

## 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

The data gaps summarized here are often 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 data gaps encountered throughout the REA process for the North Slope study area. Data gaps are organized by CA and then CE.

## 1.1. Data Gaps Summary

Significant data gaps limited the ability of our team to address the 20 selected Management Questions (MQs) based on the lack of available and reliable data for the entire study area. Below we summarize the key data gaps for each MQ that limited our ability to address the MQs spatially and identify which critical datasets would be required to address the MQ fully (Table K-1).

**Table K-1.** Key data gaps for the North Slope REA for each Management Question (MQ) and critical datasets that would be required to fully address the selected MQ.

MQ #	Management Question	Dataset Gap	Dataset Needed
AB 1	Is the fire regime changing on the North Slope and what is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire?	Not enough fire data in the region to make the model very robust.	Need more information on fire history.
AB 2	How will permafrost change spatially and temporally over the next two decades?	No data on fine-scale permafrost change; feedback from other CAs not accounted for in the model.	Higher resolution permafrost map; integrated permafrost model with other CAs to better assess temporal component
AP 1	What physical and perceptual limitations to access to subsistence resources by local residents are caused by oil/gas activities?	No surveys employed to specifically address this question	Structured surveys on an annual basis
AP 2	How are oil, gas, and mineral development on the North Slope impacting near- and far-field air quality, with particular emphasis on communities and “sensitive class 2” areas such as ANWR, Gates, Noatak?	No air quality models created for the entire region	Long time monitoring of air quality in North Slope and other contributing areas

<b>MQ #</b>	<b>Management Question</b>	<b>Dataset Gap</b>	<b>Dataset Needed</b>
AC 1	How does water withdrawal from lakes for oil and gas activities (year-round industrial and domestic use and winter operations) affect lake water quantity and water quality, outflow/stream connectivity, and down-basin stream habitat?	No water withdrawal maps are available. The lake distribution maps are uncertain and have a high degree of error.	Need water withdrawal maps for the region and need an update to the National Hydrography Dataset (NHD).
AC 2	How does oil and gas infrastructure (e.g. roads, pads, pipeline), both permanent and temporary, affect fish habitat, fish distribution, and fish movements?	Not enough fish occurrence data to develop fish distribution datasets.	Need more fish occurrence data in order to develop fish distribution models.
AF 1	What are baseline characteristics and trends in fish habitat (lakes and streams), fish distribution, and fish movements?	Not enough fish occurrence data to develop fish distribution datasets.	Need more fish occurrence data in order to develop fish distribution models.
AF 2	What are the measurable and perceived impacts of development on subsistence harvest of fish?	No surveys employed to specifically address this question	Structured surveys on an annual basis
AT 1	What parameters can help measure impacts from anthropogenic activities independently of natural cycles and vice versa?	No data that has been consistently collected to address this question	Consistent monitoring of both natural and human systems
AT 2	What potential impacts will oil/gas exploration and development have on CE habitat?	Magnitude of future oil and gas development unknown	More detailed estimate of oil and gas development footprint
AT 3	What additional contaminants baseline data are needed for fish, birds, marine and terrestrial species, particularly those that affect the health and safety of subsistence foods?	No systematic collection	Systematically collected contaminant data for all subsistence species

<b>MQ #</b>	<b>Management Question</b>	<b>Dataset Gap</b>	<b>Dataset Needed</b>
TC 1	What are the impacts of oil/gas development (i.e. gravel pad and road construction; pipeline construction) on vegetation and hydrology? (Known impacts include burial, dust, saline runoff and altered soil moisture.)	Current extent, much less future extent, is poorly represented in publically available datasets.	Comprehensive infrastructure dataset available to the public
TC 2	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	Mismatch of land cover datasets used by the different models. Mismatch of land cover used to model species and those used to map coarse-filter CEs.	Comprehensive, unified, hierarchical land cover dataset that is used across all modeling efforts.
TC 3	How will changes in precipitation, evapotranspiration, and active layer depth alter summer surface water availability in shallow-water and mesic/wet tundra habitats and how reliable are these projections?	Lack of understanding of hydrologic conditions, no spatial data, no hydrologic models, and no hydroclimatic models.	Watershed-scale hydrologic models for the North Slope
TC 4	What are the expected changes to habitat as a result of coastal erosion and coastal salinization?	No comprehensive current shoreline and historic shoreline maps and no storm surge model.	Consistently developed current shoreline and historic shoreline maps and a storm surge model.
TC 5	How is climate change affecting the timing of snow melt and snow onset, spring breakup and green-up, and growing season length?	Temporal resolution of climate data is too coarse to precisely quantify these changes	Daily climate data, better snow models
TF 1	What are the baseline data for the species composition, numbers of individuals, vegetation type used, and change in numbers/species composition of land birds and their habitat over time?	No spatial data for land birds and their habitat over time.	Need spatial data on land birds and their habitat over time.

MQ #	Management Question	Dataset Gap	Dataset Needed
TF 2	What are caribou preferences for vegetation communities? Where do these vegetation communities exist?	No high resolution data (<30m) on lake margins, riparian corridors, and tidal marshes.	Need lake margin, riparian corridor, and tidal marsh vegetation maps at higher than 30m resolution.
TF 3	What are the measurable and perceived impacts of development on subsistence harvest of caribou?	No surveys employed to specifically address this question	Structured surveys on an annual basis
TF 4	What are caribou seasonal distribution and movement patterns and how are they related to season and weather?	No kernel density, whether seasonal or annual, were available for the Porcupine Herd. No raw telemetry data was received by AKNHP for the Western Arctic, Teshekpuk, and Central Arctic herds. No seasonal fall and spring ranges were available for the Teshekpuk Herd.	Radio-collar data would improve the accuracy and utility of the seasonal distributions and would enable mapping of ranges during migration seasons.

## 1.2. Data Gaps Related to Climate Change Modeling

Uncertainty relating to climate modeling, climate data, and the cliomes model are described in detail in Section C-1.5. This uncertainty led to some limitations in the temporal and spatial scale at which results could be analyzed and the conclusions that could be drawn from the data. In addition to the constraints imposed by these inherent uncertainties and limitations, there were also constraints to this analysis imposed by gaps for which no climate data was available. These gaps are summarized below.

- Available temperature data refers to air temperature only. Although spot data for water temperature from specific sites and locations are available, no systematic, consistent, complete, or gridded data are available. This limits the applicability of SNAP provided climate data to aquatic assessments.
- Although many of the weather phenomena that affect CEs are linked more closely to extreme events than to average conditions, no consistent gridded climate data were available at a temporal scale finer than the monthly data available from SNAP. Lack of daily data makes it difficult to project events such as extreme heat, extreme cold, flash floods, and rain-on-snow events.

- The available precipitation data do not differentiate between rain and snow; nor is any direct metric available for snow pack depth, rain on snow events, or other parameters that directly or indirectly impact certain CEs. We did estimate snow-day fraction and cumulative snowfall for the season, but this does not include compaction, sublimation, wind transport, etc., and thus provides only a very coarse and approximate surrogate for snow depth. We recognize that snow pack is very important to all species and suggest that this is a key data gap for the region.
- Long-term climate stations are extremely sparse in general in Alaska, and very few of these stations are located above 500 m elevation.
- Lack data on microclimates, driven (in part) by the lack of a high resolution DEM.
- Need more studies that explicitly address the climate variables that can be modeled and the response of species (especially CEs) to those variables.
- Lack of defined (or even hypothesized) thresholds for CEs in response to change agents.
- Time lags can be expected between changes in climate and associated changes in vegetation, but there is little data on the duration of these lags.
- The cliomes model only correlates climate envelopes to vegetation communities and therefore does not take into account ecological changes such as fire on the landscape.
- The cliomes model is linked only to climate, and not to physiographic features that also determine habitats and ecosystems.

### **1.3. Data Gaps Related to Permafrost**

The outputs of permafrost modeling and mapping are imperfect, despite being based on the best available data layers. Uncertainty is present at multiple levels, stemming from the inherent uncertainties of climate modeling and the uncertainty associated with linking climate to soil thermal dynamics.

