurately. Through workshops and multiple iterations with the Assessment Management Team (AMT) – a volunteer team of representatives from various agencies and organizations that are responsible for land management within the assessment boundary, 64 Management Questions were ultimately chosen for analysis as part of this assessment (Appendix D).

Below is the current list of management questions. Questions are presented first in their original wording, and in some cases as a rewritten question. Additionally, management questions necessarily require the identification of conservation elements and change agents to address the questions. All conservation elements and change agents identified in management questions were specifically considered during the conservation elements and change agents selection process (see Conservation Element and Change Agent sections).

Landcover

- ***What are the possible impacts on vegetation communities from climate change?***
  Resolution: **Accept**. This is a biome climate envelope model that is currently answered with SNAP models.

- ***What is the current distribution of vegetation communities?***
  Resolution: Accept.

- ***Where is the habitat for sensitive species?***
  Resolution: **Accept**. **Re-written** to include only sensitive species that are also CE's. USGS suggest delete but we need to keep to answer "What is the risk of invasive species-driven ecological impacts to populations of BLM sensitive species?" Other reviewers also suggested keeping it.
  - ***Where is habitat for sensitive species that are also conservation elements?***

- ***How and where will changes in permafrost impact vegetation?***
  Resolution: Accept. AMT members recommended that we keep this question. Some habitats are linked to permafrost such as tussock tundra and permafrost plateaus. If they are mapped then we can predict where they will change due to loss of permafrost. Answering this question will also address where permafrost is located in the region, and how permafrost is expected to change over time?

- ***Where is lichen habitat in the region?***
  Resolution: Omit. See response to the following MQ.

- ***How might lichen habitat change in response to change agents?***
  Resolution: Omit. These two lichen habitat questions are redundant with the following caribou MQ. What is the current distribution of primary winter forage (lichen) for caribou in the region and how is that expected to change?
  We will also be addressing the same types of habitat questions for Moose and Musk-ox. What is the current distribution of primary winter forage (willow) for moose in the region and how is that expected to change? Is there musk ox habitat in the region? If there is musk ox habitat in the region, how might it change in the future? Where does musk ox habitat currently overlap with change agents (climate change, fire, development, invasive species, etc.)?

- ***Where are key sensitive area/core habitat areas?***

Resolution: Omit. It is redundant with the wildlife MQs. We will be addressing this when we answer the individual species questions.

- ***Where are the least ecologically sensitive areas?***
  Resolution: Omit. AMT members suggested removal of this question. Least ecologically sensitive is a subjective term that differs from species to species and habitat to habitat.

- ***Where will the habitat for sensitive species be in the future?***
  Resolution: Omit. AMT members suggested removal of this question. Our predictive capacity is too poor for this to be useful.

- ***Where might breakup and/or precipitation based floods (frequency, duration, magnitude, water levels) impact winter moose habitat?***
  Resolution: Omit. Low support for this question from the AMT.

- ***What are the primary lichen species that compose the lichen landcover classes in the region?***
  Resolution: Omit. We will answer this when we address lichen distribution for caribou.

- ***What is the distribution of ecological site descriptions throughout the region?***
  Resolution: Omit. While this is interesting information, the NRCS maintains an active database of ecological site descriptions that can be accessed by any BLM staff that is interested in the information. We suggest not repeating what is already available via NRCS web portals.

- ***How do we maintain ecosystem integrity?***
  Resolution: Omit. This question was labeled to broad and vague to be answered within the REA context. AMT supported this designation.

- ***What is the tipping point for ecosystem integrity?***
  Resolution: Omit. Tipping point is a highly subjective term, and too vague a term to be answered in this REA. However, we will partially address this question when we answer ecosystem integrity.

- ***Where are key movement corridors?***
  Resolution: Omit. This is redundant and will be answered in the individual wildlife species questions.

- ***What is the minimum size for "unfragmented" habitats?***
  Resolution: Omit. This would need to be applied to species like moose, caribou, musk-ox and species of concern. We will partially address this question when we answer ecosystem integrity.

- ***What are cascading effects of development resulting in fragmentation?***
  Resolution: Omit. This will be answered, in part, through the final landscape condition model.

- ***How much development is reasonable to maintain functional and intact ecosystems?***

Resolution: Omit. Ecosystem integrity will be a final output from the REA process and will, in part, address this question.

Wildlife

- ***Where is caribou habitat (specifically lichen) in the region and how does it seasonally vary (wintering grounds, calving grounds, etc.)?***

  Resolution: Accept. Rewritten and combined with the following MQ, as these two questions and the subsequent resolution was inter-related.

- ***How is caribou habitat expected to change?***

  Resolution: Accept. AMT respondents indicated that the first question relating to caribou habitat was impossible to answer as written and that it needed to be more inclusive of the actual season or habitat of interest – in this case winter, when the primary forage is lichen, and also on the calving grounds, the two times of year when caribou are the most stressed/vulnerable. The second question about habitat change was too vague. To resolve these ambiguities, the two questions were **re-written** as follows:

  - ***What is the current distribution of primary winter forage (lichen) for caribou in the region and how is that expected to change?***
  - ***Where are caribou calving grounds in the region and how are they expected to change?***

- ***Where is moose habitat (specifically willow) in the region and how does it seasonally vary? How is moose habitat expected to change?***

  Resolution: Accept. The above two questions were **rewritten** below. Respondents indicated that the first question relating to moose habitat was impossible to answer as written and that it needed to be more inclusive of the actual season or habitat of interest – in this case, winter when the primary forage is willow. It was not clear if seasonal variation was related to willow availability or moose distribution. The second question about habitat change was too vague. To resolve these ambiguities, the two questions were **re-written** as follows:

  - ***What is the current seasonal distribution of moose in the region?***
  - ***What is the current distribution of primary winter forage (willow) for moose in the region and how is that expected to change?***

- ***Is there musk ox habitat in the region?***

  Resolution: Accept. This question was **rewritten** and combined with the one below. There were no comments regarding the content of the three questions relating to muskox. Muskox does not occur with regularity within the region, although they have been reported as infrequent visitors. There is some concern that muskox could move into the region as a result of changing climate or due to competitive pressures from outside the region. The three muskox related questions received the lowest priority for the implicit wildlife questions, and would be the first to be eliminated from this grouping if the MQ list is reduced.

- ***If there is musk ox habitat in the region, how might it change in the future?***

  Resolution: Accept. This question was **rewritten** and **combined** with the one above.

- **Rewrite:** ***Is there musk ox habitat in the region, and if so, how might it change in the future?***

- ***Where does musk ox habitat currently overlap with change agents (climate change, fire, development, invasive species, etc.)?***

  Resolution: Omit. Since musk ox are considered a CE, this question will automatically be answered as part of the CE and CA analysis and does not need to be addressed separately.

- ***Where are key habitats and corridors likely to be in the future?***

  Resolution: Accept. This question received high priority by all respondents and therefore we recommend that it be retained. Discussion with BLM managers indicated this question was written specifically to address migration corridors for caribou. Key habitats for caribou are already being addressed in another MQ; therefore, this question was **rewritten** to read as:

  - ***What is the current distribution of migration corridors for caribou and how are they likely to change in the future?***

- ***Where are key prey species located in the region?***

  Resolution: Accept. The two questions regarding prey species received lower priority ranks by reviewers. However, prey species are important drivers to ecosystem dynamics and we feel it is important that they be represented in the mix of CEs. We suggest addressing the current distribution of prey species as an assemblage of small mammals (CEs) to include voles, lemmings, and shrews (borrowing animals, also identified in the conceptual model). Suggestions for representative taxa include northern red-backed vole, brown lemming and dusky shrew.

- ***How might key prey species distributions change in the future?***

  Resolution: Omit. Prey distributions in the future were low priority. The UA team agrees to omit this question.

- ***Are there specific landscape changes that might create barriers to migration pathways?***

  Resolution: Omit. Respondents agreed that this question should be deleted. The UA team agrees to omit these questions.

- ***What is the historical distribution of the Mulchatna caribou herd? How does this compare to the current distribution?***

  Resolution: Omit. Respondents agreed that this question should be deleted. The UA team agrees to omit these questions.

- ***What are the current densities of brown bears and black bears throughout the region?***

  Resolution: Omit. Respondents agreed that this question should be deleted. The UA team agrees to omit these questions.

- ***What are current types and levels of disease in wildlife populations?***

  Resolution: Accept. One respondent suggested restricting the question to certain species and populations of interest such that it is within the scope of the REA. **Rewritten as:**

- ***What are the current types and potential impacts of diseases in ungulate populations (caribou, moose) and how are these impacts expected to change in the future?***

- ***What is the current distribution of the American Peregrine Falcon in the region and how is that expected to change?***

  Resolution: Accept. During the first AMT meeting, and through discussion with managers afterwards, it was decided to include the American Peregrine Falcon as a specific management question. This taxon is under review by BLM as a resource identified in their Resource Management Plan for Areas of Critical Environmental Concern.

Aquatics

- ***How, where, and when could Essential Fish Habitat (EFH) be affected by predicted changes in climate?***

  Resolution: Accept. This is a priority question accepted by the AMT. Due to lack of data predicting changes in climate that will affect fish (e.g. water temperature or hydrology); this question will be answered by performing a literature review.

