# K. Data Gaps and Omissions

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**Summary**

Section K. *Data Gaps and Omissions* details the compiled data gaps from all topics included in the REA and describes important omitted management questions.

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# 1. Data Gaps and Limitations

The data gaps summarized here are related to the limitations described after the results for each CA, CE, or MQ in the previous sections. The summary below is intended to provide comprehensive documentation of all listed data gaps encountered throughout the REA process for the Central Yukon study area. However, this is intended to provide a quick reference of data gaps and limitations. ***For full context of data gaps please refer to appropriate text sections.*** Data gaps are organized by CA and then CE. A list of omitted and high to low level ranked Management Questions are summarized at the end.

## 1.1 Data Limitations Related to Climate Change Modeling

- While the baseline climate data used in SNAP's downscaling procedure (e.g. PRISM and CRU data) have been peer reviewed and accepted by the climate research community; nonetheless, data inputs, as well as subsequent analysis and interpretation, includes multiple sources of error. Thus uncertainty is inherent in all climate projections.
- Much of this uncertainty is addressed by using averages across multiple models and across decades. Uncertainty with regard to human behavior leads to inherent uncertainty in selecting the most appropriate emissions scenario. Regardless, all projections must still be understood in the context of the methodology.
- As described under Temperature Sensitivity Analysis and Precipitation Sensitivity Analysis, climate results are deemed significant when trends are outside the range of variability that can be expected within and between models.
- While between-model variability does not capture all sources of uncertainty, it serves as a reasonable proxy for model uncertainty.

### Temperature

- Available temperature data at the scale, coverage, and resolution necessary for this analysis were monthly rather than daily resolution. This imposed limitations, especially when trying to relate temperature change to communities, species and habitats.
- Extreme temperatures and temperature variability from day to day are sometimes more important variables than mean temperatures, when predicting the effects of heat stress, cold tolerance, and resilience.

### Precipitation

Precipitation data do not differentiate between rain and snow; nor is any direct metric available for snowpack depth, rain on snow events, or other parameters that directly or indirectly impact certain CEs. However, we were able to add snow day fraction to the climate-related datasets in order to partially meet this need.

### Snow Day Fraction

- Although the equations provide a reasonable fit to the data, model evaluation demonstrated that some weather stations are consistently less well described by regional models than others. Very few weather stations with long records are located above 500 m elevation in Alaska, so the equations were developed primarily from low-elevation weather stations, and thus may not be appropriate in the mountains.

- Equations summarize a long-term monthly relationship between temperature and precipitation type that is the result of short-term weather variability.
- In using these equations to make projections of future snow, we are assuming that these relationships remain consistent over time.

### Date of Freeze and Date of Thaw

- Date of freeze (DOF), date of thaw (DOT), and season length do not correspond to metrics of freeze and thaw for particular waterbodies or soils.
- Varied lag times apply.
- Change in DOF or DOT can reasonably be used as a rough proxy for related measures, however. For example, if DOT is projected to shift one week later in the area surrounding a wetland or lake, it is reasonable to expect that the wetland or lake would lose its ice cover approximately one week later, as compared to current averages.
- If land managers or local residents have a feel for what is “normal” then such metrics can prove useful for future decision-making.

## 1.2 Data Limitations Related to Fire

- Alaska Frame-based Ecosystem Code (ALFRESCO) is not suited to fine-scale analysis at either a temporal or spatial level, due to the stochastic nature of its outputs. Thus, interpretation should be considered more broadly, in terms of trends over time, rather than in terms of specific fire behavior at particular sites.
- Given that data were not available regarding fire severity, either in the historical data or via model outputs, we could not analyze the impacts of this important factor.
- Because the ALFRESCO model is not directly linked to either the climate/vegetation (cliomes) model or the permafrost model used in this assessment, feedback between vegetation, fire, and soil thermal dynamics could be considered only qualitatively, not quantitatively.

## 1.3 Data Limitations Related to Soil Thermodynamics

- Uncertainty of permafrost modeling is present at multiple levels, stemming from the inherent uncertainties of climate modeling and the uncertainty associated with linking climate to soil thermal dynamics.
- Despite the best available ground-truthing and validation of the Geophysical Institute Permafrost Laboratory (GIPL) permafrost model model and the most reliable available climate projections from SNAP data, uncertainty is inherent in both models, and in the linked modeling of climate-induced permafrost change.
- Fine-scale changes in permafrost conditions at a scale of meters rather than kilometers cannot be accurately predicted by the GIPL model.
- The GIPL model cannot predict the formation of specific thermokarst features or the drainage of specific lakes from permafrost thaw. However, the predicted changes in permafrost at the landscape level indicate where such phenomena will be most likely.
- The feedbacks between permafrost thaw and vegetation change are not always clearly understood. Moreover, these threshold dynamics are complicated by feedbacks between fire, vegetation, and climate.

- Permafrost can thaw very rapidly following fire, especially if the organic layer is consumed, but, stochastic models cannot predict the exact timing, location, or intensity of fires.
- The joint SNAP/GIPL model represents, at best, data for climate, soils, insulating vegetation and other key variables at 1 km resolution. Discontinuous permafrost can vary at scales much finer than this, due to variable slope and aspect, drainage patterns, and numerous other factors.

## 1.4 Data Gaps and Limitations Related to Invasive Species

- Survey data on non-native species are lacking for many regions of the state, including a large portion of the CYR study area.
- Surveys are concentrated in areas associated with population centers and along road systems.
- Interpretation of current infestations is based on a fraction of the area being surveyed for non-native plants, and those surveys being conducted preferentially in habitats likely to have non-native plants.
- The spatial bias in survey intensity towards areas in, and adjacent to, human habitation is likely to inflate the importance of roads and population centers in the classification tree analysis. However, the surveys that have been conducted in more remote areas of the state suggest that non-native species are very uncommon outside of roadways and population centers.
- The invasion vulnerability model did not include a number of variables that may influence invasion potential, notably wildfire. The frequency, extent, and severity of wildfire may influence probabilities of future invasions in this region.
- Disturbances such as herbivorous insect outbreaks and wildfires are expected to increase the probability of non-native plant invasion; however, we are unable to incorporate these factors in a meaningful spatial context.
- The analysis of infestation vulnerability is restricted to a scale coarser than the area we are likely to see invaded on the landscape. For example, a 5$^{th}$-Level HUC with “high infestation vulnerability” is likely to have weed infestations present only in a small portion of the HUC.

### Elodea

- Our invasion vulnerability approach to the aquatic invader, *Elodea*, did not incorporate many habitat and probability of dispersal variables that are known to be important.
- We developed a coarse rubric to define accessibility of lakes by floatplanes, which was not able to include additional factors such as lake depth or shape, presence of obstructions, lack of appropriate approach to shore, etc., that would result in inaccessibility of lakes longer than 1 km.
- The probability or frequency of landings was not incorporated; lakes closer to urban centers or those with greater recreational uses are likely to receive more floatplane traffic.
- While we did include a broad-scale climate suitability approach with this species, we were not able to incorporate finer-scale habitat features that influence the establishment of *Elodea* (e.g., pH from 6.0–7.5, organic substrates, etc.).

- Future infestation vulnerabilities are based on scenarios of climate change and development that are inherently uncertain (see Section C. Abiotic Change Agents) and caution should be exercised in interpretation of those outputs.