- Limited number of field validation points.
- Lack of a regionally-defined permafrost model. Current model was developed statewide, which may oversimplify soil thermodynamics occurring on the North Slope.
- Lack of historical data on the vegetation response to changes in permafrost conditions.
- Soil thermal dynamics are complicated by feedback between fire, vegetation, and climate, and no data or models fully account for these feedbacks.
- 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 or the response of permafrost.
- The best available permafrost model provides outputs at 1 km resolution. Discontinuous permafrost can vary at scales much finer than this, due to variable slope and aspect, drainage patterns, etc.
- Thermokarst risk is based only on soil conditions and topography, and is not yet directly linked to permafrost data.
- The surface area over which the changes in active layer occur makes even small changes significant forces on the landscape, but these changes are hard to predict. The transition from

low-centered to high-centered polygons, for example, can be driven by a couple centimeter change in elevation.

- Little information is known about how water moves through the active layer and out into the ocean. Understanding the role of the active layer in maintaining or creating hydrologic connectivity is essential for understanding how vegetation could respond to changing permafrost conditions.

## Management Questions

<b>MQ AB 2</b>	How will permafrost change spatially and temporally over the next two decades?
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As noted above, readily available models do not capture fine-scale changes in permafrost, although these changes can be estimated, based on broader-scale warming of soils. Additionally, temporal changes may be altered by feedbacks not accounted for in the model. For example, fire is likely to accelerate thaw in burned areas, especially if the fire is high-intensity, and removes the insulating organic layer. The available model also does not fully account for localized changes along waterways or around lakes.

### 1.4. Data Gaps Related to Fire

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 must be considered more broadly, in terms of trends over time, rather than in terms of specific fire behavior at particular sites.

- No clear and consistent data are available regarding fire severity.
- No consistent data are available on changes in lightning strikes or other fire starts over time. The existing lightning strikes dataset does not serve our purposes because the frequency of lightning strikes recorded increases with advances in detection technology.
- Calibrating tundra fire frequency is extremely difficult, due to the rarity of such fires and thus the sparseness of available data.
- 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.
- ALFRESCO uses more general landcover definitions from those used elsewhere in this project, and these cannot be completely reconciled. An updated and broadly accepted vegetation or land cover map need to be developed for the region so future modeling efforts can use a consistent baseline.

## Management Questions

<b>MQ AB 1</b>	Is the fire regime changing on the North Slope and what is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire?
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Because tundra fires are rare, and are projected to continue to be rare, and because occasional very large fires can create outliers in the data, assessing trends over time can be very difficult. In other words, changes in mean values are likely to be small compared to standard deviation or other measures of variability. Additional data on the nature and size of tundra fires in similar systems could help better parameterize the ALFRESCO model.

### 1.5. Data Gaps Related to Invasive Species

Uncertainty related to invasive species is described in detail in Section D-3.4. These uncertainties led to limitations in the scale at which results are meaningful and what conclusions could be drawn. These primary gaps are summarized below.

- Survey data for invasive species is lacking for many regions and concentrated in and adjacent to population centers. Therefore current distributions of non-native species are likely to represent a subset of the total area. Interpretations of current and future infestation vulnerabilities are likely to inflate the importance of roads and population centers.
- Future infestation vulnerabilities are based on development scenarios and climate change models that are inherently uncertain – caution should be exercised in interpretation of these outputs.
- Interactions among disturbances, climate change, and human activities are likely to be very important in invasive species establishment; however we have limited understanding of these indirect effects.
- Research specifically directed towards movements of invasive species in rural Alaska is very limited.
- Research on ecological impacts of invasive species on species and habitats of conservation concern (and specifically for CEs represented here) are largely absent in Alaska.

### 1.6. Data Gaps Related to Anthropogenic Change Agents

Quantifying the human component within an ecoregional context is particularly challenging and fraught with data gaps due to the transdisciplinary nature of the endeavor. Here are some of the key data gaps associated with this assessment:

- Social data not collected or reported at ecological scales or within ecological boundaries
- Road and other land use data not consistently created across jurisdictional boundaries, leading to spatial mismatches and uncertainty in accuracy and authority.

- Oil and gas infrastructure data is still largely proprietary, thus limiting the ability to comprehensively map human activity on the landscape.
- Subsistence data not consistently collected or mapped for all villages across the North Slope.
- No method for tracking food sharing across the ecoregion, limiting the ability to understand region-wide impacts of changes in subsistence species accessibility.

## **Management Questions**

Multiple management questions concerning people’s perception of environmental change were particularly challenging due to limited data availability. These data gaps stem partially from the difficulty in translating traditional ecological knowledge into western scientific concepts.

- Lack of targeted surveys to explore the perceived versus observed changes in caribou, fish and access to subsistence in general due to oil and gas development. Few studies that have explicitly studied the relative impact of human activities versus natural disturbances on key subsistence species.

### **1.7. Data Gaps Related to Landscape Condition Model (LCM)**

Although the LCM utilizes our best available knowledge related to impacts of human land use on a landscape, there are some necessary generalizations made. 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.

- Only a few publically available studies have assessed the impacts of current ice roads on various ecosystem functions, and the results are unclear.
- Snow and ice road data was not available for the entire ecoregion, nor is it something that was modeled into the future, thus limiting our ability to model LCM into the future.
- Accurately mapped local road data are poor, as many are missing from the Alaska Department of Transportation dataset, and could not be extracted from other datasets.
- Trail data are of poor quality and unreliable. Accurately mapped and attributed trail information is an important data gap identified in this analysis, and would allow for a more accurate estimate of landscape condition.
- Spatial data on gravel pits and mines were not available and were therefore not included in the LCM.

### **1.8. Data Gaps Related to Terrestrial Coarse-Filter Conservation Elements**

Land cover and vegetation distributions are well mapped on the North Slope compared to other regions in the state. However, there are still some key data gaps that would improve this assessment if they were filled.

- Current barrier island distribution data are incomplete, therefore we used National Wetland Inventory (NWI) polygons.
- Current Tidal Marsh distribution are incomplete, therefore we used NWI polygons.
- The NSSI map does not include an accuracy assessment. Therefore we are unable to provide a level of confidence for the distribution of landcover classes used to generate the CEs.
- A mismatch of scale exists between SNAP products and vegetation mapping. Therefore intersections between products mapped at 30 m resolution and SNAP products can be misleading, especially for CEs with small or linear distributions.
- The ALFRESCO vegetation map is too generalized to be useful for CEs that include tundra landcover classes. A key data gap is a consistently used, multi-scaled map of vegetation and land cover for the region.
- Spatial data on gravel mines were not available and are considered a data gap; this layer was not included in the Landscape Condition Model or in the current footprint for oil and gas.

### Management Questions

<b>MQ TC 1</b>	What are the impacts of oil/gas development (i.e. gravel pad and road construction; pipeline construction) on vegetation and hydrology? (Known impacts include burial, dust, saline runoff, and altered soil moisture.)
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Few studies have been designed to address the cumulative impacts of oil and gas development on vegetation and hydrology. Furthermore, none have produced spatial data that was available for this analysis. Our best available information was that produced by the LCM, limiting our ability to accurately address this management question.

- No public spatial data on the impact of roads and pipelines on hydrology in the North Slope
- No public spatial data on the impact of roads and pipelines on vegetation in the North

<b>MQ TC 4</b>	What are the expected changes to habitat as a result of coastal erosion and coastal salinization?
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We explored contrasting an older coastline map with a new coastline map to empirically determine which habitats had been lost or gained due to coastal erosion. However, the old coastline map was inaccurate and generating a new coastline is beyond the scope of this assessment. A storm surge model would be needed to evaluate the effects of coastal inundation.

- Lack of a consistently developed current and historic shoreline
- Lack of a storm surge model for the region

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

Publically available spatial information on species distributions has long been missing from Alaska. Fortunately, the AKGAP program has made a substantial dent in that data gap for the state. However,

data at the regional scale is still often missing, and the need for more systematic surveys or non-game species is essential.

- The AKGAP distribution model for the Nearctic brown lemming was the best available model that we could obtain for this assessment, yet associated accuracy statistics were low. An improved distribution model, or alternative data to test the model are recognized as a priority.
- No suitable snow depth layer exists currently for the North Slope study area. A suitable snow-depth layer for the North Slope study area would allow for:
  - Better interpretation and prediction of snow characteristics in relation to sub-nivean and caribou habitat availability, and also ptarmigan herbivory.
  - Identification of where snow depth might preclude caribou travel or limit migration routes in early spring.
- We lacked a suitable spatial layer to explore the relationship between spring storm events and Lapland longspur distribution.
- Since limited spatial data were available on fire, most potential changes related to ptarmigan habitat were qualitatively described based on literature review and ALFRESCO model outputs.
- We felt we lacked suitable raptor distribution models to explore the potential relationships with permafrost and thermokarst disposition. Although we sought to compile a comprehensive raptor dataset for the REA it is likely that there are numerous data sets that are lacking from this synthesis of observations. We developed a database structure for this project that includes 5,166 records, which can easily be added to and updated over time as new information becomes available.