- ***Where are areas of overlap between mineral resources and fishery habitat?***

  Resolution: Accept. This question has been accepted by the AMT. It has been **re-written** to include a discussion of how mineral resource development may affect fish habitat.

  - ***Where and how might mineral resource development affect fishery habitat?***

- ***How and where could changes in water temperature impact aquatic species (esp. fish)?***

  Resolution: Accept. This question has been accepted by the AMT. It will not be possible to model where changes in water temperature will occur due to lack of data and a model, but a literature review will be performed to discuss how warming temperatures may affect aquatic species.

- ***What datasets and models could be used to determine where and when water temperatures will change in the future?***

  Resolution: Omit. Not identified as a priority question by the AMT.

- ***Would there be affects to hyporrheic flow and spawning areas or wintering habitat?***

  Resolution: Omit. This will be included in the MQ that addresses the effects of climate change on essential fish habitat, where literature is available.

- ***Have the increased number of weirs on the Kuskokwim River reduced the size of King Salmon runs?***

  Resolution: Omit. This question was brought up at the Aniak community meeting. However, it was not identified as a priority question by AMT.

- ***How might water chemistry change as a result of future CA (fire, development/mining, warming, etc.)?***

Resolution: Accept. Recommended for inclusion by USFWS and BLM Yukon Field Office Staff. Recommend keeping this question and answering it using a literature review.

Soil Thermal Dynamics

- ***What are the current soil thermal regime dynamics?***
  Resolution: Accept.

- ***How will the thermal soil regimes likely to change in the future?***
  Resolution: Accept. This was **rewritten** in order to be more clear and definitive
  - ***Based on the predictions of the best available climate models and soil temperature models, how will soil thermal regimes change in the future?***

- ***Where are predicted changes in soil thermal regimes associated with communities/villages?***
- ***How might changes in permafrost impact transportation routes?***
  Resolution: Accept. These two questions were **rewritten** in order to reduce the number of questions and simplify mapping outputs
  - ***Where are predicted changes in soil thermal regimes associated with communities and transportation routes?***

- ***How might permafrost-driven waterfowl habitats change in the future?***
  Resolution: Omit. This question was not included on its own but instead added to the hydrology question below, based on feedback from the AMT meeting Dec 2012.

- ***How might changes in permafrost impact water quality for human consumption?***
  Resolution: Omit. Low AMT support.

- ***How might changes in permafrost impact resource development?***
  Resolution: Omit. Low AMT support.

- ***How might changes in permafrost impact lake drying?***
  Resolution: Omit. Low AMT support.

- ***How might changes in permafrost impact designated wetlands?***
  Resolution: Omit. Low AMT support.

Hydrology

- ***How might changes in temperature, precipitation and evapotranspiration affect general hydrology in the region? How might freeze-up and break-up differ in timing and magnitude in the future? What are the likely impacts of changing freeze-up and break-up on CE habitat? How might potential changes in hydrology impact subsistence species?***
  Resolution: Accept. These four questions were **rewritten** to include soil thermal dynamics based on feedback from the AMT meeting Dec 2012, and was also combined with other accepted questions and with an added question linking waterfowl habitat.

- ***How might changes in temperature, precipitation, evapotranspiration and soil thermal dynamics affect general hydrology and hydrology-dependent CEs such as waterfowl in the region?***

- ***How will changes in permafrost change current erosion patterns?***
  Resolution: Omit. Low AMT support.

- ***What are the likely impacts of changing freeze-up and break-up on transportation and community access?***
  Resolution: Omit. Low AMT support.

- ***What are the likely impacts of changing surface water hydrology on water resources?***
  Resolution: Omit. Low AMT support.

- ***How will climate change affect glacially dominated watersheds and non-glacial systems?***
  Resolution: Omit. Low AMT support.

- ***Where are high erosion areas located within the ecoregion currently?***
  Resolution: Omit. Low AMT support.

Climate

- ***What are the projected monthly, seasonal and annual temperature, precipitation, and length of warm and cold seasons for the REA, and how do these projections vary across time, across the region, and across varying global greenhouse gas emissions scenarios?***
  Resolution: Accept.

- ***Where will climate change impact subsistence species?***
  Resolution: Accept. Rewritten re feedback from AMT December 2012 to reflect the broader nature of the true question.
  - ***Where will climate change impact CEs, including subsistence species?***

- ***How will climate change affect the distribution of invasive species (plants and insects)?***
  Resolution: Moved to invasives per suggestion

- ***Where will climate change events impact subsistence species?***
  Resolution: Omit. This pertains to single specific events, which are unpredictable.

- ***What is the current frequency (by location) of icing events in the REA?***
  Resolution: Omit. Low AMT support.

- ***How might climate change affect the frequency and location of icing events in the REA?***
  Resolution: Omit. Low AMT support.

- ***Could changes in climate impact current or future timber harvests?***
  Resolution: Omit. The more general effects on vegetation will be addressed in other parts of this assessment.

Fire

- ***What is the fire history of the ecoregion?***
  Resolution: Accept.

- ***What climactic conditions are likely to result in significant changes to fire activity?***
  Resolution: Accept.

- ***What is the current frequency (return interval) for fire in the ecoregion and broad sub-regions?***
- ***What is the likely future frequency (return interval) for fire in the ecoregion and broad sub-regions?***
  Resolution: Accept. The two questions above were combined and **rewritten** following AMT comments.
  - ***What is the current frequency (return interval) and what is the likely future frequency for fire in the ecoregion and broad sub-regions?***

- ***Where might future fires occur in relationship to future wildlife habitat?***
  Resolution: Omit. Deleted and combined with hydrology questions following AMT comments.

- ***Are wildlife and smoke impacts to communities likely to increase in response to climate change?***
  Resolution: Omit. Low AMT support.

- ***What wildfire and smoke risks have historically been experienced by communities?***
  Resolution: Omit. Low AMT support.

- ***What was the historic lightning strike frequency and pattern in the ecoregion?***
  Resolution: Omit. The AMT suggested we revaluate this questions, potentially looking at a 10 year historical time period. *Note – yes, AFS has this data, but the data are not consistently accurate over time. As detection gets better and better, more strikes are recorded. Thus, any derived correlation between fire frequency and lightning strikes is likely to be misleading.*

- ***What is the historic data for burn severity in the ecoregion?***
  Resolution: Omit. *Again, these data are inconsistent, and thus difficult to use in modeling.*

Invasive Species

- ***What is the current distribution of introduced and invasive species?***
  Resolution: Accept. Rewritten to combine with MQ: "*What is the current known area of invasive species infestations in the YKL?"* We combined these two questions in response to USGS recommendations. The two components of the question are related but

address different issues: distribution is locational (i.e. where are the populations) and area represents % of infested land (in this case 273/41,000,000 acres = $6.6e^{-6}$). The distribution informs us of particular areas or resources that may be threatened, area infested informs us about the biological integrity of the region. Both components are implicit to estimating ecological integrity of the ecoregion and are recommended to be retained.

- ***What is the current distribution and area (percent of land with infestations) of introduced and invasive species in the YKL?***

- ***What is the current known area of invasive species infestations in the YKL?***
  Resolution: Omit. Combined above.

- ***Which areas are most susceptible to infestation by invasive plant species?***
  Resolution: Accept. See below for **rewritten** questions.

- ***How will climate change likely affect the distribution of suitable habitat for invasive plant and insect species?***
  Resolution: Accept. The above two questions were **rewritten** as two questions and insects are excluded because we are not aware of non-native and ecologically damaging species in the region.
  - ***Which areas are most likely to be susceptible to infestation by invasive plant species currently?***
  - ***Which areas are most likely to be susceptible to infestation by invasive plant species in the future, specifically in relationship to climate change and proposed development?***

- ***What is the current distribution of bark beetle in the ecoregion?***
  Resolution: Accept. Rewritten. *A number of AMT and/or BLM managers have indicated native defoliators are an important ecological component to the landscape. It is possible to use known areas of defoliation from aerial surveys in the ecoregion to address this question. Factors associated with outbreaks and future scenarios of infestation is deemed inappropriate due to numerous species, stochastic nature of outbreaks, and data gaps, as well as desires to limit invasive species management questions.*
  - ***What is the current distribution of forest pest outbreaks in the ecoregion?***

- ***What are the likely vectors for new infestations or spread of existing infestations?***
  Resolution: Accept. This questions was suggested by AMT as critical for land managers. *Really addressing this question requires a separate research approach, as there are no existing studies or data for this region. An alternative approach could include a literature review on the subject more generally.*

- ***What is the risk of invasive species –driven ecological impacts to populations of BLM sensitive species?***
  Resolution: Accept. Rewritten. *UA team agreed that the original question was too broad and needed revision. Data gaps made the original question unanswerable. The rewritten question presented above emphasizes which species and/or populations appear to be most susceptible to invasive species impacts.*

- ***Which plant and animal species of conservation concern (present on federal or state conservation lists, e.g., Threatened – USFWS, Sensitive Species - BLM) may be impacted by highly invasive species?***

- ***Which abiotic factors explain the most variation in habitat suitability for highly invasive species present in the REA or likely to occur in the REA?***

  Resolution: Omit. Respondent indicated that questions related to which factors are associated with the presence of invasive species is outside the scope of the REA. Assuming habitat/climate envelop modeling is used, environmental layers explaining variation in habitat suitability is a common output and can easily be included. The UA team, however, agrees with the general comment that there are too many invasive species questions relative to the importance in the region and we therefore suggest that factors associated with suitability are included in products, but are not pulled out as separate management questions.

