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Seward Peninsula - Nulato Hills - Kotzebue Lowlands

RAPID ECOREGIONAL ASSESSMENT
FINAL WORK PLAN I-4-C

Prepared for:
Department of the Interior
Bureau of Land Management
Rapid Ecoregional Assessments

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Submitted to:
Department of the Interior
Bureau of Land Management
222 W. 7th Avenue, #13
Anchorage, AK 99513
Attn: Paul Krabacher, Ecoregional Assessment Project Manager

Submitted by:
NatureServe
4600 North Fairfax Drive, 7th Floor
Arlington, Virginia 22203

Patrick Crist, Principal Investigator
Keith Boggs, Co-Investigator

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Approved Changes

Change	Submission date	Approval date

Seward Peninsula – Nulato Hills – Kotzebue Lowlands Rapid Ecoregional Assessment Work Plan

Introduction

Task 4 of Phase I of the Seward Peninsula – Nulato Hills – Kotzebue Lowlands (SNK) Rapid Ecoregional Assessment (REA) calls for the development, submission, review, and approval of a work plan to conduct the remaining Phase II work.

This workplan is organized by task; Phase II Tasks 1-3 are now referred to as Tasks 5-7, consistent with other REAs (Table 1) and we reference steps of the workflow as applicable (many steps are internal to BLM review). After approval of the workplan, any significant changes (identified in consultation with BLM AMT lead) will be submitted in writing for BLM approval and recorded in the Approved Changes summary in this document.

Table 1. BLM REA Phases and Tasks

Phase #	Phase	Task #	Revised Task #	Task Description
Phase I	Pre-Assessment	Task 1	NA	Refine Management Questions, Select Conservation Elements
Phase I	Pre-Assessment	Task 2	NA	Identify, Evaluate, and Recommend Potential Data
Phase I	Pre-Assessment	Task 3	NA	Identify, Evaluate, and Recommend Models, Methods, Tools
Phase I	Pre-Assessment	Task 4	NA	Prepare Rapid Ecoregional Assessment Work Plan (REAWP)
Phase II	Conduct Assessment	Task 1	Task 5	Compile and Generate Source Datasets
Phase II	Conduct Assessment	Task 2	Task 6	Conduct Analyses and Generate Findings
Phase II	Conduct Assessment	Task 3	Task 7	Prepare Rapid Ecoregional Assessment Report and Documents

The key parts of this REA workplan are:

1. Process work flow diagram (for Phase II and for tasks) that incorporate the flow of data and the activities of contractors, BLM staff, and the AMT, particularly review and approval steps.
2. Information work flow diagrams (for Phase II and for tasks as needed) that focus on the flow of information from sources through analyses to products.
3. Summary schedule for entirety of Phase II
4. Phase II tasks work descriptions
5. Data Management Plan
6. Appendices
    a. Appendix Ia contains the management question (MQ) table that clarifies the established (as of acceptance of the workplan) MQ status and definition, the original MQ definition, reporting unit, and reporting metrics. Appendix Ib lists the MQs that were proposed and removed from this assessment for a variety of reasons.
    b. Appendix II is a **draft** summary of all anticipated models (both spatial models and conceptual models), literature reviews, statistical analyses, and other products designed to answer the established MQs. This summary of products was developed to help the REA team organize its thinking for the development of the work plan. This summary information is organized thematically in eight tables:
        Table A-1. Coarse-filter terrestrial CEs and their corresponding models.
        Table A-2. Fine-filter terrestrial CEs and their corresponding models.
        Table A-3. Coarse-filter aquatic CEs and their corresponding models.
        Table A-4. Fine-filter aquatic CEs and their corresponding models.
        Table A-5. Subsistence CEs and their corresponding models.
        Table A-6. Subsistence-related assessments that are not specific to an individual CE.
        Table A-7. Other assessments that are not subsistence related and not specific to an individual CE.

Table A-8. CAs and their corresponding models.

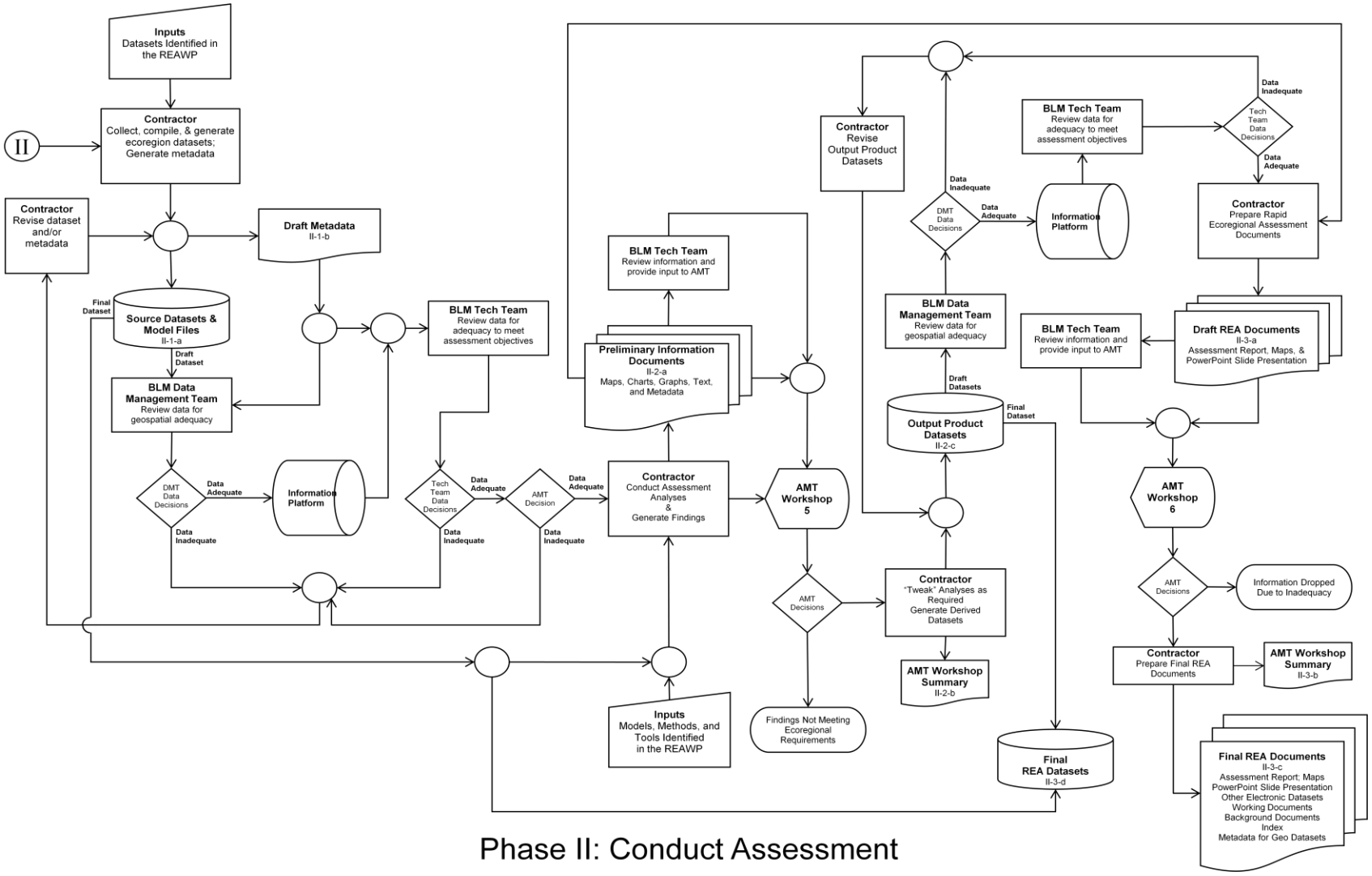
c. Appendix III contains the AMT and USGS comments and the assessment team's responses to those comments.

7. Glossary
8. List of Acronyms

Workflow

Figure 1, provided by BLM, diagrams the process workflow for information, contractor work, BLM work, and AMT interactions.

Figure 1. Process workflow for Phase II.
The original numbering of the Phase II tasks is followed in this diagram. II-1 = Task 5; II-2 = Task 6; II-3 = Task 7.



Summary Phase II Schedule

Table 2 summarizes dates agreed to with the BLM point of contact for Tasks 5, 6, and 7. Dates are provided as the start of the week of anticipated completion / delivery / occurrence of the activity except where noted with an * to indicate a specific date. This is to allow flexibility in scheduling, particularly for AMT meetings.

Table 2. Summary schedule

Date	Activity
	Phase I, Task 4: Workplan
08/24/11*	Submit workplan (I-4-a)
09/8/11*	AMT workshop 4 webinar to review REA workplan
09/30/11*	Final workplan submission (I-4-c)
	Phase II, Task 5: Data Generation
12/2/11*	Delivery of generated datasets (II-1-a) and metadata (II-1-b). *Per BLM request, it is anticipated that data will be delivered as it is completed rather than as one consolidated delivery.*
October - February	Specialized data and methods webinars *Dates and times for these webinars will be solidified once work begins on Task 5.*
12/9/11	BLM data review/approval
	Phase II, Task 6: Assessment
02/06/12	Preliminary information documents (II-2-a)
02/16/12	BLM Review of II-2-a
02/20/12	AMT Workshop 5. *Proposed 2-day workshop, exact date will be determined with BLM.*
03/27/12	Revised documents (II-2-c)
04/02/12	BLM Approval Review
	Phase II, Task 7: Final documents delivery
05/01/12	Draft Ecoregional Assessment Report (II-3-a)
05/14/12	AMT Workshop 6 *Proposed 1-day workshop or webinar, exact date will be determined with BLM.*
06/13/12	Contractor plan to revise deliverables per comments (proposed new task)
07/11/12	Project completion - Final documents (II-3-c) and datasets (II-3-d)
07/20/12	BLM Approval Review

Topical Webinars

We are proposing up to 8 webinars of 60- to 90-minutes each to present and discuss with the AMT preliminary results of modeling exercises prior to final product delivery. These webinars will be interactive and will help facilitate intermediate discussion; they will also provide opportunities for the AMT to review initial products.

Table 3. Topics and approximate dates for webinars for the SNK REA.

Approximate Month	Webinar Topic
October	terrestrial coarse-filter distributions
November	fire / ALFRESCO models
December	invasives
December	terrestrial FF distributions

December	development CAs and landscape condition model
January	aquatic coarse-filter and fine-filter distributions
January	species climate niche modeling
February	ecological status assessments

Workplan Overview

The bulk of the work plan is focused on documenting the steps and schedule to complete Tasks 5, 6 and 7 of Phase II of the REA. Tasks 5 and 6 are treated together in a single section because of the integrated nature of that work while Task 7 is in its own section as the summation and delivery of the entire REA process and products. The Data Management Plan is at the end, following Task 7; it provides details required by BLM's National Operations Center (NOC), who will review and take ownership of the final data products. The processes and procedures outlined in it apply to the entire assessment.

The BLM uses the term "assessment" to refer to analysis conducted specifically to complete Task 6. However, much of the work necessary to complete Task 5 requires complex spatial modeling or other analysis; in this work plan, the term "assessment" is used more broadly to refer to any of the spatial and non-spatial analytical work necessary for both Tasks 5 and 6. Because the work plan is intended to clearly and concisely summarize these steps, the documentation of the rationale and thinking behind the analytical tools and processes is not included; **refer to Memorandum I-3-c for that information**. In rare instances where methods have been altered since that memorandum, the changes are briefly noted in the workplan. The technical work of the REA as expressed in Tasks 5 and 6 are the most complex part of the REA process. We have endeavored to aid the reader in understanding this section by providing a summary outline of the Task 5 and 6 analyses and products below. We encourage readers to first focus on understanding the high level workflow (Figure 2), then focus on the details of interest to them. A glossary and list of acronyms has been provided to assist the reader with unfamiliar terms.

Outline for Tasks 5 and 6

This outline sequentially lists the *spatial* analyses and assessments that will be completed to answer MQs that can be addressed in whole or in part with spatial data and GIS analysis. It is organized in part to reflect the necessary sequencing of analyses; for example, the Conservation Element (CE) distributions must be completed before they can be intersected with any current or future locations of Change Agents (CAs), and the development CAs must be compiled before the Ecological Integrity Assessment can be developed. While this outline reflects our best estimate of the chronology of the work, in reality many of these will be taking place at the same time. For example, mapping distributions of CEs and CAs will all occur early on in Task 5, and aquatic Ecological Status Assessments (ESA) work may well occur at the same time as the terrestrial ESA work. Conceptually simple analyses (e.g., "where are CEs") are listed toward the beginning, and more complex assessments (climate space trends analysis, models of future fire regime) follow; some, but not all, of the more complex assessments are dependent on the simpler assessments. Assessments which are entirely non-spatial (e.g., literature reviews or statistical analysis of non-spatial data) are *not* included in this outline; their timing is largely not dependent on the completion of any particular spatial analysis work. However, they are included in the workplan.

1) Current CE distributions
   a) Terrestrial coarse-filter CE distribution
      i) Land cover maps mosaicked and reclassified
      ii) Identify priority land cover types to treat as coarse-filters
   b) Landscape species distribution
      i) GAP vertebrate species models
   c) Species assemblage distribution

i) Compile EOs for species in the assemblage, complete deductive or inductive models to map distributions

d) Local species distribution
   i) EO data from AKNHP, compiled and reported by 5th level HUC
e) Aquatic coarse-filter distribution
   i) NHD, other data layers to map aquatic types
f) Aquatic species distribution
   i) Four fish species modeled with various data sets

2) Current distributions of development change agents
   a) Development CA, current distribution:
      i) Land cover (selecting areas of development, other impacted cover classes)
      ii) Roads
      iii) Communities
      iv) Oil and gas developments
      v) Alternative energy developments
      vi) Mines
      vii) Recreation
      viii) Contaminated sites
      ix) Military sites
      x) Grazing
      xi) Other data layers
3) Selected development CA data layers (not all of the above) will be assembled to create a current land use scenario for intersecting with CEs to answer MQs related to where development CAs affect CEs.
4) Model current distribution of continuous and discontinuous permafrost
   a) Current distributions of other CAs (fire, climate change, invasive species) are listed below after Permafrost in this outline
5) Analyses to develop Ecological Status Assessments to answer MQs about current conditions
   a) Terrestrial system and species indicators
      i) Develop conceptual models for the terrestrial CEs to document knowledge of their ecosystem dynamics, and the scorecard for how the indicators and metrics will be measured
      ii) Landscape Condition Model (LCM) as indicator of key ecological attribute of Landscape Context
         (1) Compile selected development CAs
         (2) Assign index of site intensity to each
         (3) Assign distance decay function to each
         (4) Build spatial model
      iii) Invasive Plants Index as indicator of key ecological attribute of Ecological Condition (biotic composition)
         (1) Use existing distributions of invasive plants categorized by degree of invasiveness
         (2) Create an index
         (3) Build spatial model
   b) Aquatic system and species indicators
      i) Develop conceptual models for the aquatic CEs to document knowledge of their ecosystem dynamics, and the scorecard for how the indicators and metrics will be measured
      ii) Dendritic Connectivity Index will be used as an indicator of stream connectivity
         (1) Applied to distribution models of coho salmon, Dolly Varden, and arctic grayling on the Nome road system.
      iii) The LCM (see above), AKNHP non-native species occurrences, and placer mining ditches will be used as indicators of the surrounding land use context.
         (1) An average LCM score for each 5th level HUC will be calculated and used for scoring within each category.

(2) The total number of non-native species occurrences and their invasiveness will be used for the non-native species scores.

iv) ADEC's list of state impaired waters and APDES permits will be used as indicators of water quality.
   (1) The total number of impaired waters, based on their category, will be used to develop the scores for each category.
   (2) The total number of APDES permits within a 5th level HUC will be scaled to develop the scores.

v) ADF&G's listing of fish stocks of concern will be used as an indicator of aquatic biotic condition.
   (1) The total number of stocks of concern for each 5th level HUC will be used for scoring.

vi) Build spatial models for each of the above

6) Ecological Status Assessments applied to:
   a) Terrestrial coarse-filter and landscape species CEs: Use scorecard metrics for landscape condition model and invasive plants index, each intersected with individual CE distributions; scored by 5th-level HUC, stored in a geodatabase by CE x indicator x HUC and by CE x KEA x HUC, and by CE x all scores x HUC.
   b) Aquatic coarse-filter and fish species CEs- use scorecard metrics for each aquatic indicator and intersect with individual CE distributions; scored by 5th-level HUC, stored in a geodatabase by CE x indicator x HUC and by CE x KEA x HUC, and by CE x all scores x HUC.
7) Ecological Integrity "Roll-up": by HUC and ecoregional roll-up of ecological statuses of CEs
8) Socioeconomic assessments
   a) Current populations, demographic and employment statistics, and recent changes will be mapped and tabulated
   b) Forecasted populations of communities in 2025 and 2060
   c) Identify and map communities that are expected to need to relocate by 2025 and 2060
9) Subsistence assessments
   a) Includes locational and harvest data for individual subsistence species
   b) Intersect habitat distribution maps of subsistence species with relevant development CAs
10) Permafrost
   a) Current conditions: see earlier item in this outline
   b) 2025 scenario: active layer thickness (ALT) and mean annual ground temperature (MAGT) projected under climate change (SNAP climate data) for that time frame, summarized by subregions (Nulato Hills, Seward Peninsula, etc)
   c) 2060 scenario: active layer thickness (ALT) and mean annual ground temperature (MAGT) projected under climate change (SNAP climate data) for that time frame, summarized by subregions (Nulato Hills, Seward Peninsula, etc)
   d) Intersected with selected terrestrial coarse-filter CEs
      i) 2025 soil dynamics intersected with CEs: percent of CE by subregion
      ii) 2060 soil dynamics intersected with CEs: percent of CE by subregion
11) CA: Fire
   a) Current / recent fire regime: recent fire perimeters will be mapped
   b) 2025 scenario: projected fire regime under climate change for that time frame (SNAP climate data) for four broad vegetation categories: tundra, white spruce, black spruce, deciduous
      i) % area burned
      ii) % area re-burned
      iii) Fire return interval
      iv) Vegetation composition (the 4 above categories)
   c) 2060 scenario: projected fire regime under climate change for that time frame (SNAP climate data) for four broad vegetation categories: tundra, white spruce, black spruce, deciduous
      i) % area burned

ii) % area re-burned
iii) Fire return interval
iv) Vegetation composition (the above 4 categories)

12) CA: Future Development Scenario
    a) Current development is compiled earlier to develop the Landscape Condition Model for use in Ecological Status Assessments; and as a current land use scenario (see items #3 and #5 above)
    b) Projected development for 2025: some development is projected to occur and those will be compiled into a 2025 scenario
        i) Roads to Ambler and Nome
        ii) Alternative sites for Kivalina and Shishmaref
        iii) Alternative energy sites (those currently approved for development and areas of high capability within 25 miles of existing settlements)
    c) Projected development for 2060
        i) All that are included in 2025
        ii) New mines along possible roads
        iii) Removal of some communities that are projected to erode away in the next 50 years
        iv) Proposed oil transportation infrastructure associated with Chukchi offshore development
    d) Intersection of 2025 development scenario with selected CEs; map and summarize overlap with each CE by 5th level HUC
    e) Intersection of 2060 development scenario with selected CEs; map and summarize overlap with each CE by 5th level HUC
13) CA: Non-native Species
    a) Current documented locations of invasive EOs will be used solely for Invasive Species Index that will be used in the Ecological Status Assessments listed earlier; these data will not be further assessed against CEs
    b) We are exploring the feasibility of completing climate envelope modeling for four invasive plant species present in AK but not yet found in SNK
    c) If completed, the predicted distributions for these four invasive species will be overlapped with the current distributions of terrestrial CEs, and statistics generated by 5th-level HUC of their overlap.
14) CA: Pests and Diseases
    a) Recent beetle outbreaks will be mapped from aerial forest surveys
    b) No data are available to map distributions of beaver or coyote
15) CA: Climate Change
    a) Climate trends
        i) Baseline: recent historic climate space
        ii) Current climate
        iii) 2025 climate
        iv) 2060 climate
        v) Comparison of each "time slice" to characterize magnitude of change in seasonal temperature and precipitation, by subregions.
    b) Bioclimatic niche modeling / species range shift modeling
        i) Intersect landscape species' modeled current distribution with current climate to identify species climate envelope
        ii) Use the climate envelope to identify and map areas with suitable climate in 2025
        iii) Use the climate envelope to identify and map areas with suitable climate in 2060
16) Other assessments
    a) Protected areas
        i) Develop list of protected areas to map; compile spatial data for those
        ii) Intersect protected areas with CE distributions, report on CEs within protected areas
    b) High biodiversity sites

i) Develop list of high biodiversity sites to map; compile spatial data for those
ii) Intersect with CE distributions, report on CEs within high biodiversity sites

c) CE survey effort
d) Dispersal barriers
   i) Compile current distributions for subset of CEs
   ii) Compile future (climate range shift models) distributions of CEs
   iii) Compare against DEM for topographic barriers; against 2060 development model for human barriers
e) Habitats for terrestrial species of concern
   i) Intersect current species CE distributions, or EOs for local species, with land cover map
   ii) List species occurrence by land cover class

Tasks 5 and 6: Conducting Assessments to Answer Management Questions

In Tasks 5 and 6, we complete input data gathering and evaluation, then integrate and analyze the data sets and other information sources needed to address the overall questions of where are CEs and CAs, and to address the final set of MQs identified for this REA. These tasks are described by BLM in two parts: Task 5 is the compilation and generation of "source" data sets, and Task 6 is the analysis of data to generate findings. Task 6 encompasses the analyses needed to address the MQs.