## 1.5 Data Gaps and Limitations Related to Insects and Disease

- Range polygons or distribution models for insect agents are not available in Alaska.
- Aerial forest damage surveys do not delineate the ranges of insect agents, only those present in high enough concentration to cause defoliation or mortality severe enough to be seen from an airplane.
- Aerial forest damage surveys have concentrated along major riparian corridors in the past, leaving large areas of spruce forest, mixed spruce – hardwood forest, and tall shrub un-surveyed.
- Of surveyed areas, some were visited in multiple years where others were only flown during a single year.
- No more than 25% of the forested area of Alaska is surveyed during a single year, so data from any single year provides an incomplete synopsis of trends in the status of insect and disease agents.
- Many of the observations are not ground-truthed because of the limited resources.
- Some insect and disease agents are not readily detectable by aerial survey.
- Damage polygons vary in accuracy. Generally, they should be regarded as having low accuracy boundaries.
- A large area of forest damage observed in the CYR study area is not associated with a causal agent. Only native insect and disease agents have been specifically identified as causal agents.
- Any potential forest damage caused by non-native species has been lumped with forest damage caused by native insect and disease agents in the aerial forest damage surveys and therefore in this assessment as well.
- Distinguishing the relative contribution of stochasticity versus annual survey coverage is not possible when comparing data between individual years. Large fluctuations in the amount of damage observed annually for a single insect agent could be the result of: a.) actual annual fluctuations in insect activity and population or b.) survey coverage of areas differentially affected by particular insect agents.
- Because of the stochasticity of insect outbreaks, it was not possible to predict or model future insect outbreaks by area, location, or intensity. Modeling future potential for insect outbreaks was also not possible because of stochasticity of outbreaks and poor understanding of many environmental factors influencing outbreaks.
- The climate-vulnerability assessment for spruce beetle cannot be interpreted as a prediction of location or severity of future spruce mortality nor does it show the locations of future severe, regional spruce beetle outbreaks.

## 1.6 Data Gaps Related to Anthropogenic Change Agents

- The State of Alaska has excellent demographic and census data, but assessing the effect of specific industries (i.e., oil/gas, mining, tourism, etc.) can be difficult because secondary employment, expenditures, and spending are often uncoupled during data collection.
- One of the largest data gaps is the lack of a regularly maintained infrastructure dataset (i.e., land and air) that includes dates for expansion or contraction.
- Another data gap is the lack of historic resource extraction information. The ARDF attempts to capture past mining, but this database is a work in progress.
- The BLM has started to digitize their materials sites data the GIS information prior to 2009 is only updated as needed. One issue with the material sites permits is that there are separate permitting numbers used by different agencies.
- We used the USGS mineral potential report and spatial data as a proxy for potential future mining activity. This is a big assumption the correlation between high potential and high development is not always true. Overall, future mining activity presented in this report should be viewed with caution.
- The USGS mineral report does not cover the entire CYR study area so only the ARDF was used to examine areas outside of the report region.
- The distressed community list compiled by the Denali Commission is useful at identifying communities that are distressed, however the underlying mechanisms are not captured because there is no documentation about which of the two criteria were not met by each community.
- Data about recreation use on federal land, other than NPS, and state land is limited.
- The NPS data that was used has issues in that the definition of a visitor differs from place to place.
- Failing to report hunting activity or harvests is an issue with all self-reporting harvest data and reported hunting and harvest data should be viewed as a minimum.
- The same can be said for the sport fish angler data. Especially given that slightly less than half of the communities in the CYR study area (n = 32) reported sport fishing activity. So harvests reported with this database do not reflect subsistence harvest, even subsistence harvest done with a rod and reel.
- After 2010 the State harvest data is no longer included in the federal data due to security issues. Now the federal database only captures a small portion of harvest activity in the CYR study area.
- Only the federal database reports harvest at the community level and residency (Alaska versus Non-Alaska resident). State data is reported at the GMU level, which is too large to make inferences about community harvests or how certain development actions (i.e., access) might change harvest.
- Subsistence surveys typically include a mapping component but they are not conducted in every community and there may only be a single year of data and harvest activity can vary greatly from year to year.
- Household surveys are also not conducted that often in larger communities (> 1,000 people).
- The ADF&G Division of Subsistence has more spatial data, but currently there is no automated system for public access. Thus employees must handle requests, which take time and money away from their current duties.

- Native or Tribal entities, collect subsistence information but access is limited and data is scattered and can be lost.
- Changes in reporting methods and data collection can obscure trends as was seen with caribou harvests (Figure E-40).
- Harvests increased in the northern regions, but in the 1990s there were no harvests reported.
- Another data gap is the lack of caribou data from hunters living north of the Yukon River.
- Overall, the harvest data for residents of rural Alaska is likely represents a minimum of actual harvests levels.
- The ADF&G data does not differentiate between hunters and hunts which is an issue because the use of multiple permits (i.e., hunts) is becoming an issue and can over estimate the amount of hunting activity.
- The CSIS database contains information on subsistence harvests in Alaska, but it is easy to misuse. Harvests can be overestimated because the data is reported multiple times at different scales with no clear guide how lower level resources fit into higher level categories.

## 1.7 Data Gaps Related to Landscape and Ecology

### Landscape Condition Model

- Not all landscapes respond the same way to specific land uses (i.e., roads likely have a larger impact on wetlands than uplands), and thus the LCM serves as a relative measure of impact.
- Along these lines, little empirical data exist for the impacts of specific land uses on ecosystem components that exist in Alaska.
- Accurately mapped local and community road data are identified as a data gap.
- Finally, although this data is provided at a 60 m resolution, results and analysis should be interpreted at a broader scale. The LCM, like other datasets from this REA, is best considered in the context of the entire assessment area, or summarized at the 5th-level HUCs.

### Landscape Intactness

- Our landscape intactness model assumes that 1) the current and historical human footprint is accurately modeled for the region and 2) areas not impacted by the human footprint are indeed intact.

### Cumulative Impacts

- The collinearity between the different change agents means that this analysis could overestimate impacts to the landscape (i.e. active layer thickness is certainly correlated to mean July temperature, but are included as two distinct stressors in this analysis).
- Some CAs are spatially restricted (i.e. active layer is only available with continuous permafrost) and is therefore not correlated with climatic variables across the entire region. Thus, although the CI ignores the collinearity between CAs, it still provides a cumulative assessment of potential landscape stressors that would require different resource management strategies.

- Modeled outputs are placed into other models, each with different assumptions, potentially propagating errors throughout. While many of these models were never designed to interact, we feel confident that all our modeling efforts represent the best available knowledge about the system and potential impacts.

## 1.8 Data Gaps and Limitations Related to Terrestrial Coarse-Filter Conservation Elements

### Landcover Datasets and CE Distributions

#### *Limitations of the floodplain layer*

- Floodplain models based on IfSAR elevation data would provide a more accurate depiction of floodplain boundaries; however IfSAR, coverage is currently incomplete across the CYR study area.

#### *Limitations in the NLCD forest classification*

- The forest classes in NLCD are defined by trees at least 5 m tall with at least 20% canopy cover, and thus, short-statured trees and woodland classes (< 20% tree cover) may be included within the NLCD shrub/scrub class.
- However, because NLCD uses a consistent forest classification across the region and has a published accuracy assessment, we felt that this inherent limitation in the classification was outweighed by other benefits of the NLCD.

#### *Limitations in the NLCD shrub and herbaceous classes*

- We used the AKVM to define the alpine dwarf shrub tundra CE and alpine and arctic tussock tundra CE because the NLCD classification of non-forested vegetation does not accurately reflect the tundra and alpine vegetation classes of Alaska. This resulted in drastic under-mapping of tussock tundra vegetation with much of the tussock tundra area included in the shrub/scrub or dwarf shrub classes.

#### *Limitations of the AKVM*

- The AKVM is a mosaic of various source maps, some of which are based on old LandSat imagery, and many maps are out-of-date due to the frequent fire return interval of the region.
- Areas that were recently burned at the time of mapping area classified simply as “burn scar,” which is no longer an accurate depiction of the burned area.
- The AKVM does not differentiate wetland forests from non-wetlands.

### ALFRESCO

- Area and distribution of deciduous forest and shrub classes differ between the ALFRESCO map and the NLCD rendering comparison of modeled changes to landcover classes or CEs difficult.
- ALFRESCO's climate to area burned relationship is based on present conditions. As climate and vegetation cover changes, the relationship between climate and burning that the model uses may no longer hold true.
- Wetland transitions and thermokarst are not active in the ALFRESCO model.

- Spruce is always reset to deciduous forest after fire, so the self-replacement model that may be more common in some black spruce stands and in white spruce stands near treeline is not represented.

## 1.9 Data Gaps Related to Terrestrial Fine-Filter Conservation Elements

It is important to note that this study was limited to assessing the effect of specific CAs on CEs that we could spatially model and that had strong cause-and-effect linkages in the literature. There may be additional factors not addressed in this study that play an important role in determining the status of the CE species throughout the CYR study area.