- ***How are the abiotic factors that explain the most variation in habitat suitability for highly invasive species likely to change over time?***

  Resolution: Omit. Future species habitat/climate envelop modeling requires the assumption of no change in parameters of species niche space. Current areas susceptible to invasion may be possible to address (although invasion susceptibility is highly species specific and exploration is possible with only a limited number of species). Future areas susceptible to invasion are acknowledged to be highly speculative (and species specific); however climate envelope modeling and relationship of invasion to development can be explored through scenarios analysis. We have reworded question 4 and reworked the invasive species in the future question.

- ***Which areas are most susceptible to infestation by pest defoliating insects and bark beetles?***

  Resolution: Omit. UA team is very dubious about modeling defoliating insect outbreak susceptibilities since factors would be species specific (and there are > 10 species of defoliators in the ecoregion). Additionally, insect outbreaks are very stochastic, and we have little data to address.

- ***Which factors explain the most variation in presence and absence of pest defoliating insect outbreaks?***

  Resolution: Omit. UA team is very dubious about modeling defoliating insect outbreak susceptibilities since factors would be species specific (and there are > 10 species of defoliators in the ecoregion). Additionally, insect outbreaks are very stochastic, and we have little data to address.

- ***What effects on subsistence species populations would the introduction of wood bison have?***

  Resolution: Omit. AMT and UA team agrees to omit this question.

- ***How are areas susceptible to pest defoliating insects and bark beetles likely to change over time?***

  Resolution: Omit. Again, the UA believes there is a problem of breadth: multiple species responding to different variables, as well as a problem of stochasticity.

Socio-economic

- ***Where are communities?***
  Resolution: Accept.

- ***What are current socio-economic conditions in YKL communities?***
  Resolution: Accept.

- ***What are the projected socio-economic conditions in the future?***
  Resolution: Accept.

- ***How could community economic profiles vary with respect to development scenarios (including mines) in the near future (including access to subsistence, energy sources, and other resources)?***
  Resolution: Accept. Attention to potential impacts of Pebble and Donlin mine (of interest to communities). This question was asked by Aniak Village Countil Chair "How will the Donlin Mine affect the community of Aniak if the plans for the mine come to fruition?".

- ***Where are culturally relevant sites located in the REA and are they likely to be disturbed by development?***
  Resolution: Omit. Scale of cultural sites is too small. Low priority for AMT.

- ***Where are culturally relevant sites in the region?***
  Resolution: Omit. See above

- ***What is the settlement history of communities in the ecoregion? (Mining settlement, original AK Native settlement, statehood, military, etc.)***
  Resolution: Omit. Too broad, vague. Low priority for AMT.

- ***How are declining fish and wildlife populations restricting sport hunting and fishing?***
  Resolution: Omit. Too broad, out of scope. Many other factors affect sport hunting levels. Would take a long time to answer. Low priority for AMT.

- ***How have general regulations affected general harvest species?***
  Resolution: Omit. Of interest to AMT out of scope. It would take a long time to estimate the relationship between harvest regulations and species populations, because there are many other factors involved.

Subsistence

- ***Where are current subsistence harvest areas?***
  Resolution: Accept.

- ***What do harvest data and TEK/LTK show about how harvest amounts, types of fish/animals/plants, harvest seasons changed in the recent past?***
  Resolution: Accept. Rewritten to reference beavers, community concern from Aniak. Original MQ from community: What are the effects of beaver trapping? Would allowing beaver trapping to control beaver populations attract bears or cause possible conflicts?

- ***What do ADFG harvest data and TEK/LTK show about how harvest amounts, types of fish/animals/plants, harvest seasons changed in the recent past (including beavers)?***

- ***Is there unreported subsistence take, and if so what is the estimated amount?***
  Resolution: Omit. No data. Most Subsistence harvest reporting is not mandatory.

- ***Are non-subsistence activities (transporters/tourists/sport hunters/sport fishermen) affecting subsistence harvests or access?***
  Resolution: Omit. Too broad, vague. Low priority for AMT.

- ***How could subsistence harvests (species, amounts, and seasons) change in the future?***
  Resolution: Omit. Too broad, as per AMT review and out of scope. Factors affecting this are beyond the region.

Sport, and commercial hunting and fishing

- ***How could changes in the hunting industry impact recreational levels?***
  Resolution: Omit. Low priority for AMT.

- ***How is commercial harvest of salmon likely to change in the future?***
  Resolution: Omit. Of interest to AMT but out of scope. Salmon population is a huge question, affected by climate change and change in ocean habitat and by-catch.

- ***What are general (sport) harvest levels of salmon, moose, caribou in the recent past?***
  Resolution: Accept. High AMT support.

- ***What have been the commercial harvest levels of salmon over the past 10 years?***
  Resolution: Accept. High AMT support.

- ***Where are current sport hunt areas?***
  Resolution: Accept Added from AMT review comments.

- ***Where are current commercial fish harvest areas?***
  Resolution: Accept. Added from AMT review comments.

Land Use

- ***Where are current timber harvests?***
  Resolution: Accept.

- ***Where is the human footprint in the region?***
  Resolution: Accept.

- ***Are there areas in the REA that are impacted by mercury contamination?***
  Resolution: Accept. Originally suggested for omission, but revised following AMT suggestions. If the contamination is coming from the closed Red Devil mine, it is a land use question and will be

merged with the following question about mines. If mercury contamination is from other sources and being exposed by permafrost thaw, it could become a permafrost question.

- ***Where are current and recent mine sites?***
  Resolution: Accept.

- ***Where are areas of highest mineral potential?***
  Resolution: Accept.

- ***Where is planned transportation/communication infrastructure to be located?***
  Resolution: Accept, **re-written** to explicitly include local trails, noted in community meetings.
    - ***Where is transportation and communications infrastructure (including local trails)?***

- ***Where are alternative and renewable energy sites?***
  Resolution: Accept.

- ***Where are areas of potential for wind, hydro, biomass energy?***
  Resolution: Accept. Rewritten to add community sites to provide information about access which was of interest to AMT.
    - ***Where are areas of potential for wind, hydro, biomass energy (and where do they overlap with communities)?***

- ***What are the potential impacts of renewable energy projects on local economies the region?***
  Resolution: Accept and **rewritten** to qualify potential impacts, available information is from Alaska Energy Authority (AEA) and is focused on the effects on fuel costs in local communities.
    - ***What are the potential impacts of renewable energy projects on local economies the region?***

- ***What is current land status in the region?***
  Resolution: Accept.

- ***Where are unsettled land claims?***
  Resolution: Accept. Of interest to communities (Aniak).

- ***Where is recreation activity highest?***
  Resolution: Accept.

- ***Where will mines be located? Can we estimate the total footprint (including tailings and associated infrastructure)?***
  Resolution: Accept.

- ***Where is planned transportation/communication infrastructure to be located?***
  Resolution: Accept.

- ***Where are planned sites for alternative/renewable energy?***
  Resolution: Accept.

- ***How might recreational use in the region change over time?***
  Resolution: Accept.

- ***How might change in transportation corridors impact communities?***
  Resolution: Accept.

- ***How could larger community populations affect subsistence resources?***
  Resolution: Accept.

- ***What are documented impacts of mining in the region?***
  Resolution: Omit. Information will be included in discussion of current and recent mines (under Recommended Inclusions, Land Use). Community meeting suggestion from Aniak original proposed: How will increased mining activity and the associated influx of new citizens affect communities and their subsistence resources?

- ***What forestry products (biomass) are available now?***
  Resolution: **Omit**. Low priority for AMT.

- ***How might accessibility of forestry products (biomass) to communities change in the future?***
  Resolution: Omit. Included under future location of energy resources and communities (under Land Use)

- ***Are current contaminated sites vulnerable to disturbance as a product of erosion in the future?***
  Resolution: Omit. Scale of contaminated data sites too small (point data), with the exception of mercury contamination from Red Devil mine (under Land Use).

- ***How is the human footprint impacting the environment?***
  Resolution: **Omit.** Low priority for AMT.

- ***How and where might newer development areas impact the environment?***
  Resolution: **Omit.** Low priority for AMT.

- ***How might timber harvest change in the future?***
  Resolution: **Omit.** Low priority for AMT.

- ***What is expected life cycle for Donlin mine? Startup-peak-end.***
  Resolution: Omit. Not regional in scope.

- ***What is the current status and impacts if any from military lands and what is forecast?***
  Resolution: Omit. Low priority for AMT.

- ***What is the seasonal round in each community (for which there is a study/data)?***
  Resolution: Omit. Low priority for AMT.