As defined by BLM, "source" data sets are those needed to spatially represent CEs, CAs, and other features (e.g., permafrost, high biodiversity sites) that will be assessed. In many cases, substantial spatial analysis is needed in order to develop the "source" data sets. Because the line between generating source data sets (Task 5) and conducting analyses to answer assessment questions (Task 6) is often fuzzy, with BLM approval we treat the two tasks together in this workplan.

Details for each management question to be addressed in these assessments are provided in Appendix Ia and include the following key information (extracted from an Excel spreadsheet that contains the full history of MQ changes and notes from previous tasks):

- MQ tracking number: a fixed number applied to each MQ that was accepted for assessment as of the end of Task 3.
- MQ Group: original themes by which the MQs were organized.
- Final MQ: the final description of the MQ
- Original MQ: the original description of the MQ provided in the SOW or community meetings.
- Reporting unit: the unit at which MQ results will be reported.
- Reporting metrics: the numeric values used to answer or support the MQ (e.g., many MQs simply ask where a CE or CA exists; supporting metrics may also provide areal statistics).

Reporting units are listed for each MQ per above and in general follow reporting requirements established by BLM in the SOW. Many spatial analytical results will be provided as summaries using landscape reporting units of 5th-level 10-digit hydrologic units. Climate assessment results will be summed and reported by either the sub-unit ecoregions or 5th level HUCs; reporting units for those assessments still need to be resolved. Our intent is to utilize reporting units and metrics at the finest extent and grain supported by the source data; for example, a "where is it?" MQ will be answered using the source data resolution (e.g., 30 m to depict terrestrial coarse-filter CE distribution).

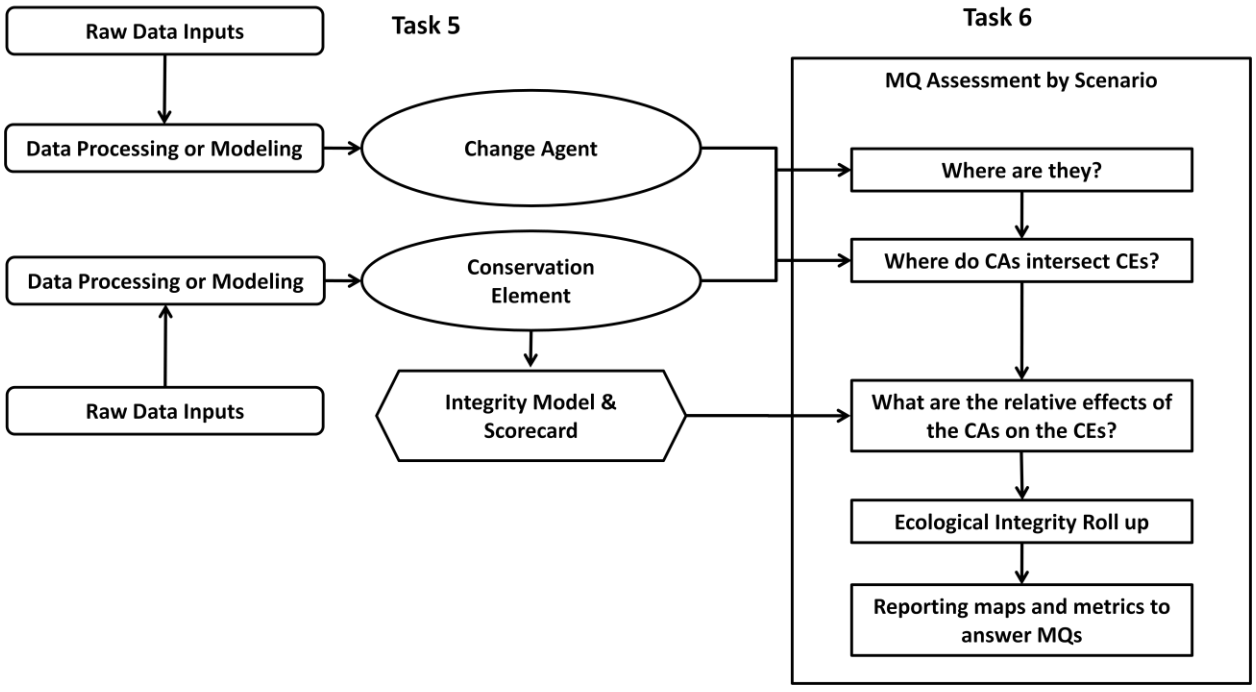
A generalized workflow for Tasks 5 and 6 is provided in Figure 2. (Detailed workflow diagrams for individual spatial and other analyses were provided in Memorandum 3c and are not repeated in the workplan.) The assessments to address Tasks 5 and 6 are organized according to the features depicted in Figure 2, elaborated here:

- Where are CEs and CAs?: These MQs are addressed with basic assessments conducted using the source data or generated distributions of CEs and CAs.

- What is the current condition of the CEs?: These MQs also are addressed with basic assessments conducted using the source data or generated distributions of CEs and CAs.
- Where do CAs intersect CEs?:
    - These will be addressed for three different time scenarios generated from the CAs for current, 2025, and 2060 timeframes.
    - All CEs and relevant CAs will be intersected for the current time scenario.
    - Twelve terrestrial animal species will be intersected for the current, 2025, and 2060 scenario.
- Relative effects of CAs on CEs: The Landscape Condition Model developed for the current scenario will be applied to characterize effects of current development CAs on CEs.
- Other assessments (not shown in the figure): these cover special assessments not covered by the above categories and some MQs pertain to subjects lacking adequate spatial data; in those cases, tabular data may be compiled in a summary form or a literature review may be conducted.

Where possible, we provide an expansion of the relevant portions of the Task 5 and 6 workflow diagram (Figure 2) for the detailed sections under Tasks 5 and 6.

Figure 2. Generalized information workflow for Phase II, Tasks 5 and 6.
Note that the development of the Ecological Status Assessment (ESA) Scorecard indicators and metrics occurs in Task 5. The application of the ESA to assess the current condition of each CE occurs in Task 6.



As described in Memorandum 3c and further illustrated here, we are utilizing a scenario-based approach to answer MQs relevant to different timeframes requested in the REA SOW:

- Current: represented by mapped CAs or those for which we can model their distribution as of 2011.
- 2025: includes all current CAs and those forecast to occur by 2025.
- 2060: includes all of the above CA distributions plus climate change forecasts for 2060.

While several MQs are interested in individual CAs or groups of CAs, the scenario approach also supports a cumulative effects assessment of the interaction of all identified CAs. The aggregation of CAs

in scenarios supports results for multiple MQs, from basic questions about interactions among CAs and CAs with CEs, to modeling the CE ecological integrity ramifications of the different scenarios.

All components of the workplan fall within eight general assessment categories:

i) Where are CEs and CAs?
ii) Ecological status of CEs (and ecological integrity assessment roll-up)
iii) Socioeconomic assessments
iv) Subsistence assessments
v) Scenario assessments
vi) Where do CEs intersect CAs? (these are included under "Scenario Assessments")
vii) Other assessments
viii) Non-spatial assessments (e.g., literature reviews)

For each assessment category we include specific information related to data inputs, processing, products, and timelines using the template below. Work flow diagrams are provided to place the specific assessment area in the context of all Task 5 and 6 assessments, following the structure of Figure 2. Tables listing resulting models and other products are provided in Appendix II.

Applicable scenario(s): If applicable to the task item, this identifies which of the 3 scenarios this item applies to.

Inputs required: List of data inputs

Analytical process: Brief summary bullet list of process steps, referencing input data layers

Outputs: Outputs are listed briefly in the template for each task item, as well as being summarized in Appendix II, Tables A-1 through A-8

Anticipated timeline

Sequencing and dependencies: Notes whether other assessment data have to be developed before this data can be developed

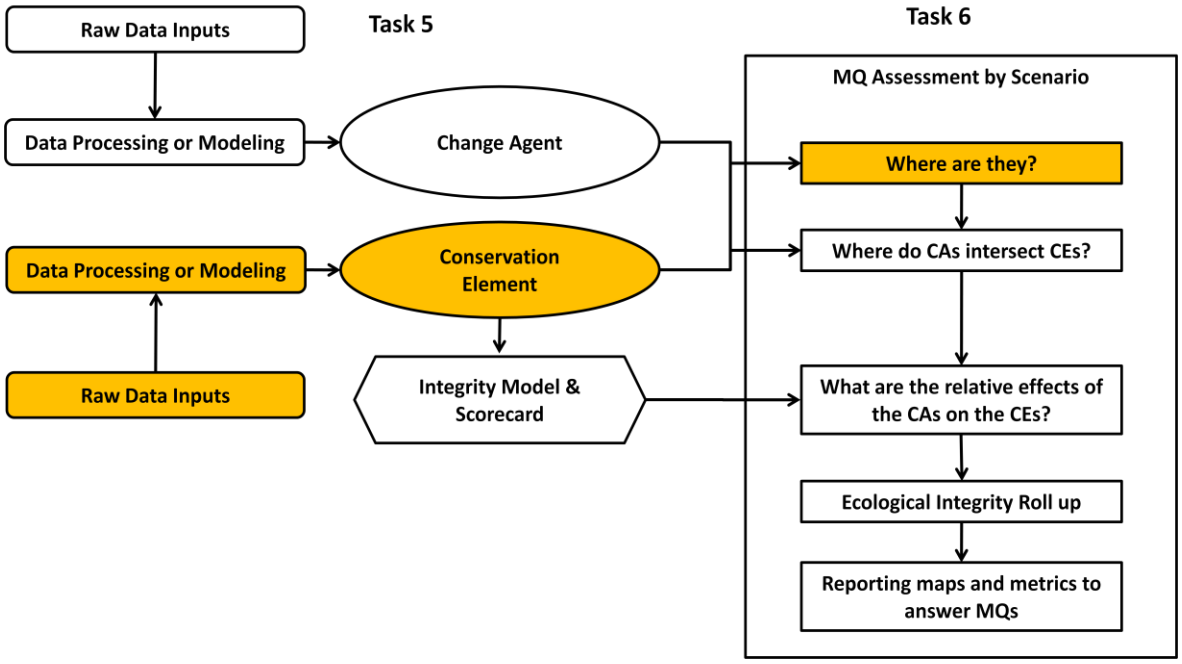
Where are CEs?

This assessment was described in Memorandum 3c and asks for source maps of the locations or modeled distributions of each CE and CA. Locational data for individual CEs or CAs were gathered during Task 2 and additional data were gathered in Task 3. Additional processing of data to develop distribution maps (as needed) will be generated in Task 5. To complete the assessment we will create the standard map outputs and generate spatial statistics on the mapped area of each feature.

Conservation Elements

The general work flow of developing CE distribution layers or models is simple (Figure 3). For each terrestrial and aquatic coarse and fine filter CE distribution model, detailed inputs and processing have been described in Memo 3.

Figure 3. General workflow diagram of CE distribution models addressing "Where are the CEs?".



Terrestrial Conservation Elements

Terrestrial Coarse-Filter Land Cover Classes

The methods and underlying rationale for mapping the distribution of terrestrial coarse-filter CEs is described in detail in Memorandum 3C. A landcover map was completed in Tasks 2 and 3 through mosaicking existing land cover maps. Additional modeling of land cover classes might be completed through Task 5 and 6. Figure 4 is a simplified illustration of the workflow for this mapping process, shown in the context of all Task 5 and 6 work. Thirty land cover classes have been mapped (Table 4). A literature review will be conducted in order to develop descriptive conceptual models for all land cover classes; vegetation succession will be described for 12 priority land cover classes (see Appendix II, Table A-1). The 12 priority land cover classes will be treated as the "coarse-filter" units, each will have its current distribution mapped, will be the subject of the current ecological status assessments, and included in the ecological integrity roll-up process for the 5th level HUCs and the REA. They will also be included in the analysis to answer MQs such as where does development affect CEs? The remaining 18 land cover classes will be components of the ecoregion's land cover map and will have conceptual descriptions developed, but not be included in the EIA procedures. The complete land cover map will be a stand-alone product, and will be used to answer some specific MQs, such as "What habitats support terrestrial species of concern (rare plants, rare animals, and subsistence species)?"

In the SNK Memorandum I-3-c, we suggested nesting the aggregated land cover classes into four ecoregion conceptual model units: Coastal, Upland, Lowland and Aquatic (USDI National Park Service Arctic Network). Upon mosaicking the four land cover maps we found that the land cover classes cannot be nested within the Upland versus Lowland units. The land cover classes were not described or mapped based on these Upland or Lowland concepts except for the Arctic Network Map that covers the northern 25% of the REA. In contrast, we will be able to nest our coastal land cover classes into the Coastal unit. The freshwater coarse-filter aquatic unit is described in the Aquatic CE Characterization and Conceptual Models section.

In the earlier memo we also stated we would model succession using the Vegetation Dynamics Development Tool (VDDT). We will not use the VDDT models in part because they are redundant with the ALFRESCO models.

Figure 4. Workflow diagram for mapping the distribution of terrestrial coarse-filter CEs.

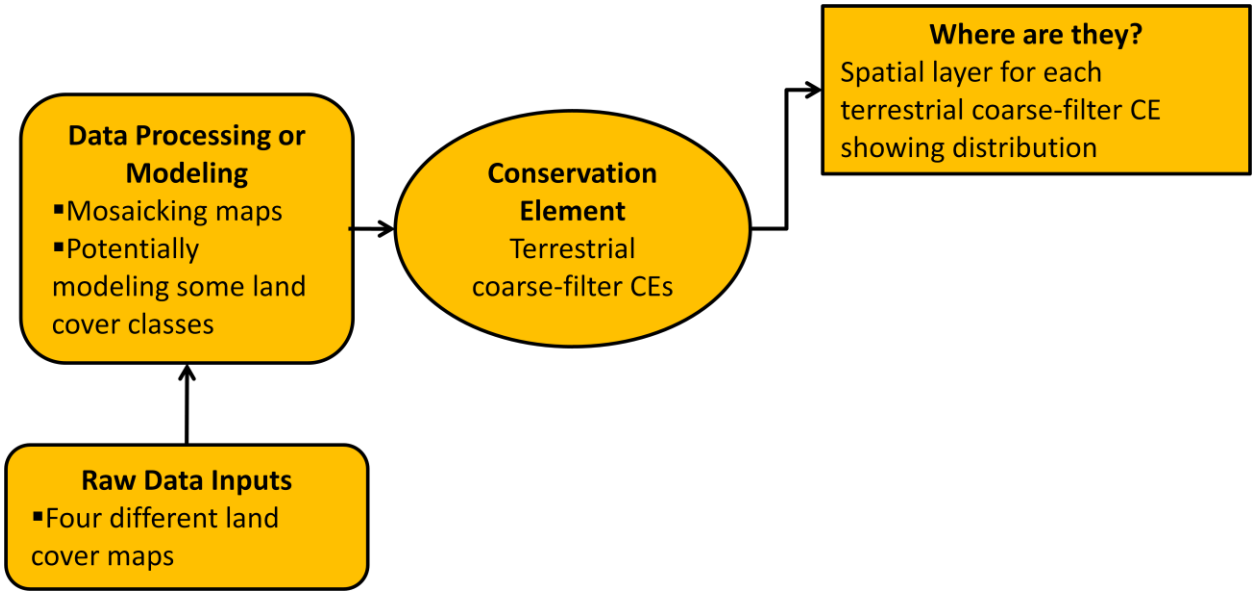


Table 4. Final list of land cover classes.
All classes will have descriptive conceptual models. Priority types that will be treated as the coarse-filter classes are in bold.

Land cover classes
Black Spruce (Open)
Black Spruce (Woodland)
Black Spruce/Lichen (Woodland)
Black spruce/Tussock (Woodland)
White Spruce (Open)
White Spruce (Woodland)
White Spruce/Lichen (Open)
White Spruce/Lichen (Woodland)
Deciduous (Open-Closed)
Needleleaf-Deciduous (Open-Closed)
Tall Shrub (Open-Closed)
Low Shrub birch/Lichen
Low Shrub Birch-Ericaceous-Willow
Low Shrub-Tussock Tundra
Low Willow
Dwarf shrub
Sedge-Dwarf shrub (Peatland)
Dwarf shrub-Lichen
Dwarf shrub-Lichen-Sphagnum (Permafrost plateau)
Herbaceous (Marsh)

Land cover classes
Herbaceous (Mesic)
Herbaceous (Wet)
Pondlily
Tussock Tundra
Elymus (Coastal)
Salix-Sedge (Tidal)
Sedge (Tidal)
Lichen
Moss
Sparse Vegetation

Terrestrial Fine-filter

Terrestrial fine-filter species were selected and grouped using established criteria in the REA as part of Memorandum 3C into four general treatments: species represented as part of the coarse-filter units, ecologically based assemblages, landscape species, or local species (see Appendix II, Table A-2 for a listing of all species and their treatment categories). A general workflow for all terrestrial species CEs is illustrated in Figure 5. All species that were represented as part of the coarse-filter units will not have distribution maps and are assumed to have the same distribution map as their corresponding land cover class. All other distribution map treatment categories are described further below. All landscape species, ecological assemblages, and local species will have descriptive conceptual models (see Appendix II).

Landscape Species

Birds and mammals are the only terrestrial species taxonomic groups treated as landscape species. For birds and mammals we will use existing Alaska Gap Analysis Project distribution models, through the intersection of the inductive and deductive model to map the current distribution of all terrestrial CEs. A more detailed description of the methods can be found in Memorandum 3C.

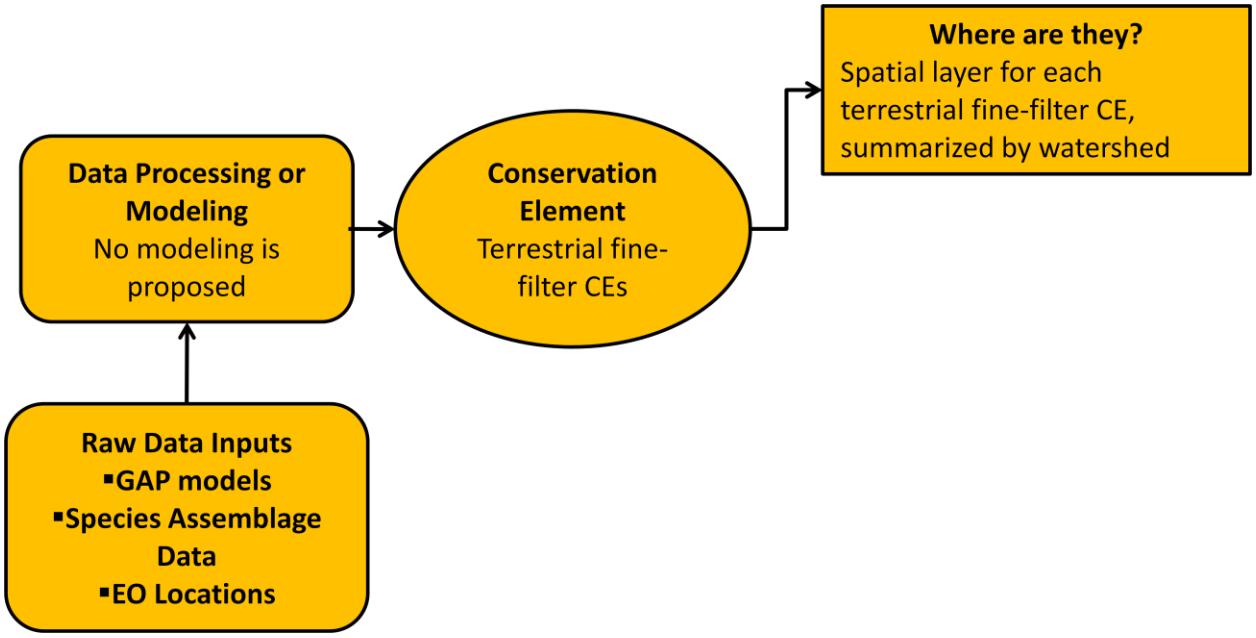
Ecological Assemblages (animals only)

Species assemblages will be mapped using existing point and polygon location maps and summarized by watershed.