The ALFRESCO) outputs do not include fire severity or precise spatial/temporal predictions of future fires (see Section C, Abiotic Change Agents), therefore identifying areas where wildfire cycling may increase habitat and forage productivity for the CE species was not possible with these data.

### Caribou

- The spatial representations of caribou seasonal distribution are based on the best available and obtainable information. This included kernel density polygons for the Western Arctic and Central Arctic herds, however, such fine-scale data were not available for the other herds.
- Winter precipitation predictions, that uncertainty in precipitation projections is relatively high (see Section C. Abiotic Change Agents).

### Dall Sheep

- Snow depth is an important climatic variable that has an impact on sheep survival and having accurate measures of snow depth will allow for more accurate predictions of future climatic impacts.
- The habitat distribution model was built using the Vegetation Map of Northern, Western, and Interior Alaska and may have inaccuracies associated with erroneous classifications in the base map.

### American Beaver

- GAP Analysis data are derived from remote sensing and modeling to make general assessments about distributions and habitat.

### Snowshoe Hare

- The habitat association model for snowshoe hare distribution has not been ground-truthed and relies on the accuracy of the landcover maps used in the habitat association analysis.

### Golden Eagle

- Habitat association models for golden eagle have not been ground-truthed.

### Swainson's Thrush

- Grey-cheeked thrush was originally proposed as a Terrestrial Fine-filter CE, however, very little information or data were available to develop an accurate species distribution model, or perform a useful impact analysis, therefore Swainson's thrush was substituted into the study.
- The habitat association model for Swainson's thrush distribution has not been ground-truthed and relies on the accuracy of the landcover maps used in the habitat association analysis.
- More Alaska-specific studies on the effect of climate and prey availability are needed to understand the effects of different variables on Swainson's thrush survival and reproductive success.

### Trumpeter Swan

- We have used mean annual ground temperature as a proxy for permafrost melt, however, obtaining a better measure/predictive model of permafrost melt may allow for more accurate predictions for impacts to trumpeter swan habitat.

## 1.10 Data Gaps Related to Aquatic Coarse-Filter Conservation Elements

The critical data gaps for managing aquatic resources in Alaska include the lack of seamless, high resolution digital elevation models and an accurate stream network spatial dataset.

The National Hydrography Dataset (NHD) is the best available spatial data depicting aquatic resources across the CYR study area. The current version provides a digital representation of streams and lakes shown on USGS topographic maps, which were created from historic aerial photos. It has several limitations:

- The NHD underrepresents small streams because they are often masked by vegetation cover and not visible on aerial photography.
- The NHD is very outdated (most topographic maps were created in the 50's and 60's) and stream locations and lake areas have likely changed due to natural hydrologic disturbances and climate change.
- Both stream order and stream gradient are needed to map aquatic habitats; the NHD is not attributed with stream order and does not align with valley bottoms in the digital elevation model (DEM) so stream gradient cannot be calculated accurately.

The best available DEM for the study area is the National Elevation Dataset (60 m pixels). Due to the limitations of the NHD, aquatic habitats were mapped by creating a synthetic stream network from the DEM, which has its own set of drawbacks:

- Utilizing a coarse DEM to map streams results in a gross oversimplification of the stream network length and complexity.
- The DEM does not match the NHD, which is the best available representation of what exists on the ground.

- When creating a stream network from a DEM, a decision must be made regarding the size of the watershed required to initiate a first-order stream. There is no available data relating area to perennial flow initiation for the study area and, due to the diversity of topographic, geologic, and permafrost characteristics across the study area, this relationship will vary.

As far as we know, there are no climate change predictions specific to aquatic habitats, such as changes to water temperature or hydrologic regime, available for the study area.

## 1.11 Data Gaps Related to Aquatic Fine-Filter Conservation Elements

- The only spatial dataset representing fish distribution in the CYR study area was the Anadromous Waters Catalog (AWC).
- The AWC included habitat for anadromous species, and ADF&G estimated that it represents less than half of the streams, rivers, and lakes actually used by anadromous species.
- The AWC was used as the sole data source to represent distributions for Chinook salmon and chum salmon.
- Because Chinook rear in freshwater and new rearing habitats have been discovered far from spawning grounds, Chinook salmon distribution was likely underrepresented in the study area.
- The chum salmon distribution in the AWC included several drainages without spawning habitat.
- Dolly Varden distribution was represented by both the anadromous habitats identified in the AWC and a resident habitat distribution model. The AWC may have underrepresented anadromous populations of Dolly Varden because we were unable to find research on their life histories in the Yukon drainage.

Potential habitat for resident Dolly Varden populations was modeled using the best available data on presence and absence collected during stream surveys, but these data had the following limitations:

- There were very few data points informing the model given the size of the study area. The data points that did exist were spatially clustered along the road network in the central part of the study area with a few additional data points along the potential road to the Ambler mining district.
- Absence data were obtained from ADF&G projects in the Alaska Freshwater Fish Inventory that targeted the entire fish community. If a target species was not observed during field surveys it was considered an absence point. These data points may not represent true absences because Dolly Varden could occupy the site during other times of the year than when the sampling occurred.
- Measurement error and sampling method could also lead to not observing a fish when it was actually present.
- Many of the data points were from ADF&G projects that strategically located their sites in order to extend the Anadromous Waters Catalog, which resulted in a bias towards low order streams.
- Most of the data points were from August because that was when ADF&G conducted surveys to extend the AWC. Since Dolly Varden spawn in the fall, the

predicted distribution likely represented summer feeding and rearing habitats. Additional sampling at other times of the year could capture spawning and overwintering habitats.

- There were no distribution datasets for northern pike or humpback whitefish and very few presence data in the AFFI that could be used for modeling distribution. Distributions for these two fine-filter CEs were considered data gaps.
- In addition to very limited data on species distributions for the CYR study area, the CA datasets were generally poorly applicable to aquatic habitats and species.
- Models used to predict habitat suitability for fishes based solely on air temperature tend to perform poorly because air temperature is a poor surrogate for stream temperature.
- Lack of information on overwintering habitats, which could be limiting distributions or productivity.
- Lack of information on harvest or population sizes (for all except salmon).
- Genetic baseline for understanding how mixed-stock harvests affect populations.
- Life history information for humpback whitefish, inconnu, and Dolly Varden all of which have both anadromous and resident forms.

# 2. Data Gaps Related to Management Questions

All original MQs from the BLM had overarching questions of “How reliable are these predictions? Are there other data/models which provide information that is different than the output presented?”. We answered these questions when appropriate as some MQs were not model or predictive based. The following section summarizes data gaps and limitations and summarizes both questions regarding Management Questions.

## 2.1 Management Questions Related to Abiotic Change Agents

### MQ. A1: How is climate change likely to alter the fire regime in the dominant vegetation classes and riparian zones?

- No other currently available landcover or vegetation model offers a dynamic perspective on fire and vegetative succession.

### MQ. B1: How is climate change likely to alter permafrost distribution, active layer depth, precipitation regime, and evapotranspiration in this region?

- The reliability of SNAP climate predictions is discussed in the climate section of this report.
- Existing models of potential evapotranspiration are likely too simplistic to account for fine-scale variations in incoming shortwave radiation, wind speed and humidity. Thus, examining the impacts on vegetation from changes in PET may more effectively be conducted using outputs from the stochastic ALFRESCO fire model.

### MQ C1: How will changes in precipitation, evapotranspiration, and active layer depth alter surface water availability and therefore ecosystem function (dominant vegetation classes)?

- The reliability of SNAP climate predictions is discussed in the climate section of this report.
- Existing models of potential evapotranspiration are likely too simplistic to account for fine-scale variations in incoming shortwave radiation, wind speed and humidity. Thus, examining the impacts on vegetation from changes in PET may more effectively be conducted using outputs from the stochastic ALFRESCO fire model.

### MQ E1: How is climate change affecting the timing of snow melt and snow onset, spring breakup and green-up, and growing season length?

- The reliability of SNAP climate predictions is discussed in the climate section of this report.