TEK

- ***What TEK is available for the region?***

  Resolution: Accept. Rewritten to clarify. Although TEK is a valuable resource, it is varied and vast and consumes enormous amount of time and resources to glean through. Since TEK is not systematically organized, it will be helpful to catalogue available TEK for the region before TEK can be used to answer a particular MQ.
    - ***What TEK is available for the region? TEK to include but not limited to ADFG case studies, and ethnographies. This project will collect and catalog TEK by community, and CA and CE where relevant.***

Conservation Elements

Conservation elements (CEs) are biotic constituents (i.e. wildlife and plant species or assemblages) or abiotic factors (i.e. soils) of regional importance in major ecosystems and habitats across the ecoregion. Selected conservation elements are meant to represent key resources in the region so that the collective group of conservation elements serves as a tool to assess ecological integrity across the region. This REA uses a two-track focus to identify conservation elements:

- **Core CEs** are resources of the ecoregion that support regional biodiversity, provide critical ecosystem functions, and provide major ecosystems services. Core CEs include native fish, wildlife, plant species, populations, and communities of regional significance. Core CEs are critical to the assessment of ecological integrity of landscapes and waterscapes and are derived primarily from the conceptual ecoregion model.
- **Desired CEs** are resources identified by the AMT, agencies, and stakeholders through management questions. Desired CEs are similar to Core CEs in that they can be comprised of wildlife, fish, species, communities, or populations of significance.

Several initial factors were considered as part of the CE selection process:

1. Whether the CE was directly identified through a management question.
2. Whether the CE was directly identified in the conceptual model.
3. Whether upon review of a preliminary list of CEs, BLM managers and/or AMT and Tech Team participants identified additional CEs that were important management considerations, but not explicitly identified in an MQ or captured in the conceptual model.

In addition to the above factors, core CEs were defined through the "coarse-filter/fine-filter" approach required by BLM guidelines and used extensively for regional and local landscape assessments (Jenkins 1976), (Noss 1987). This approach focuses on ecosystem representation as "coarse filters" with a limited subset of focal species and species assemblages as "fine filters". The coarse filter – fine filter approach is closely integrated with ecoregional and CE-specific modeling exercises.

Coarse-filter Conservation Elements

Coarse-filter CEs were identified first and include regionally significant terrestrial vegetation types and aquatic ecosystems within the assessment area. These terrestrial and aquatic coarse-filter CEs

represent the dominant ecological patterns of the ecoregion. They represent the habitat requirements of most characteristic native species, ecological functions, and ecosystem services. Ecological models (both conceptual and spatial) for these coarse-filter CEs will be fully developed later in the assessment in order to quantify the individual and cumulative impacts of change agents on the CEs.

Terrestrial coarse-filters

Nine terrestrial coarse-filter conservation elements were derived from the management questions and/or the ecosystem conceptual model (**Error! Reference source not found.**). Eight of the CEs are ecosystems. Our ecosystems are well defined and accepted within the scientific literature and include types such as Floodplains, Low Shrub (Upland-Alpine) and White Spruce (Woodland-Closed) (Upland). These ecosystems are similar and often the same as other existing classifications for Alaska including Viereck et al. (1992), Ecotypes (Jorgenson et al. 2009) and Landtype Associations in the ECOMAP (1993) hierarchy.

Note that each of our ecosystems will be treated as a successional unit and has a unique environmental site potential or site potentials. For each ecosystem we will provide bibliographies, detailed descriptions, successional information, and a map of their locations.

Table 1: Terrestrial coarse-filter conservation elements (CEs). Core CEs are derived directly from the ecoregional conceptual model; Desired CEs are derived from management questions.

No.	Conservation Element	Core/ Desired	Selection Criteria linkages to Management Questions or Conceptual Model
1	Permafrost	Core/Desired	Conceptual ecosystem function = Sediment, soil, and water retention, MQ regarding impact of changes in permafrost on vegetation.
2	Wetlands (i.e. marshes, wetlands, petlands)	Core	Conceptual ecosystem function = Nutrient inputs from the soil resources to the freshwater resources.
3	Dwarf Shrub (Upland-Alpine) (i.e not wetland and above treeline)	Core	Conceptual ecosystem function = Provides habitat for birds, mammals, and invertebrates.
4	Low Shrub (Upland-Alpine)	Core	Conceptual ecosystem function = Provides habitat for birds, mammals, and invertebrates.
5	Tall Shrub (Upland-Alpine)	Core	Conceptual ecosystem function = Provides habitat for birds, mammals, and invertebrates. Alder is also an important source of nitrogen in interior Alaska.
6	Deciduous Forest (Open-Closed) (Upland) (Includes White Spruce – Deciduous Forest)	Core	Conceptual ecosystem function = Provides habitat for birds, mammals, and invertebrates.

7	White Spruce (Woodland-Closed) (Upland)	Core	Conceptual ecosystem function = White spruce alters fire regime and fire is a primary change agent in the region.
8	Floodplains	Core	Conceptual ecosystem function = Oxbows and floodplain springs provide fish habitat.
9	Black Spruce (Woodland-Open)	Core	Conceptual ecosystem function = Provides habitat for birds, mammals, and invertebrates.

Aquatic coarse-filters

Five aquatic habitats will be used as aquatic course-filters. Headwater streams will include all first and second order streams, rivers that are third order and higher will be split into low-gradient rivers (< 2%) and high gradient rivers (> 2%), and lakes will be separated based on their connection to the stream network (connected or disconnected). The criteria used to select each aquatic coarse-filter are described in **Error! Not a valid bookmark self-reference.**.

Table 2: Seven aquatic habitats selected as coarse-filter conservation elements (CEs).

Core CEs are derived directly from the ecoregional conceptual model; Desired CEs are derived from management questions. Selection criteria number indicates the CE was (1) identified though a management question, (2) identified in the conceptual model, or (3) identified by managers.

No.	Conservation Element	Core/Desired	Selection Criteria No.	Selection Criteria linkages to Management Questions or Conceptual Model
1	Headwater streams	Core	1, 2	MQ regarding Essential Fish Habitat. Conceptual model = fish and invertebrate habitat, export of nutrients and organic matter downstream.
2	Low gradient rivers	Core	1, 2	MQ regarding Essential Fish Habitat. Conceptual model = fish and invertebrate habitat.
3	High gradient rivers	Core	1, 2	MQ regarding Essential Fish Habitat. Conceptual model = fish and invertebrate habitat.
4	Connected lakes	Core	1, 2	MQ regarding Essential Fish Habitat. Conceptual model = fish and invertebrate habitat.
6	Disconnected lakes	Core	2	Conceptual ecosystem function = flood storage, groundwater regeneration, invertebrate and waterfowl habitat.

Fine-filter Conservation Elements

Fine-filter species represent a combination of core and desired conservation elements. Core fine-filter CEs provide critical ecosystem functions and services that are not adequately represented by the coarse-filter units and are critical to the assessment of ecological integrity. Core CEs are derived directly from the ecoregional conceptual model. Desired CEs serve the same ecosystem functions and services as core CEs, but are derived from the management questions.

An initial list of taxa was developed for potential inclusion and treatment as fine-filter species in the assessment, including:

- Taxa that were forwarded by the AMT, Central Yukon and Anchorage BLM Field Offices, stakeholders, agencies, or identified during community meetings. These resources represent important subsistence species in the region or species of management consideration.
- Full species, subspecies, or varieties listed as BLM Special Status and those listed as Species of Greatest Conservation Need (SGCN) by the Alaska Wildlife Action Plan whose habitat included areas within the ecoregion.

Terrestrial fine-filters

A list of terrestrial vertebrate species was developed to provide context to the process of selecting fine-filter CEs. This list was obtained by overlaying polygon range maps

(http://aknhp.uaa.alaska.edu/maps/biotics/) for individual taxa and REA boundary. This initial list consisted of 213 taxa of which 169 were birds, 43 mammals and 1 amphibian. Of the 213 taxa, 13 (11 birds, 2 mammals) were BLM Sensitive or Watchlist Species and 119 (97 birds and 22 mammals) were included as SGCN in the Alaska Wildlife Action Plan.

BLM staff provided a list of 8 mammalian and 15 avian species for consideration as terrestrial fine-filters (**Error! Reference source not found.**). Four avian species on this list, Bristle-thighed Curlew (*Numenius tahitiensis*), Townsend's Warbler (*Setophaga townsendi*), Emperor Goose (*Chen canagica*), and McKay's Bunting (*Plectrophenax hyperboreus*) were immediately excluded from further consideration because their ranges did not extend into the REA boundary.

Nine species were selected as terrestrial fine filter conservation elements (

, Appendix E). Distribution of each of the nine terrestrial fine-filter CEs will be mapped and the potential change in distribution – caused by change agents – will be assessed. This assessment will include:

1) A species-centric conceptual model of each conservation element and its relationship to the ecoregion; and
2) Assessing the integrity of each individual conservation element.

Table 3: Nine species or assemblages selected as terrestrial fine-filter conservation elements (CEs). Core CEs are derived directly from the ecoregional conceptual model/ Desired CEs are derived from the management questions. Selection criteria number indicates the CE was (1) identified though a management question, (2) identified in the conceptual model, or (3) identified by managers. See Appendix E for additional ecological information considered during the CE selection process including body size, habitat, season of residency, winter strategy, and home range and dispersal.