Local Species

Local-scale species will require no additional modeling steps and will be summarized by watershed.

Figure 5. Workflow diagram for mapping the distribution of all terrestrial fine-filter CEs (including plants and animals).



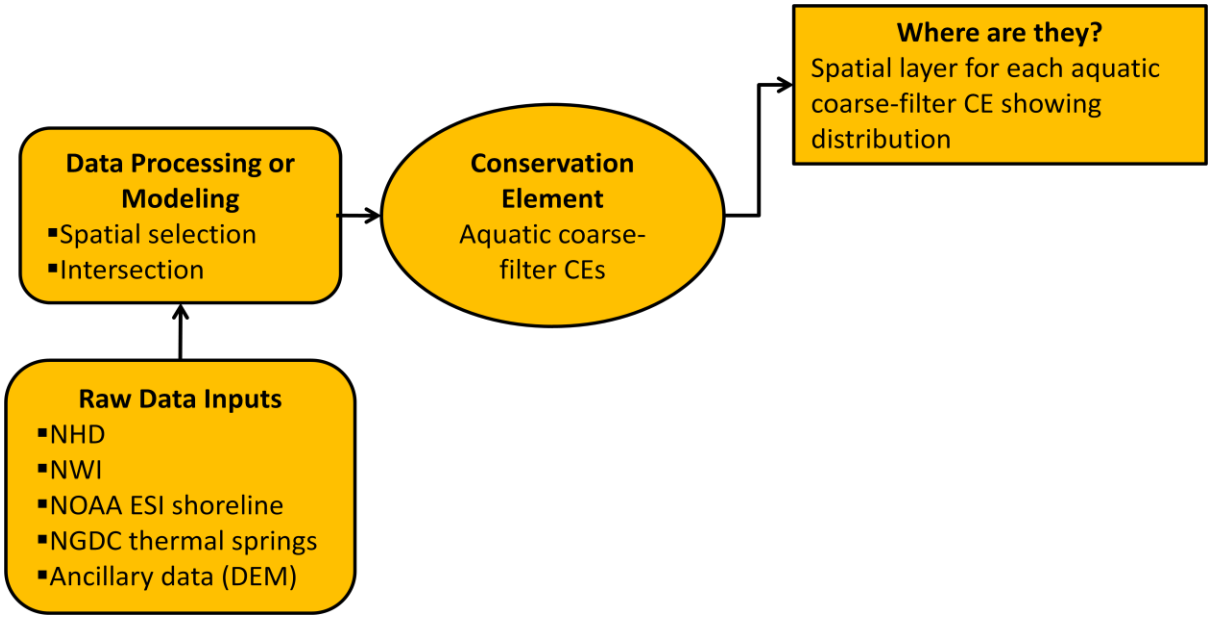
Aquatic Conservation Elements

Aquatic Coarse-Filter CEs

The methods and objectives for mapping the distribution of aquatic coarse filter CEs is described in detail in Memorandum 3C. In addition to the distribution mapping, a literature review will be conducted to help inform the conceptual models describing the aquatic habitats and their importance to fish species in the REA study area. Upon completion of the distribution mapping, spatial statistics summarizing the mapped area, lineage, or number of each feature class will be provided. Figure 6 illustrates a general workflow diagram summarizing the aquatic distribution mapping.

Inputs required: National Hydrography Dataset (NHD), National Wetlands Inventory (NWI), Environmental Sensitivity Index (ESI), National Geophysical Data Center's (NGDC) thermal springs locations, and the ASTER 30 m Digital Elevation Model (DEM).
Analytical process: The lakes, rivers, and headwater streams will all be selected from the NHD using simple intersection and size selection models. The NGDC thermal springs dataset will be used to represent hot springs. The NWI and ESI will be combined to located estuaries and lagoons. The DEM will be combined with the rivers layer from the NHD to identify lowland streams.
Outputs: Point feature class of hot springs; vector feature classes for headwater streams, rivers, and lowland streams; polygon and/or vector feature class of estuaries and lagoons; and polygon feature classes for the four lake habitat types.
Anticipated timeline: October – November 2011
Sequencing and dependencies: The aquatic coarse filter distribution models will be the first item completed for the aquatic resources because they do not require analysis or generation of ancillary source datasets.

Figure 6. Workflow diagram for mapping the distribution of aquatic coarse-filter CEs.

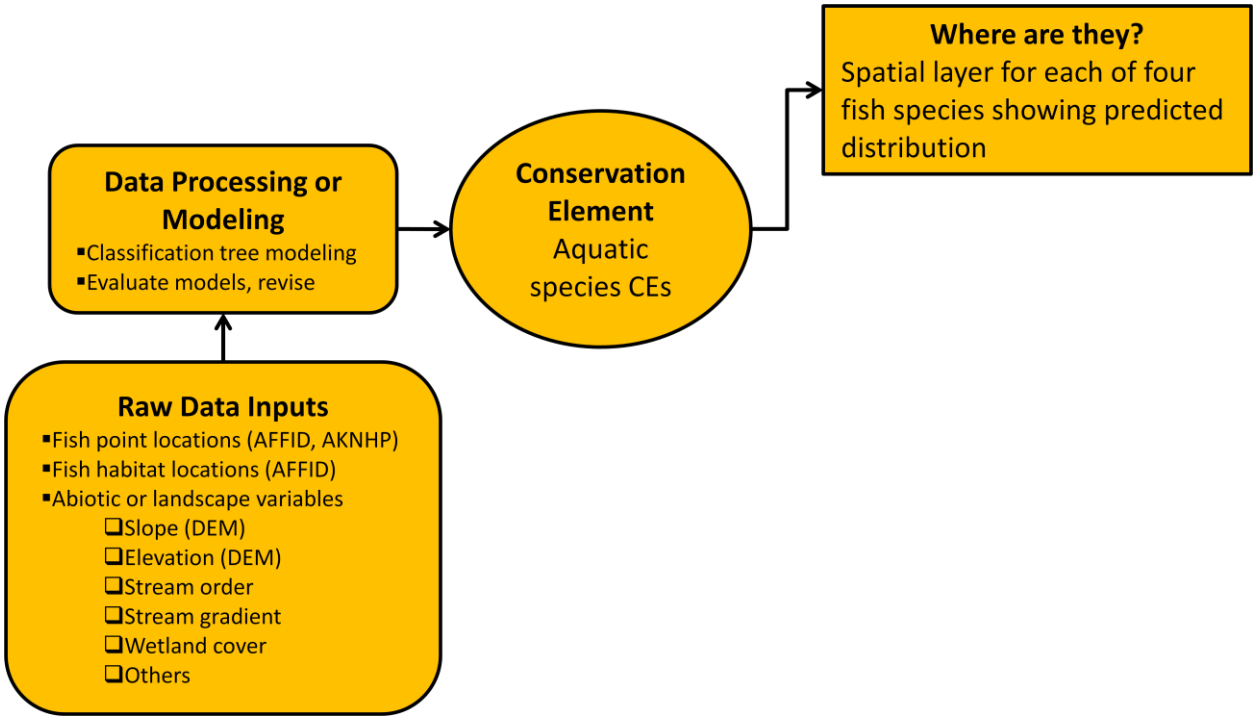


Aquatic Species CEs

The methods and objectives for mapping the distribution of aquatic fine filter CEs is described in detail in Memorandum 3C. In addition to the distribution mapping, a literature review will be conducted to help inform the conceptual models describing the general ecology, life history patterns, and aquatic habitats used by fish species in the REA study area. Upon completion of the distribution mapping, spatial statistics summarizing the total area (lakes or estuaries) and lineage (streams) of potential habitat will be provided for each fish species with a distribution model. Figure 7 illustrates a general workflow diagram summarizing the aquatic distribution mapping.

Inputs required: Anadromous Waters Catalog (AWC), Alaska Freshwater Fish Inventory Database (AFFID), AKNHP Fish Occurrences, BLM lake survey for arctic char, ASTER 30 m DEM, NHD, and NWI.
Analytical process: For sheefish, sockeye, Chinook, chum, and pinks: the AWC will be used to select stream habitat identified in the REA study area for each species. The BLM lake survey for arctic char will be used to identify habitat in the Kigluaik Mountains that support arctic char. For arctic grayling, Alaska blackfish, coho salmon, and Dolly Varden; a suite of predictor variables will be used to develop Classification Tree models to identify potential habitat beyond their current distributions identified in the AWC, AFFID, and AKNHP datasets.
Outputs: Vector (streams) and polygon (lakes) feature classes identifying known distributions for all ten species and predicted potential distributions for four fish species.
Anticipated timeline: October 2011– January 2012
Sequencing and dependencies: Several source datasets will require acquisition and analysis in order to develop the predictor variables for the fish distribution models for arctic grayling, Alaska blackfish, coho salmon, and Dolly Varden. Datasets that must be acquired via download for the entire study area include the ASTER 30 m DEM and the NHD with populated flow tables. Additional analysis of the DEM and NHD will be required to generate predictor variables such as stream gradient, stream order, watershed area, topographic wetness index (TWI), number of branches from the mainstem, and others that may be useful for one of the four fish species based on a literature review. Many of these analyses can be conducted using tools available in Spatial Analyst, ArcHydro, or Network Analyst.

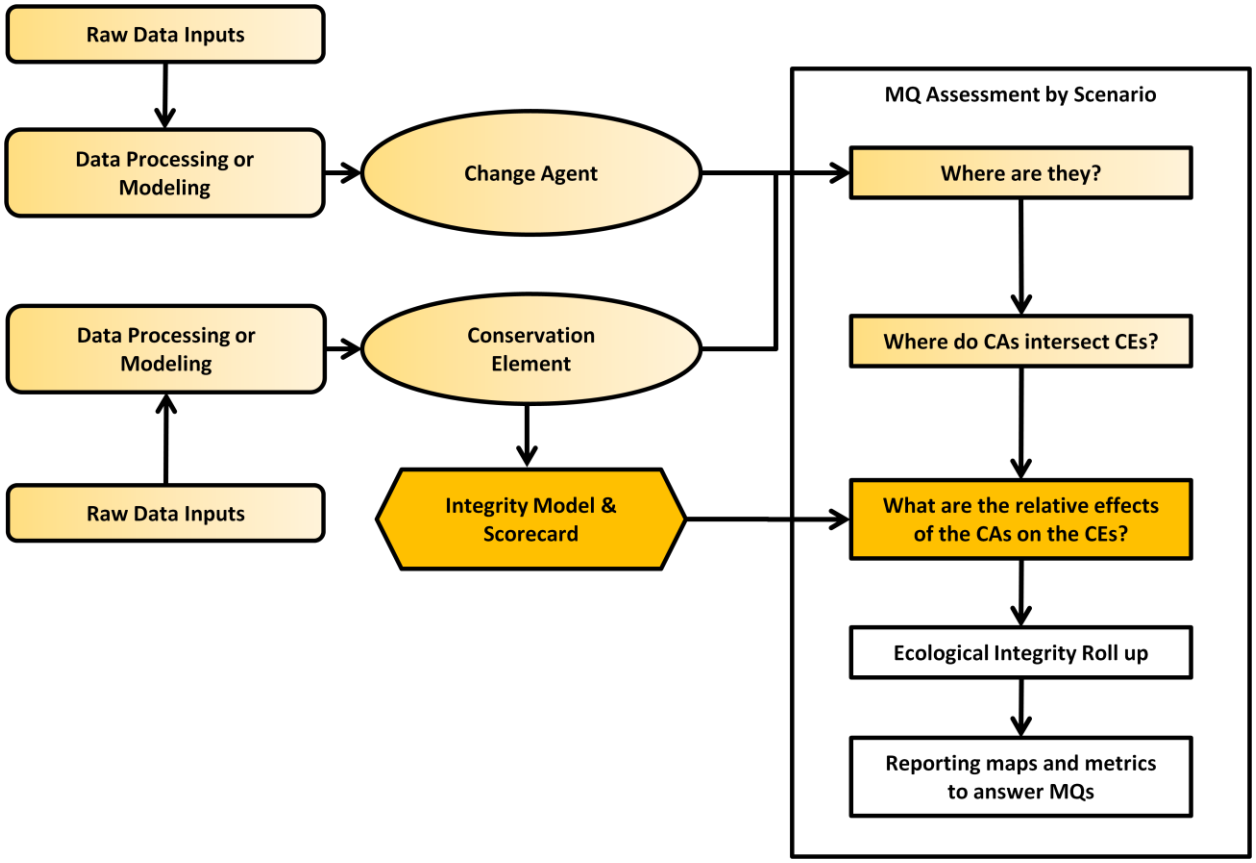
Figure 7. Workflow diagram for mapping the distribution of aquatic species CEs.



Current Status or Condition of CEs

This assessment was described in Memorandum I-3-c and involves the generation of ecological status assessment (ESA) scores for the status of each terrestrial and aquatic CE based on Key Ecological Attributes (KEA; Landscape Context, Condition) and associated indicators (Figure 8). This assessment category includes all MQs that focus on the current status of CEs, and those that focus on specific stressors affecting current status. To complete the assessment we will generate assessment results for each indicator, for each KEA, by reporting unit, and "roll up" these KEA-level results into a CE score by reporting unit. Memorandum I-3-c presents the methodology and an example. The current status of coarse-filter terrestrial and aquatic CEs will be evaluated through a series of analyses. The KEA of landscape context will be represented by a "landscape condition model" (LCM), created using the development-related data sets. The LCM is a way to represent the major effects of development and infrastructure across the landscape. The LCM will serve as one of two or more metrics used to assess ecological status of terrestrial and aquatic coarse-filter CEs.

Figure 8. Workflow diagram for developing ecological status assessment scores.



Landscape Condition Model

Major effects of development and management actions are captured in the Landscape Condition Model (LCM) using the approach developed by NatureServe (Comer and Hak 2009). The condition model can be tailored to individual or groups of CEs and models the direct and offsite (distance) effect of CAs. The results are a continuous raster surface representing an index of landscape condition from 0.0 to 1.0 with 1.0 being very high landscape condition. This model will be used as an index for measuring ecological status of most CEs.

We are modifying the national model for this region by using spatial data for land use currently found in the REA. We expect the model to indicate that the SNK REA, compared to others, is predominantly in very good landscape condition, with the exception of a few areas around some of the communities, and adjacent to roads, mines, and a few other current infrastructure sites.

Inputs required:

- Roads layer from ESRI StreetMap
- 2009 National Land Cover Data
- Contaminated sites footprint layer
- Alternative energy footprint layer
- Community locations layer
- Mining footprint layer
- Military sites layer
- Oil and gas development areas
- Revised distance decay function for each input layer

- Revised relative site intensity function for each input layer

Analytical process: Comer and Hak model, with SNK-specific spatial inputs, re-estimated distance decay, and site intensity functions.
Outputs: Raster layer of landscape condition
Anticipated timeline: November-December 2011
Sequencing and dependencies: The development CA distribution data sets must be compiled prior to estimating the LCM. These data sets are described in more detail in the Development section of the Scenario Assessments discussion.

Ecological Status of CEs

The ecological status assessment was described in Memorandum 3c and involves the generation of ecological status assessment (ESA) scores for terrestrial and aquatic CEs based on key ecological attributes and/or other associated indicators. This assessment category includes all terrestrial and aquatic CEs categorized as landscape species with existing or modeled distribution maps, all of the aquatic coarse-filter CEs, and a selected set of 12 terrestrial coarse-filter CEs (see Appendix II, Tables A-1 through A-5). The data will be gathered or generated in Task 5. To complete the assessment we will generate assessment results for each key ecological attribute / indicator (e.g. landscape integrity, ecological condition) by reporting unit (5^{th} level HUC), and "roll up" these results to provide ecological integrity scores for each 5^{th} level watershed based on the ecological status scores for individual CEs occurring within each watershed. Memorandum 3c presents the methodology and an example. During Task 6, options for roll-up will be further explored and determined through analysis and consultation with BLM leadership and the AMT.

Terrestrial CEs

The ecological status assessment for all landscape-level terrestrial CEs, including landscape species, will be scored using the following criteria:

Landscape Context

The key ecological attribute of Landscape Context is represented by a model (the Landscape Condition Model, LCM) constructed to represent major human activities on the landscape, which are presumed to have effects on CEs occurring in the vicinity. Major effects of development and management actions are captured in the LCM (described above, Landscape Condition Model) by intersecting the mapped area of the CE distribution with the LCM and reporting the mean LCM index score for the type distribution within each HUC 10 unit.

Condition

The key ecological attribute of condition is represented by an Invasive Plant Index as the measurable indicator. The invasive plant index is developed by measuring the number of non-native plant infestations by watershed for species that are highly invasive (invasiveness scores >70) and for less invasive species. Highly invasive species with >25 infestations will be treated as the most degraded while areas with no infestations will be regarded as intact.

Inputs: Landscape Condition Model, localities of invasive / exotic plant occurrences
Analytical process: The analytical process differs for each indicator type, but all analyses generate output structured according to the same scorecard framework, as described in Memorandum I-3-c.
Outputs: Landscape condition index, invasive plant index, map of ecological status scores for each CE by 5^{th}-level HUC
Anticipated timeline: January-February 2012
Sequencing and dependencies: The distributions of relevant CEs and the Landscape Condition Model must be completed first.

Aquatic CEs

The ecological status assessment (ESA) will be used to determine the condition of both aquatic habitats (coarse filters) and the nine fish landscape species (fine filters) that have distribution models. The EIA for aquatics consists of five key ecological attributes, not all of which have indicators due to the lack of data for the REA study area. A detailed description of the key ecological attributes, indicators, and scoring for the ESA is included in Memorandum 3C.

Connectivity
The Dendritic Connectivity Index is a model proposed for use to measure differences in stream connectivity for arctic grayling, coho salmon, and Dolly Varden; the three fish species most affected by fish passage issues on the Nome road system.

Surrounding Land Use Context
Three indicators are being used to quantify differences in the surrounding land use for aquatic resources: the Landscape Condition Model, non-native species occurrences in a buffer around the riparian zone, and the length of placer mining ditches in each watershed.

Water Quality
Water quality impacts will be evaluated using ADEC's list of state impaired waters and the number of Alaska Pollution Discharge Elimination Permits within a watershed.

Aquatic Biotic Condition
The condition of the aquatic biota will be assessed using ADF&G's listing of fish stocks of concern.

Inputs: ADF&G Fish Passage Inventory Database, Landscape Condition Model, AKNHP non-native species occurrences, NHD placer mining ditches, ADEC list of impaired waters, APDES permits, and ADF&G fish stocks of concern.
Analytical process: For all of the indicators except connectivity, the analyses include simple GIS models such as buffering and intersection along with spatial summary statistics. The connectivity indicator is based on the Dendritic Connectivity Index, a peer-reviewed model published in Landscape Ecology (Cote et al. 2009).
Outputs: A polygon feature class of 5th level HUCS with ESA scores for each CE in the attribute table.
Anticipated timeline: December 2011 – February 2012
Sequencing and dependencies: In order to complete the ESA for the aquatic CEs, the distribution models and the Landscape Condition Model must be completed.

Socioeconomic Assessments

Socio-economic assessments include both historical, current, and forecast conditions of communities in the REA. Communities are both CEs and CAs. Community demographics are a key indicator of sustainability. We will provide information on which communities have high rates of out-migration and among those which have few young adults. Nome and Kotzebue have larger populations, more job opportunities, and larger shares of non-Natives. We will use age structure, employment, and earning information to forecast future population. We will also include information from the Army Corp of Engineers on which communities will need to relocate by 2025 and 2060 due to damage from erosion. Other research demonstrates that subsistence resources allow people to remain in villages. Fire and climate change affect habitat, animal populations, and hunter access to subsistence resources. We will use information from future habitat and fire maps to develop growth scenarios.

Current scenario: We will use data from 1980 thru 2010 US Censuses of Population, and Alaska Department of Labor and Workforce Development to provide information on community size, and changes in demographics and employment over time. The US Census no longer conducts a long-form

survey (employment, migration, education, income, language). The American Community Survey, which has replaced the long form, does not have adequate sample size in rural Alaska to provide reliable estimates. We will estimate employment in 2010 using information from past censuses, IRS data, and AKDoLWD.

Inputs required:

- Community location maps
- Alternative site maps for Shishmaref
- US census population and employment data – place level
- IRS tax data by zip code
- Data from AkDoLWD
- Reports by Army Corps of Engineers

Analytical process:

Linking tabular demographic data to maps

Outputs:

- Maps of community locations with demographic and employment information (Census places and HUCs to be reconciled)
- Demographic and employment information as layers

Anticipated timeline: October 2011

Sequencing and dependencies: Input to Landscape Condition Model, Subsistence assessments

Future scenarios: We will combine data from 1980 thru 2010 US Censuses of Population, vital statistics, employment, and income (including transfers) to forecast the population of communities in 2025 and 2060. We will use Army Corps studies to identify communities that are expected to need to relocate by 2025 and 2060. For 2060, we will include outputs from the mines and tourism scenarios.