### Management Questions

<b>MQ TF 1</b>	What are the baseline data for the species composition, numbers of individuals, vegetation type used, and change in numbers/species composition of land birds and their habitat over time?
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- Data were not available spatially, but rather in tabular form. Spatial composition and population data is an important data gap.

<b>MQ TF 2</b>	What are caribou preferences for vegetation communities? Where do these vegetation communities exist?
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- Lake margins and riparian corridors are preferred habitats for caribou in summer. These habitats may not be adequately represented in the NSSI Landcover Map because they often occur with widths less than 30 m, therefore not filling a 30 × 30 m grid cell for vegetation classification. There also likely exists more tidal marsh vegetation than is classified as such in the NSSI landcover map because tidal marshes are often not wide enough to fill the 30 × 30 m grid cell mapping resolution.

<b>MQ TF 4</b>	What are caribou seasonal distribution and movement patterns and how are they related to season and weather?
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- The importance of habitat as represented by kernel density, whether seasonal or annual, for the Porcupine Herd was not obtained because of telemetry data for the Porcupine Herd is managed jointly between Alaska and Yukon. Although AKNHP formed a data sharing agreement with ADF&G within the timeframe of the REA, AKNHP did not receive any raw telemetry data. We were therefore unable to produce methodologically identical seasonal kernel densities for the Western Arctic, Teshekpuk, and Central Arctic herds. The lack of unified methodology between all herd ranges and seasons precludes detailed comparison between herds or seasons.
- Seasonal ranges for fall and spring migrations were only available for the Teshekpuk Herd, and therefore fall and spring ranges were not mapped for this assessment. Radio-collar data would improve the accuracy and utility of the seasonal distributions and would enable mapping of ranges during migration seasons.

**1.10. Data Gaps Related to Aquatic Coarse-Filter Conservation Elements**

Data gaps are particularly abundant for aquatic systems in the North Slope. From fundamental datasets like the NDH, to basic information about hydrologic regimes, systematic collection, synthesis and mapping of this data is absent.

- No existing aquatic habitat classification exists for the North Slope (or anywhere in the state).
- The National Hydrography Dataset (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.
- Gauging stations are few and far between, limiting our ability to understand potential changes in hydrographs due to climate change.
- Little consensus exists on what constitutes a connected vs. disconnected lake in the North Slope, much less data to support those classifications.
- Water temperature data is few and far between and not systematically collected for regional-scale assessments of climate change.

**Management Questions**

<b>MQ AC 1</b>	How does water withdrawal from lakes for oil and gas activities (year-round industrial and domestic use and winter operations) affect lake water quantity and water quality, outflow/stream connectivity, and down-basin stream habitat?)
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Spatial data on water withdrawal is a big data gap limiting our ability to effectively address this question. Additionally, no systematic monitoring of water quality at sites with withdrawal is performed.

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

We identified the Fine-Filter CEs as a data gap during the data discovery phase of this project. Similar to previous REAs in Alaska (Seward Peninsula and Yukon-Kuskokwim REAs), aquatics data related to both Coarse-Filters CEs and Fine-Filters CEs have been very limited and have largely been identified as data gaps. The Fine-Filter CEs for the NOS study area are especially data limited to the point that we were not able to accurately produce distribution models or maps for any of our Fine-Filter CEs.

Our efforts to assist BLM with entering fish distribution data into RipFish database have contributed greatly to our understanding of fish baseline data for the NOS study area. However, information on feeding and overwintering areas, migrations and movements, and population level studies are lacking. Future research efforts should focus on obtaining these data for the North Slope.

- Water temperature data for the NOS study area is lacking, and the impacts to fish that occupy the North Slope is largely unknown.
- Climate-linked aquatic models to predict future changes in water temperature are not available.
- Data related to long-term trends and temporal changes in fish populations are not available.

### Management Questions

<b>MQ AC 2</b>	How does oil and gas infrastructure (e.g. roads, pads, pipeline), both permanent and temporary, affect fish habitat, fish distribution, and fish movements?
<b>MQ AF 1</b>	What are baseline characteristics and trends in fish habitat (lakes and streams), fish distribution, and fish movements?

Without fish distribution models, and given the limitations of the human footprint maps we developed, there are some fundamental data gaps in addressing these management questions.

- No fish distribution models
- Imperfect human footprint data
- Lack of consistent fish population monitoring
- Lack of temporal data on fish habitat, limited known about their current distribution, much less historical distribution.
- Lack of available data on fish movements.

## 2. Omitted Management Questions

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A list of Management Questions (MQs) was initially generated by the UA Team after they scoured various documents, identifying management and research objectives for the North Slope. Additionally, the BLM Arctic Field Office identified MQs for the NPR-A in 2011, and also provided additional questions specifically for this effort. This produced a list of approximately 275 potential MQs. However, because the REA is rapid, the BLM has mandated that only 20 - 40 MQs be addressed through an REA. To reduce the list to a workable number, the UA Team refined the list by:

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

This produced a list of 54 high ranked (recommended) MQs, 38 medium ranked MQs, and 71 low ranked MQs. This list of high, medium and low ranking questions, as well as those 111 questions considered out of scope were then given to state and field BLM offices for further review and prioritization. We received feedback from four BLM staff (one field office, three state office specialists) that resulted in 72 high ranked (recommended) MQs, 35 medium ranked MQs, and 68 low ranked MQs. We then presented the 72 MQs that ranked highest priority to the AMT in June 2013, during the AMT 1 Workshop for prioritization. We tallied the ranks and reordered the questions for another round of ranking. The second round yielded responses, which we again tallied and sorted accordingly. The questions were ranked a final time with a result of a clear set of 20 MQs that were considered the highest priority by the AMT and Technical Team (Section B - 2-3). We retained an additional 10 MQs that were ranked highly by the AMT, as additional questions to consider if we were forced to remove MQs due to data gaps (Table K-2). A complete list of original and omitted MQs ranked as high, medium, low, and out of scope is included as Table K-3, Table K-4, Table K-5, and Table K-6.

**Table K-2.** 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 and were maintained as alternative MQs in the event data gaps prohibited addressing a top priority MQ during analysis.

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

### 3. Highest Ranked Management Questions

**Table K-3.** Highest ranked MQs provided to AMT 1 Workshop for review. Organized by theme (listed alphabetically), showing source of the question, original question, and rewrite of question (if applicable).

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

Theme	Source	Original Question	Rewritten Question
Cultural Resources	ArFO MQs, NPRA AIM	What are the effects of climate change on cultural and paleontological resources?	
Erosion	Emerging Issues	What are the expected changes to habitat as a result of erosion and related redistribution of both fresh and saline water?	<b>Rewritten to:</b> What are the expected changes to habitat as a result of coastal erosion?
Fire Regime	Emerging Issues	How will vegetation respond given projected fire and climate regimes?	
Fire Regime	Emerging Issues	What are the current links between climate and fire, fire and vegetation, vegetation and ungulates (especially caribou)?	
Fire Regime	Emerging Issues	Given future scenarios for climate, fire, and vegetation response, how are herbivores likely to respond?	
Fire Regime	Emerging Issues	How will key forage species for caribou and other ungulates be impacted by a changing fire regime, and will this alter habitat use and migration?	
Fire Regime	Emerging Issues, NPRA AIM	What is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire on the North Slope?	<b>Rewritten to:</b> Is the fire regime changing on the North Slope and what is the likely future fire regime (or range of regimes) based on climate projections and current knowledge of the relationships between climate and fire?
Fire Regime	Emerging Issues	Will lightning activity change in terms of frequency, location, seasonal pattern?	
Fire Regime	Emerging Issues	Will fire intensity and burn severity change; and if it does, what will be the impacts, for example on permafrost and the active layer?	
Fire Regime	NPRA AIM	What changes in permafrost and vegetation will be driven by fire and how will these effect the communities that they support?	
Fire Regime	Emerging Issues, NPRA AIM	Is there/what is the current relationship between fire, vegetation succession, and landform on the North Slope?	
Fire Regime	NPRA AIM	How will permafrost thaw affect fire regime?	