## 2.2 Management Questions Related to Terrestrial Coarse-Filters

### MQ B2: What are the expected associated changes to dominant vegetation communities and CE habitat in relation to altered permafrost distribution, active layer depth, precipitation regime, and evapotranspiration?

- Data gaps and limitations of the layers used to develop the CE distributions are described in the Methods section of Section G. Terrestrial Coarse-filter Conservation Elements.
- See Section°C. Abiotic Change Agents for data gaps and limitations pertaining to the SNAP climate models, the GIPL ground temperature model, and the ALFRESCO model.

### MQ F3: How are major vegetation successional pathways likely to change in response to climate change, with special emphasis on increased shrub cover and treeline changes?

- See Section°C. Abiotic Change Agents for information about the reliability of the SNAP climate models and the ALFRESCO model.
- Information about the various landcover maps available for the region that are suitable for developing CE distributions is presented in the Methods section of Section G. Terrestrial Coarse-filter Conservation Elements.
- The climate models, ground temperature models, and ALFRESCO model used in this analysis are the only models available for predicting change in temperature, precipitation, permafrost, and vegetation for the study area

### MQ G1: Where are refugia for unique vegetation communities (e.g. hot springs, bluffs, sand dunes) and what are the wildlife species associated with them?

- See text for MQ AH1.

### MQ AH1: What rare, but important habitat types that are too fine to map at the REA scale and are associated with Coarse- (or Fine-) Filter CEs that could help identify areas where more detailed mapping or surveys are warranted before making land use allocations (such as steppe bluff association with dry aspen forest)?

- Rare ecosystems data are limited by the completeness and precision of their respective map sources, which vary among ecosystems. Please see page G-149 for more detailed information regarding the source of each ecosystem.
- A number of Ecosystems of Conservation Concern (G1-G3) that occur in Interior Alaska have not been described nor mapped in sufficient detail to be included in our analyses (Table K-1). These undescribed ecosystems of Conservation Concern require further study or literature review for an accurate assessment of their rarity or intrinsic vulnerability, trends, and threats. Although these undescribed rare ecosystems were beyond the scope of this rapid assessment, they are listed in the table below for reference.

**Table K-1.** Potentially rare ecosystems that may warrant further investigation.

| Undescribed Ecosystems of Potential Conservation Concern |
|---|
| Calcareous Fen BpS |
| Hill Prairie |
| Sky Islands in Boreal Alaska |
| Trona (hydrous sodium carbonate and bicarbonate in partially evaporated lake basins) |
| Vegetation Communities on Basalt Substrates |

***Wildlife Data Limitations***

- The AKGAP distribution models have been developed for a majority of Alaska rare animal species, distribution models do not exist for every rare species that occurs within the CYR study area, like, for example, the gray-crowned rosy-finch (*Leucosticte tephrocotis*, G5S3).
- Our distribution sets for bird species are limited in that they model only breeding distribution.
- Because we used H.A. Database and AKGAP analysis to infer potential relationships between rare ecosystems and rare animal species, our analysis is also subject to the limitations of those models and should be viewed as hypotheses.
- Spatial correlation between a given ecosystem and a given wildlife species does not necessarily indicate that the species relies upon services provided by that ecosystem that cannot be provided by other, more common ecosystems.
- Including birds in a rare ecosystem may provide a biased view of the rare ecosystem with respect to birds as they are more likely to be using surrounding associated habitat instead of the rare ecosystem habitat itself.
- AKGAP models vary in accuracy but during development, each model was subjected to an accuracy assessment to quantify “classification success” — the percent of training points (known occurrence records) correctly predicted as present by the model. Please see text on page G-151 for more detailed information on specific classification success scores.

## 2.3 Management Questions Related to Terrestrial Fine-Filters

### MQ N3: How might Dall sheep distribution shift in relation to climate change?

- Snow depth is an important climatic variable that has an impact on sheep survival and having accurate measures of snow depth will allow for more accurate predictions of future climatic impacts.
- The habitat distribution model was built using the Vegetation Map of Northern, Western, and Interior Alaska and may have inaccuracies associated with erroneous classifications in the base map.

## MQ AE1: Where is primary waterfowl habitat located?

- The accuracy of breeding distribution models was not assessed within the CYR study area as part of this assessment. However, model accuracy for the entire state of Alaska was assessed using area-under-curve (AUC) as part of the Alaska Gap Analysis Project. Values larger than 0.5 indicated a performance better than random. Model performance for each species is provided in on page H-146.
- The Alaska Gap Analysis Project was a generalized effort to produce the first statewide distribution models for all terrestrial vertebrate species in Alaska. Therefore, input data layers were not selected specifically for relevance to waterfowl.

## MQ T1: What areas would be most likely to biologically support a reindeer herd?

### *Seasonal Forage Quality*

- The Vegetation Map of Northern, Western, and Interior Alaska was produced by mosaicking the best available (prioritized by detail and accuracy) regional landcover maps into a single spatial coverage. Although regional landcover maps were assessed for accuracy within their coverages, no accuracy assessment has been conducted for the mosaicked dataset. Regional differences in seasonal forage may therefore partially be artifacts of inconsistent classification.
- Diet varies between calves, adult females, and adult males but we combined forage preferences for calves, adult females, and adult males to produce generalized forage quality datasets. However, this generalized approach prevented any insights into sexual segregation within herds.
- Diet also varies by region and herd and diet studies are not available for all herds so information was generalized to all herds of Central Alaska.

### *Biological Potential for Reindeer Herding*

- Herd ranges constantly change and it was not possible to predict future herd ranges.
- Herd ranges for all herds within the study area except for the annual ranges of the Western Arctic, Teshekpuk, Central Arctic, and Porcupine herds are estimates.
- Herd ranges selected for this assessment, excluding the four North Slope herds, were digitized from the Alaska Habitat Management Guides.
- Telemetry data is not available for all caribou herds.
- To enable a more detailed and accurate assessment of biological potential for reindeer herding, caribou herd annual and seasonal ranges for the most recent 10 to 15 years should be delineated using standardized kernel density estimation or similar suitable methodology.
- Future biological potential for reindeer herding is dependent on current and future changes in caribou herd ranges. Therefore, the biological potential for reindeer herding will not remain constant into the future.

## MQ X1: What have the past cumulative impacts of road construction and mineral extraction been on terrestrial CE habitat and population dynamics?

- Please see MQ X2.

**MQ X2: How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads [Umiat, Ambler, Stevens Village], pads, pipeline, both permanent and temporary) affect species habitat, distribution, movements and population dynamics (especially caribou, moose, sheep)?**

- Although an analysis of the association of roads with sport harvests was proposed for MQs X1 and X2, the resolution of sport harvest data prevented any meaningful comparisons.
- Sport harvest data is maintained by GMU subunit and does not make spatial analysis with landscape features possible. In the absence of collecting sport and subsistence harvest data as individual points at the coordinates of the kill, determination of association of roads with harvest levels would require a focused study with collection of new data.
- The impacts of mineral extraction on caribou, moose, and sheep are not well studied.
- The impacts of infrastructure in general are not well studied for Dall sheep, likely because major impacts have not been suspected based on little overlap between Dall sheep habitat and distribution of infrastructure.

## 2.4 Management Questions Related to Aquatic Fine-Filters

**MQ V1: How does human activity (e.g. mineral extraction, gravel extraction) alter stream ecology and watershed health (i.e. water quantity, water quality, outflow/stream connectivity, fish habitat, and riparian habitat)?**

- Please see MQ W2.

**MQ W2: How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads, pads, pipeline) affect fish habitat, fish distribution, and fish movements (especially chinook, chum, inconnu)?**

- Please see the data gaps and limitation section for Aquatic Fine-filter on pages K-7–K-9.

# 3. Highest Ranked Management Questions

Given the rapid nature of the REA, the BLM National Operations Center (NOC) suggested we limit the number of Management Questions (MQs) to around 20 (with a maximum of 30). In previous REA projects we had success on selecting MQs using the Delphi survey method (Hess and King 2002; Scolozzi et al. 2012; O'Neill et al. 2008) to prioritize and focus our MQs. The UA team replicated the same approach for the Central Yukon REA.