No.	Conservation Elements (CEs)	Core/ Desired	Selection Criteria #	Selection Criteria Linkages to MQs or Conceptual Model
1	prey species (small mammal assemblage comprised of northern red-backed vole, brown lemming and dusky shrew or Alaska tiny shrew)	Desired	1,2	Prey species were identified directly through a management question. We suggest an assemblage of small mammals as the CE, to include voles, lemmings, and shrews. Ecosystem function =habitat availability (burrowing animals), prey base.
2	American Beaver (*Castor canadensis*)	Core	2	Ecosystem function = mechanical disturbance, major driver of hydrologic change on aquatic and riparian ecosystems.
3	Moose (*Alces americanus*)	Desired	1,2	Moose were identified directly through management questions and are an important subsistence resource to the region. Ecosystem function = food availability (prey), herbivory.
4	Caribou (*Rangifer tarandu*s)	Desired	1,2	Caribou (inclusive of the 7 herds that utilize the REA at some time during the year) were identified directly through management questions and are an important subsistence resource to the region. Ecosystem function = food availability (prey), herbivory, trampling.
5	Muskox (*Ovibos moschatus*)	Desired	1,2	Muskox were identified directly through management questions. Ecosystem function = food availability (prey), herbivory, trampling.
6	Gray Wolf (*Canis lupu*s)	Core	2	Gray wolf was selected because it is a top-level predator in the region. Ecosystem function = predation.
7	American Peregrine Falcon (*Falco peregrinus anatum*)	Desired	1,2	American Peregrine Falcon were identified directly through a management question. Conceptual model ecosystem function = predation.

No.	Conservation Elements (CEs)	Core/ Desired	Selection Criteria #	Selection Criteria Linkages to MQs or Conceptual Model
8	Trumpeter Swan (*Cygnus buccinator*)	Core	2	Condition and availability of freshwater resources influences habitat availability for waterfowl populations. Trumpeter Swan were selected as to represent waterfowl, as they are widespread in the REA, and were included in the original list of proposed conservation elements provided by BLM. Ecosystem function = habitat availability.
9	Olive-sided Flycatcher (*Contopus cooperi*)	Core	3	Boreal obligate, BLM sensitive species. Suggested by AMT member and included in the original list of proposed conservation elements provided by BLM.

Aquatic fine-filters

BLM staff proposed a list of 17 fish species for consideration as aquatic fine-filters. None of these proposed species met any of the conservation criteria listed above; therefore, the same criteria used for terrestrial fine-filters were used to select seven aquatic fine-filter species as conservation elements, which are summarized in The selection of six of the aquatic fine filters was based on species that served important ecological functions identified in the conceptual model, although those functions overlap for many of the closely related species. It is expected that the list will be reduced during data discovery to include one salmon species (subfamily Salmoninae), one whitefish species (subfamily Coregoninae) and one resident fish species.

. The selection of six of the aquatic fine filters was based on species that served important ecological functions identified in the conceptual model, although those functions overlap for many of the closely related species. It is expected that the list will be reduced during data discovery to include one salmon species (subfamily Salmoninae), one whitefish species (subfamily Coregoninae) and one resident fish species.

Table 4: Seven fish species selected as aquatic fine-filter conservation elements (CEs). Core CEs are derived directly from the ecoregional conceptual model/ Desired CEs are derived from the management questions. Selection criteria number indicates the CE was (1) identified though a management question, (2) identified in the conceptual model, or (3) identified by managers.

No.	Conservation Element	Core/ Desired	Selection Criteria No.	Selection Criteria linkages to Management Questions or Conceptual Model
1	Chinook salmon (*Oncorhynchus tshawytscha*)	Core	2	Conceptual model = nutrient inputs to both aquatic and terrestrial ecosystems, food resource for large predators.
2	chum salmon (*Oncorhynchus keta*)	Core	2	Conceptual model = nutrient inputs to both aquatic and terrestrial ecosystems, food resource for large predators.
3	sockeye salmon (*Oncorhynchus nerka)*	Core	2	Conceptual model = nutrient inputs to both aquatic and terrestrial ecosystems, food resource for large predators.
4	Dolly Varden (*Salvelinus malma*)	Core	2	Conceptual model = headwater streams. Dolly Varden are typically found in the smallest reaches of the river network.
5	northern pike (*Esox lucius*)	Core	2	Conceptual model = predation in aquatic food webs. Northern pike are resident fish that feed on other fish resulting in bioaccumulation of contaminants.

6	sheefish or inconnu (*Stenodus leucichthys*)	Core	2	Conceptual model = predation in aquatic food webs. Sheefish feed mostly on other fish and have both anadromous and resident populations, both of which tend to migrate over long distances.
7	humpback whitefish (*Coregonus clupeaformis*)	Desired	3	USGS suggested an additional whitefish species be included that is important to subsistence users. Humpback whitefish are harvested in high numbers in Interior Alaska.

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 factors that have region-wide impacts such as wildfire, invasive species, climate change, and pollution, as well as localized impacts such as development, infrastructure, and extractive energy development. CAs act differentially on individual CEs, and for some CEs, may have neutral or positive effects, but in general are expected to cause negative impacts. CAs can impact CEs at the point of occurrence as well as through indirect effects. CAs are also expected to act synergistically with other CAs to have increased or secondary effects. Change Agents in the region can be broadly organized as:

- Climate Change
- Fire
- Invasive Species
- Insects and Disease
- Land Use and Development

Climate Change

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

Climate change impacts on terrestrial habitats (with mammals and birds secondarily influenced by habitat change) are part of the REA. This includes assessment of potential changes in habitat driven by climate envelope shifts based on existing SNAP climate envelope modeling using 18 clusters for all of AK and western Canada, and linking these clusters to vegetation maps. However, it will not include direct modeling of envelopes defined by the veg/cover types identified elsewhere in the project, since such datasets are too fine-scale to be applied using this type of methodology.

Climate change impacts on aquatic habitats (with fish secondarily influenced) will be assessed based on terrestrial temperature and precipitation change, as no direct aquatic data are available. This assessment will include a qualitative discussion of potential effects, but not direct modeling of water temperature.

Fire

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

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

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

Invasive Species

Invasive species are included as change agents in all BLM Rapid Ecoregional Assessments due to their widespread capacity to disrupt ecological processes and degrade biological resources. In most of Alaska invasive species are not considered an immediate threat, however, terrestrial invasive species are causing significant ecological and economic impacts to some areas and they represent a threat to the ecological integrity of the region (see Carlson and Shephard 2007, Schwörer et al. 2011).

Examples of invasive species impacts in the state include extensive transformation of nutrient-rich, high productivity, forb-graminoid communities into nutrient-poor ericaceous tundra communities in the Aleutians due to seabird declines following fox and rat introductions (Croll et al. 2005). The establishment of sweetclover, which reaches high densities on stretches of the Nenana, Knik, Matanuska, and Stikine river floodplains, inhibits recruitment of native species (Spellman & Wurtz 2010); sweetclover also alters native plant-pollinator networks (Schneller & Carlson 2012). The expansion of waterweed, *Elodea*, in the Fairbanks area is associated with declines in grayling habitat

(Lisuzzo 2012). In Southeast and Southcentral Alaska, reed canarygrass is rapidly invading ditches, encroaching active channels, and forming mono-specific stands in wetlands (Schrader and Hennon 2005).

At present, invasive species are largely restricted to anthropogenically-disturbed areas in this ecoregion (AKEPIC 2012). It should be noted that currently benign conditions are no guarantee for future behavior; many of the most invasive species on the continent, such as purple loosestrife and starlings, have maintained deceptively innocuous populations in anthropogenic areas before spreading (Mack 2003). A total of 41 non-native plant species are known to occur within the ecoregion, most of which are not considered significant threats to natural systems (**Error! Reference source not found.**). Floodplains, wetlands, and sagebrush-graminoid steppe habitats may be most susceptible to invasion by non-native plants in the ecoregion. Aquatic systems (lakes, ponds, and slow moving, clearwater streams) could be impacted by the establishment of the waterweed *Elodea*, which has been found upstream in the Tanana watershed. Presence of invasive animal species in the ecoregion is unknown.

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

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

Insect and Disease

Insects and diseases are well-known to cause significant alterations to native habitats in Alaska. 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, larch sawfly etc.). Large-scale defoliation and mortality of dominant boreal forest communities can result in cascading effects on plant communities, wildlife, and even alter salmon spawning habitats (Fricker et al. 2006; Tremblay et al. 2011). Additionally, insect and disease impacts are closely associated with climate. For example, seasonally above normal temperatures are responsible for causing outbreaks of leafminers and spruce beetles that can result in increased wildfire activity. Thus, interactions between climate change, fire, and

insects and disease are likely to influence CEs. The impact of insect defoliators as a change agent analysis will likely be limited to existing opportunistic aerial survey data from the Forest Health Protection program (State and Private Forestry, USDA Forest Service, and Alaska Department of Natural Resources) and literature review due to the stochastic nature of insect outbreaks.