Theme	Source	Original Question	Rewritten Question
Fire Regime	Emerging Issues	What is the role of fire in tundra surface stability – e.g., will increased albedo and removal of vegetation layer increase active layer thaw and thermokarsting?	
Fish	ArFO MQs	How does oil and gas infrastructure (e.g. roads, pads, pipeline), both permanent and temporary, affect fish habitat, fish distribution, and fish movements?	
Fish	ArFO MQs	What are baseline characteristics and trends in fish habitat (lakes and streams), fish distribution, and fish movements?	
Fish	ArFO MQs	How does water withdrawal from lakes for oil and gas activities (year-round industrial and domestic use and winter operations) affect lake water quantity and water quality, outflow/stream connectivity, and down-basin stream habitat?	<b>Rewritten to:</b> How does water withdrawal from lakes affect down-basin stream habitat?
Invasive Species	NPRA AIM	What are the location, abundance, and trend of invasive species?	
Invasive Species	Emerging Issues	Are we likely to see new invasive species; which ones; by which pathway; how do we reduce/prevent invasion; how do we best detect and respond to invasion; and what will the effects of increased invasion be?	<b>Rewritten to:</b> 1. Which areas of the REA are more susceptible to invasive species establishment currently? 2. Which areas of the REA are more susceptible to invasive species establishment in the future? 3. Which CEs are most likely to be impacted by invasive species? 4. What are the potential ecological impacts of invasive species on CEs?
Invasive Species	NPRA AIM	What are the known and likely introduction vectors of invasive species and what is the current status of populations?	<b>Rewritten to:</b> What are the known and likely vectors for introduction of invasive species?
Migratory Birds	Emerging Issues	Is there sufficient data on rare species to credibly advise whether a specific management action is/isn't needed?	<b>Rewritten to:</b> Where are threatened/endangered/rare/sensitive species found?
Migratory Birds	ArFO MQs	What are the baseline data for the species composition, numbers of individuals, vegetation type used, and change in numbers/species composition of landbirds and their habitat over time?	
Migratory Birds	ArFO MQs	How has the abundance and distribution of yellow-billed loons changed over time in the NPR-A?	<b>Rewritten to:</b> How has the distribution of yellow-billed loons changed over time on their north slope breeding grounds?

Theme	Source	Original Question	Rewritten Question
Permafrost	Emerging Issues	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	
Permafrost	Emerging Issues	NSSI agencies' immediate need is to be able to predict how permafrost will change temporally and spatially over the next one to two decades.	<b>Rewritten to:</b> How will permafrost change spatially and temporally over the next two decades?
Permafrost	Emerging Issues	How will changes in permafrost condition manifest for winter tundra travel, does an increasing depth of the active layer impact seasonal tundra travel?	
Permafrost	NPRA AIM	What are the changes in habitat and vegetation related to changing permafrost conditions, and what will these changes mean to wildlife and habitats?	
Permafrost	NPRA AIM	Is the permafrost-fire relationship driven by fire or the loss of permafrost?	
Social and Economic Structure	Emerging Issues	What may be the relevance of various existing management authorities (e.g., Executive Order 12898 [Environmental Justice], NEPA, and the OCS Lands Act) to considerations of the impacts of energy development or climate change on social and economic structure on the North Slope?	<b>Rewritten to:</b> What are the impacts of energy development on social and economic structure on the North Slope? This rewording is misrepresenting the original question. Recommend: "What are the different layers of regulatory control in North Slope with respect to energy development and their impact on social and economic structure in the North Slope?"
Social and Economic Structure	NPRA AIM	What are the cumulative effects of anthropogenic activities?	
Social and Economic Structure	Emerging Issues	What are the appropriate social and economic indicator data that should be gathered (e.g., for historic baseline and trend data)?	
Social and Economic Structure	Emerging Issues	How should we integrate local and traditional knowledge into social and economic investigations of North Slope people and communities?	
Social and Economic Structure	Future Needs	What are the effects of weather on construction season?	

Theme	Source	Original Question	Rewritten Question
Social and Economic Structure	Emerging Issues	What are industry activities in winter and spring (need to develop a database of industry activities for winter and spring)?	
Soils	NPRA AIM	Where are the locations of soils suitable for infrastructure development?	<b>Rewritten to:</b> Where are the locations of soils suitable/unsuitable for infrastructure development?
Subsistence	ArFO MQs	Is the harvest of caribou by residents of the NPRA and nearby communities affected by oil and gas activity in the NPR-A?	<b>Rewritten to:</b> What is the impact of development on subsistence harvest of caribou?
Subsistence	ArFO MQs	Is the harvest of fish by residents of the NPRA and nearby communities affected by oil and gas activity in the NPR-A?	<b>Rewritten to:</b> What is the impact of development on subsistence harvest of fish?
Subsistence	ArFO MQs	What physical and perceptual limitations to access to subsistence resources by local residents are caused by oil/gas activities?	
Subsistence	ArFO MQs	Have erosion and/or other environmental changes affected subsistence use areas and caused people to adjust their hunting/fishing/gathering practices?	
Terrestrial Wildlife	Emerging Issues	What parameters can help measure impacts from anthropogenic activities independently of natural cycles and vice versa?	
Terrestrial Wildlife	Emerging Issues	What is the winter ecology of caribou?	
Terrestrial Wildlife	Emerging Issues	What is the seasonal variation in caribou food production under changing climate conditions?	
Terrestrial Wildlife	Emerging Issues, NPRA AIM	How might changing fire regimes and fire response affect caribou distribution and the distribution of caribou food sources?	
Terrestrial Wildlife	ArFO MQs	What impacts will oil/gas exploration and development have on wildlife populations and how can we mitigate those impacts?	<b>Rewritten to:</b> What potential impacts will oil/gas exploration and development have on CE habitat?
Terrestrial Wildlife	ArFO MQs	What are their seasonal distribution and movement patterns?	

Theme	Source	Original Question	Rewritten Question
Terrestrial Wildlife	ArFO MQs, NPRA AIM	What are the status and trend of these communities?	<b>Rewritten to:</b> What are caribou preferences for vegetation communities? Where do these vegetation communities exist?
Terrestrial Wildlife	ArFO MQs	How are polar bears using the NPR-A today (pre-development) for natal denning and summer activity?	<b>Rewritten to:</b> Where is polar bear seasonal habitat?
Terrestrial Wildlife	Emerging Issues	What baseline measurements of caribou are needed but not yet documented?	
Terrestrial Wildlife	ArFO MQs	How are movement rates related to season and weather?	<b>Rewritten to:</b> How are movements related to season and weather?
Terrestrial Wildlife	ArFO MQs	How have types and levels of contaminants changed in the last 10 years for Colville River peregrine falcons?	<b>Rewritten to:</b> How have types and levels of contaminants changed in the last 10 years for peregrine falcons?
Terrestrial Wildlife	AK BLM State Office	How will introduction of a reindeer herding program affect caribou and vegetation?	
Vegetation	NPRA AIM	What are the condition and trend of vegetation (including rare) species and communities in natural and disturbed areas?	<b>Rewritten to:</b> Which rare species and vegetation communities are threatened by CAs?
Vegetation	NPRA AIM	What are the location, abundance, and pattern of vegetation (including rare) species and communities in natural and disturbed areas?	<b>Rewritten to:</b> Where are rare species and vegetation communities?
Vegetation	ArFO MQs	What are the impacts of oil/gas development (i.e. gravel pad and road construction; pipeline construction) on tundra vegetation? (Known impacts include burial, dust, saline runoff and altered soil moisture.)	
Vegetation	Emerging Issues	Will a changing fire regime play a role in vegetation change and should fire be used as an active tool for vegetation management?	<b>Rewritten to:</b> What is the impact of fire regime on vegetation
Vegetation	NPRA AIM	Where has disturbance occurred related to energy, fire, development, and insects and disease?	
Vegetation	WildREACH	How will plant species composition shift in response to long-term climate change, and what are the implications for habitat structure and quality of the prevalent available forage (i.e., digestibility, nutrient content)?	