The Central Yukon Field Office generated an original list of MQs. This first list in its unaltered state is located in section 2.6 of this document. The UA Team responded with the feasibility of answering the questions and parsed out the questions because the recommended MQs had several questions embedded into the topic.

The UA team sent out the parsed out list of MQs to the AMT and asked members to rank the top 20 questions, which 20 additional questions where next priority (mid), and which questions were of lowest priority to them (remove). The following definitions were provided with the MQs.

- **Top** - This is a critical question that needs to be addressed, irrespective of data availability or any other limitations.
- **Mid** - I/we think this is an important question, but need some preliminary data to assess its relevancy to the REA.
- **Remove** - This is an important question, but given REA timeframe/budget/scope, it can be removed from this assessment.

Each AMT member was asked to consider the following guidance from the BLM NOC on how to craft a good Management Question:

- Is the MQ about large-scale, region-wide issues?
- Can the MQ be answered by available geospatial information, remote sensing, or acceptable surrogates at the landscape scale?
- If the MQ cannot be addressed spatially, would a literature review be an appropriate use of the REA?
- If it is an inventory question, can it be addressed within the timeframe of the REA?
- Does the MQ inform a specific practical management decision or resource allocation to be made (i.e., Which areas due to resource vulnerability require protection as ACEC's? Which areas should be avoided for authorization of new roads or utility corridors?)
- Does the MQ identify the potential subsequent decision process and or action associated with the answer to the question?
- Has the MQ been answered in another recently competed ecoregional assessment and is there additional information that warrants reexamining this issue?

After receiving 10 responses from our first ranking by the AMT, 18 MQs surfaced as being the top or mid priority MQs by the majority of the voting members of the AMT. The UA team met with the AMT and Technical Team members during our first AMT meeting on September 5, 2014 and discussed the MQ ranking process, survey method, and asked for additional MQs to be considered. Based on this process, one additional MQ was added to the list to be included in a second round of voting. To ensure consistency and confidence in our MQ selection, we sent out

another round of MQ surveys to ensure the first ranking was agreed upon by the majority of the AMT.

The second round of MQ surveys resulted in seven responses. The results were tallied based on ranks for each question then reordered based on those tallies. Questions that were consistently ranked as either Top 20 or Mid 20 by over half of the voting AMT members were selected as our final list of MQs (Table K-2). In addition to the to 20 MQs we also identified 12 alternative MQs with almost half of the AMT agreeing on these questions being either top 20 or mid 20 MQs (Table K-3). These questions were considered as replacement MQs if any of the final MQs could not be adequately addressed by the UA team, pending AMT approval.

**Table K-2**. Final working list of MQs for the Central Yukon REA. Shown is the Management Question, and the associated CE or CA.

| MQ# | Management Question | CE | CA |
|---|---|---|---|
| A1 | How is climate change likely to alter the fire regime in the dominant vegetation classes and riparian zones? | Terrestrial (Vegetation) | Fire |
| AE1 | Where is primary waterfowl (black scoter or trumpeter swan) habitat located? | Terrestrial (waterfowl) | Climate/ Land Use and Development |
| AH1 | What rare, but important habitat types that are too fine to map at the REA scale and are associated with coarse (or fine) filter CEs that could help identify areas where more detailed mapping or surveys are warranted before making land use allocations (such as steppe bluff association with dry aspect forest)? | Terrestrial | |
| B1 | How is climate change likely to alter permafrost distribution, active layer depth, precipitation regime, and evapotranspiration in this region? | Terrestrial (Vegetation) | Soil Thermodynamics |
| B2 | What are the expected associated changes to dominant vegetation communities and CE habitat? | Terrestrial (Vegetation) | Soil Thermodynamics |
| C1 | How will changes in precipitation, evapotranspiration, and active layer depth alter surface water availability and therefore ecosystem function (dominant vegetation classes)? | Terrestrial (Vegetation) | Climate |
| E1 | How is climate change affecting the timing of snow melt and snow onset, spring breakup and green-up, and growing season length? | Terrestrial (Vegetation) | Climate |
| F3 | How are major vegetation succession pathways likely to change in response to climate change, with special emphasis on increased shrub cover and treeline changes? | Terrestrial (Vegetation) | Climate |
| G1 | Where are refugia for unique vegetation communities (eg. hotsprings, bluffs, sand dunes) and what are the wildlife species associated with them? | Terrestrial (Vegetation) | Climate |
| G2 | Which unique vegetation communities (and specifically, which rare plant species) are most vulnerable to significant alteration due to climate change? | Terrestrial (Vegetation) | Climate |

| MQ# | Management Question | CE | CA |
|---|---|---|---|
| L1 | What are caribou seasonal distribution and movement patterns? | Terrestrial (Caribou) | Climate/ Land Use and Development |
| N3 | How might sheep distribution shift in relation to climate change? | Terrestrial (Sheep) | Climate/ Land Use and Development |
| Q1 | Which subsistence species (aquatic and terrestrial) are being harvested by whom and where is harvest taking place? | Terrestrial and Aquatic | Land Use and Development |
| T1 | The introduction of free-ranging reindeer herds to this region has been proposed. What areas would be most likely to biologically support a reindeer herd? | Terrestrial (Reindeer/Caribou /Vegetation) | |
| U1 | Compare the footprint of all types of landscape and landscape disturbances (anthropogenic and natural changed) over the last 20 and 50 years. | | Land Use and Development |
| U3 | How and where is the anthropogenic footprint most likely to expand 20 and 50 years into the future? | | Land Use and Development |
| V1 | How does human activity (e.g. mineral extraction, gravel extraction) alter stream ecology and watershed health (i.e. water quantity, water quality, outflow/stream connectivity, fish habitat, and riparian habitat)? | Aquatic (Fish) | Land Use and Development |
| W2 | How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads, pads, pipeline) affect fish habitat, fish distribution, and fish movements (especially chinook, chum, sheefish)? | Aquatic (Fish) | Land Use and Development |
| X1 | What have the past cumulative impacts of road construction and mineral extraction been on terrestrial CE habitat and population dynamics? | Terrestrial (Mammals) | Land Use and Development |
| X2 | How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads [Umiat, Ambler, Stevens Village], pads, pipeline, both permanent and temporary) affect species habitat, distribution, movements and population dynamics (especially caribou, moose, sheep)? | Terrestrial (Mammals) | Land Use and Development |

# 4. Medium Ranked Management Questions

Table K-3 is a list of alternative MQs in the event a highest priority MQ could not be answered.

**Table K-3.** Second Tier MQs, based on the Delphi survey of MQs. Questions were subsequently weighted to reflect scores of high, moderate, and low priority ranks. The cumulative scores for these questions represent the next highest priority. These questions were retained as alternative MQs.

| MQ # | Recommended Management Question | CE | CA |
|---|---|---|---|
| AD1 | How will climate-related changes in snow cover, active layer depth, and breakup affect regulation (specifically the allowed timing of) of winter travel on BLM managed lands? | Climate | |
| AE2 | How might waterfowl (black scoter or trumpeter swan) distribution shift in relation to climate change? | Terrestrial (waterfowl) | Climate/ Land Use and Development |
| IN5 | Where should potential roads to Ambler, Nome, Umiat, and Stevens village (100 foot wide road or utility corridors from the Dalton Highway) be placed in order to protect conservation system units (as far away as possible from the CSUs)? | Land Use and Development | |
| J1 | What are baseline characteristics and trends (historic based on data and TEK as well as future based on anticipated development) in quality and quantity of fish habitat (lakes and streams) as well as fish distribution and movement? | Aquatic (Fish) | Land Use and Development |
| K1 | How will caribou winter and summer habitat be affected by climate change? | Terrestrial (Caribou) | Climate |
| L3 | How might caribou seasonal distribution and movement patterns shift in relation to climate change? | Terrestrial (Caribou) | Climate/ Land Use and Development |
| O1 | What additional baseline data (i.e. drivers) are needed for fish, birds, and other terrestrial species for enhancing food security (health and safety of subsistence food)? | Terrestrial and Aquatic | Land Use and Development |
| Q2 | What are historic and projected trends in subsistence harvest of these species? How reliable are these predictions? | Terrestrial and Aquatic | Land Use and Development |
| V3 | What percentage of headwater streams in the region are currently in an intact/pristine state? | Aquatic (Fish) | Land Use and Development |
| W1 | What have the past cumulative impacts of road construction and mineral extraction been on aquatic CE habitat and population dynamics? | Aquatic (Fish) | Land Use and Development |
| Y1 | What and where are the impacts of mineral and gravel extraction development (i.e. gravel pad and road construction) on vegetation communities and hydrology (known impacts include burial, dust, saline runoff and altered soil moisture)? | Terrestrial (Vegetation) | Land Use and Development |
| Z1 | Which BLM lands create important linkages between | | Land Use and Development |

# 5. Omitted Management Questions

Table K-4 is a list of MQs that were removed by the UA Team as being out of scope or low priority by the AMT.