Inputs required: Mines scenarios, tourism scenarios.

- US census population data – place level,
- AkDoLWD population and employment forecasts
- Alaska vital statistics
- Army Corps reports of erosion and community relocation.
- Employment estimates from mine reports
- Habitat maps
- Fire maps

Analytical process:

- Remote Area Model (Huskey and Knapp, 1990)
- Community population projections
- Employment projections
- Map alternative sites for Shishmaref

Outputs: Maps of community locations with forecast population and employment information

Anticipated timeline: October-November 2011

Sequencing and dependencies: Employment estimates from mine development, tourism scenarios, future fire and habitat range maps.

Subsistence Assessments

This assessment was described in Memorandum 3C and asks for maps of the current locations of subsistence species as well as MQs regarding impacts by CAs in current and future scenarios. Locational and harvest data for individual species were gathered during Task 2 and 3. To complete the assessment we will create the standard map outputs and generate spatial statistics on the mapped area of each feature. Current subsistence harvest data for all species are available for some, but not all communities. We will include a confidence attribute on map outputs to indicate data adequacy.

Inputs required: Distribution maps, harvest records, herd size, forage map,
Analytical process: Spatial statistics calculations
Outputs:

- Maps of individual species distribution
- Maps of harvest by main species in each community, and change in harvest over time
- Maps of intersections of individual species with appropriate CAs.
- Maps indicating where species habitats intersect with multiple CAs.

Anticipated timeline: October 2011 – January 2012
Sequencing and dependencies: Distribution models for most terrestrial subsistence species have already been developed by the AKGAP Project.

Scenario Assessments

To answer many of the MQs, we will assess the current and projected locations of CAs and their intersections with relevant CEs. The future projections are generally for the years 2025 and 2060. The assessments for the current and two future projections are referred to as "scenario assessments." The workflow descriptions for these scenario assessments are organized by CA type and include the following assessment components under each CA:

- Where is the CA *currently*?
- Where is the CA projected to be in 2025 and 2060?
- Where does the current distribution of the CA intersect with relevant CEs?
- Where do the future distributions of the CA intersect with relevant CEs?

There are a few development CAs (mining, recreation, others?) for which only the current distribution will be mapped and intersected with relevant CEs.

The workflow for assessing the current and projected CAs is broadly illustrated in Figure 9 in the context of the overall assessment workflow. The total number of proposed models for each individual CA is listed in Appendix II, Table A-8. Figure 10 places the intersection of CAs with CEs in the overall assessment context. The total number of intersection models for CAs with individuals CEs is listed in Appendix II with individual tables separated by coarse and fine-filter CEs for both terrestrial and aquatic species as well as an individual table for subsistence species (see Tables A-1 through A-5).

Figure 9. Workflow diagram for addressing "Where are CAs currently?" and where are they projected to be in future scenarios.

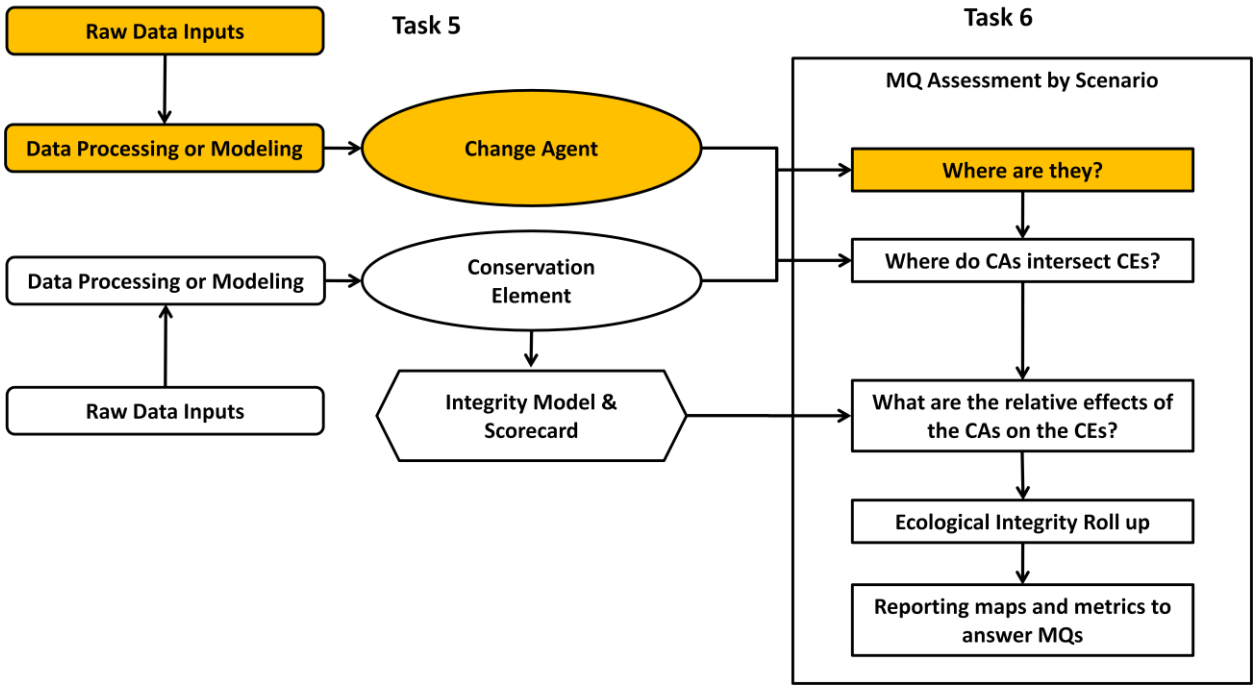
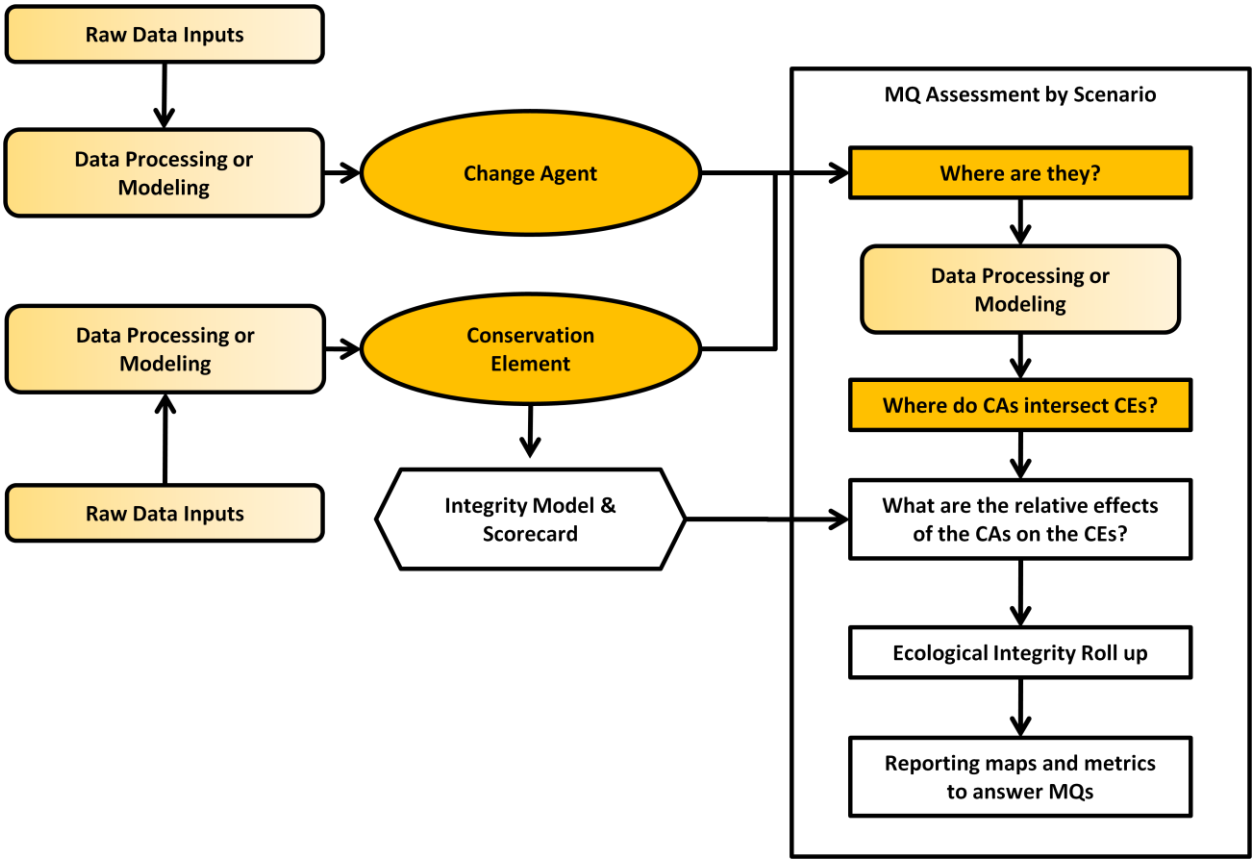


Figure 10. Workflow diagram for addressing where CAs intersect with CEs.



Permafrost

As a surrogate for permafrost, soil thermal dynamics will be modeled for the current and future (2025 and 2060) scenarios. The simulation modeling effort to project future soil thermal dynamics within the REA study area will utilize the Geophysical Institute Permafrost Lab's (GIPL, v. 1.0) model. The GIPL-1 model is a quasi-transitional, spatially distributed equilibrium model for calculating future scenarios of active layer thickness (ALT; the thin layer above permafrost that seasonally freezes and thaws) and mean annual ground temperature (MAGT). Scenarios Network for Alaska and Arctic Planning (SNAP) climate data are used to drive the GIPL-1 model, thereby creating projections of the impacts of changing climate on permafrost regime.

To assess the impact of changing soil thermal dynamics, we will utilize the GIPL-1 model independently and intersect its outputs with candidate CEs that most likely will be impacted by thermokarst.

Applicable scenario(s): Spatial and tabular analyses will be conducted for the current scenario and both the 2025 (2020-29) and 2060 (2060-69) future scenarios.

Inputs required:

- vegetation class
- height of vegetation class
- soil thermal properties
- soil water content
- snow water equivalent (SWE)

- thermal diffusivity of vegetation in the frozen and thawed state;
- thermal conductivity of frozen and thawed soil;
- volumetric later heat of ice fusion
- volumetric heat capacity of snow cover and frozen and thawed ground
- climate forcing data (SNAP down-scaled GCMs)

Analytical process: GIPL-1 is a literature and expert-based model characterization of permafrost regime that simulates the thermal response of soils to transient climatic changes (see Memorandum 3c for further detail about analytical processes; Marchenko et al. 2008).

The approach to determine ALT and MAGT is based on an approximate analytical solution that includes freezing/thawing process and provides an estimation of thermal offset due to the difference in frozen and thawed soil thermal properties (Kudryavtsev et al. 1974). This approach is the core of the GIPL model and treats the complex system including air, snow cover, surface vegetation, and the active layer as a set of individual layers with different thermal properties.

Outputs: The primary outputs of the GIPL model are spatial and tabular estimates of ALT and MAGT identifying areas that may become ice-free in the future. In permafrost regions, MAGT is the same as the mean annual temperature at the permafrost table (upper surface of permafrost). In permafrost-free regions, which do not occur within the REA study area today but are projected to occur in the future, MAGT is the mean annual temperature at the bottom of the seasonally frozen layer. Outputs will be considered in spatial and tabular form across the Nowacki et al. (2001) unified ecoregions of Alaska. These outputs will be intersected with all applicable CEs and results summarized for current and future scenarios.

Anticipated timeline: January-February 2012

Issues and limitations: The presence or absence of permafrost is not an output of the GIPL-1 model. Instead, the model uses climate as a driver and projects soil thermal dynamics into the future. To model thermokarst is not a trivial task, and efforts are underway to do so on a more local scale. At the landscape level, the GIPL-1 is the best model available to indirectly assess future changes in permafrost regime. Although model outputs cannot be used to pinpoint areas that will undergo thermokarst, they can be used to identify broader regions at high risk of permafrost thaw and thermokarst. This information can then be used to inform possible future scenarios.

Fire

The primary simulation modeling effort to project future fire regimes within the REA study area will utilize Boreal ALFRESCO (Alaska Frame-Based Ecosystem Code). Boreal ALFRESCO is a state-and-transition model of vegetation successional dynamics that explicitly represents the spatial processes of fire and vegetation recruitment across the landscape. Fire regime is simulated stochastically and is driven by climate, vegetation type, and time since last fire (Rupp 2007). Scenarios Network for Alaska and Arctic Planning (SNAP) climate data are used to drive the ALFRESCO model, thereby creating projections of the impacts of changing climate on fire regime.

To assess the impact of wildfire as a CA, we will utilize Boreal ALFRESCO independently and intersect its current and future scenario outputs with candidate CEs that most likely will be impacted by a changing fire regime. Of particular interest are spatial Boreal ALFRESCO outputs of the probability of fire occurrence for each subregion of the ecoregion.

Applicable scenario(s): Spatial and tabular analyses will be conducted for the current scenario and both the 2025 (2020-29) and 2060 (2060-69) future scenarios.

Inputs required:

The inputs to the Boreal ALFRESCO model include:

- historical fire perimeters

- simulated fire perimeters
- fire burn severity (based on relationship between fire size and fire severity; Duffy et al. 2007)
- vegetation class
- stand age
- topography
- climate forcing data (SNAP down-scaled GCMs)

Analytical process: Boreal ALFRESCO is a literature and expert-based model characterization of fire regime that simulates the responses of subarctic and boreal vegetation to transient climatic changes (see Memorandum 3c for further detail about analytical processes; Rupp et al. 2007).

Due to the stochastic nature of the Boreal ALFRESCO model the simulated vegetation characteristics (e.g., type and age) do not provide a direct prediction of ***where*** a fire or specific vegetation type will occur. However, by looking at many replicates together, maps can be made of where fire activity or a specific vegetation type is likely to occur most frequently. For instance, an analysis of how many times each 1 km grid cell burns through time and across replicates can be divided by the number of replicates and the number of years to create a fire risk map for that time frame -- i.e., the probability of any given cell burning in any one year. The inverse of that probability is the fire return interval.

Outputs: The primary outputs from Boreal ALFRESCO are spatial and tabular estimates of: 1) percent area burned, 2) percent area re-burned, 3) fire return interval (years) and 4) vegetation composition (none, tundra, black spruce, white spruce, deciduous) under the current and two future scenarios. These outputs will be considered spatially on a percentage basis (e.g., a given pixel might have a 10% chance of being black spruce in 2025 and a 90% chance of being deciduous). These results will be presented as maps of the entire REA area. Outputs will also be summarized in tabular form by averaging across Nowacki ecoregions. For example, a particular region might show an expected shift from 50% black spruce to 20% black spruce, or a shift from a mean stand age of 80 years to a mean stand age of 50 years. These outputs will be intersected with all applicable CEs and results summarized for current and future scenarios.

Anticipated timeline: November-December 2011

Issues and limitations: While Boreal ALFRESCO provides historical and projected fire regime scenarios, the modeled potential future successional dynamics are limited to four vegetation classes including: black spruce forest, white spruce forest, deciduous forest and tundra. These vegetation classes represent the complex vegetation mosaic occupying the circumpolar arctic and boreal regions, yet it does not account for the substantial variation in species composition within these and other intermediate vegetation types. For the REA, this is a substantial limitation of the model as differences among tundra vegetation types are ignored and lumped as a single tundra class. However, for many CEs, even these broad-level categories can help to inform possible future status.

Anthropogenic Activities

The first step in the current development scenario assessment will be to compile the data for each human land use category and produce the necessary map layer for each. These then become inputs to a scenario, wherein all of the development layers are combined for use in an analysis to explore spatially the intersections of development CAs with CE distributions. Not all CEs will be intersected with the current development scenario, for example culverts are relevant to fish or aquatic CEs, but not to terrestrial CEs. And some terrestrial human land uses are not relevant to the aquatic CEs. We will likely create a development scenario for use with terrestrial CEs, and another for use with the aquatic CEs. The results of these intersections will be acres by 5th-level HUC for each CE that intersects one or more development CA; additional reporting could be % of the HUC with development; and % of the CEs total distribution overlapped by one or more development CAs.

Oil and Gas Development
There is currently little oil and gas development in the region. We will reproduce maps of proposed off-shore development and associated infrastructure. Chukchi Sea Oil and Gas development projects are north of the REA. We will also provide maps of existing oil and gas sites.
Inputs required: Maps of off-shore proposed development and locations of oil/gas in region
Analytical process:
Outputs: Reproduction of existing maps
Anticipated timeline: November 2011
Sequencing and dependencies: Input to LCM
For 2060, we will overlay a map of proposed oil transportation infrastructure associated with Chukchi offshore development and map of areas identified to have oil and gas potential.

Alternative Energy Development
Alternative energy is small scale and for local communities. We will provide maps with the locations of alternative energy sites. We will also identify areas with wind and biomass potential that are located within 25 miles of communities. We will use definitions and research from the Alaska Energy Authority (AEA) to determine 'potential'.
Inputs required:

- Tiger files of community boundaries (US Census) (output from Socioeconomic Development scenarios)
- locations of alternative energy production sites (AEA)
- Information about quantity of energy produced, and effects on community fuel prices.

Analytical process: Overlay
Outputs: Map of alternative energy sites and wind and biomass potential within 25 miles of communities.
Anticipated timeline: October-November 2011
Sequencing and dependencies: Input to LCM
Because alternative energy is intended for local markets, and currently all projects are funded through state grants, we do not anticipate large scale alternative energy development by 2025. For 2025, we will include location and energy production information for small scale sites that are currently in planning or early development stages. For 2025 and 2060, we will combine maps identifying renewable energy potential and maps of possible sites for relocation.

Mining
Inputs required: For mining we will use the USGS Mineral Resource Data System (MRDS) which includes past and present mines, and prospects.
Analytic process and tools: Buffer the point features by 1km then intersect these buffers with areas identified as “Non-specific disturbed” land cover class as identified by the NatureServe (2009) land cover map. Intersected areas will be reclassified as mining or refuse management, depending on the source of the point buffer.
Outputs: A summary map that combines all past and current mining developments, employment estimates to use in socio-economic assessments
Sequencing and dependencies: Input to LCM
Issues: Areas that are currently used for mining are only represented by point locations. This requires a simple modeling effort to represent these features in a way that more accurately represents the infrastructure footprint. We propose to buffer the point features by 1km then intersect these with areas identified as “Non-specific disturbed” land cover class as identified by the NatureServe (2009) land cover map. Where the mining buffers intersect this land cover class, these areas will be reclassified as mining or refuse management.

Recreation

Tourism and recreation is a relatively undeveloped sector because of the region's remoteness and roadless status. As a result, we will primarily utilize more non-traditional datasets in this analysis. For remote roadless regions, ISER has developed variety of tourism indicators and estimation methods (Fay and Colt, 2010, 2007; Fay 2005a, 2005b, 2005c; Dugan et al., 2009, Colt, et al, 2008). There is little data available on visitors to the region because of remoteness, small numbers, seasonality, and short stays.

Inputs required:

- Maps of recreational areas
- tabular data of visitors by activity
- reports of user conflicts
- Reports estimating tourism activity (DoT, 2004)

Analytical process: Include estimates of visitor days on map data, differentiating by visitor use. We will also note areas where user conflicts are reported.

Outputs: Maps with estimates of visitor days by activity, identifying areas where there are user conflicts

Anticipated timeline: October-November 2011

Sequencing and dependencies: Input to subsistence model

For 2025 and 2060 scenarios of effects of climate change and other CAs on recreation, we will overlay tourism and CA maps.

Transportation

We will provide maps of existing and planned transportation infrastructure, ESRI: StreetMap Series and using data from DCRA and the Denali Commission, Red Dog mine port expansion plan, Northwest Area Transportation Plan to identify ports, roads, and airports that are in need of repair or replacement, and new projects.

Inputs required:

- Maps of roads, ports, and airports;
- Maps of proposed routes to Nome.
- Infrastructure assessments (DCRA, Denali Commission)

Analytical process: Mapping

Outputs: Maps of transportation infrastructure with layer containing information about infrastructure condition.

Anticipated timeline: October-November 2011

Sequencing and dependencies: Input to Landscape Condition Model.

For 2025 and 2060 scenarios, we will overlay maps of proposed routes of Nome and Ambler roads with habitat and mining maps, and use information from existing impact studies (Red Dog mine, Donlin mine) to estimate the impact of mine development and roads on wildlife populations) to understand the trade-offs of proposed routes.