Theme	Source	Original Question	Rewritten Question
Vegetation	Emerging Issues	Can we model the habitat effects of vegetation change (e.g., effect of vegetation change on habitat of yellow-billed loon, other species)?	
Vegetation	Emerging Issues	Can we (or do we need to) identify refugia for vegetation types and the bird species associated with them?	<b>Rewritten to:</b> Where are refugia for unique vegetation communities and the bird species associated with them?
Vegetation	Emerging Issues	Can we expect new ESA listings among North Slope plants species; which species are most likely?	<b>Rewritten to:</b> Where are rare (federally listed, BLM sensitive species) species found?
Vegetation	Emerging Issues	Do we have the baseline data needed to detect change?	
Vegetation	NPRA AIM	Do we have the baseline data needed to detect change?	
Vegetation	Combined-Emerging Issues and NPRA AIM	What should we expect in the way of range extensions? How will vegetation changes affect the food base for herbivorous species (especially caribou), and how will that in turn affect their numbers and use? How will vegetation change affect lichen fields and their recovery? How will shrub size and extent change?	<b>Rewritten to:</b> Where and how will shrub expansion impact caribou food availability?
Vegetation	NPRA AIM	What are the major vegetation successional pathways for the tundra vegetation classes, and how do the most common disturbance types affect those pathways?	

## 4. Medium Ranked Management Questions

**Table K-4.** Medium ranked MQs provided to AMT 1 Workshop for review. Organized by theme (listed alphabetically), showing source of the question, original question, and rewrite of question (if applicable).

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

Theme	Source	Original Question	Rewritten Question	UA Rationale
Cultural Resources	ArFO MQs	What are the impacts of recreational public travel through cultural and paleontological resource areas?		Identifying cultural and paleontological resources, and assessing the impacts of resource development activities, climate change, and recreation uses are within our expertise
Fire Regime	Emerging Issues	Will human safety conditions change if/when fire increases; how will this affect fire suppression decisions; and how will this affect communications with villages so that they are kept in touch on fire status?	How will altered fire regime affect communities, subsistence opportunities, infrastructure, and human safety?	ISER can provide location information on infrastructure and other anthropogenic uses.
Fire Regime	Emerging Issues	What is the role of fire in tundra surface stability – e.g., will increased albedo and removal of vegetation layer increase active layer thaw and thermokarsting?		This can be partially addressed independently using our fire and permafrost models
Invertebrates	WildREACH	How will warming and changing seasonality affect abundance and peak activity periods of biting insects, and what are the bioenergetic consequences for caribou in particular?	How will warming and changing seasonality affect abundance and peak activity periods of biting insects?	Literature review plus possible spatial data for current mosquito and fly harassment areas. Recent paper by Wilson et al. 2012 addresses some of the spatial aspects of this MQ - summer resource selection for the Teshekpuk herd
Invertebrates	WildREACH	How will warming and changing seasonality affect the prevalence of parasites and disease vectors (e.g., nematode parasites of muskoxen and Dall's sheep)?		Question cannot be answered with spatial data. We have a very similar question for YKL. Literature review only.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Invertebrates	WildREACH	How does temperature affect growth and development of aquatic insects?		There are already several publications addressing this question - many from the Arctic. This can be answered in a literature review. Another AKNHP project is looking at this question across sites in coastal Alaska, but data are not yet ready for analysis.
Migratory Birds	Emerging Issues	How & where will oil spill risks to birds (from rig operation, loading/ transport, pipelines) be altered if additional energy development occurs?	What are the effects of potential energy development on migratory bird habitats?	Needs clarification. Requires information on important waterfowl areas. Other migratory species? Need clarification on species or species groups. Spatial data to map current distribution and link to habitats is likely available.
Migratory Birds	ArFO MQs	What are the possible impacts to other geese resulting from the increasing snow goose population in the NPR-A?	What are the possible impacts to other geese resulting from the increasing snow goose population	Reframe so this is a spatial assessment, not population level
Permafrost	NPRA AIM	Is the permafrost-fire relationship driven by fire or the loss of permafrost?		We can model both, but not simultaneously
Saltwater Intrusion	Emerging Issues	How will increasing salinity in near shore waters affect fish species? How will it affect fish in areas not currently saline (lower reaches of rivers, flood lakes, ...)?		Near shore waters probably considered marine, this might be out of scope. But, can try to address effects of saltwater intrusion in coastal lakes and rivers on fish species using a literature review. Review would include tolerance of fish species.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Sea Ice and Ocean Conditions	Emerging Issues	How will changes in sea ice affect the need for land-based infrastructure (e.g., barge landings)?		ISER can provide location information on infrastructure and other anthropogenic uses.
Sea Ice and Ocean Conditions	Emerging Issues	How will over land weather (precipitation, wind, snowfall) be affected by changing sea ice & how will it affect management decisions (off-road travel, water permits)?		We are limited in our ability to answer this by the assumptions built into the GCMs we will use in this REA
Social and Economic Structure	Emerging Issues	Need to understand the factors that affect these social indicators – i.e., need to know how to explain what drives cause and effect in observed changes in social indicators.		Needs clarification. Depends upon the indicators of interest, and how much cause and effect is desired. This needs to be focused, but seems to fit within the capabilities of ISER.
Social and Economic Structure	Emerging Issues	What are industry activities in winter and spring (need to develop a database of industry activities for winter and spring)?		The availability of data is unknown, but this would be within our capacity.
Subsistence	ArFO MQs	Has land use by local residents changed since the 105(c) studies were conducted in the late 1970s? If so, can changes be attributed to adaptations resulting from an increased presence of oil and gas exploration activity (or in the future: development activity)?		Needs clarification
Terrestrial Wildlife	Emerging Issues	What may be the effect of changes in caribou numbers and distribution on subsistence use?	What may be the effect of changes in caribou distribution on subsistence use?	This requires seasonal use data which may not be available, but if it is then this fits within our expertise.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Terrestrial Wildlife	ArFO MQs	How do occupancy and productivity numbers for cliff-nesting raptors along the Colville River fluctuate in a pre-development environment?	What is the current distribution of cliff-nesting raptors along riparian corridors in pre-development areas?	
Terrestrial Wildlife	ArFO MQs, NPRA AIM	What habitats are most preferred by cliff-nesting raptors along the Colville River?	What habitats are most preferred by cliff-nesting raptors?	Combined with other question
Vegetation	Emerging Issues	What should we expect in the way of range extensions?		Needs clarification. This will be done, in part, during the core analysis. However, if there are specific species/communities that are of interest, then we need clarification.
Vegetation	Emerging Issues, NPRA AIM	How will vegetation changes affect the food base for herbivorous species (especially caribou), and how will that in turn affect their numbers and use?		We are addressing a similar question in the YKL REA, focused just on lichen, so this is within our capacity. Could be a core question if lichen becomes a CE.
Vegetation	Emerging Issues	How will vegetation change affect lichen fields and their recovery?		Could be core question if lichen is a CE. This is something within our capacity.
Vegetation	Emerging Issues, NPRA AIM	How will shrub size and extent change?		The first part of this question is out of scope for the REA, but the second part could be considered a core analysis if shrubs are chosen as a CE or CA.
Vegetation	Emerging Issues	For change detection, which species or habitat types should be measured and at what scale; which sites should be used and how do we ensure comparability?		This is within our expertise, but again would require major work effort. Part of it will be identified through the core analyses.

Theme	Source	Original Question	Rewritten Question	UA Rationale
Air Quality	Lon Kelly	How will oil and gas exploration and development, industry in northern Europe and Asia, research projects, changing climate, and environmental regulation impact air quality on the North Slope in aggregate, and how can these activities be controlled by land managers to minimize negative impacts?		We need clarification on regional impacts (northern Europe and Asia outside of ecoregion). Outside of our expertise, but would be able to find sources to help address the question.
Fire Regime	Emerging Issues	What is the nature of the link between fire regime and hydrology and will a change in this link have cascading effects on fish, birds, and other species?		This is an advanced modeling exercise that could be outside the scope of an REA. We can model some of these things independently, but this really represents a much larger research agenda.
Saltwater Intrusion	Emerging Issues	How will the use of saltwater for ice roads impact vegetation over time?		As stated now, this isn't a landscape-wide issue, and if included, will likely just be a literature review
Social and Economic Structure	Emerging Issues	We need objective measures for thresholds to identify what constitutes a significant change.	What threshold constitutes significant social or economic change?	Needs clarification. This is very vague and is likely out of scope for an REA
Vegetation	Emerging Issues	Will vegetation change affect active layer depth?		This is likely limited to a literature review at this scale and timeframe.