**Table K-4.** List of MQs that were omitted or low priority.

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| | Land Use and Development | AB1 | Where should potential roads to Ambler, Nome, Umiat, and Stevens village (100 foot wide road or utility corridors from the Dalton Highway) be placed in order to protect existing human infrastructure (as far away as possible from existing infrastructure)? | Substantial: Could be addressed using products of core analysis. | No | spatial |
| | Land Use and Development | AC1 | Where are the locations of geological substrates suitable for extraction (e.g. precious metals, gravel) and locations suitable/unsuitable for infrastructure development (e.g. roads, maintenance stations)? | Low | Potentially. HOWEVER, suitability for infrastructure development is out of scope (engineering study). | spatial |
| | Climate | AD2 | How will these projected changes affect how BLM regulates permittee access (specifically the timing of access)? | Substantial | No | literature review |
| Terrestrial (waterfowl) | Climate/ Land Use and Development | AE3 | How might waterfowl (blackscoter or trumpeter swan) distribution shift in relation to development (especially roads)? | Low | Yes | spatial |
| | Land Use and Development | AF1 | What are the visual resource inventory classifications for the Utility Corridor and the remote western lands? | Substantial | No | spatial |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| | Land Use and Development | AG1 | How will the viewshed and visual sensitivity change with the potential development of access roads to mining and energy operations? | Substantial | No | spatial |
| | Land Use and Development | AG2 | What are the visual impacts from gravel pits, pipelines, and other developments? | Substantial | No | spatial |
| | Land Use and Development | AG3 | How far can they be seen from the air and the ground? | Substantial | No | spatial |
| Terrestrial (Vegetation) | Soil Thermodynamics | D1 | How will expected changes in permafrost distribution and active layer depth alter the hydrological cycle in the region? | Substantial | Yes. However, we will be limited to existing information and models. | spatial and literature review |
| Terrestrial (Vegetation) | Soil Thermodynamics | D2 | How will these manifest as changes to terrestrial and aquatic CE habitat quality and quantity (in dominant vegetation classes as well as riparian zones within each)? | Substantial | Yes. However, the resolution of the permafrost model is likely to limit our ability to address this question spatially at a meaningful scale. | spatial and literature review |
| Terrestrial (Vegetation) | Climate | E2 | How does [change in snow melt/onset, spring breakup and green up and season length] vary between dominant vegetation classes and riparian zones? | Low | Yes | spatial |
| Terrestrial (Vegetation) | Climate | F1 | What are the major vegetation successional pathways for upland and lowland forest and tundra vegetation classes? | Low if using existing descriptions. HOWEVER, if more description is required: moderate effort and a substantial effort would be required to create state-and-transition models. | Yes | literature review |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| Terrestrial (Vegetation) | Climate | F2 | What are the most common disturbances impacting each and how do these disturbances impact successional trajectories? | Low if using existing descriptions. HOWEVER, if more description is required: moderate effort and a substantial effort would be required to create state-and-transition models. | Yes | literature review |
| Terrestrial (Soils) | | H1 | Where are the areas of greatest topographic and soils diversity? | Substantial | Potentially | spatial |
| Terrestrial | Climate/Social Thermodynamics | I1 | What are the current locations and rates of inland erosion and how might these change in the future? | Substantial effort and would be highly speculative. HOWEVER, moderate effort for a simple GIS model of erosion-prone areas. | Yes | spatial |
| Terrestrial | Climate/Social Thermodynamics | I2 | In areas likely to be subject to erosion (including [but not limited to] flooding in riparian zones and fire affected areas) what are the expected changes to habitat and cultural sites? | Low: if data are available. HOWEVER, if limited data then literature review: moderate effort. | Yes | spatial and literature review |
| Terrestrial (Caribou) | Climate | K2 | What evidence exists for increased shrub cover? | Moderate effort | Yes | literature review |
| Terrestrial (Caribou) | Climate | K3 | What are the likely impacts of increased shrub cover on caribou habitat? | Moderate effort | Yes | literature review |
| Terrestrial (Caribou) | Climate | K4 | How will projected habitat changes alter caribou utilization patterns? | Moderate | Yes: HOWEVER, we will not be able to project how utilization patterns would change. | spatial |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| Terrestrial (Caribou) | Climate/ Land Use and Development | L2 | How are caribou seasonal distribution and movement patterns related to season and weather? | Moderate | Yes: HOWEVER, we are limited to only existing information, and interpretation would likely be limited to overall climatic patterns. | spatial |
| Terrestrial (Caribou) | Climate/ Land Use and Development | L4 | How might caribou seasonal distribution and movement patterns shift in relation to development (especially roads)? | Distribution: substantial effort. Movement patterns: substantial effort (if data available). | Yes | spatial |
| Terrestrial (Caribou) | Climate/ Land Use and Development | L5 | Where is future development likely to most impact hunter access to caribou populations? | Low | Yes | spatial |
| Terrestrial (Moose) | Land Use and Development | M1 | For moose populations in this region what is historic and current distribution and density? | Substantial effort (if data available). | No | literature review |
| Terrestrial (Moose) | Land Use and Development | M2 | What major drivers behind the shifts in moose distribution have been identified? | Substantial effort (if data available). | Yes | literature review |
| Terrestrial (Moose) | Land Use and Development | M3 | What is the history of moose harvest by subsistence users per given area within the region? | Moderate | Yes | literature review |
| Terrestrial (Sheep) | Climate/ Land Use and Development | N1 | Where is primary sheep habitat located? | Low | Yes | spatial |
| Terrestrial (Sheep) | Climate/ Land Use and Development | N2 | How does sheep distribution shift in response to season and weather? | Moderate | Yes: HOWEVER, we are limited to only existing information, and interpretation would likely be limited to overall climatic patterns. | spatial |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| Terrestrial (Sheep) | Climate/ Land Use and Development | N4 | How might sheep distribution shift in relation to development (especially roads)? | Low | Yes | spatial |
| Terrestrial (Sheep) | Climate/ Land Use and Development | N5 | Where is future development likely to most impact hunter access to sheep populations? | Low | Yes | spatial |
| Terrestrial and Aquatic | Land Use and Development | O2 | What are known drivers and what drivers require more information? | Substantial effort (we would include key data gaps). | Yes | literature review |
| Terrestrial and Aquatic | Land Use and Development | P1 | What are the major ecosystem services provided by the lands and waters within this REA? | Substantial effort. | No | literature review |
| Terrestrial and Aquatic | Land Use and Development | P2 | What factors influence their value and can any of the services be quantified? | Substantial effort. | No | literature review |
| Terrestrial and Aquatic | Land Use and Development | Q3 | What is the economic value (market equivalent) of these species? | Substantial effort. | No | economic analysis |
| Terrestrial and Aquatic | Land Use and Development | R1 | What real and perceived limitations to access and/or collection of subsistence resources (aquatic and terrestrial) by local residents are caused by non-subsistence hunting and fishing activity? | Substantial effort (significant data gaps and limitations). | Yes. HOWEVER, perceived limitations would be limited to existing information and could be considered out of scope. | literature review |
| Terrestrial and Aquatic | Land Use and Development | R2 | In which areas are the real and perceived limitations to access and/or collection of subsistence resources (as a result of non-subsistence hunting and fishing activity) occurring? | Low | Yes | literature review |
| Terrestrial and Aquatic | Land Use and Development | R3 | What solutions to conflicts are promoted by local resident subsistence users? | Substantial effort (significant data gaps). | No | literature review |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| Terrestrial and Aquatic | Land Use and Development | S1 | What real and perceived limitations to access and/or collection of subsistence resources (aquatic and terrestrial) by local residents are associated with human infrastructure (mineral extraction, roads)? | Real limitations: potential data gaps and 'real' is ambiguous. Physical limitations: moderate effort. Other limitations: substantial effort. Perceptual limitations: substantial effort. | Yes | literature review |
| Terrestrial and Aquatic | Land Use and Development | S2 | How might [real and perceived limitations] change in response to planned future development, especially new roads? | Obvious physical limitations: low additional effort. | Yes | literature review |
| Terrestrial and Aquatic | Land Use and Development | S3 | What solutions to conflicts are promoted by local resident subsistence users for specific limitations? | Substantial effort (potential significant data gap). | No | literature review |
| Terrestrial (Reindeer/Caribou/Vegetation) | | T2 | How would introduction of a reindeer herding program affect caribou and vegetation? | Moderate | Yes. | literature review |
| Terrestrial (Reindeer/Caribou/Vegetation) | | T3 | What is the economic service of maintaining intact caribou habitat in comparison to the economic gain of reindeer herding (market value)? | Substantial effort (potential significant data gap). | No | economic analysis |
| | Land Use and Development | U2 | Where are these footprints located now? | Low (data gap potential) | Yes | spatial |
| | Land Use and Development | U4 | What is the viewshed of large anthropogenic features? How far can they be seen from the air and the ground? | Substantial effort | No | spatial |
| Aquatic (Fish) | Land Use and Development | V2 | Specifically, what is the relative importance of headwater streams to stream ecology and watershed health? | Moderate effort (if data available). | Yes | literature review |