Grazing

We will combine maps of grazing areas, herd size and forage to estimate baseline grazing conditions. Local knowledge helps estimate future impacts on vegetation. The Western Arctic Caribou Herd (WACH) has increased in size from 75,000 the mid 1970s to around 350,000 in 2011 and has been expanding its range, mixing with reindeer on the Seward Peninsula. In the 1990s, over 17,000 reindeer left with migrating caribou. We will include changes in herd size on the maps, and code data so that causes of herd decline are evident.

Inputs required:

- Map data of herd grazing allocations (Source BLM EIS map files)
- Tabular data of herd size (Finstead)

Analytical process: Mapping, create tables as layer.

Outputs: Maps

Anticipated timeline: October-November 2011
Sequencing and dependencies:

Military Sites
There are few active military sites in the region. We will provide maps of site locations. We will also provide map data of closed sites and information about the sites (size, contaminants present, clean-up status).
Inputs required: Maps of current and closed sites, DNR
Analytical process: Map
Outputs: Maps
Anticipated timeline: November-December 2011
Sequencing and dependencies: Input to LCM.
We do not know of any plans to develop military sites in the region. We will provide maps of clean-up efforts on current sites and anticipated clean up status in 2025. While not needed for any MQ, this information will be part of the delivered database.

Contaminated Sites
Contaminated sites are point data, we will use the database provided by Alaska DNR to an index using information about size, type of contaminant, and clean up status.
Inputs required: Maps of contaminated sites, access database of contaminated sites
Analytical process: Mapping
Outputs: Map of sites and footprint. Clean up status. Estimate of cost and cleanup effort.
Anticipated timeline: November-December 2011
Sequencing and dependencies: Input to CM.
We consider abandoned village sites to be contaminated sites and will map their location and estimate the length of time for clean up.

Intersection of CEs with Anthropogenic Activities CAs
This is a spatial process to answer MQs relevant to "where do change agents [human activities] overlap with CEs?". Anthropogenic activities will be assembled into one scenario/amp and then intersected with the CE distributions. Tabular output will provide statistics about the area of each CE intersected by one or more of the development CAs. These intersections are identified for each CE in Appendix II, Tables A-1 through A-5.
Applicable scenario(s): Current
Inputs required: Distribution maps for CEs and CAs
Analytical process: Spatial statistics calculations
Outputs: Map of each CE and by current scenario for development CAs and statistic of the area of each CE and CA
Anticipated timeline: February 2012
Sequencing and dependencies: Dependent on completing distribution mapping of the CEs and individual CAs.
Issues and limitations: Much of the occurrence data for CEs was derived from third-party sources and represents a range of data resolutions, currency, and accuracy. Additionally, distribution models for terrestrial CEs obtained from the Alaska Gap Analysis Program are 60 m resolution, while most other data products will be 30 m resolution.

Non-Native Species

We will conduct climate envelope modeling of up to four highly invasive plants for current to estimate current and future potential distributions. Additional environmental predictor layers (e.g., current

and future roads, permafrost, surficial geology, etc.) may be included if these spatial layers are at an appropriate scale, accuracy, and spatial extent to build a more comprehensive model of the invasive species' niche space.

The risk probability models proposed produce 0-1 probability surfaces. The models will use the existing infestation locations of up to four highly invasive species (n = 301 *Cirsium arvense*, n = 1,959 *Hieracium aurantiacum*, n = 1,894 *Melilotus alba*, n = 6,205 *Phalaris arundinacea*) and SNAP's statewide climate data. Models will be applied to address future scenarios representing potential shifts in species range as they apply to both current and future distributions of predictor variables.

Spatial representations of current and future distributions of the four invasive species will be generated. Bioclimatic niche envelopes of these species will then be summarized by probability of occurrence at 5th level HUCs. Areas of high current suitabilities for these invasive plant species can then be overlain by terrestrial CE locations.

Pests and Diseases

USDA conducts annual aerial forest damage surveys using a predetermined route across Alaska's forests and recording insect damage within one mile on either side of the flight path. They draw polygons on a DEM and, for tree, willow and alder defoliators, record degree of damage in three categories of increasing intensity. For spruce bark beetle damage they record tree mortality. We will answer MQ 134 "Where have recent beetle outbreaks occurred?" using aerial surveys of disease and insect activity identified in the last decade.

Climate Change

As a CA, climate change is predicted to have a range of effects on individual CEs, and these effects are likely to vary considerably across the distribution of a given CE within the ecoregion. The MQs involving climate change require two different methods of assessing climate change impacts: 1) a climate space trends analysis which will examine how a specific CE's climate is changing and the magnitude of departure that future climates represent compared to historical baselines, 2) a model of spatial distributions of the bioclimatic envelope for each CE which will show how its current bioclimate is predicted to shift under future climates.

Climate Space Trend Analysis

Climate space can be defined as the range of values for primary climate data that occur across the spatial extent of the target. Our objectives in assessing the ecological impacts of climate change are to identify a robust climatic baseline (1901-1981), to analyze the spatial and temporal nature of recent (1992-2006) and future (2020-2029; 2060-2069) climate space trends for the SNK ecoregion. Baseline and recent climate data will be from the CRU database, and future data will be with SNAPs downscaled climate projections. Only the A2 greenhouse gas emissions scenario is being examined in the climate space trend analyses. This scenario has been selected because at the present time it most closely represents the global emission trajectory we are on. The Intergovernmental Panel on Climate Change created a range of scenarios to explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting greenhouse gas emissions. The A2 scenario describes a very heterogeneous world with high population growth, slow economic development and slow technological change.

Products will include maps for the entire REA showing mean temperature and precipitation for the baseline and selected future time periods. Outputs will also include tabular data outlining mean monthly temperature and precipitation values for each Nowacki ecoregion in the REA. Standard deviations will be included to show the relationship between interannual variation, inter-decadal variation, and long-term trends. Graphs will demonstrate the magnitude of change between modeled future seasonal climates and

observed historical and current climates, as defined by seasonal characterization of temperature and precipitation.

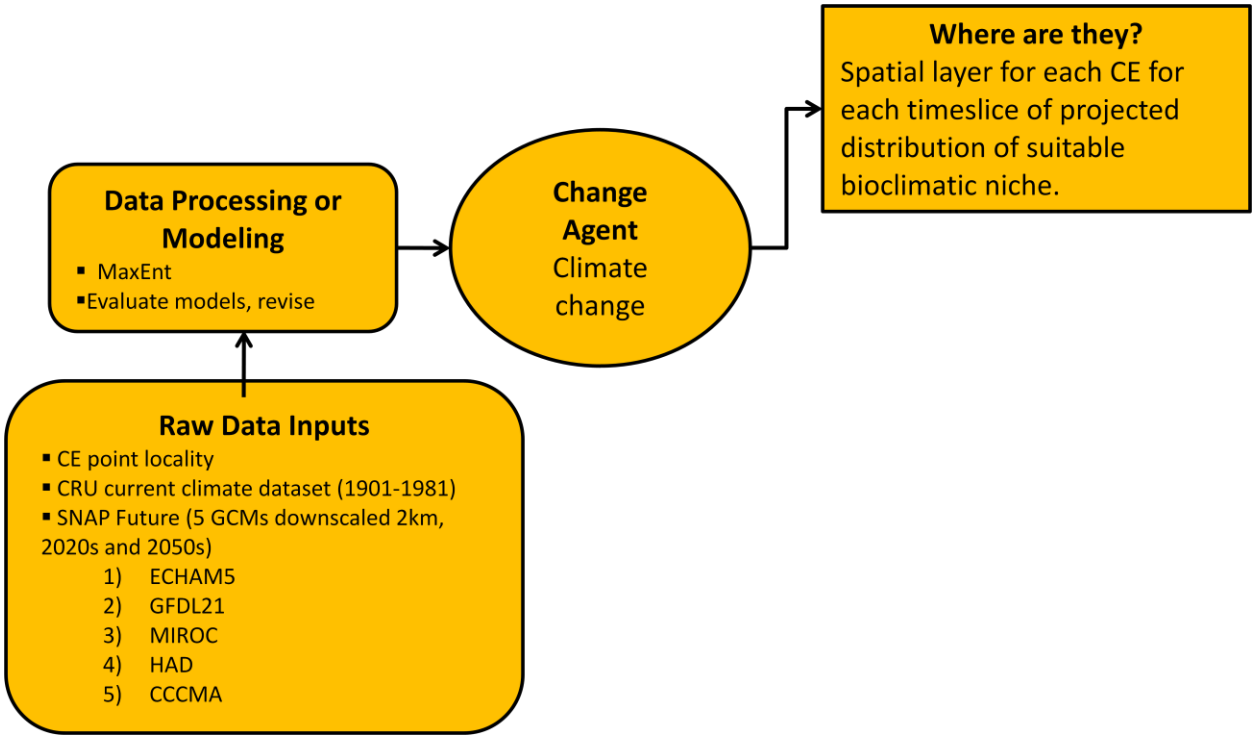
Bioclimatic Niche Modeling

For a subset of CEs for which such modeling is useful and appropriate, bioclimatic range shift modeling will be used (Figure 11). This method will entail assessing the impacts of climate change on a certain CE by using statistical correlations between observed locality data and current climate, and then using this relationship to project potential future distributions based on future climate scenarios. Such modeling is only appropriate in cases where there is clear evidence that species range is controlled or limited by temperature and/or precipitation, or by variables directly linked to temperature and precipitation, such as the availability of browse, cover, or water supplies that are likely to be climate-limited. Thus, CEs with well-understood physiological limitations and limited ranges are more likely to yield useful results from this type of modeling. Conversely, a species such as caribou, which inhabits an extremely broad range of habitats and exhibits high plasticity with regard to bioclimatic conditions, is not an appropriate CE for this method except within limited time periods such as calving when habitat may be more climate-limited.

This step will use the historical CRU dataset and the SNAP Climate Projections (both at 2km resolution) to produce a current niche and potential bioclimatic shift for a given CE under future emission scenarios. A current bioclimatic envelope will be generated using MaxEnt (Phillips et al. 2006), which is a niche modeling algorithm that estimates a distribution across geographic space based on the relationship between observed occurrence localities and environmental variables. The current bioclimatic envelopes will use the CRU 2km monthly data to define the current niche of a species, which will then be used to estimate future range shifts using the SNAP Climate Projections of downscaled spatial climate surfaces from 5 different GCMs. Multiple GCMs allows an assessment of the degree of agreement across a range of global climate models, thereby offering an assessment of uncertainty. Two time slices will be explored: 2020's and 2050's. This will complete a time series from 20th century baseline to mid 21st century based on temperature and precipitation.

As noted above, only a select number of terrestrial CEs were selected for bioclimatic niche modeling. A complete listing of species selected for modeling is included in Appendix II, Tables A-1 through A-5.

Figure 11. Workflow diagram for mapping change in suitable bioclimate over time for CEs.



Applicable scenario(s): Emissions scenarios for 2020s and 2050s
Inputs required

- SNAP 2km downscaled Global Climate Models
- CRU 2km monthly climate data: monthly average temperature, monthly total precipitation, and derived variables as appropriate for each modeled CE.
- Locality data for selected CEs

Analytical Process: See above details and Memoranda 3c
Outputs (see Memorandum 3c for further details about outputs)
Anticipated timeline: January-April 2012
Issues and limitations

- For caribou, we will develop two models: one for caribou winter range and another that addresses bioclimatic conditions on the calving grounds. Development of the second model is contingent upon gaining access to caribou telemetry data.
- In most cases, range data from outside the REA area will be necessary to provide meaningful inputs to the model.
- Model outputs will be summed and reported by either the sub-unit ecoregions or 5th level HUCs. Reporting unit still needs to be resolved.

Climate change and CE Distributions
To answer MQ#63 "Where will the distribution of CEs and wildlife ranges likely experience significant change in climate?", we can use the results from the climate space trends analysis above, summarized by Nowacki ecoregions, and report on CE distributions within each ecoregion.
Inputs required: wildlife distribution maps, climate space trends
Analytic process: review climatic space trends with existing and future wildlife distribution maps to look for areas with significant climate change

Outputs: Summary report and recommendations; tabular summaries of climate variables and CE distributions by Nowacki ecoregion.
Anticipated timeline: January 2012
Sequencing and dependencies: None.
Issues and limitations: None.

Other Assessments

Other assessments include MQs that are not specific to a specific CE or CA, rather more applicable to broader taxonomic groups. Each of these assessments will be grouped below according to general MQ theme using the same template as the sections above describing the CEs and CAs. Appendix II, Table A-7 lists twelve proposed models for all the other assessments.

High Biodiversity Sites

Areas of High Biodiversity are represented in the data by previous analyses characterizing locations with concentrated at-risk biodiversity. Information on high biodiversity sites will be given as a distinct reporting unit. Data types falling within this class include: 1) the Important Bird Areas dataset for Alaska, created by Audubon Alaska, and 2) The Nature Conservancy Portfolio database identifying specific places of importance for long-term conservation planning. These "portfolio sites" equate with areas of high biodiversity.

Inputs required

- Important Bird Areas
- TNC Portfolio Database
- Locality data for selected CEs

Analytical Process: Intersection of high biodiversity areas and selected CEs.
Outputs: Map of taxonomic groups by high biodiversity areas.
Anticipated timeline: February 2012
Sequencing and dependencies: Dependent on completing distribution mapping of the CEs.
Issues and limitations: High biodiversity areas are identified existing datasets that may not reflect current conditions.

Protected Areas and Land Ownership or Management

For the revised MQ "What are the proportions of CEs that coincide with different management areas?" we propose to use the USGS Protected Areas Database (PAD) for the boundaries within which to report the percentages of land cover classes and species distributions. The subclasses of protected areas or land ownership categories will be determined through discussion with the AMT as to which types of protected areas and ownership units are found in the REA, and would make useful reporting units (e.g. wilderness, ACECs, National Parks, Refuges).
Inputs required: USGS Protected Areas Database (PAD) and land ownership map
Analytical Process: Intersection of protected areas/land ownership data and land cover classes, or species distributions.
Outputs: Map and statistics of protected areas, and land management/ownership units; tabular summaries for each CE across these places.
Anticipated timeline: January 2012
Sequencing and dependencies: Dependent on completing terrestrial coarse filter land cover map, and species distributions.
Issues and limitations: None

CE Survey Effort

Survey effort is variable in this region, limiting our understanding of the CE's distribution and habitat requirements and where future survey efforts should be directed. Presence data for CEs,

particularly rare species, alone is insufficient for understanding where effort has been directed but no species have been found. We propose to summarize densities of collections by 5th level HUC for a random sample of 25 species known to occur in the REA for four taxonomic categories 1) fishes, 2) mammals, 3) birds, and 4) plant species. Survey effort will also be estimated for plant communities, where we will summarize plot densities per 5th Level HUC. Location data will be down loaded from the University of Alaska Museum's Arctos Specimen Database. Plant community survey effort will use location data from the USGS-NPS Plots Database.

Inputs required

- Locality data for selected species
- Locality data for plant community plots
- HUC layer

Analytical Process: Summary of collections or plots per HUC for each taxonomic category.
Outputs: Map of survey intensity by taxonomic category.
Anticipated timeline: February 2012
Sequencing and dependencies: Dependent on selection and acquisition of species and plot location data.
Issues and limitations: Since negative data is not available, randomly selected species are treated as a proxy for survey effort that would result in collections of the CEs.

Dispersal Barriers

For the MQ "Which CE's are likely to be more vulnerable due to dispersal barriers?" we propose using existing data or distribution models and overlapping these with future projected distribution models. We will then identify any topographic barriers or other barriers that would potentially make an individual CE less able to disperse.

Habitat fragmentation has the potential to impede dispersal of animals, thereby reducing gene flow and colonization. As a consequence, there is a need to understand whether and how sources of fragmentation, including changes wrought by climate change, could potentially affect dispersal.

Inputs required

- Current distribution maps for birds, mammals
- Bioclimate niche modeling distributions for birds, mammals
- Digital Elevation Model or other environmental data.

Analytical Process: Intersection between current and future species distributions and identification of noticeable dispersal barriers. We propose a simplified spatial (structural) approach to answer this question for a limited number of species by comparing known current distribution to predicted future distribution. We will conduct a literature review and/or consult with experts to identify potential structural constraints to dispersal (e.g., elevation gradients, lack of sufficient habitat types for forage that might limit migration potential). For those species with sufficient data, we will also perform a nearest neighbor measurement as a connectivity metric. We will identify potential structural barriers to dispersal using current distribution models and then assess whether similar barriers to dispersal are also present in bioclimatic envelope modeled results. The final outputs will not be quantified statistically; instead, they will simply include a list of CEs vulnerable to dispersal barriers derived through an intersection of current and future models.
Outputs: Summary of species vulnerable to dispersal barriers through an intersection model.
Anticipated timeline: February 2012
Sequencing and dependencies: Dependent on availability of future species distribution models.
Issues and limitations: Dispersal barriers data may be limited to a coarse level Digital Elevation Model (60 m resolution) to assess topographic barriers.

Habitats for Terrestrial Species of Concern

To answer the MQ "what habitats support terrestrial species of concern?" (including rare plants, animals, and subsistence species) we plan to intersect our map of land cover classes with the distribution maps for species and/or the Element Occurrence data. This intersection will identify where these species occur within the 30-m pixel land cover classes.

Inputs required

- Current distribution for rare plants, animals, and subsistence species
- Map of land cover classes

Analytical Process: Intersection between land cover map and distribution maps for rare plants, animals, and subsistence species.
Outputs: List of species occurrence by land cover classes
Anticipated timeline: December 2011
Sequencing and dependencies: Dependent on finalizing species distribution maps.
Issues and limitations: The land cover's map 30-m pixel resolution may be too coarse to specifically identify habitats of concern for the rare plants and animals with specific habitat niches. For landscape species, they are more likely to be adequately treated within the scale of the land cover map.

Hydrologic and Aquatic Questions
MQ116: Where are predicted changes in hydrologic regime associated with important aquatic resources?
Inputs required: hydrologic regime (PET model)
Analytic process: overlay changes in hydrologic regime and conduct literature review to describe impacts to fish resources by ecoregion
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: Need distribution map for aquatic resources.
Issues and limitations: Hydrologic regime data may be limited.

MQ117: Where will aquatic resources likely experience significant and abrupt deviations from normal temperature regime?
Inputs required: hydrologic regime (PET model)
Analytic process: overlay changes in hydrologic regime and conduct literature review to describe impacts to fish resources by ecoregion
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: Need distribution map for aquatic resources.
Issues and limitations: Hydrologic regime data may be limited.

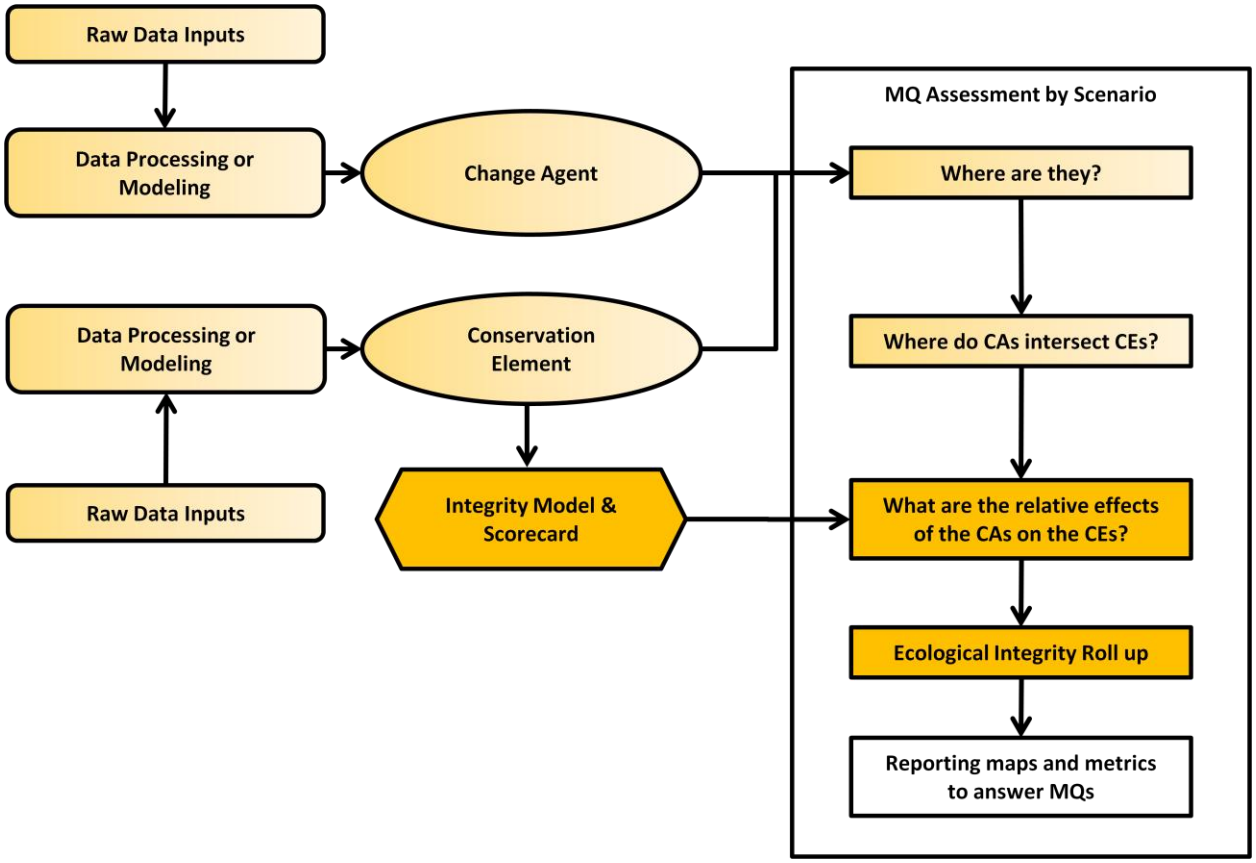
MQ157: Where are predicted changes in soil thermal regimes associated with aquatic communities?
Inputs required: soil temperature regime (output from GIPL model)
Analytic process: overlay changes in soil temperature regime and conduct literature review to describe impacts to fish resources by ecoregion
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: Need distribution map for aquatic resources, and GIPL model output
Issues and limitations: Soil temperature regime data may be too coarse.