Anthropogenic Uses

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

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

- **Mining**: Possible major developments are Pebble mine, an open-pit copper mine site north of Iliamna Lake, about 17 miles from Iliamna; and Donlin Creek mine, an open-pit gold mine site about 10 miles north of the Kuskokwim River and the village Crooked Creek. Either mining project can potentially have substantial impact on transportation infrastructure, energy supply, and impact community populations, employment and subsistence. Both mines are also potential sources of contamination.
- **Recreation**: Recreation in the region includes visitors to remote lodges, dispersed and centralized facilities in state and national recreation areas. The region also hosts the Iditarod in early March which attracts hundreds of visitors but over a very short period of time.
- **Commercial and sport hunting and fishing**: Many local residents, specifically in the Lime Hills ecoregion, are commercial fishermen. Importance of commercial fishing to residents of the region, as well as the relationship between commercial and subsistence harvests will be assessed.
- **Transportation and communications infrastructure**: Most transportation infrastructure – existing and planned – is small in comparison to other areas of the US, and located within community footprints. Transportation infrastructure includes local roads, airports, ports, and local summer and winter trails that are used for subsistence purposes. Communication infrastructure includes broadband and cellular service towers and related infrastructure.
- **Energy development**: Diesel generators are the main source of electricity in communities, with increased reliance on renewable sources of energy. . Renewable energy projects in the region are small scale and designed to replace some of the energy produced by diesel generators. Lack of transmission infrastructure and a small customer base limit the size of these projects.

- **Timber harvests**: Although wood is harvested throughout the region for individual households' fuel, commercial harvesting of timber is minimal.

Limitations and Unresolved Issues

In comparison to BLM's original intent of having 30-50 MQs for the REA, the current list of MQs is too long. Current criteria for question reduction have been exhausted. While some questions may be reworded or otherwise changed during later phases of the assessment, more criteria must be identified to limit the number of questions to fit the scope and timeline of this REA.

References

AKEPIC 2012. Alaska Exotic Plant Information Clearinghouse Database. Alaska Natural Heritage Program, University of Alaska Anchorage. http://aknhp.uaa.alaska.edu/botany/akepic/ .Accessed 5 November 2012.

Bureau of Land Management (BLM) 2011. Request for Applications BLM-AK-RFA-11-L11AS00213 CFDA No. 15.231 Yukon Lowlands-Kuskokwim Mountains-Lime Hills Rapid Ecoregional Assessment Project, Alaska. Attachment 1 page 20. AUGUST 8.

Brazil, Chuck, Doug Bue, Holly Carroll, and Travis Elison. 2011. 2010 Kuskokwim Area Management Report. Fishery Mangement Report No. 11-67. Anchorage, AK. 187 pp.

Braund, Stephen R. 2011. Subsistence uses and traditional knowledge. Pages 23-1 to 23-99 In Pebble Limited Partnership. Pebble project: environmental baseline document 2004-2008.

Carlson, M.L., I.V. Lapina, M. Shephard, J. S. Conn, R. Densmore, P. Spencer, J. Heys, J. Riley and J. Nielsen. 2008. Invasiveness ranking system for non-native plants of Alaska. USDA Forest Service, R10-TP-143. 218 pp.

Carlson, M.L., and M. Shephard. 2007. The spread of invasive exotic plants in Alaska: is establishment of exotics accelerating? Harrington, T.B. and S.H. Reichard (tech. eds.). Meeting the Challenge: Invasive Plants in Pacific Northwestern Ecosystems. USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Rep. PNW-GTR-694.

Coppolillo P, Gomez H, Maisels F, Wallace R. 2004. Selection criteria for suites of landscape species as a basis for site-based conservation. Biological Conservation 115: 419–430.

Croll, D. A., J.L. Maron, J. A. Estes, E. M. Danner, G. V. Byrd. 2005. Introduced predators transform subarctic islands from grassland to tundra. Science 307:1959-1961.

Dynamac. 2011. Colorado Plateau Rapid Ecoregional Assessment. Final Memorandum I-3-c: Models, Methods, and Tools. Report to Bureau of Land Management. http://www.blm.gov/pgdata/etc/medialib/blm/wo/Communications_Directorate/public_affairs/landscape_approach/documents1.Par.2170.File.dat/FinalCPMemo1-3-c3-21-11R.pdf.

Hunter, M. L. 1991. Coping with ignorance: The coarse filter strategy for maintaining biodiversity. Pages 266-281 *in* Kohm KA, ed. Balancing on the Brink of Extinction. Washington D.C. : Island Press.

Jenkins, R. E. 1976. Maintenance of natural diversity: Approach and recommendations. *Fourty-First North American Wildlife and Natural Resources Conference*, (pp. 441-451). Washington DC.

Lisuzzo, N. 2012. Changes in Arctic Grayling fishery following the introduction of the non-native aquatic weed, *Elodea nuttallii*, altered Ffow regimes and changes in management policy. Committee for Noxious and Invasive Plant Management annual meeting. 30-31 October 2012.

Mack, R. N. 2003. Global plant dispersal, naturalization, and invasion: Pathways, modes, and circumstances. *In* G. M. Ruiz and J. T. Carlton (eds.) Invasive Species: Vectors and Management Strategies. Island Press, Washington, D.C.

Noss, R. F. 1987. From plant communities to landscapes in conservation inventories: A look at the nature conservancy (USA). *Biological Conservation , 41* (1), 11-37.

Nowacki, Gregory; Spencer, Page; Fleming, Michael; Brock, Terry; and Jorgenson, Torre. Ecoregions of Alaska: 2001. U.S. Geological Survey Open-File Report 02-297 (map).

Schneller, L. C., M. L. Carlson. 2012. Influence of white sweetclover on plant-pollinator community interactions in Alaska. Presentation 13-14 March 2012: Conserving Plant Biodiversity in a Changing World: A View from NW North America. http://depts.washington.edu/uwbg/research/plant-biodiversity-2012.shtml.

Schrader, B. and P. Hennon, compilers. 2005. Assessment of Invasive Species in Alaska and its National Forests. USDA Forest Service, Regional Office, Anchorage, AK. 26 pp.

Schwörer, T., R. Federer H. Ferren. 2011. Managing invasive species: how much money do we spend? ISER, UAA publication. http://www.iser.uaa.alaska.edu/Publications/2012_07-InvasiveSpecies.pdf.

Spellman, B.T. and T.L. Wurtz. 2010. Invasive sweetclover (*Melilotus alba*) impacts native seedling recruitment along floodplains of interior Alaska. Biological Invasions. Published online: January 6, 2011.

Stephen R. Braund & Associates. 2011. *Chapter 23: Subsistence uses and traditional knowledge Bristol Bay Drainages.* Retrieved October 15, 2012, from ARLIS: http://www.arlis.org/docs/vol2/Pebble/2004-2008%20EBD/CH23%20Subsistence%20BB.pdf

Unnasch, R. S., D. P. Braun, P. J. Comer, G. E. Eckert. 2009. The Ecological Integrity Assessment Framework: A Framework for Assessing the Ecological Integrity of Biological and Ecological Resources of the National Park System. Report to the National Park Service.

U.S. Census Bureau. 2010. *American Fact Finder*. Retrieved October 15, 2012, from http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml

Appendix A: YKL REA Community Meeting Summary

Community Meetings Structure

Three community meetings were held in Galena on 10/23/12, Newhalen on 10/24/12, and Aniak on 10/25/12. A team of BLM and University of Alaska team members presented informational material about what an REA is, where the REA will occur, and what conservation elements, change agents, and management questions will potentially be addressed. We also asked for feedback about the REA and documented community concern. We evaluated potential additions to conservation elements, change agents, and management questions and when appropriate incorporated these into the REA process.

Conservation Element Suggestions

1.1 Add martins and river otters to the conservation elements. (Aniak Traditional Council IGAP Coordinator)

1.2 Add beavers to the conservation elements; beaver populations are perhaps detrimentally high. (Aniak Traditional Council IGAP Coordinator, USFWS/Galena)

1.3 Add musk ox. Musk ox have been spotted 30 miles west of Aniak. (Aniak) Musk ox have been documented from the refuges in the western part of the study area. (Tom Seaton ADF&G)

1.4 Add Conservation Element wood bison for the potential expansion of wood bison range into the area. Innoco Flats will reintroduce wood bison eventually. (USFWS/Galena; see 3.5)

1. Change Agent Suggestions

1.1. Add larch saw fly as an invasive insect. (USFWS/Galena)

1.2. Can beavers be considered change agents? (USFWS/Galena)

2. Management Question Suggestions

2.1. What are the effects of beaver trapping? Would allowing beaver trapping to control beaver populations attract bears or cause possible conflicts? Beaver trapping ceased in the 1980s. (Aniak)

2.2. Have the increased number of weirs on the Kuskokwim River reduced the size of King Salmon runs? The first weirs were installed in the 1970s but most were installed from 1998 to 2000. These are owned and operated by ADF&G and USFWS. (Aniak)

2.3. How will increased mining activity and the associated influx of new citizens affect communities and their subsistence resources? (Aniak Village Council Chair; see 8.1 and 8.2)

2.4. What are the "fixed assets" (features that are at risk in the ecoregion that cannot move) in the study area? (USFWS/Galena)

2.5. What are the potential impacts of the expansion of wood bison range into the study area? Innoco Flats NWR will reintroduce wood bison eventually. (USFWS/Galena; see 1.5)

2.6. Why have caribou populations declined in the study area? Where have they gone and where might they be? Mulchatna herd has not been in the area for 15 years. Aleutian herd comes to Lake Iliamna and turns back, whereas they used to stay in the area in the past. Compare historical patterns to current trends and generate future predictions. (Newhalen)