## 5. Low Ranked Management Questions

**Table K-5.** Low ranked MQs provided to AMT 1 Workshop for review. Organized by theme (listed alphabetically), showing source of the question, original question, and rewrite of question (if applicable).

Theme	Source	Original Question	Rewritten Question	UA Feedback
Climate and Weather	Emerging Issues	How will changes in weather pattern/climate affect coastal erosion?		Can be addressed via SNAP models linked to permafrost models from GIPL, but shore-fast ice and storms can only be addressed via the literature.
Climate and Weather	Emerging Issues	What information is needed to understand coupling (or de-coupling) of changes in benthic and water column characteristics with changes in weather?		lit review? No SNAP data available
Climate and Weather	Emerging Issues	What will be potential effects of changing weather conditions on lake depth (re: winter water removal and fish habitat)?	How will lake depth be affected by changing weather conditions, especially with regards to winter water removal and fish habitat?	Needs clarification. This can be addressed via permafrost modeling and perhaps via P-PET models, but results will be regionally generalized rather than site specific.
Climate and Weather	Emerging Issues	There seems to be a similar set of concerns with weather stations as with hydrological gauging stations (cost, maintenance, proper placement, ...); can we learn anything from our knowledge of hydrological gauging stations to help deal with these challenges for weather stations?	What is the number, distribution, seasonal use, and short- or long-term placement of hydrological gauging stations on the North Slope and how do these compare with weather stations?	lit review? No SNAP data available
Climate and Weather	NPRA AIM	What is the carbon sequestration potential of BLM-managed lands?		SNAP does not have any data to address this. Lit review might turn up something, but I doubt it. Doing calculations from scratch is probably out of scope.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Climate and Weather	WildREACH	What are the expected changes in snowpack characteristics (depth, density, presence of ice layers), and how might these vary on a regional and local scale?		This is more specific than what our models at SNAP offer. We can offer qualitative discussion, but not spatially explicit analysis.
Climate and Weather	WildREACH	Will increased fogginess/cloudiness exert a negative or positive feedback effect on air temperature in the coastal zone, and what is the expected spatial extent of this effect?		We do not have data at SNAP on fog and clouds
Contaminants	Emerging Issues	Effective regulation of local industry requires a baseline of contaminants present prior to industry in order to best assess what, and how much, contaminants local industry adds to the environments. What is our current knowledge of such a baseline?		Needs clarification. Depends upon the contaminant, but this would largely be left to a literature review.
Erosion	Emerging Issues	What are the erosion risks to communities and to subsistence opportunities and access?	What are the risks of erosion to communities, cultural sites, and subsistence opportunities?	ISER can provide location information on infrastructure and other anthropogenic uses. The UA Team does not currently have anyone that specializes in erosion, or hydrology in general, so some of these may have to be addressed more qualitatively than quantitatively
Erosion	Emerging Issues	What are the links between coastal or riverine erosion and contaminant risk and where is the overlap between erosion and contamination?		ISER can provide location information on infrastructure and other anthropogenic uses. The UA Team does not currently have anyone that specializes in erosion, or hydrology in general, so some of these may have to be addressed more qualitatively than quantitatively
Erosion	Emerging Issues	What are the links between coastal and riverine erosion and changing permafrost conditions?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions

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

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

Theme	Source	Original Question	Rewritten Question	UA Feedback
Hydrology	Emerging Issues	Is the hydrologic cycle undergoing significant and rapid change in response to climate change; is it well understood how this will affect cycle complexity, high/low flows, etc.?	Is the hydrologic cycle undergoing significant and rapid change in response to climate change?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	How can we measure and model duration of outflow of lakes? This is needed to define "full" for lake recharge.		Needs clarification. The UA Team does not currently have a hydrologist
Hydrology	Emerging Issues	How does snow water equivalent vary on a local scale? How do we determine how much water is available? How accurate are current methods of determining basin storage?	How does snow water equivalent vary on a local scale? How do we determine how much water is available?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	How do the coastal plain and foothills differ in water availability?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	ArFO MQs	Is adequate hydrologic information available to determine whether development is occurring within the 100-year floodplain?	Is there current and potential development within different levels of floodplains?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	How will changing patterns of seasonal runoff affect stream flow?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	What is the contribution of groundwater in various systems, and is it sufficient to maintain year-round flow?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	Will drought conditions and changes in drainage patterns decrease water body connectivity?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	WildREACH	Which Coastal Plain lakes are susceptible to tapping (rapid drainage) and on what time scale?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions

Theme	Source	Original Question	Rewritten Question	UA Feedback
Hydrology	Emerging Issues	To what extent and rate is lake drying occurring now and can we predict or model for the future? What is the geographic variation?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	Are there characteristics of lakes (e.g. basin shape, soils/substrate, vegetation, etc.) that are more/less prone to drying?	What are the mechanisms (e.g., changes in active layer, precipitation, evaporation, etc.) that lead to lake drying, and what lake characteristics increase or decrease potential for drying?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Hydrology	Emerging Issues	Is there evidence of lake expansion, or formation of new lakes, that would offset lake drying? What are the rates and patterns of this phenomenon?	What are the rates and patterns of lake expansion or formation and will expansion and formation offset drying?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Invasive Species	NPRA AIM	What are the known and likely introduction vectors of invasive species and what is the current status of populations?	What are the known and likely vectors for introduction of invasive species?	This question will likely only be addressed through a literature review.
Invertebrates	WildREACH	How does earlier spring thaw affect timing of life cycle events and peak availability to predators?		Phenological question - cannot be answered with spatial data. Literature review only.
Migratory Birds	NPRA AIM	What changes in habitat are driving changes in the distribution and abundance of migratory birds?		Needs clarification. Question at the least needs to be reframed to address what are the potential/expected changes in habitat and how could those influence the distribution of migratory birds. Abundance part of question is out of scope.
Migratory Birds	Emerging Issues	Are there likely to be shifts in species composition and how will this affect subsistence use patterns?		Needs clarification. Question could be reframed to include more specific habitat types that species area associated with.

Theme	Source	Original Question	Rewritten Question	UA Feedback
Migratory Birds	ArFO MQs, NPR-A AIM	How has the abundance and distribution of spectacled eiders changed over time in the NPR-A and what is driving this change?	How has the distribution of spectacled eiders changed over time on the north slope? What is driving this change?	Although abundance questions are generally considered out of scope, the USWFS does have density estimates for Steller's Eider across N. Slope which they have developed into a GIS coverage as birds/km <sup>2</sup> . However, we are more concerned with current and future distribution than past changes.
Migratory Birds	ArFO MQs	What are current population estimates and productivity of spectacled eiders in the NPR-A?	What are current population estimates and productivity of spectacled eiders?	Population estimates, unless the already exist, are outside the scope of an REA.
Migratory Birds	ArFO MQs	What is the current population estimate for yellow-billed loons in the NPR-A?	What is the current population estimate for yellow-billed loons?	Population estimates, unless the already exist, are outside the scope of an REA.
Saltwater Intrusion	Emerging Issues	What species of fish and fish predators are more/less tolerant of salt intrusion?		Duplicate of another question, but could be addressed through a literature review
Saltwater Intrusion	Emerging Issues	To what extent may ice road construction need to rely on the use of saltwater?		ISER can provide location information on infrastructure and other anthropogenic uses, but this is mostly non-spatial.
Saltwater Intrusion	Emerging Issues	How will the use of saltwater for ice roads impact vegetation over time?		As stated now, this isn't a landscape-wide issue, and if included, will likely just be a literature review
Saltwater Intrusion	Emerging Issues	What is currently known about the level of saltwater intrusion on the North Slope; who's measuring it; where; is it being measured adequately?	What is the level of saltwater intrusion?	Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Saltwater Intrusion	Emerging Issues	To what extent is saltwater intrusion occurring now and can we predict or model it for the future? What is the geographic variability?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions

Theme	Source	Original Question	Rewritten Question	UA Feedback
Sea Ice and Ocean Conditions	Emerging Issues	How will a changing ice edge affect specific species?		Needs clarification. We lack expertise in sea ice modeling
Sea Ice and Ocean Conditions	Emerging Issues	How will sea ice changes affect species' onshore vs. offshore distributions?		Needs clarification. Likely considered out of scope based on time limitations.
Sea Ice and Ocean Conditions	Emerging Issues	What will be the effect on wave regime and how will that relate to erosion patterns?		Good question, but we aren't qualified to weigh in on hydrologic or erosion questions
Sea Ice and Ocean Conditions	Emerging Issues	Will diminished sea ice affect fire regime?		Needs clarification. We lack the capacity to model sea-ice extent
Social and Economic Structure	Emerging Issues	We need objective measures for thresholds to identify what constitutes a significant change.	What threshold constitutes significant social or economic change?	Needs clarification. This is very vague and is likely out of scope for an REA
Social and Economic Structure	Emerging Issues	Many studies are a "snapshot" in time, without follow up to detect change. Need to synthesize existing studies, predictions, recommendations for social and economic impacts of energy development and climate change.		Needs clarification. In part, this is what an REA will do. If there is a more specific question, then we can assess it independently
Social and Economic Structure	Future Needs	What are the effects of weather on infrastructure and communities?		Needs clarification. We cannot model weather, but we do address this partially with climate change impacts. Otherwise, this would be limited to a literature review.
Subsistence	ArFO MQs	Have subsistence cabins and camping areas been impacted by scientific research projects in the NPR-A, and if so, how?	Have subsistence cabins and camping areas been impacted by scientific research projects, and if so, how?	Data is likely to be lacking, but if available we could do this.
Terrestrial Wildlife	Emerging Issues	Need to review the appropriateness of stipulations and their value to caribou		Needs clarification

Theme	Source	Original Question	Rewritten Question	UA Feedback
Terrestrial Wildlife	Emerging Issues	What may be the response of naïve caribou herds to oil and gas exploration?		Needs clarification
Terrestrial Wildlife	WREMSS	What are the condition and trends of wildlife habitat in basins emphasized in the Energy Policy and Conservation Act (EPCA) report?		Needs clarification
Terrestrial Wildlife	WREMSS	What are the stressors or drivers of change that affect wildlife habitat in basins emphasized in the EPCA report?		Needs clarification. Stressors (CA's) and drivers are addressed in each species conceptual model - so to some degree with will be addressed for each CE. However, this assessment is not specific to basins? What role to basins play on the NOS? Requires clarification.
Terrestrial Wildlife	Emerging Issues	What are unique traits, threats, and uses for each caribou herd?		Not appropriate scale for REA
Terrestrial Wildlife	ArFO MQs	What are pre-development numbers of caribou?		We are not certain about the availability of pre-development caribou data.
Terrestrial Wildlife	ArFO MQs	What impacts will oil/gas activity have on populations of ground-nesting birds through effects on predator populations?		Population estimates, unless the already exist, are outside the scope of an REA. The REA timescale is insufficient to link changes in population to oil/gas development.
Vegetation	Emerging Issues	Will we see the loss of unique vegetation types and how will this affect the life histories of other species?	1. Where are habitats for rare species expected to be in the future? 2. Which rare species appear vulnerable to reductions or changes in future habitats	This can be addressed spatially, but question below makes it a little easier to focus on specific species.
Vegetation	NPRA AIM	What is the correlation to predict the types and distribution of vegetative communities and habitats over time?		Needs clarification

Theme	Source	Original Question	Rewritten Question	UA Feedback
Vegetation	NPRA AIM	What are the location and trend of rare species or communities?	What are the population trends of rare species?	We are comfortable with this, but it is a duplicate of another question. Also, there is no known demographic studies of rare plants that we know of.
Vegetation	WildREACH	How will changes in the seasonality of stream discharge and occurrence of flood events influence development of riparian vegetation communities?		This would be limited to a literature review.
Vegetation	Emerging Issues	Will vegetation change affect active layer depth?		This is likely limited to a literature review at this scale and timeframe.
Vegetation	WildREACH	What is the time scale of expected shrub increase, and how will this vary by species/growth form (low vs. tall shrub) and ecoregion?		This is largely out of our expertise and the timescale of an REA.

## 6. Out of Scope Management Questions

**Table K-6.** Potential MQs not considered for the North Slope REA.

Theme	Source	Original Question	UA Feedback
Climate and Weather	Emerging Issues	What do we know about, and can we synthesize, information on the number, distribution, seasonal use, and short- or long-term placement of meteorological stations on the North Slope?	out of scope - methods question
Climate and Weather	Emerging Issues	How will changing weather conditions affect ice movement (loss or gathering)?	Out of scope - non-terrestrial
Climate and Weather	Emerging Issues	How does weather condition correlate to oceanographic conditions and how will this affect oil spill modeling?	Out of scope - non-terrestrial
Climate and Weather	Emerging Issues	What parameters are currently being measured at North Slope weather stations and are these correct and sufficient for our analysis and modeling needs?	out of scope - methods question
Climate and Weather	Emerging Issues	Are the data being collected by different types of weather stations, e.g., RAWS and USGS, comparable?	out of scope - methods question
Climate and Weather	Emerging Issues	Is the current location of meteorological stations appropriate and sufficient, for example, for predictive capacity and fire modeling?	out of scope - methods question
Climate and Weather	Emerging Issues	What are the hurdles to facility siting (e.g., wilderness designation, cost, access)?	Out of scope - policy question
Climate and Weather	Emerging Issues	Is the data that is obtained through currently placed meteorological stations linked to any pan-arctic accessible data network; if not, should it be; how; which one?	out of scope - methods question
Climate and Weather	Emerging Issues	What is that state of access to and can we improve access to real time and historic weather data?	out of scope - methods question
Climate and Weather	Emerging Issues	Can access to weather data be facilitated through the NSSI website and can the Projects Database help to identify data gaps, compare data types, share standards, etc.?	out of scope - policy question
Climate and Weather	Emerging Issues	What should various agency roles be in gathering, funding, or accessing real time and historic weather data?	out of scope - policy question

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Contaminants	Emerging Issues	Do we have sufficient information on ice, marine currents, and wind to inform spill models in a changing environment? If not, what are the priority needs and who is doing such modeling?	Out of scope - non-terrestrial
Contaminants	ArFO MQs	What are the effects of coastal and lake-shore erosion on legacy wells and other documented sites containing hazardous materials?	Out of scope - inappropriate scale
Cultural Resources	ArFO MQs, NPRA AIM	How can cultural and paleontological resources give us information on past climate change and the possible effects of climate change on the landscape in the future?	Out of scope - requires new data
Cultural Resources	ArFO MQs	Has the lack of precise measuring and location of cultural and paleontological resources allowed some sites to be compromised?	Out of scope - inappropriate scale
Cultural Resources	ArFO MQs	How can oil and gas activities and BLM activities mesh to minimize or avoid compromise of cultural or paleontological resources and still allow practical means of activity and exploration?	Out of scope - policy question
Erosion	Emerging Issues	How and where is erosion being measured?	Out of scope - methods question
Erosion	Emerging Issues	How have engineering considerations responded to accelerating erosion processes for current and future infrastructure?	Out of scope - inappropriate scale
Erosion	Emerging Issues	Are there mechanisms to consider for adapting to or mitigating for erosion?	Out of scope - methods question
Fire Regime	Emerging Issues	How will estimates of changing fire regime affect development planning? For example, will a changing fire regime alter the suitability of potential facility locations, or impact development activities through air quality (leading to equipment shutdown) and the need to gear up for suppression activities?	Out of scope - policy question
Fire Regime	Emerging Issues	Would comparing burned and unburned locations and their current, historical and potential vegetation on winter range and calving habitat for ungulates help answer these questions?	Out of scope - methods question

Theme	Source	Original Question	UA Feedback
Fire Regime	Emerging Issues	Will current fire behavior models (e.g., FlamMap, FSPRO, FARSITE) work under changing climate conditions? Need to be sure to model under differing climate scenarios, not just the most probable scenario. For example, the maps that LandFire produces should be evaluated under different climate scenarios in order to feed appropriate information into the fire behavior models.	Out of scope - methods question
Fire Regime	Emerging Issues	Might the presence of coal deposits affect management strategies for fires?	Out of scope - policy question
Fire Regime	Emerging Issues	May need to update/influence changes in the National Fire Plan re: wildland fire decision support system, village fire protection planning, access to funding for fire response. Can this be done via the State of Alaska's Immediate Action Working Group?	Out of scope - policy question
Fire Regime	Emerging Issues	Will a changing fire regime require the land managers (BLM, DNR, USFWS, NPS) to change their management strategies for fire on the North Slope (full protection status for villages?). Are we set up to do so?	Out of scope - policy question
Hydrology	Emerging Issues	What kind of network of long term gauging stations is needed?	Out of scope - methods question
Hydrology	Emerging Issues	Are there means (experimental or known) that can enhance the ability of energy exploration and development to move forward in water challenged environments?	Out of scope - methods question
Hydrology	ArFO MQs	What differences exist in climate and river flow responses between the coastal plain, foothills, and upland areas in NPR-A, and how might that affect design of oil and gas infrastructure?	Out of scope - policy question
Hydrology	ArFO MQs	Are temporary and permanent stream crossing structures adequately designed and monitored to minimize channel disruption, erosion and sedimentation?	Out of scope - inappropriate scale
Hydrology	Emerging Issues	Do we currently have remote sensing capability for monitoring lakes?	Out of scope - methods question
Hydrology	Emerging Issues	Are current data sets (3-7 years) adequate for estimates of peak, mean and low flows or do we need a minimum of >10 years of data?	Out of scope - methods question