| Conservation Element | Change Agent | MQ # | Recommended Management Question | Effort Required by UA | In Scope? | Possible Approach |
|---|---|---|---|---|---|---|
| Aquatic (Fish) | Land Use and Development | V4 | What is the ecological value of maintaining intact headwater streams? | Moderate effort | Yes | literature review |
| Terrestrial (Vegetation) | Land Use and Development | Y2 | How and where might these impacts spread as the anthropogenic footprint expands? | Moderate | Yes | spatial |
| | Land Use and Development | Z2 | Which BLM lands provide transportation development linkages (roads) for non-conservation system unit lands? | Substantial effort. | No | spatial |

# 6. Original Management Questions

The following table is the list of management questions that were created from the BLM Central Yukon Field Office and were provided to the UA Team for feedback (Table K-5). The UA Team worked with these MQs and responded with a "gut" reaction as to the feasibility of answering the questions to the BLM Central Yukon Field Office. Additionally, the UA Team parsed out the questions because the recommended MQs had several questions embedded into the topic.

**Table K-5**. Original MQs created by the Central Yukon Field Office and provided to the UA Team.

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
|---|---|---|---|---|---|
| Conservation Element | Climate Change | Fire | How is climate change likely to alter the fire regime in the following large scale vegetation communities; upland tundra, lowland tundra, upland forest, lowland forest, as well as riparian zones within each? How reliable are these predictions? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on specific ecosystems. Perhaps defining these vegetation communities (for this and other questions below) is better done as Coarse Scale CE (but this can serve as an exmple). | |
| Conservation Element | Climate Change | Permafrost | How is climate change likely to alter permafrost distribution, active layer depth, precipitation regime, and evapotransporation in this region? What are the expected associated changes to vegetation communities (specifically upland tundra, lowland tundra, upland forest, lowland forest, as well as riparian zones within each) and CE habitat? How reliable are these predictions? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on specific ecosystems. | |
| Conservation Element | Climate Change | Hydrology | How will changes in precipitation, evapotranspiration, and active layer depth alter surface water availability and therefore ecosystem function (specifically in lowland tundra, lowland forest, and riparian zones within each)? How reliable are these projections? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on specific ecosystems. | |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
|---|---|---|---|---|---|
| Conservation Element | Climate Change | Hydrology | How will expected changes in permafrost distribution and active layer depth alter the hydrological cycle in the region? How will these manifest as changes to terrestrial and aquatic CE habitat quality and quantity (specifically upland tundra, lowland tundra, upland forest, lowland forest, as well as riparian zones within each)? How reliable are these predictions? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on connection between permafrost and hydrology. | |
| Conservation Element | Climate Change | Seasonality | How is climate change affecting the timing of snow melt and snow onset, spring breakup and green-up, and growing season length? How does this vary between upland tundra, lowland tundra, upland forest, lowland forest, and riparian zones? How is this likely to change in the future and how reliable are these projections? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on specific ecosystems. | |
| Conservation Element | Climate Change | Vegetation | What are the major vegetation successional pathways for upland and lowland forest and tundra vegetation classes? What are the most common disturances impacting each and how do these disturbances impact successional trajectories? How are these pathways likely to change in response to climate change, with special emphasis on increased shrub cover and treeline changes? How reliable are these projections? Are there other data/models which provide information that is different than the output presented? | Literature search and text report. GIS depiction of projected changes in shrub cover and treeline advance | |
| Conservation Element | Climate Change | Vegetation | Where are refugia for unique vegetation communities (eg. hotsprings, bluffs, sand dunes) and what are the wildlife species associated with them? Which unique vegetation communities (and specifically, which rare plant species) are most vulnerable to significant alteration due to climate change? How reliable are these projections? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special refugia analysis and emphasis on unique vegetation and wildlife communities. Rare Plant habitat modelling using Max Ent. | |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
|---|---|---|---|---|---|
| Conservation Element | Baseline Info | Soils | Where are the areas of greatest topographic and soils diversity? | GIS analysis. | |
| Conservation Element | Climate Change | Erosion | What are the current locations and rates of inland erosion and how might these change in the future? In areas likely to be subject to erosion (including [but not limited to] flooding in riparian zones and fire affected areas) what are the expected changes to habitat and cultural sites? How reliable are these projections? Are there other data/models which provide information that is different than the output presented? | GIS depiction of areas likely to be affected by erosion (riparian zones and burn scars) overlain with known cultural sites and CE habitat with projections of flood and fire based on climate change. | |
| Conservation Element | Climate Change | Fish | What are baseline characteristics and trends (historic based on data and TEK as well as future based on anticipated development) in quality and quantity of fish habitat (lakes and streams) as well as fish distribution and movement? | Deduce historic trends in each of the above by analyzing historic data and compiling records of TEK. Inherent REA analysis to project future trends. | |
| Conservation Element | Climate Change | Caribou | How will caribou winter and summer habitat be affected by climate change? Specifically, what evidence exists for increased shrub cover and what are the likely impacts on caribou habitat? How will projected changes alter caribou utilization patterns? How reliable are these projections? Are there other data/models which provide information that is different than the output presented? | Inherent REA product with special emphasis on specific questions. | |
| Conservation Element | Climate Change | Caribou | What are caribou seasonal distribution and movement patterns? How are they related to season and weather? How might these shift in relation to climate change and development (especially roads)? Where is future development likely to most impact hunter access to caribou populations? Are there other data/models which provide information that is different than the output presented? | Literature review specific to the region. GIS depiction of distribution, likely habitat and current and future access routes to caribou populations. | |
| Conservation Element | Climate Change | Moose | For moose populations in this region what is historic, current and historic distribution and density? What major drivers behind the shifts in moose distribution have been identified? What is the history of moose harvest by subsistence users per given area within the region? | Inherent REA product with special attention to when moose populations became established (where not previously detected). | |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
|---|---|---|---|---|---|
| Conservation Element | Climate Change | Sheep | Where is primary sheep habitat located and how does sheep distribution shift in response to season and weather? How might these shift in relation to climate change and development (especially roads)? Where is future development likely to most impact hunter access to sheep populations? | Literature review specific to the region. GIS depiction of likely habitat and current and future access routes to sheep populations. | |
| Subsistence | Socioeconomic | Food security | What additional baseline data (i.e. drivers) are needed for fish, birds, and other terrestrial species for enhancing food security (health and safety of subsistence food)? What are known drivers and what drivers require more information? | Analysis output should be aimed specifically to provide driver information necessary for full food security analysis. www.iccalaska.org/servlet/content/Traditional%20Knowledge.html | |
| | Socioeconomic | Ecology | What are the major ecosystem services provided by the lands and waters within this REA? What factors influence their value and can any of the services be quantified? | Full scale ecosystem service analysis by ISER. | |
| Subsistence | Socioeconomic | Food harvest | Which subsistence species (aquatic and terrestrial) are being harvested by whom and where is harvest taking place? What are historic and projected trends in subsistence harvest of these species? How reliable are these predictions? What is the economic value (market equivalent) of these species? | Data compilation: ADFG current and historical hunt records, OSM current and historical hunt records. Ecosystem service analysis to estimate economic value of food obtained through subsistence harvesting. | |