2.6.1. Has the high volume of helicopter traffic caused caribou to leave or avoid the study area? (Newhalen)

2.6.2. Have high bear populations, especially on calving areas, caused caribou to leave or avoid the study area? (Newhalen)

2.6.3. Have the caribou eaten all of their food resources in the study area? A Newhalen resident claims that the NPS indicated that caribou left the ecoregion because they had eaten all of the moss, which takes 7 years to grow back. (Newhalen)

2.7. How can brown bear and black bear populations be managed? There is some feeling that there are too many bears in the study area and a control program is needed. (USFWS/Galena)

2.8. How will the Donlin Mine affect the community of Aniak if the plans for the mine come to fruition? The Legislative Finance Committee has not funded planning assistance for the community. There is concern over the planning for new citizens in the community and how those new citizens will impact the subsistence resources. (Aniak Village Council Chair; see 3.3)

3. Traditional Ecological Knowledge

3.1. Deep snow insulates vegetation over winter and results in better growth during summer. (Nondalton resident)

4. Study Questions and Comments

4.1. Can the Management Questions be posted online or made into a web site once completed? Additionally, a web site could explain the rationale behind the YKL REA specifically. (USFWS/Galena)

4.2. Can management questions be removed from the REA based on lack of data? (USFWS/Galena)

4.3. Will new regulations result from this study? (Donlin Village Council Chair)

4.4. How will this information be used? (Aniak Community Member, Newhalen)

4.5. Need unbiased information. BLM and UA are sources of unbiased information. (Nondalton resident)

4.6. How useful is landcover data for site-specific impacts? (USFWS/Galena)

4.7. How will Lichen be used as a landcover class and how can fine resolution data be incorporated? (USFWS/Galena)

4.8. A data gap exists for systematic invasive plants surveys. (USFWS/Galena)

4.9. UAF may have water quality data from the Newhalen area. The local school participated in a study with UAF gathering water quality data. (Newhalen)

5. Agency Questions and Comments

5.1. How will the agencies work together? (Aniak Community Member)

5.2. How is the state of Alaska involved? (Pebble Representatives)

5.3. The BLM and Red Devil Mine have a relationship of distrust (Aniak Traditional Council IGAP Coordinator)

5.4. Smaller corporations should be involved and included as well (Aniak Traditional Council IGAP Coordinator)

6. Socioeconomic and Subsistence Questions and Comments

6.1. There is currently a notion in the ecoregion of incorporating and becoming a borough to be able to provide the governmental framework for increased population size and development. (Aniak Village Council Chair; see 3.3)

6.2. There are still lots of unclaimed/unsettled claims lands that the state and those with Native claims disagree over. (Aniak)

6.3. Solicit local knowledge of trails and snow machine use (USFWS/Galena)

7. Useful Project Contacts Suggested at the Meetings

7.1. John Oscar: Kuskokwim Watershed Council, Bethel, AK, 907-545-3980 (work)

7.2. Joshua Rose: USGS conducting permafrost and soils analysis along the Yukon River at high resolution (Yukon Flats Permafrost Mapping and Modeling)

7.3. Tom Seaton: ADF&G state coordinator for musk ox

List of attendees and their affiliation for each of the community meetings.

Name	Organization	E-mail
Galena-October 23, 2012		
Scott Guyer	BLM	sguyer@blm.gov
Keith Ramos	FWS	keith_ramos@fws.gov
Aimee Rockhill	FWS	aimee_rockhill@fws.gov
Karin Bodony	FWS	karin_bodony@fws.gov
Shelly Jacobson	BLM	S05jacobso@blm.gov
Ben Pratt	FWS	benjamin_pratt@fws.gov
Jeremy Havener	FWS	jeremy_havener@fws.gov

Name	Organization	E-mail
Steve Hartmann	BLM	shartmann@blm.gov
Nancy Fresco	UAF	nlfresco@alaska.edu
Monica McTeague	UAA	mlmcteague@uaa.alaska.edu
Jamie Trammell	UAA	ejtrammell@uaa.alaska.edu
Newhalen-October 24, 2012		
Virginia Delkittie	Self	N/A
Cathleen Gust	Self	mybabyangel@hotmail.com
Denise Nickoli	PLP	denisenickoli@pebblepartnership.com
Taralynn Anelon	Self	trefon2donlee@hotmail.com
Terry Wassille	NTC	N/A
Russ Leslie	UAF	N/A
Bill Cornell	UAF	N/A
Monica McTeague	UAA	mlmcteague@uaa.alaska.edu
Jamie Trammell	UAA	ejtrammell@uaa.alaska.edu

Name	Organization	E-mail
Scott Guyer	BLM	sguyer@blm.gov
Aniak – October 25, 2012		
Scott Guyer	BLM	sguyer@blm.gov
Monica McTeague	UAA	mlmcteague@uaa.alaska.edu
Jamie Trammell	UAA	ejtrammell@uaa.alaska.edu
Enric Fernandez	Donlin Gold	efernandez@donlingold.com
Muriel Morgan	TKC	ltbearwoman@yahoo.com
William G. Morgan	TKC	itbearwoman@yahoo.com
Gina D. McKinely	Aniak Traditional Council	aniakepadept@yahoo.com
Wayne Morgan	Donlin Gold/Aniak Traditional Council	wmorganchief@yahoo.com
Verdene Morgan	Aniak Traditional Council	aniakepadept@yahoo.com

Appendix B: Rare Fine-Filter Conservation Elements Identified by BLM.

Proposed list of Conservation Elements developed by the BLM Anchorage Field Office (AFO) and Central Yukon Field Office (CYO) for the YKL REA.

Mammals
Western arctic caribou hers
Mulchatna caribou herd
Small isolated caribou herds
Moose
Muskox
Black bear
Brown bear
Gray wolf
Alaska tiny shrew
Alaskan hare
Birds
American Peregrine Falcon
Bristle-thighed Curlew
Black Scoter
Rusty Blackbird
Blackpoll Warbler
Gray-cheeked Thrush
Townsend's Warbler
Trumpeter Swan
Emperor Goose
Kittlitz's Murrelet
Marbled Murrelet
Short-eared Owl
Olive-sided Flycatcher
Golden Eagle
McKay's Bunting
Other raptors (ACECs on Kuskokwim Mountains for raptor nesting habitat)

Appendix C: List of non-native plants in the Yukon Lowlands, Kuskokwim Mountains, Lime Hills Ecoregion

List of non-native plants in the Yukon Lowlands, Kuskokwim Mountains, and Lime Hills Ecoregion. Data are extracted from the University of Alaska's Alaska Exotic Plant Information Clearinghouse (http://aknhp.uaa.alaska.edu/maps/akepic/). * Rank indicates Invasiveness Rank (see Carlson et al. 2008 and Nawrocki et al. 2011).

Scientific Name	Common Name	Family	Rank*	Total Infested Acres
Amaranthus retroflexus L.	redroot pigweed	Amaranthaceae	45	0.078
Bromus inermis Leyss.	smooth brome	Poaceae	62	1.093
Campanula rapunculoides L.	rampion bellflower	Campanulaceae	64	0.5
Capsella bursa-pastoris (L.) Medik.	shepherd's purse	Brassicaceae	40	0.101
Caragana arborescens Lam.	Siberian peashrub	Fabaceae	74	0.101
Cerastium fontanum Baumg. ssp. *vulgare* (Hartm.) Greuter & Burdet	big chickweed	Caryophyllaceae	36	2.01
Chenopodium album L.	lambsquarters	Chenopodiaceae	37	38.596
Crepis tectorum L.	narrowleaf hawksbeard	Asteraceae	56	38.021
Descurainia sophia (L.) Webb ex Prantl	herb sophia	Brassicaceae	41	0.023
Elymus repens (L.) Gould	quackgrass	Poaceae	59	2.85
Euphrasia nemorosa á(Pers.) Wallr.	common eyebright	Orobanchaceae	42	0.02
Fallopia convolvulus (L.) A. Love	black bindweed	Polygonaceae	50	0.01
Galeopsis bifida Boenn.	splitlip hempnettle	Lamiaceae	50	5.801
Galeopsis tetrahit L.	brittlestem hempnettle	Lamiaceae	50	0.001
Hordeum jubatum L.	foxtail barley	Poaceae	63	20.837
Hordeum vulgare L.	common barley	Poaceae	39	0.51
Leontodon autumnalis L.	fall dandelion	Asteraceae	51	0.1
Lepidium densiflorum Schrad.	common pepperweed	Brassicaceae	25	0.001
Leucanthemum vulgare Lam.	oxeye daisy	Asteraceae	61	1.22
Linaria vulgaris P. Mill.	yellow toadflax	Plantaginaceae	69	0.84
Lolium multiflorum Lam.	Italian ryegrass	Poaceae	41	0.5
Lolium perenne L.	perennial ryegrass	Poaceae	52	1
Matricaria discoidea DC	pineappleweed	Asteraceae	32	45.841
Melilotus albus Medikus	white sweetclover	Fabaceae	81	0.011
Phleum pratense L.	timothy	Poaceae	54	0.078
Plantago major L.	common plantain	Plantaginaceae	44	35.383
Poa annua L.	annual bluegrass	Poaceae	46	1.502
Poa pratensis L. ssp. *irrigata* (Lindm.) H. Lindb. or *Poa pratensis* L. ssp. *pratensis*	spreading bluegrass or Kentucky bluegrass	Poaceae	52	0.612
Polygonum aviculare L.	prostrate knotweed	Polygonaceae	45	12.424