Ecological Integrity Roll-up

BLM REA guidance for ecological integrity assessment (EIA) calls for a roll-up across all CEs for the ecoregion (Figure 12) although there is no explicit MQ addressing this assessment. We propose to conduct this roll-up and report summary statistics for the **current conditions** for each 5th level HUC. The roll-up will be based on the ecoregional conceptual model where CEs are placed into one of three major ecosystems units: uplands, coastal, or aquatic. We propose to combine the ecological status scores of CEs in each of these, by 5th level HUC, with each CE contributing to the HUC score according to its proportion of distribution within the HUC. We are still considering whether species should be combined with coarse-filter ecosystems for this roll-up. BLM has convened a group consisting of the REA

contractors, USGS, and BLM staff to create standard methods for EIA. NatureServe is part of this group and will continue to integrate developments from that group as work progresses.

Figure 12. Workflow diagram for developing ecological integrity roll-up.



Non-Spatial Assessments

Several MQs were deemed important to retain by the AMT even though spatial data were not available to produce a modeled answer. These questions will be answered through review of current literature and or input provided from experts in the field. These questions are listed below and summarized by total number of proposed models in Appendix II, Table A-7.

MQ7: Given current and estimates of future subsistence species populations, are harvest regulations adequate to protect subsistence species populations?
Inputs required: Federal and State agency harvest regulations and related reports.
Analytic process: literature review
Outputs: Summary report of effects of regulations on harvest.
Anticipated timeline: November-December 2011
Sequencing and dependencies: This will provide rules for subsistence model

MQ28: What types of traditional and local knowledge data exist for the region? How can these data be best incorporated into management decisions?
Inputs required: Case studies
Analytic process: literature review
Outputs: Summary report and recommendations

Anticipated timeline: November-December 2011
Sequencing and dependencies: This will also provide rules for subsistence model

MQ74: Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?
Inputs required: Case studies
Analytic process: literature review
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: None.
Issues and limitations: Wildlife disease agent data may be limited.

MQ140: Which CE's are likely to be most affected by invasive species?
Inputs required: Invasive species data case studies and CE distribution maps
Analytic process: A literature review will be used to describe the species most susceptible to invasives documented in Alaska.
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: Need information on aquatic and terrestrial invasives.
Issues and limitations: Limited data on aquatic and some terrestrial invasives.

MQ143: What are the known and likely introduction vectors of invasive species?
Inputs required: Invasive species data case studies
Analytic process: A literature review will be used to describe potential vectors for movement of invasives into the REA study area.
Outputs: Summary report and recommendations
Anticipated timeline: December 2011
Sequencing and dependencies: Need information on aquatic and terrestrial invasives vectors.
Issues and limitations: Limited data on aquatic and some terrestrial invasives vectors.

MQ120: How is the potential future fire regime anticipated to impact permafrost?
Inputs required: Potential future fire regime (ALFRESCO output), permafrost distribution (GIPL output)
Analytic process: A literature review will be used to assess the impact of fire on permafrost.
Outputs: Summary report
Anticipated timeline: December 2011
Sequencing and dependencies: None.
Issues and limitations: SNAP and the Geophysical Institute's Permafrost are currently coupling the ALFRESCO and GIPL-1 models for the Alaska Integrated Ecosystem Model project but we do not anticipate these results will be available statewide within the timeline of a rapid assessment.

MQ129.5: What does the paleorecord reveal about fire history?
Inputs required: Timeline of previous fires in the ecoregion from radiocarbon dated lake sediment cores
Analytic process: A literature review will be used to describe the fire history of the ecoregion.
Outputs: Summary report
Anticipated timeline: December 2011
Sequencing and dependencies: None.
Issues and limitations: These data are likely limited to only a few sites in the ecoregion. We will likely extrapolate from other studies in western and northern Alaska to better understand the fire history of the ecoregion.

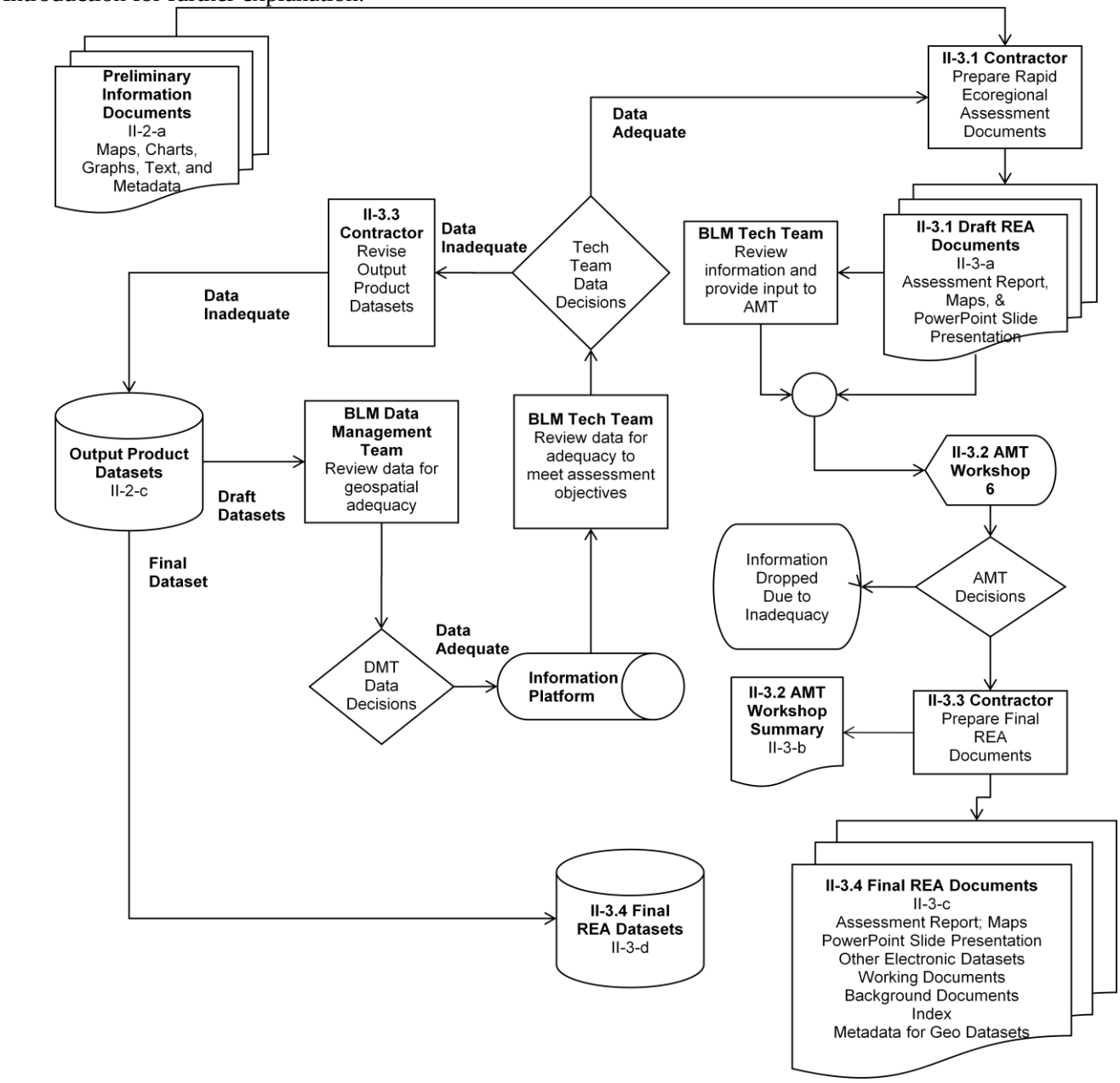
Tasks 5 and 6 Schedule

Task 5	
Draft datasets (II-1-a) and metadata (II-1-b)	12/02/11
BLM Approval Review	12/09/11
Task 6	
Preliminary information documents (II-2-a)	02/06/12
BLM Review of II-2-a	02/16/12
AMT Workshop 5	02/20/12
Workshop summary (II-2-b)	02/27/12
BLM comments to Contractor	02/29/12
Draft status and potential change (II-2-c)	03/27/12
BLM Approval Review	04/02/12

Task 7: Prepare Rapid Ecoregional Assessment Documents

The objective of this task is to consolidate the information and findings from the REA into several products. The REA will be summarized in several work product documents focused on the Rapid Ecoregional Assessment Report and final data products (see list of all final deliverables below). Much of this information will have been developed and written as memoranda and associated work product documents during prior Phase I and Phase II tasks with this task being conducted to compile that information into the assessment's final deliverables. NatureServe will prepare both draft and final versions of these primary REA documents. The draft documents will be presented at an AMT workshop in order to describe the products and receive feedback and direction prior to preparation of the final work product documents. The process work flow for this Task is shown in Figure 13. In addition the task includes compiling, documenting and delivering many ancillary documents acquired or developed during the REA.

Figure 13. Task 7 process workflow.
The original numbering of the Phase II tasks is followed in this diagram. II-2 = Task 6; II-3 = Task 7; see Introduction for further explanation.



1. Develop draft REA documents and deliver to AMT

We will assemble a complete set of deliverables and submit them to the AMT for initial review prior to the workshop. Deliverables include:

- Draft Ecoregional Assessment Report
- Draft ARCH size D or larger maps for presentation use (because the REA will generate hundreds of digital maps we will only print those identified by BLM for this purpose)
- Draft PowerPoint "slide-library" presentation.

At a minimum, the following information will be included in the REA Report:

- Executive Summary
- Introduction, including description of the ecoregional assessment process
- Ecoregional resource concerns and MQs
- Brief summary of the methodologies used in the investigation
- Summary of ecoregion conditions regarding CEs and CAs
- Results and findings of output products regarding status and potential for change
- Specific answers to MQs
- A description of how this information may be used in planning for land use, developing best management practices, authorizing uses, and establishing conservation and restoration priorities
- Lessons learned from the REA, and what next steps could be taken
- Appendices describing datasets, tools, models, and processes used for the assessment.

Other documents we will prepare include maps to depict the current status of the assessed CEs, CAs, and for status integrated to the watershed level or provided in a regular 30-meter grid. Individual maps as identified by BLM will be included in the REA report (11 x 17 format), and also provided in formats suitable for wall map (e.g., ARCH size D or larger), and as PowerPoint slide(s).

A PowerPoint presentation will be developed that presents the report information summarized in the above bullet points. This "slide library" will build on those developed for earlier Phase I and Phase II tasks, and will provide a complete description of the ecoregional assessment process and findings (including select maps).

2. Conduct AMT Workshop 6 and deliver a summary for BLM review

Per agreement with BLM, this workshop will be conducted as a webinar after sufficient review time for the AMT. All of the essential content will have been reviewed in AMT 5; therefore a webinar should be sufficient to identify final revision needs. We will focus the webinar on discussion of items that received significant and or contradictory review by the AMT. We will prepare a summary of the webinar documenting guidance we receive from the AMT and required revisions to the draft products.

3. Revise deliverables according to comments received from AMT for final review

Revisions will be conducted promptly and will be resubmitted for review. These may include revisions to documents, as well as to data products, as they are reviewed by BLM.

4. Develop final versions of products and submit for BLM acceptance

Based on the above review, we will conduct any additional necessary revisions and submit all deliverables for final acceptance.

List of Final Deliverables

- Final REA documents (II-3-c): to be submitted for final BLM review
  - Final Ecoregional Assessment Report
  - Final ARCH size D or larger maps for presentation use

- Final PowerPoint "slide-library" presentation.
- Other Electronic Datasets (II-3-c): Other electronic data or datasets collected or generated by NatureServe.
- Documentation (II-3-c):
  - We will provide step-by-step methods documentation that includes references to the submitted model builder and other tool application steps that were used for data processing. These documented methods will be routinely updated throughout the project to account for changes and improvements made along the way.
  - Notes and Working Documents: Workshop summaries and other notes taken from communications with BLM and within the team will also be documented and linked to tasks.
  - Background Documents and Index (II-3-c): NatureServe will provide all documents (e.g., agency reports, maps) collected by NatureServe during the course of the project that are used to support the REA. The documents will be provided in suitable binding, boxed collections, and digital media per guidance provided by BLM and the volume will be referenced to the steps of the process.
- Final REA Datasets (II-3-d): NatureServe will provide the final collected, compiled, and generated CE and CA datasets; final output status and potential for change datasets in a form acceptable to BLM.

Task 7 Schedule

We have proposed and discussed with BLM a revision to the original schedule, which extends the final completion date. Because of the State-of-the-Science LCC workshop in April 2011, our work on Tasks 2 and 3 was delayed to allow for discovery of new data or methods during that workshop. Also, summer field season made it difficult to engage the AMT, in Task 3 and the Task 4 workshop, so the Phase 2 schedule has been extended.

Table 5. Summary schedule for Task 7

Item	Date
Draft REA documents will be completed and delivered	05/01/12
AMT Workshop 6 (webinar) Exact date TBD	05/14/12
Workshop summary	05/21/12
AMT final comments due	05/30/12
Plan for revision of products	06/13/12
BLM review and guidance	06/27/12
Final products	07/11/12
BLM final review	07/20/12

Data Management Plan

The REA process will utilize and generate many datasets, both tabular and spatial, along with many documents. NatureServe has implemented tools for tracking both data and documents which integrate and follow BLM guidelines for such. These data management and documentation procedures are utilized throughout the assessment, from data discovery and evaluation through to the delivery of final products. The data management plan follows the sections on Tasks 5-7, not because the work will be completed last, but because it is a stand-alone section.

Below we provide information about several aspects of our data and document management, but focus primarily on data management and documentation. Some aspects of the data management remain to be resolved through interaction with the BLM NOC data team as they work through the implementation of the BLM REA data portal, and other contractor requirements.

Secure File Transfer

NatureServe established a secure file transfer site for the BLM REA work that is being used for transferring data between NatureServe, NatureServe sub-contractors, and data sources. The secure file upload requires a username and password, and files placed in this repository can only be retrieved by NatureServe data management staff. This upload resource is being used to allow people to contribute data in a secure manner. For datasets that NatureServe need to share with REA subcontractors, NatureServe has established a secure file download site that requires a different username and password. All usernames and passwords are tightly controlled and only distributed to the relevant project team members.

BLM has indicated that in the coming months, its official data portal will be set up and ready for use, by AMT to review data products. The portal will be the mechanism used by BLM for secure file transfer to the AMT.

Secure Collaborative Workspace

Using Microsoft SharePoint software, NatureServe has created a secure collaborative workspace for the REA project team. The Data Management component of this SharePoint site includes resources such as the data management guideline materials provided by BLM, technical instructions and documentation developed by NatureServe, and a "Master Data List" of "source" datasets. The Master Data List is NatureServe's core tool to track datasets that were provided by BLM as well as new datasets identified by the NatureServe REA team. This tool allows NatureServe to easily track which datasets are being included in REA analyses, work status, conduct data quality evaluations, and prepare materials for reporting and creating tables.

Based on the materials developed for Phase I Task 1, NatureServe identified data to evaluate for possible inclusion in the assessment to represent CEs, CAs, and Places (PLs). Working closely with BLM to minimize redundancy in data requests, the responsibility for identifying datasets was assigned to various team members based on areas of expertise. When possible, we obtained the full dataset as well as all supporting metadata and reports. When the data were not available, we requested and obtained at a minimum metadata and supporting materials, with sample data as available. As each member of the team obtained and compiled their source datasets, the information was entered in the Master Data List and the appropriate team experts notified so they could begin the data quality evaluation process.

To create the Master Data List, NatureServe initially imported to SharePoint the spreadsheet provided by BLM: "Att6.2-DMP-DataLayers.xlsx." After reviewing the materials in the BLM document "Rapid Ecoregional Assessment (REA) Data Management Plan: Contractor Guidance" (hereafter referenced as "BLM DMP"), NatureServe added attributes from the following appendices critical for achieving compliance with those guidelines:

Appendix 7: Data Quality Evaluation Worksheet
Appendix 8: QA/QC Checklist
Appendix 9: Pre-Acquisition Data Assessment Worksheet

In addition, the NatureServe project team added attributes to the Master Data List for internal data management and tracking purposes.

The information already captured in the Master Data List provides the foundation for the Phase II Task 1 compilation and generation of source datasets. We are tracking which datasets have been requested, acquired, and their physical management.

Data Management and Tracking

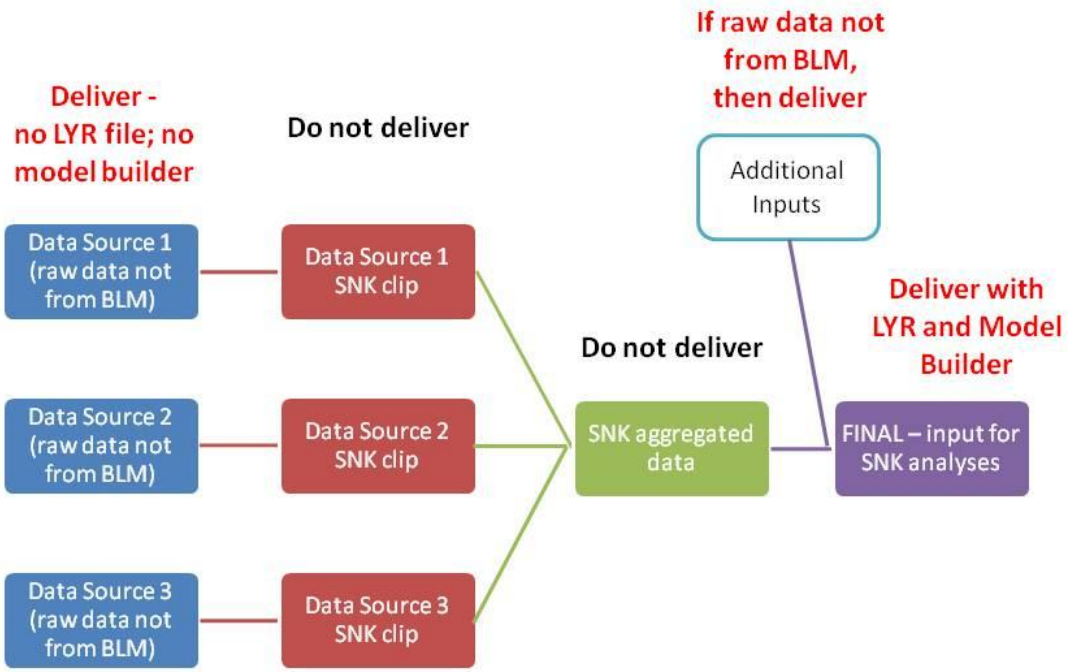
In addition to the Master Data List, NatureServe has developed a database to manage information about individual datasets as well as track the status of work being conducted for all deliverables, both "source" and "generated" datasets. The information in NatureServe's deliverable tracking database includes:

- information about source and generated datasets (dataset name, dataset description, data source, data type, data class, deliverable type, metadata)
- information about data management (filename and location where data resides on NatureServe's servers; filename as delivered to BLM)
- work status (deliverable lead, deliverable status, target delivery date, date work completed, date delivered to BLM, BLM review status)
- how data will be used in the REA analyses (type of CE, CA, or place; applicable REA(s))
- Data Delivery Tracking Form (DDTF) (data type, product type, analysis type, association to CE or MQ in the REAWP, model filename, layer filename, dependent datasets, media type, and delivery comments)
- status of metadata for compliance to BLM guidelines
- BLM QA/QC checklist

The deliverable tracking database identifies all deliverables as one of the following types, which facilitates NatureServe delivery of the correct supporting materials, as summarized in Figure 14 below:

- raw source - new from NatureServe
- analysis input - 1 raw source, clip and reproject ONLY
- analysis input - 2 or more sources or modeling
- FINAL analysis / model output

Figure 14. Data delivery: source datasets and generated datasets.