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Hydrology	Emerging Issues	Are alternative technologies being investigated and if so, will they lead to alternative criteria (regulatory requirements) versus science requirements?	Out of scope - methods question
Hydrology	Emerging Issues	Is there a significant data gap in relating annual surface runoff to annual precipitation and what will it take to fill this data gap?	Out of scope - methods question
Invertebrates	WildREACH	What climate-related changes are likely in community composition of macroinvertebrates in stream, lake, and saturated soil environments?	Out of scope - inappropriate scale
Invertebrates	WildREACH	How will changes in the distribution and quality of surface waters and shifts from pelagic to benthic productivity in deep lakes affect availability of macroinvertebrates to fish and wildlife?	Out of scope - inappropriate scale
Marine Activity	Emerging Issues	In what ways will increased access enable increased development?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Will increased activity cause more bird strikes?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	What are the Law of the Sea implications?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	We will need even greater fed/state/local coordination to avoid regulatory uncertainty for activity management.	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	How will infrastructure expand to serve development and what may be the effect of this expansion?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	What are, and how will we measure, the cumulative effects of increases in various marine activities?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Baseline information is lacking for many categories of information (species, habitats, water quality, ...); to the extent it exists, is there adequate access to the data?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	Will the spread of invasive species increase? If so, which species and which pathways will be important? How can the spread of invasive species be reduced?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	How will the acoustic ecology change and what is the comparability of prior studies (Gulf of Mexico vs. Arctic)?	Out of scope - non-terrestrial

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Marine Activity	Emerging Issues	How will shipping and other marine operations interfere with species and their pursuit by subsistence hunters (e.g., will whale migrations be deflected and whaling access thus be altered)?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	To what degree will increased marine discharges of pollutants affect water quality (e.g., for prey species)?	Out of scope - non-terrestrial
Marine Activity	Emerging Issues	What are the risks from the increasing presence of non-ice-hardened cruise ships?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How do we differentiate and assess the separate and combined effects of climate change and development on various species and their interaction?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	What will be the metric of successful management in the future (for example, under ESA)?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How might a shift in species distribution from sea to land (e.g., polar bears, walrus) affect land management?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	How may this shift affect predator/prey relations on land and/or in marine waters?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Will changes in ocean currents affect species distribution and recruitment (e.g., nearshore currents and larval drift)?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Can prey species shifts in distribution and abundance be better modeled; how and with what precision?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	What will be the ecosystem level effects of shifts in the distribution and abundance of fish and other species?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	If fish species shift north, will fishing (incl. commercial fishing) patterns change and what will the effect be on management options, on non-target species, ...?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Will shipping affect whale migration and hunter access?	Out of scope - non-terrestrial
Marine Mammals	Emerging Issues	Can we identify species/habitat conservation refugia?	Out of scope - non-terrestrial
Migratory Birds	Emerging Issues	Are current breeding bird surveys sufficient to meet management needs in a changing environment?	Out of scope - methods question

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Migratory Birds	Emerging Issues	How will any changes in migratory waterfowl numbers or distribution alter risks to aircraft from bird strikes?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs, NPRA AIM	What are pre-development numbers, distribution, and survival rate of molting geese in the Teshekpuk Lake area (TLA)?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs, NPRA AIM	How has distribution and abundance of molting geese in the TLA changed over the last 20 years and what is driving this change?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	How has the abundance and distribution of Steller's eider changed over time in the Barrow Triangle and what is driving this change?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	What are current population estimates and productivity of Steller's eiders in the Barrow Triangle?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	What is the trend in population estimates of nesting snow geese on the Ikpikuk River delta?	Out of scope - inappropriate scale
Migratory Birds	ArFO MQs	How are the snow geese impacting the nesting and brood-rearing habitat on the Ikpikuk River delta?	Out of scope - inappropriate scale
Migratory Birds	Emerging Issues	Will the nature of ice edges as locations of food gathering and/or resting places change, and what will be the effect of this change on species' bioenergetics?	Out of scope - non-terrestrial
Migratory Birds	Emerging Issues	What changes may be in store for ice leads as habitat and what may be the effect of any changes in oil spill risks on the likely function/value of ice leads?	Out of scope - non-terrestrial
Permafrost	Emerging Issues	How and where is permafrost being measured; is it adequate; and is the data accessible?	Out of scope - methods question
Permafrost	Emerging Issues	What is the impact of changing permafrost to traditional ice cellars?	Out of scope - inappropriate scale
Permafrost	Emerging Issues	Are current measurement techniques sufficiently precise (e.g., to address subsidence)?	Out of scope - methods question
Permafrost	Emerging Issues	What are the restoration methods for such structures as VSMs in a changing environment?	Out of scope - methods question
Permafrost	Emerging Issues	Is seabed permafrost adequately mapped and what is the interaction between seabed permafrost and permafrost in coastal areas as exploratory drilling and off-shore to on-shore infrastructure is developed?	Out of scope - non-terrestrial

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

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

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Terrestrial Wildlife	Emerging Issues	Is there a better technology for gathering consistent census data across the Slope?	out of scope - methods question
Terrestrial Wildlife	NPRA AIM	What changes in habitat are driving changes in the distribution and abundance of wildlife – specifically caribou?	Out of scope - time limitation
Terrestrial Wildlife	WREMSS	Are applied mitigation and best management practices for habitat and human disturbance related to energy development effective in the conservation of wildlife habitat?	Out of scope - policy question
Terrestrial Wildlife	WREMSS	Are reclamation activities related to energy development accomplishing wildlife and associated habitat objectives as stated in the activity plans and/or land use plans?	Out of scope - policy question
Terrestrial Wildlife	Emerging Issues	Need to establish a network to share caribou information between and among herd managers and researchers	Out of scope - policy question
Terrestrial Wildlife	Emerging Issues	Better reporting of subsistence and sport harvest data would aid in determining relationship with impacts from exploration and development activities	Out of scope - policy question
Vegetation	Emerging Issues	What other cumulative food web effects may occur with vegetation change?	Out of scope - theoretical
Vegetation	Emerging Issues	Can vegetation change serve as an indicator of cumulative impact?	Out of scope - policy question
Vegetation	Emerging Issues	What form(s) of sampling and protocol will be needed to detect change?	Out of scope - methods question
Vegetation	Emerging Issues	How does/should vegetation change model outputs affect management decisions and timing (e.g., can/should we manage for plant species that favor certain herbivores)?	Out of scope - policy question
Vegetation	NPRA AIM	What are the vegetation impacts from development activities versus background “natural” changes?	Out of scope - methods question
Vegetation	Emerging Issues	Can we differentiate ‘natural’ change from human-induced change?	Out of scope - methods question
Vegetation	WildREACH	How will changes in the length and timing of the growing season influence plant phenology, including seasonal changes in nutritional quality?	Out of scope - this is a research question.

<b>Theme</b>	<b>Source</b>	<b>Original Question</b>	<b>UA Feedback</b>
Vegetation	WildREACH	What is the likelihood of widespread conversion from sedge and sedge-shrub meadow to bog meadow (paludification) and how would this affect herbivore and detritus-based trophic systems?	Out of scope - time limitation
Vegetation	Emerging Issues	Are there good vegetation change models for the North Slope and if not, what can we do to help develop them?	Out of scope - methods question
Vegetation	Emerging Issues	What rate of vegetation change is 'normal' (are there previous change estimates?) and how will its definition affect interpretation of future change rates?	Out of scope - theoretical