| Subsistence | Socioeconomic | Food harvest | What real and perceived limitations to access and/or collection of subsistence resources (aquatic and terrestrial) by local residents are caused by non-subsistence hunting and fishing activity? Where are controversial areas located? What solutions to conflicts are promoted by local resident subsistence users? | Literature/text product. GIS portrayal of subsistence use areas and high use hunting and fishing areas. Identification of data gaps. | |
| Subsistence | Socioeconomic | Food harvest | What real and perceived limitations to access and/or collection of subsistence resources (aquatic and terrestrial) by local residents are associated with human infrastructure (mineral extraction, roads)? How might this change in response to planned future development, especially new roads? What solutions to conflicts are promoted by local resident subsistence users for specific limitations? | Literature/text product. GIS portrayal of subsistence use areas and current/proposed human infrastructure. Identification of data gaps. Ecosystem service analysis comparing future development benefits to loss in subsistence opportunity. | |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
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| Subsistence | Socioeconomic | Reindeer | The introduction of free-ranging reindeer herds to this region has been proposed. What areas would be most likely to biologically support a reindeer herd? How would introduction of a reindeer herding program affect caribou and vegetation? What is the economic service of maintaining intact caribou habitat in comparison to the economic gain of reindeer herding (market value)? | Literature search and text report. GIS depiction of potentially high value reindeer herd locations. Ecosystem service analysis to estimate economic value of food obtained through subsistence harvesting. Reindeer as CE? | |
| Development Impacts or Issues | Baseline Info | Visual Resources | What are the visual resource inventory classifications for the Utility Corridor and the remote western lands? | Conduct GIS viewshed analysis to establish visual resource inventory baseline for landscape scenic quality and contrast levels. Road accessible areas should follow the procedure in the BLM VRM handbook to establish VRI classifications. A GIS analysis can be used to establish VRI classifications in the in areas without road access. | BLM VRM Manual 8400 and VRM Handbooks 8410 and 8431 |
| Development Impacts or Issues | Socioeconomic | Landscape disturbance | Compare the footprint of all types of landscape disturbances (anthropogenic and natural) over the last 20 and 50 years. Where are these footprints located now? How and where is the anthropogenic footprint most likely to expand 20 and 50 years into the future? What is the viewshed of large anthropogenic features? How far can they be seen from the air and the ground? | Bar Chart Comparison (e.g. Square miles of gravel extraction, hardrock mining, fire, road footprints, gravel pads, village expansion). GIS depiction of anthropogenic footprint and projected footprint locations. Viewshed analysis of anthropogenic features. Combine efforts above into Visual Resource Management analysis (see manual link). | BLM VRM Manual 8400 and VRM Handbooks 8410 and 8431 |
| Development Impacts or Issues | Socioeconomic | Landscape disturbance | How will the viewshed and visual sensitivity change with the potential development of access roads to mining and energy operations? What are the visual impacts from gravel pits, pipelines, and other developments? How far can they be seen from the air and the ground? | Conduct GIS viewshed analysis to establish visual resource sensitivity levels to changes on the landscape. | BLM VRM Manual 8400 and VRM Handbooks 8410 and 8431 |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
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| Development Impacts or Issues | Ecology | Fish | How does human activity (e.g. mineral extraction, gravel extraction) alter stream ecology and watershed health (i.e. water quantity, water quality, outflow/stream connectivity, fish habitat, and riparian habitat)? Specifically, what is the relative importance of headwater streams to stream ecology and watershed health? What percentage of headwater streams in the region are currently in an intact/pristine state? What is the ecological value of maintaining intact headwater streams? | Literature review specific to the region. GIS depiction of headwater stream location and disturbance history. ecosystem service approach to glean economic value of maintaining intact streams (especially headwater streams) vs development (disturbance) of headwater streams. | |
| Development Impacts or Issues | Ecology | Fish | What have the past cumulative impacts of road construction and mineral extraction been on aquatic CE habitat and population dynamics? How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads, pads, pipeline) affect fish habitat, fish distribution, and fish movements (especially chinook, chum, sheefish)? | Literature review specific to the region. GIS depiction highlighting waterway intersection with current and future development. ecosystem service analysis to compare the economic value of development (roads, pads, pipeline) vs maintenance of unaltered habitat and intact populations of aquatic CE species. | |
| Development Impacts or Issues | Ecology | Mammals | What have the past cumulative impacts of road construction and mineral extraction been on terrestrial CE habitat and population dynamics? How might future road construction and mineral extraction infrastructure (e.g. both temporary and permanent roads [Umiat, Ambler, Stevens Village], pads, pipeline, both permanent and temporary) affect species habitat, distribution, movements and population dynamics (especially caribou, moose, sheep)? How reliable are these predictions? | GIS depiction of human footprint (current and future). ecosystem service analysis to compare the economic value of development (roads, pads, pipeline) vs maintenance of unaltered habitat and intact populations of terrestrial CE species. | |
| Development Impacts or Issues | Ecology | Landscape disturbance | What and where are the impacts of mineral and gravel extraction development (i.e. gravel pad and road construction) on vegetation communities and hydrology (known impacts include burial, dust, saline runoff and altered soil moisture)? How and where might these impacts spread as the anthropogenic footprint expands? | GIS exercise showing likely areas to be impacted by development (including actual development and adjacent areas likely to be impacted). | |

| Broad Category | Sub Category | Topic | Recommended Management Question | Recommended Analysis | Notes |
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| Development Impacts or Issues | Ecology | Landscape disturbance | Which BLM lands create important linkages between conservation system units (via roads and waterways)? Which BLM lands provide transportation development linkages (roads) for non-conservation system unit lands? | GIS exercise on habitat connectivity to inform the following two questions. | |
| Development Impacts or Issues | | | Where should potential roads to Ambler, Nome, Umiat, and Stevens village (100 foot wide road or utility corridors from the Dalton Highway) be placed in order to protect conservation system units (as far away as possible from the CSUs)? | GIS exercise which may be performed solely in house (BLM GIS). | |
| Development Impacts or Issues | | | Where should potential roads to Ambler, Nome, Umiat, and Stevens village (100 foot wide road or utility corridors from the Dalton Highway) be placed in order to protect existing human infrastructure (as far away as possible from existing infrastructure)? | GIS exercise which may be performed solely in house (BLM GIS). | |
| Development Impacts or Issues | Socioeconomic | Landscape disturbance | Where are the locations of geological substrates suitable for extraction (e.g. precious metals, gravel) and locations suitable/unsuitable for infrastructure development (e.g. roads, maintenance stations)? | GIS depiction of known high value areas and areas with elevational contours amenable to road construction | |
| Development Impacts or Issues | Climate Change | Seasonality | How will climate-related changes in snow cover, active layer depth, and breakup affect regulation (specifically the allowed timing of) of winter travel on BLM managed lands? How will these projected changes affect how BLM regulates permittee access (specifically the timing of access)? How reliable are these projections? Are there other models which provide information that is different than the output presented? | Analyze based on current winter restrictions to overland travel (i.e. staging will not be allowed until October 1 of each year. Winter cross country travel will only be allowed when there is a snow cover of 12" and frost depth to 6" for overland moves in the foothills and 12" freeze/6" snow on the coastal plain.) GIS depiction of waterways likely to be used for winter transport and projections of breakup timing | |