Data Quality Evaluation

The Master Data List has been NatureServe's primary tool for conducting the Phase I, Task 2 Data Quality Evaluation. To conduct this data evaluation, NatureServe started with the materials in "Appendix 7: Data Quality Evaluation Worksheet" from the BLM DMP and enhanced these by including a *Comments* field for each of the eleven Data Quality Evaluation criteria. This *Comments* field allows the expert conducting the data review to explain the assignment of one of the following confidence ratings: Very High, High, Moderate, Low, and Unknown. The NatureServe team's evaluation also includes information on the intended use of the data, and the suitability for these uses. Based on the information in the data evaluation attributes, we then assign an Overall Data Confidence Rating, again accompanied with comments where relevant.

The data evaluation process employed by NatureServe also encompasses metadata. The metadata review includes an evaluation of whether the metadata are incomplete (missing key information), minimally complete (has abstract, purpose, currentness, scale, projection, attribute definitions, and contacts), or accepted (the data have robust, complete metadata). The reviewer can also record comments about the metadata, particularly if there are incomplete areas or questions that need to be resolved.

NatureServe has found that data quality varies considerably. Despite that, we have resisted assigning a fixed threshold that dictates what data will and will not be used in the REA. Data evaluation has focused more on the concept of "fitness for intended use" which is consistent with the BLM data quality protocols.

Data Storage

Prior to delivery to BLM NOC in Denver, CO, all source and generated datasets will be managed out of NatureServe's Network Operations Center using a working ArcSDE geodatabase in ArcGIS 10.0. The NatureServe working geodatabase is organized using the following Feature Class categories:

CE Class I Terrestrial Coarse Filter
CE Class II Terrestrial Fine Filter
CE Class III Physical Feature (e.g., erodible soils)
CE Class IV Aquatic/Wetland Coarse Filter
CE Class V Aquatic/Wetland Fine Filter
CA Class I Wildfire
CA Class II Anthropogenic Activities
CA Class III Undesired Species
CA Class IV Climate
PL Class I Sites of High Biodiversity
PL Class II Specially Designated Areas of Ecological or Cultural Value
PL Class III General Managed Lands
PL Class IV Spatial Reporting Units
OT Other

To ensure that the data and products are delivered per the BLM DMP Appendix 5 directory structure, NatureServe has created a "deliver workspace" with a template of the correct directory structure that is replicated for individual deliverables. Delivery to BLM will be in ArcGIS 10 file geodatabases using the folder structure and file-naming conventions specified in BLM DMP Appendix 5. The data delivery geodatabase will be populated from NatureServe's working geodatabase using a script and the "Export Table" lookup table (see Data Processing and Generation Documentation section below).

The primary NatureServe server for BLM REA analyses is a Windows Server 2008, 64-bit, SP 2 with two 2.66 GHz processors and 14 GB RAM. Software tools utilized at NatureServe's NOC include: ArcGIS 10.0 suite (ArcCatalog, ArcGlobe, ArcMap, ArcScene), including ArcSDE, and Microsoft SQL server 2008. The ArcGIS Desktop 10 software is kept updated with the current ESRI Service Packs. NatureServe has ensured that all project staff have access to this software through a secure Remote

Desktop Connection. The BLM NOC confirmed in February, 2011 that it will accept ArcGIS 10 products as well as ArcGIS 9.3.1.

Metadata

To ensure the development of FGDC-compliant metadata that adhere to the BLM metadata template and guidelines, NatureServe has installed all patches and add-ins necessary to use ArcGIS 10 to create, edit, and export FGDC-compliant metadata. The NatureServe data management lead has created detailed instructions to guide team members through the process of converting existing FGDC-compliant metadata to ArcGIS 10, editing and creating metadata using both ArcCatalog and the EPA Metadata Editor (EME), and exporting FGDC-compliant metadata from ArcGIS 10.

To ensure compliance with BLM metadata guidelines, the NatureServe data management lead has developed specific instructions and sample metadata for the three different types of data deliverables:

a) New "raw" source datasets: update metadata with keywords from the BLM-THEME, ISO 19115 Topic Category, and BLM-STATE thesauri
b) Minor processing of source datasets (clip and reproject): update metadata with keywords from the BLM-THEME, ISO 19115 Topic Category, and BLM-STATE thesauri; add source information; add process step; update bounding coordinates and spatial reference
c) Newly created datasets (analysis inputs, generated datasets): metadata needs to be in full compliance with BLM metadata guidelines

NatureServe has created a "BLM Metadata Template" that includes information about all metadata elements that are required or recommended according to the BLM metadata guidelines, and includes the draft language provided by BLM for the Access Constraints, Use Constraints, and Distributor Liability. Where possible, NatureServe will develop and implement additional metadata templates for generated datasets that will both ensure compliance with the BLM metadata guidelines and facilitate the creation of metadata. The NatureServe metadata expert will review draft metadata for compliance to FGDC and BLM standards.

Draft metadata generated for each dataset will be delivered in three forms. Metadata will be linked to datasets for viewing in ArcCatalog and exported to both an XML and a text (TXT) file format. A text format (Word and PDF file formats) draft reference document will compile metadata for all datasets, and will be incorporated into an appendix of the Ecoregional Assessment Report.

Data Processing and Generation Documentation

NatureServe will manage and deliver all spatial data using a 2-tier process, and will include both raw source data and developed analytical input data such as predictive distribution models or tabular score card tables relating analysis results to appropriate analysis units. Within NatureServe's data environment we maintain spatial and associated tabular information using the schema described in the "Data Storage" section.

All vector based data will be stored within the appropriate feature group. For example, CA Class I Wildfire feature group will hold all vector data representing fire-associated layers such as recent burn boundaries. All layers (raster and vector) and tabular data names will be preceded by the related feature group code identifying a layer by its appropriate assignment, data source and, if associated, the region of analysis. For example, the vector source layer will be named CAI_BLM_Historic_Wildfire_Boundaries and can be identified as a CA class 1 from BLM and with no analysis region association. A summary table of burn years would be named CAI_tbl_BLM_CRB_Historic_Wildfire_year_summary.

The data schema described in the "Data Storage" section is not representative of the delivery schema, but only applies to NatureServe data management. All data will be delivered to BLM based upon the required schema (BLM DMP Appendix 5). Export translation of the NatureServe schema to the required delivery schema will be monitored and performed using a NatureServe-generated Python script, which will link to an SDE table within the geodatabase and include the NatureServe name and export name. The output process will track both data export and update requirements as associated fields within

the SDE table. The SDE data export table will be fully representative, and inclusive, of the Master Data List as described in the "Document Management and Tracking" section.

We will maintain ongoing updating, archiving, and referencing of scripts and modeling processes associated with each numbered sub step and each data input and output. Scripts will be delivered in formats consistent with BLM requirements. For modeling conducted with published tool packages we will deliver sequential processing steps applied using those tools**.**

When custom ArcGIS scripts are developed for data processing, a draft model file (ArcGIS ModelBuilder) or other documentation will accompany each dataset. For generated data derived through software packages (e.g., species distribution models derived through MaxEnt software), basic processing documentation will be provided.

Map documents will be generated based upon the NatureServe geodatabase and will utilize ArcMap templates using the above naming convention. At this time we are unable to determine whether NatureServe will develop custom map templates that adhere to the BLM guidelines for map symbology, or adapt a BLM-supplied group of ArcMap templates.

Data Delivery and Review

Data Review Process

In anticipation of the BLM QA/QC process outlined in the BLM DMP, all datasets will be initially reviewed by the NatureServe team following the specific QA/QC steps in the BLM DMP Appendix 8. This initial, internal, review of all datasets produced by NatureServe will be conducted by at least two team members. All data products will be technically and thematically evaluated according to the process laid out in the Data Evaluation section above and in the BLM Deliverable QA/QC Process. **This enables the same data evaluation to be applied to both source input data and to derived data sets to be used in the REA.** This will provide an opportunity for evaluation of both derived model outputs and the relative effects of error with input data on derived models. While extensive research into the many possible sources of error in derived data sets would be desirable, in most instances, it will remain outside the scope of this rapid assessment. Qualitative review and documentation of modeler perspectives will form the basis for this evaluation, and these evaluations may be built upon by the broader research community. Deliverables will adhere to BLM specified standards for mapping (projection and datum), file formats and naming, and metadata guidelines. Datasets will be visually inspected to check for edge-matching and logical consistency with other datasets in the deliverable. Data tables will be reviewed to check for consistency and normalization of attributes, and the identification of any outliers. Uncertainty and known issues will be clearly documented. The date reviewed and the NatureServe reviewer will be documented and included in the delivery to BLM.

Metadata, DQE, and DDTF

Datasets generated by NatureServe will be delivered with complete FGDC metadata that is compliant with the BLM metadata guidelines.

Each product deliverable will be submitted with a completed Data Delivery Tracking Form (DDTF). The tracking forms will include the information specified in the BLM DMP. The deliverable will also include the final Data Quality Evaluations (DQE) for each submitted source dataset. Completion of the forms will be conducted using NatureServe's data management SharePoint site and delivery tracking database as described above, and following the procedures in our data management plan.

Data Submission for BLM Review

NatureServe will submit data as we consider it complete. Delivery will be made electronically using NatureServe's secure file transfer site, or by hand delivery of a portable external hard drive.

Data Revision

After the BLM has conducted its review and provided comments, NatureServe will respond to questions, make corrections to the datasets and metadata as required, and then deliver the updated materials to BLM. We will revise data consistent with agreed scope and BLM data standards.

Document Management and Tracking

Developed in parallel with the Master Data List, NatureServe has created on its BLM REA SharePoint site a Document Management List that is the primary tool for managing both reference materials cited in BLM REA memoranda and the documents generated as part of the project (memos, summaries, presentations, meeting notes, etc.). In Task 7, the data in the Document Management List will be exported to an Access database table as a deliverable, which will provide a complete cross-referencing of all documents to the REA Phases, Tasks, other deliverables, and CEs, CAs, or Places. The Document Management List includes:

- Information about the document (title, citation, publication date, type of document, keywords, restrictions / sensitivity)
- Copy of the document attached to the SharePoint record (where possible)
- Information about the document location, if not attached to the SharePoint record (URL or physical location)
- Document acquisition status (person who provided or acquired the document; acquisition status)
- How the document is being used in the REA analyses (type of CE, CA, or place; applicable REA(s); which REA publication(s) the document was cited in)

Glossary

Areas of Critical Environmental Concern (ACEC): Areas within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources or other natural systems or processes, or to protect life and safety from natural hazards. (FLPMA, 1976).

Assessment Management Team (AMT): BLM's team that provides overall direction and guidance to the REA and makes decisions regarding ecoregional goals, resources of concern, conservation elements, CAs, MQs, tools, methodologies, models, and output work products. The team generally consists of State Resources Branch Managers from the ecoregion, a POC, and possibly agency partners.

Attribute: A defined characteristic of a geographic feature or entity.

Change Agent: An environmental phenomenon or human activity that can alter/influence the future status of resource condition. Some CAs (e.g., roads) are the result of direct human actions or influence. Others (e.g., climate change, wildland fire, invasive species) may involve natural phenomena or be partially or indirectly related to human activities.

Coarse Filter: A focus of ecoregional analysis that is based upon conserving resource elements that occur at coarse scales, such as ecosystems, rather than upon finer scale elements, such as specific species. The concept behind a coarse filter approach is that preserving coarse-scale conservation elements will preserve elements occurring at finer spatial scales.

Community: Interacting assemblage of species that co-occur with some degree of predictability and consistency.

Conservation Element: A renewable resource object of high conservation interest often called a conservation target by others. For purposes of this TO, conservation elements will likely be types or categories of areas and/or resources including ecological communities or larger ecological assemblages.

Development: A type of change (CA) resulting from urbanization, industrialization, transportation, mineral extraction, water development, or other non-agricultural/silvicultural human activities that occupy or fragment the landscape or that develops renewable or non-renewable resources.

Didymo: *Didymosphenia geminate*, a species of diatom considered to be a nuisance species

Ecological Integrity: The ability of an ecological system to support and maintain a community of organisms that have the species composition, diversity, and functional organization comparable to those of natural habitats within the ecoregion.

Ecoregion: An ecological region or ecoregion is defined as an area with relative homogeneity in ecosystems. Ecoregions depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) differs from those of adjacent regions. (Omernik and Bailey, 1997).

Ecosystem: The interactions of communities of native fish, wildlife, and plants with the abiotic or physical environment.

Element Occurrence: A term used by Natural Heritage Programs. An element occurrence generally delineates the location and extent of a species population or ecological community stand, and represents the geo-referenced biological feature that is of conservation or management interest. Element occurrences are documented by voucher specimens (where appropriate) or other forms of observations. A single element occurrence may be documented by multiple specimens or observations taken from different parts of the same population, or from the same population over multiple years.

Extent: The total area under consideration for an ecoregional assessment. For the BLM, this is a CEC Level III ecoregion or combination of several such ecoregions plus the buffer area surrounding the ecoregion. See *grain*.

Fine Filter: A focus of ecoregional analyses that is based upon conserving resource elements that occur at fine scale, such as specific species. A fine-filter approach is often used in conjunction with a coarse-filter approach (i.e., a coarse-filter/fine-filter framework) because coarse filters do not always capture some concerns, such as when a T&E species is a conservation element.

Fire Regime: Description of the patterns of fire occurrences, frequency, size, severity, and sometimes vegetation and fire effects as well, in a given area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval (NWCG, 2006).

Fragmentation: The process of dividing habitats into smaller and smaller units until their utility as habitat is lost (USDI, BLM, 1997).

Geographic Information System (GIS): A computer system designed to collect, manage, manipulate, analyze, and display spatially referenced data and associated attributes.

Grain: Grain is the spatial unit of analysis for ecoregional assessment and is the smallest area analyzed and used for regional planning purposes. The many data and model outputs incorporated into an ecoregional analysis are usually upscaled or downscaled to grain scale. The grain for ecoregional analysis may be a regular size and shape (e.g., square, hexagon) but also may be defined by a particular level of hydrologic unit or similar geographic feature.

Habitat: A place where an animal or plant normally lives for a substantial part of its life, often characterized by dominant plant forms and/or physical characteristics (USDI, BLM, 1990).

Heritage: See *Natural Heritage Program.*

Heritage Program: See *Natural Heritage Program.*

Hydrologic Unit: An identified area of surface drainage within the U.S. system for cataloging drainage areas, which was developed in the mid-1970s under the sponsorship of the Water Resources Council and includes drainage-basin boundaries, codes, and names. The drainage areas are delineated to nest in a multilevel, hierarchical arrangement. The hydrologic unit hierarchical system has four levels and is the theoretical basis for further subdivisions that form the *watershed boundary dataset* 5th and 6th levels. (USDI, USGS, 2009).

Indicator: Components of a system whose characteristics (e.g., presence or absence, quantity, distribution) are used as an index of an attribute (e.g. land health) that are too difficult, inconvenient, or expensive to measure. (USDA et al, 2005).

Invasive Species: Species that are not part of (if exotic non-natives), or are a minor component of (if native), an original community that have the potential to become a dominant or co-dominant species if their future establishment and growth are not actively controlled by management interventions, or that are classified as exotic or noxious under state or federal law. Species that become dominant for only one to several years (e.g. short-term response to drought or wildfire) are not invasives (Modified from BLM Handbook 1740-2, Integrated Vegetation Handbook).

Key Ecological Attribute: An attribute, feature, or process that defines and characterizes an ecological community or system or entity; in conjunction with other key ecological attributes, the condition or function of this attribute or process is considered critical to the integrity of the ecological community or system in question. In the BLM REAs, various analyses will be conducted to calculate scores or indexes indicating the status of key ecological attributes for various Conservation Elements (CEs).

Landscape Species: Biological species that use large, ecologically diverse areas and often have significant impacts on the structure and function of natural ecosystems (Redford et al., 2000).

Landscape Unit: Because an REA considers a variety of phenomena, there will be many phenomena and process (or intrinsic) grain sizes. These will necessarily be scaled to a uniform support unit, which herein is called a *landscape unit*. This landscape unit will be the analysis scale used for reporting and displaying ecoregional analyses.

MQs: Questions from decision-makers that usually identify problems and request how to fix or solve those problems.

Metadata: The description and documentation of the content, quality, condition, and other characteristics of geospatial data.

Model: Any representation, whether verbal, diagrammatic, or mathematical, of an object or phenomenon. Natural resource models typically characterize resource systems in terms of their status and

change through time. Models imbed hypotheses about resource structures and functions, and they generate predictions about the effects of management actions. (Adaptive Management: DOI Technical Guide).

Native Plant and Animal Populations and Communities: Populations and communities of all species of plants and animals naturally occurring, other than as a result of an introduction, either presently or historically in an ecosystem. (BLM Manual H-4180-1).

Native Species: Species that historically occurred or currently occur in a particular ecosystem and were not introduced (USDI, BLM, 2007b).

Natural Community: An assemblage of organisms indigenous to an area that is characterized by distinct combinations of species occupying a common ecological zone and interacting with one another (USDI, BLM, 2007b).

Natural Heritage Program: An agency or organization, usually based within a state or provincial natural resource agency, whose mission is to collect, document, and analyze data on the location and condition of biological and other natural features (such as geologic or aquatic features) of the state or province. These programs typically have particular responsibility for documenting at-risk species and threatened ecosystems. (See natureserve.org/ for additional information on these programs.)

Occurrence: See *Element Occurrence*.

Population: Individuals of the same species that live, interact, and migrate through the same niche and habitat.

Rapid Ecoregional Assessment (REA): The methodology used by the BLM to assemble and synthesize that regional-scale resource information, which provides the fundamental knowledge base for devising regional resource goals, priorities, and focal areas, on a relatively short time frame (less than 2 years).

Rapid Ecoregional Assessment Work Plan (REAWP): The work plan (scope of services) that guides the Phase II Assessment component of a REA. This document fully establishes the design of the Phase II effort, and is essentially the 'blueprint' for that work effort and resulting products.

Resource Value: An ecological value, as opposed to a cultural value. Examples of resource values are those species, habitats, communities, features, functions, or services associated with areas with abundant native species and few non-natives, having intact, connected habitats, and that help maintain landscape hydrologic function. Resource values of concern to the BLM can be classified into three categories: native fish, wildlife, or plants of conservation concern; regionally-important terrestrial ecological features, functions, and services; and regionally-important aquatic ecological features, functions, and services.

Scale: Refers to the characteristic time or length of a process, observation, model, or analysis. ***Intrinsic scale*** refers to the scale at which a pattern or process actually operates. Because nature phenomena range over at least nine orders of magnitude, the intrinsic scale has wide variation. This is significant for ecoregional assessment, where multiple resources and their phenomena are being assessed. ***Observation scale***, often referred to as sampling or measurement scale, is the scale at which sampling is undertaken. Note that once data are observed at a particular scale, that scale becomes the limit of analysis, not the phenomenon scale. ***Analysis*** or ***modeling scale*** refers to the resolution and extent in space and time of statistical analyses or simulation modeling. ***Policy scale*** is the scale at which policies are implemented and is influenced by social, political, and economic policies.

Scaling: The transfer of information across spatial scales. ***Upscaling*** is the process of transferring information from a smaller to a larger scale. ***Downscaling*** is the process of transferring information to a smaller scale.

Status: The condition of a criterion (biological or socio-economic resource values or conditions) within a geographic area (e.g., watershed, grid). A rating (e.g., low, medium, or high) or ranking (numeric) is assigned to specific criteria to describe status. The rating or ranking will be relative, either to the historical range of variability for that criterion (e.g., a wildland fire regime criterion) or relative to a time period when the criterion did not exist (e.g., an external partnerships/collaboration criterion).

Stressor: A factor causing negative impacts to the biological health or ecological integrity of a Conservation Element. Factors causing such impacts may or may not have anthropogenic origins. In the context of the REAs, these factors are generally anthropogenic in origin.

Subwatershed: A subdivision of a *watershed*. A *subwatershed* is the 6th-level, 12-digit unit and smallest of the hydrologic unit hierarchy. Subwatersheds generally range in size from 10,000 to 40,000 acres. (USDI, USGS, 2009).

Value: See *resource value*.

Watershed: A watershed is the 5th-level, 10-digit unit of the hydrologic unit hierarchy. Watersheds range in size from 40,000 to 250,000 acres. Also used as a generic term representing a drainage basin or combination of hydrologic units of any size. (USDI, USGS, 2009).

Watershed Boundary Dataset (WBD): A National geospatial database of drainage areas consisting of the 1st through 6th hierarchical hydrologic unit levels. The WBD is an ongoing multiagency effort to create hierarchical, and integrated hydrologic units across the Nation. (USDI, USGS, 2009).