Scientific Name	Common Name	Family	Rank*	Total Infested Acres
Prunus padus L.	European bird cherry	Rosaceae	74	0.011
Prunus virginiana L.	chokecherry	Rosaceae	74	0.011
Rumex acetosella L.	common sheep sorrel	Polygonaceae	51	0.281
Rumex crispus L.	curly dock	Polygonaceae	48	0.01
Stellaria media (L.) Vill.	common chickweed	Caryophyllaceae	42	15.808
Taraxacum officinale F.H. Wigg.	common dandelion	Asteraceae	58	30.146
Trifolium hybridum L.	alsike clover	Fabaceae	57	3.11
Trifolium pratense L.	red clover	Fabaceae	53	1.5
Trifolium repens L.	white clover	Fabaceae	59	11.694
Tripleurospermum inodorum (L.) Sch. Bip.	scentless false mayweed	Asteraceae	48	0.21
Vicia cracca L. ssp. *cracca*	bird vetch	Fabaceae	73	0.01
Viola tricolor L.	johnny jumpup	Fabaceae	34	0.01

Appendix D. Current list of Management Questions

Landcover

1. ***What are the possible impacts on vegetation communities from climate change?***
2. ***What is the current distribution of vegetation communities?***
3. ***Where is habitat for sensitive species that are also conservation elements?***
4. ***How and where will changes in permafrost impact vegetation?***

Wildlife

5. ***What is the current distribution of primary winter forage (lichen) for caribou in the region and how is that expected to change?***
6. ***Where are caribou calving grounds in the region and how are they expected to change?***
7. ***What is the current seasonal distribution of moose in the region?***
8. ***What is the current distribution of primary winter forage (willow) for moose in the region and how is that expected to change?***
9. ***Is there musk ox habitat in the region, and if so, how might it change in the future?***
10. ***What is the current distribution of migration corridors for caribou and how are they likely to change in the future?***
11. ***Where are key prey species located in the region?***
12. ***What are the current types and potential impacts of diseases in ungulate populations (caribou, moose) and how are these impacts expected to change in the future?***
13. ***What is the current distribution of the American Peregrine Falcon in the region and how is that expected to change?***

Aquatics

14. ***How, where, and when could Essential Fish Habitat (EFH) be affected by predicted changes in climate?***
15. ***Where and how might mineral resource development affect fishery habitat?***
16. ***How and where could changes in water temperature impact aquatic species (esp. fish)?***
17. ***How might water chemistry change as a result of future CA (fire, development/mining, warming, etc.)?***

Soil Thermal Dynamics

18. ***What are the current soil thermal regime dynamics?***
19. ***Based on the predictions of the best available climate models and soil temperature models, how will soil thermal regimes change in the future?***
20. ***Where are predicted changes in soil thermal regimes associated with communities/villages?***
21. ***How might changes in permafrost impact transportation routes?***
22. ***Where are predicted changes in soil thermal regimes associated with communities and transportation routes?***

Hydrology

23. ***How might changes in temperature, precipitation, evapotranspiration and soil thermal dynamics affect general hydrology and hydrology-dependent CEs such as waterfowl in the region?***

Climate

24. ***What are the projected monthly, seasonal and annual temperature, precipitation, and length of warm and cold seasons for the REA, and how do these projections vary across time, across the region, and across varying global greenhouse gas emissions scenarios?***
25. **Where will climate change impact CEs, including subsistence species?**

Fire

26. ***What is the fire history of the ecoregion?***
27. ***What climactic conditions are likely to result in significant changes to fire activity?***
28. ***What is the current frequency (return interval) and what is the likely future frequency for fire in the ecoregion and broad sub-regions?***

Invasives

29. ***What is the current distribution and area (percent of land with infestations) of introduced and invasive species in the YKL?***
30. ***Which areas are most susceptible to infestation by invasive plant species?***
31. ***Which areas are most likely to be susceptible to infestation by invasive plant species currently?***
32. ***Which areas are most likely to be susceptible to infestation by invasive plant species in the future, specifically in relationship to climate change and proposed development?***
33. ***What is the current distribution of forest pest outbreaks in the ecoregion?***
34. ***What are the likely vectors for new infestations or spread of existing infestations?***
35. ***Which plant and animal species of conservation concern (present on federal or state conservation lists, e.g., Threatened – USFWS, Sensitive Species - BLM) may be impacted by highly invasive species?***

Socio-economic

36. ***Where are communities?***
37. ***What are current socio-economic conditions in YKL communities?***
38. ***What are the projected socio-economic conditions in the future?***
39. ***How could community economic profiles vary with respect to development scenarios (including mines) in the near future (including access to subsistence, energy sources, and other resources)?***

Subsistence

40. ***Where are current subsistence harvest areas?***
41. ***What do ADFG harvest data and TEK/LTK show about how harvest amounts, types of fish/animals/plants, harvest seasons changed in the recent past (including beavers)?***

Sport, and commercial hunting and fishing

42. ***What are general (sport) harvest levels of salmon, moose, caribou in the recent past?***
43. ***What have been the commercial harvest levels of salmon over the past 10 years?***
44. ***Where are current sport hunt areas?***
45. ***Where are current commercial fish harvest areas?***

Land Use

46. ***Where are current timber harvests?***
47. ***Where is the human footprint in the region?***
48. ***Are there areas in the REA that are impacted by mercury contamination?***
49. ***Where are current and recent mine sites?***
50. ***Where are areas of highest mineral potential?***
51. ***Where is transportation and communications infrastructure (including local trails)?***
52. ***Where are alternative and renewable energy sites?***
53. ***Where are areas of potential for wind, hydro, biomass energy (and where do they overlap with communities)?***
54. ***What are the potential impacts of renewable energy projects on local economies the region?***
55. ***What is current land status in the region?***
56. ***Where are unsettled land claims?***
57. ***Where is recreation activity highest?***

58. ***Where will mines be located? Can we estimate the total footprint (including tailings and associated infrastructure)?***
59. ***Where is planned transportation/communication infrastructure to be located?***
60. ***Where are planned sites for alternative/renewable energy?***
61. ***How might recreational use in the region change over time?***
62. ***How might change in transportation corridors impact communities?***
63. ***How could larger community populations affect subsistence resources?***

TEK

64. ***What TEK is available for the region?***

Appendix E. Terrestrial Fine-filter Conservation Elements

Additional ecological information considered during the terrestrial fine-filter conservation element selection process, including body size, general habitat usage, season of residency, winter survival strategy, and home range size and dispersal ability.

No.	Conservation Elements	Body Size	Habitats (general)	Season of residency	Winter strategy	Home range/Dispersal
1	prey species (small mammal assemblage comprised of northern red-backed vole, brown lemming and dusky shrew or Alaska tiny shrew)	small herbivore (voles and lemmings); small carnivore (shrews)	Forest, tundra, low shrub, herbaceous	year-round, non-migratory	Subnivian (active beneath snow), store food	small home range, short distance dispersal
2	American Beaver (*Castor canadensis*)	medium-sized herbivore	Deciduous forest, tall shrub, lakes, rivers	yearround, non-migratory	Somewhat active, exhibit torpor, remain below ice	Home range , 2km, but juveniles may disperse up to 200 stream km
3	Moose (*Alces americanus*)	large/very large herbivore	Forest, wetlands, riparian tall + low shrub	yearround, seasonal movements	Active, adapted to cold and less food, use body reserves	home range at least 4000 hectares, some individuals migrate up to 180 km
4	Caribou (*Rangifer tarandus*)	large/very large herbivore	Tundra, open woodlands	yearround, migratory	Active, adapted to cold and less food, use body reserves	Variable by herd, >50 km. Tundra populations may migrate 1200 km between summer -winter range; other populations make seasonal elevational migrations
5	Muskox (*Ovibos moschatus*)	large/very large herbivore	Tundra, graminoid, tall + low shrub	yearround, seasonal movements	Active, adapted to cold and less food, use body reserves	up to 80 km (probably closer to 50km)
6	Gray Wolf (*Canis lupus*)	medium-large carnivore	Forests, tundra	yearround	Active, adapted to cold	home ranges 600 to 800 sq. km; highly mobile, disperse or migrate hundreds of kms
7	American Peregrine Falcon (*Falco peregrinus anatum*)	medium raptor	tundra, open forest, rocky cliffs/bluffs, rivers	summer, migratory	Migrate southward	home range 8-12 km, but disperses widely

No.	Conservation Elements	Body Size	Habitats (general)	Season of residency	Winter strategy	Home range/Dispersal
8	Trumpeter Swan (*Cygnus buccinator*)	large waterbird	ponds, lakes, marshes	summer, migratory	Migrate southward	home range @ 10km, but disperses widely
9	Olive-sided Flycatcher (*Contopus cooperi*)	small passerine	forest, woodland, burned-over areas	summer, migratory	Migrate southward	home range @ 5km, but disperses widely