Wildland Fire: Any non-structure fire that occurs in the wildland. Three distinct types of wildland fire have been defined and include wildfire, wildland fire use, and prescribed fire (NWCG, 2006).

List of Acronyms

AADT	Annual Average Daily Traffic
ACEC	Area of Critical Environmental Concern
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
AEA	Alaska Energy Authority
AFFID	Alaska Freshwater Fish Inventory Database
ADOT	Alaska Department of Transportation
AGI	Annual Grasses Index
AKNHP	Alaska Natural Heritage Program
ALFRESCO	Alaska Frame-Based Ecosystem Code
ALT	Active Layer Thickness
AMT	Assessment Management Team
AR4	International Panel on Climate Change - Fourth Assessment Report
AVHRR	Advanced Very High Resolution Radiometer
AWC	Anadromous Waters Catalog
AWS	Associate Weather Services
BLM	Bureau of Land Management
BpS	Biophysical Settings
CA	Change Agent
CCVI	Climate Change Vulnerability Index
CE	Conservation Element
CVS	Conservation Value Summary
DCI	Dendritic Connectivity Index
DEC	Department of Environmental Conservation
DEM	Digital Elevation Model
DNR	Alaska Department of Natural Resources
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
EFC	Environmental Flow Components
EIA	Ecological Integrity Assessment
EIS	Environmental Impact Statement
EO	Element Occurrence
EPCA	Energy Policy and Conservation Act
ESA	Endangered Species Act
ESA	Ecological Status Assessment
ESD	Ecological Site Descriptions
ET	Evapotranspiration
EVT	Existing vegetation type
FAO	Food and Agriculture Organization
FCC	Federal Communications Commission
FO	Field Office
FRC	Fire Regime Condition Class
FRI	Fire Return Interval
GA	Grazing Allotment
GCM	Global Climate Model
GFDL	Geophysical Fluid Dynamics Laboratory
GIPL	Geophysical Institute Permafrost Lab

GIS	Geographic Information System
HMA	Herd Management Area
HRV	Historic Range of Variation
HUC	Hydrologic Unit Code
ICLUS	Integrated Climate and Land Use Scenarios
IPCC	Intergovernmental Panel on Climate Change
ISER	Institute of Social and Economic Research
Kw	K factor (soil erodibility) Values
LCM	Landscape Condition Model
LF	LANDFIRE (Landscape Fire and Resource Management Planning Tools)
MAGT	Mean Annual Ground Temperature
MLRA	Multiple Resource Land Area
MRDS	Mineral Resource Data System
NCEP	National Centers for the Environmental Prediction
NHD	National Hydrological Dataset
NPMS	National Pipeline Mapping System
NRCS	Natural Resource Conservation Service
NREL	National Renewable Energy Laboratory
NRV	Natural Range of Variability
NTAD	National Transportation Atlas Database
NWI	National Wetland Inventory
ORV	Off-road Vehicle
PRISM	Parameter-elevation Regressions on Independent Slopes Model
REA	Rapid Ecoregional Assessments
RegCM	International Centre for Theoretical Physics Regional Climate Model
ROC	Receiver Operating Characteristic
SAR	Sodium Adsorption Ratio
SClass	Succession class
SDM	Species Distribution Model
SERGoM	Spatially Explicit Regional Growth Model
SNAP	Scenarios Network for Alaska and Arctic Planning
SSURGO	Soil Survey Geographic Database
STATSGO	State Soil Geographic Database
SWAP	State Wildlife Action Plan
TWI	Topographic Wetness Index
USGS	United States Geological Survey
USGS-CD	USGS 15km dynamically downscaled climate model outputs
VDDT	Vegetation Dynamics Development Tool

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Appendix Ia. Seward Peninsula - Nulato Hills - Kotzebue Lowlands: Management Questions

This table lists the management questions that have been accepted as of the writing of this draft work plan. Three management questions listed at the end are in discussion since the AMT 3 workshop.

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
2	Subsistence	How could changes in sea mammal harvests potentially affect land based hunting and fishing?	Accept	How will lack of sea ice impact subsistence hunting, e.g. make more dangerous / easy; increase / reduce deaths? (polar bears on land, higher waves, etc.)	5th level HUCs, acres	Number of subsistence species range map intersections with communities. Harvest levels.
4	Subsistence	How much have harvests (lbs.) changed over the past 20 years?	Accept	Are peoples' subsistence needs being met? How, where, how many, etc.? and how will change affect?	5th level HUCs	Pounds harvested by species by community 1991-2000 and 2001-2010.
6	Subsistence	Which species make up the largest share (lbs.) of subsistence harvests? How is this changing?	Accept	We need to know more about what the subsistence species are and their use patterns. And how is this changing? How could access to subsistence resources change?	5th level HUCs	Pounds harvested by species by community 1991-2000 and 2001-2010.
7	Subsistence	Given current and estimates of future subsistence species populations, are harvest regulations adequate to protect subsistence species populations?	Accept	How will harvest regulations reflect species availability?	5th level HUCs	Animals harvested by species by community
9	Subsistence	How have hunting and fishing regulations affected general hunting and fishing harvests?	Accept		5th level HUC	Animals harvested by species by community
10	Subsistence	What are the current ranges of subsistence species? Where are the subsistence communities?	Accept	With climate change, what will the impacts be to subsistence spp. (specific species, habitat) and what is the time frame that villages need to be aware of regarding subsistence species that they rely upon?	Landscape species and species assemblages: 60 m grid and 5th level HUC summary, Local species: Heritage 5th level HUC	Landscape Species and Species Assemblages: Aerial extent in acres, Local Species: # of locations
11	Subsistence	In which locations are climate change events likely to affect subsistence species?	Accept		5th level HUC	Degree of climate deviation from current by HUC per species
15	Socioeconomic and population demographics	Where is hunting and tourism taking place and how frequently	Accept	What is the current ecotourism industry and what is forecast?	5th level HUC	Visitor counts, visitor days, revenue, type of visitor

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
16	Socioeconomic and population demographics	(A) What is the current socio-economic profile for each community? (B) How are they likely to change under development and climate scenarios?	Accept	What are the predicted socioeconomic changes in the different villages? Are shoreline communities likely to be more or less affected? Compared to villages not on the ocean shoreline?	5th level HUC	Demographics and employment by community 1991-2000, 2001-2010 with forecasts for 2025 and 2060
18	Socioeconomic and population demographics	How are changes in climate likely to affect tourism destination sites, numbers of tourists and revenues?	Accept		5th level HUC	Visitor counts, visitor days, revenue, type of visitor
28	Socioeconomic and population demographics	What types of traditional and local knowledge data exist for the region and then how can these data be best incorporated into management decisions?	Accept	Customary and Traditional Knowledge-elders are commenting they are no longer able to accurately predict/interpret weather, freeze /thaw dates, fire behavior, and regional temperatures – how will changes affect traditional knowledge delivery?	N/A	Harvesting practices by species by community
29	Socioeconomic and population demographics	Where are predicted changes in river erosion associated with relevant CEs?	Accept	Among areas at risk of river erosion, which threaten relevant CEs?	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
30	Socioeconomic and population demographics	Where will losses of lakes potentially affect water supply to villages?	Accept	NEW	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
44	Development	How are transporters/tourism/sport hunt and fishing affecting the migration patterns of caribou?	Accept	How are transporters/tourism/sport hunt and fishing affecting the migration patterns of caribou?	5th level HUC	Locations of conflicts by species, year.
45	Development	Where are current and planned oil/gas activities located and where do they overlap with CEs or other relevant habitats?	Accept	What is the extent and impact of Oil/Gas activities?	5th level HUC	Offshore N/A
46	Development	Where are historic, current and potential mining activities located, and where do they overlap with CEs or other relevant habitat?	Accept	What is the current status and impacts from mining, including past mining?	5th level HUC	Mine sites by ore type, status (active, historic, potential), estimated size, estimated value.
49	Development	Where are current and potential recreational use areas located, and where do they overlap with CEs or other relevant habitat?	Accept	Where the concentrated areas of recreation are and what is the forecast or potential for future areas? Impacts sport and trophy industry?	5th level HUC	Recreation areas by type of recreation, size in acres
50	Development	Where are current and planned roads located, and where do they overlap with CEs or other relevant habitat?	Accept	Where are the travel corridors located and what are the related impacts and what is forecast?	5th level HUC	Roads

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
51	Development	Where are historic, current and planned military sites located, and where do they overlap with CEs?	Accept	What is the current status and impacts if any from military lands and what is forecast?	5th level HUC	Military site, status (closed, active), use, clean up status, size in acres
52	Development	Where are potential wind and biomass sites located within 25 miles of communities?	Accept	Will there be a change in renewable energy opportunities? For example: Biomass, geothermal, wind farms, etc. And to what extent and where are these areas?	5th level HUC	Renewable energy areas by biomass and wind, extent
60	Species	What is the current distribution of each CE?	Accept	What is the current distribution of each CE?	Landscape species and species assemblages: 30 m grid and 5th level HUC summary (except for terrestrial vertebrates which will be 60 m grid), Local species: Heritage 5th level HUC	Landscape Species and Species Assemblages: Aerial extent in acres, Local Species: # of locations
61	Species	What areas have been surveyed (i.e., inventoried) for each CE and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region?	Accept		5th level HUC	Number of collections /plots by taxonomic group
62	Species	Where do current CE distributions overlap with CA?	Accept		Landscape species and species assemblages: 30 m grid and 5th level HUC summary (except for terrestrial vertebrates which will be 60 m grid), Local species: Heritage 5th level HUC	Location and areal extent in acres
63		Where will the distribution of CEs and wildlife ranges likely experience significant change in climate?	Accept		Landscape species and species assemblages: 60 m grid and 5th level HUC summary, Local species: Heritage 5th level HUC	Location and areal extent in acres
64	Species	Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?	Accept		Landscape species and species assemblages: 60 m grid and 5th level HUC summary, Local species: Heritage 5th level HUC	Location and areal extent in acres

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
68	Species	What CE populations and movement corridors overlap with CA?	Accept	Where are change agents affecting this habitat and movement corridors?	Landscape Species and Species Assemblages: 60 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Identify populations, locations and areal extent
74	Species	Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?	Accept	Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?	NA	Literature Review
78	Species	Which CE's are likely to be more vulnerable due to dispersal barriers?	Accept	Where are potential areas to restore connectivity?	Nowacki et al. Ecoregions	Location and areal extent in acres per ecoregion
84	Species	With recent science concluding that musk ox are eating lichens now, how is this going to affect winter range availability for reindeer and caribou?	Accept	How will these changes affect caribou and reindeer populations/migration patterns that rely on the lichens for winter habitat? With recent science concluding that musk ox are eating lichens now, how is this going to affect winter range availability for reindeer and caribou?	Nowacki et al. Ecoregions	Location and areal extent in acres per ecoregion
86	Native Plant Communities	What habitats support terrestrial species of concern (rare plants, rare animals, and subsistence species)?	Accept		5th level HUC	Population number and distribution overlays of terrestrial species by landcover class
87	Native Plant Communities	How will habitats that support terrestrial species of concern likely change due to fire over the next 15 and 50 years?	Accept	How will habitats that support terrestrial species of concern likely change due to disturbance or climate change over the next 15 and 50 years?	5th level HUC	Table of expected change in acres through time + map.
88	Native Plant Communities	What are the proportions of CEs that coincide with different management areas?	Accept	Evaluate whether all species and ecosystems are conserved within the conservation network of the study area currently and over the next 15 and 50 years given climate change.	Acres and percentage or each CE per management area.	Acres and proportion of CE's distribution by management area
102	Livestock (Reindeer Grazing)	Where are the current populations of Reindeer? What is the current and historic herd size?	Accept	Where are the current populations of Reindeer?	Landscape Species and Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Location and Areal Extent in acres per 5th level HUC
103	Livestock (Reindeer Grazing)	Will suitable habitat for caribou be available with climate change?	Accept	Will Reindeer grazing grow if caribou decline due to climate and other change agents?	Nowacki et al. Ecoregions	Location and areal extent in acres per ecoregion

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
104	Livestock (Reindeer Grazing)	Where will current Reindeer grazing areas experience climate completely outside their normal range?	Accept	With climate change, what may affect the reindeer grazing viability?	Nowacki et al. Ecoregions	Location and areal extent in acres per ecoregion
105	Livestock (Reindeer Grazing)	Where will current populations of Reindeer experience overlap with Change Agents?	Accept		Landscape Species and Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Location and Areal Extent in acres per 5th level HUC
106	Livestock (Reindeer Grazing)	How have the reindeer herds changed over time? How do herds affect grazing areas?	Accept	What are the impacts on the ecoregion from reindeer grazing (ecosystem, socioeconomic,)?	5th level HUC	Herd allocations, reindeer population change, distance to caribou range.
111	Aquatic ecological function and structure	Where are hazardous waste sites?	Accept	Where are hazardous waste sites and how will climate change exacerbate pollution entering the environment?	5th level HUC	Hazardous waste sites, type of waste, clean up status
113	Aquatic ecological function and structure	Where are the important aquatic resources, such as spawning grounds and other fish habitats? (herring spawning grounds and areas used by waterfowl?)	Accept	Where are the regionally important aquatic values?	5th level HUC	Location and areal extent in acres per ecoregion. Number of important areas per HUC
114	Aquatic ecological function and structure	What is the condition of these various aquatic systems?	Accept	What is the condition of these various aquatic systems?	Nowacki et al. Ecoregion	Ecological Integrity Assessment
116	Aquatic ecological function and structure	Where are predicted changes in hydrologic regime associated with important aquatic resources?	Accept	Where are aquatic resources that will likely experience significant and abrupt deviations from normal flow regime or mean water levels?	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
117	Aquatic ecological function and structure	Where are predicted changes in air temperature associated with important aquatic resources?	Accept		Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
120	Fire	How is the potential future fire regime anticipated to impact permafrost?	Accept	How will fires impact the permafrost?	N/A	Literature Review
122	Fire	Where are predicted changes in future fire regime associated with rivers?	Accept	How will fires affect sedimentation into nearby rivers?	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
126	Fire	What is the known lightning strike frequency? Do these data show a significant trend over time?	Accept	What is the change in lightning strike frequency and distribution and subsequent ignition?	Nowacki et al. Ecoregion	Graph showing historical lightening strike frequency by decade
129	Fire	What is the fire history of the region and what is the potential future fire regime? What are the implications for vegetation?	Accept	Fire Potential – where are the areas of highest potential to change from historic and/or predicted wildfire patterns?	Nowacki et al. Ecoregion	Fire history: location, percent and areal extent in acres of observed fire perimeters; Future fire regime: location, percent and areal extent in acres of selected probability classes for a cell burning in any one year; Implications for vegetation: location, percent and areal extent in acres of the simulated distribution of vegetation classes
129.5	Fire	What does the paleorecord reveal about fire history?	Accept		N/A	Literature Review
130	Fire	Where are areas of predicted high future fire risk associated with current caribou habitat, winter range, and calving sites?	Accept	Where are the areas with highest risks to caribou habitat? Calving sites/wintering range for caribou/musk ox/moose	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
132	Fire	What is the probability of fire, based on model scenarios, near existing communities?	Accept	What is the risk to communities for wildfire and smoke?	Nowacki et al. Ecoregion	Probability class for a cell burning in any one year for communities
134	Invasive species	Where have recent beetle outbreaks occurred?	Accept	What affect will beetle populations have on fire regime and vice versa?	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
138	Invasive species	What is the current distribution of invasive species included as CAs?	Accept	What is the extent of specific introduced and/or invasive species and what are the expected trends and forecast for invasive plant occurrence?	Non-native plant populations as points, 5th level HUC summary	Number of populations
139	Invasive species	Given current patterns of occurrence, what is the potential future distribution of invasive species included as CAs? [From narrow list of species that are CA.]	Accept		2 km grid across all ecoregions	Degree of habitat suitability (cumulative probability by pixel)
139.5	Invasive species	Which CE's are likely to be most affected by invasive species	Accept		SEE MQ 64: Landscape species and species assemblages: 30 m grid and 5th level HUC summary, Local species: Heritage 5th level HUC	Landscape Species and Species Assemblages: Aerial extent in acres, Local Species: # of locations

MQ #	Group	Final Management Question	MQ Status	Original Management Question	Reporting Unit	Reporting Metric
143	Invasive species	What are the known and likely introduction vectors of invasive species?	Accept	What is the current status and forecast of invasives via straw and other use including river drainages? Subsequent impacts to moose wintering habitat	NA - non-spatial MQ	Literature Review
147	Hydrology, Sea Ice, Weather, Permafrost, Soils	What are the potential future climate scenarios for temperature and precipitation?	Accept		mean climate variables by Nowacki et al. Ecoregion	Location
156	Hydrology, Sea Ice, Weather, Permafrost, Soils	What are the current soil thermal regime dynamics and how are these predicted to change in the future?	Accept	What is the depth and extent of permafrost and how is this changing?	soil thermal types by Nowacki et al. Ecoregion	Location, change in mean annual ground temperature at the base of the active layer, maximum active layer thickness
157	Hydrology, Sea Ice, Weather, Permafrost, Soils	Where are predicted changes in soil thermal regimes associated with aquatic communities?	Accept	How will permafrost degradation and function affect vegetative and aquatic communities and to what extent? What will be permeability changes effects on water quality?	Nowacki et al. Ecoregions	Location and areal extent in acres per ecoregion
159	Hydrology, Sea Ice, Weather, Permafrost, Soils	Where are predicted changes in soil thermal regimes associated with communities/villages?	Accept	What communities/villages are at risk from permafrost melt?	Nowacki et al. Ecoregion	Location and areal extent in acres per ecoregion
178	Species	For game units that overlap REA, what are the current populations and trends in population for musk-ox, caribou, and moose?	Accept	For game units that overlap REA, what are the current populations and trends in population for musk-ox, caribou, and moose (and possibly fish or waterfowl)?	5th level HUCs	Figure showing estimated current and previous population sizes
3	Subsistence	What is the current population and range of moose?	**Accept Part A. Parts B and C are OUT OF SCOPE**	(A) What is the current population and range of moose? (B) What are moose harvest levels? (C) Are there reports of use conflicts among user groups?	5th level HUCs	Aerial extent in acres, estimated population size.
79	Species	Given current and anticipated future locations of change agents, not including climate change, where will potential habitat enhancement/restoration locations likely occur?	**OUT OF SCOPE**	Where are potential habitat restoration areas?	Landscape Species and Species Assemblages: 30 m grid and 5th level HUC summary Local Species: Heritage 5th level HUC	Location and Areal Extent in acres per 5th level HUC
33	Development	Will the changes to permafrost and hydrological resources affect mining practices or opportunities (i.e. the NPDES permits for waste water)?	**OUT OF SCOPE, Potential Literature Review**	Will the changes to permafrost and hydrological resources affect mining practices or opportunities (i.e. the NPDES permits for waste water)?		

Appendix Ib. Seward Peninsula - Nulato Hills - Kotzebue Lowlands: Removed Management Questions

This appendix lists management questions that were proposed by BLM or in community meetings, but with agreement from BLM, have subsequently been dropped from the REA due to redundancy, scope, data availability or other issues.

MQ #	Group	Proposed Management Question	Summary Conclusion	Original Management Question (from Source)
1	Subsistence		**Redundant**	What data is needed for managers to make sound decisions about ensuring 1) abundance of harvestable resources, 2) distribution of harvestable resources, and 3) harvester access. (Based on ANILCA Section 810 there are the three factors regularly mentioned that Federal Agencies are required to support.)
5	Subsistence		**Out of scope**	Do use authorizations impact access, availability and/or distribution of harvestable resources?
8	Subsistence		**Redundant**	What are subsistence users‘ concerns of increased time, effort, and expense to meet subsistence needs?
12	Subsistence	Given likely scenarios for changes in hydrological systems, what changes can be expected in subsistence species.	**Redundant**	How will the changes to hydrological systems affect subsistence species?
13	Subsistence	How could changes in snowfall, rain and icing events potentially impact subsistence species?	**Out of scope**	What snowfall changes will occur and what affect will it have on subsistence?
14	Subsistence		**Out of scope**	How can subsistence cultures best prepare for climate change and be adaptive to the changes?
17	Socioeconomic and population demographics		**Redundant**	What will community economic profiles look like in 10, 25, 50 and 100 years from now due to climate change effects?
19	Socioeconomic and population demographics		**Redundant**	What are potential increases in economic activities due to change agents?
20	Socioeconomic and population demographics	Where will relevant infrastructure potentially experience significant changes in soil thermal regime?	**Redundant**	What are the implications for infrastructure given permafrost melt?
21	Socioeconomic and population demographics		**Redundant**	What’s the viability of rural communities, given changes?
22	Socioeconomic and population demographics		**Redundant**	How will changes in fuel prices affect subsistence, tourism/guiding/, development?
23	Socioeconomic and population demographics	Based on output from storm surge models, which communities and infrastructure are most at risk for damage?	**Out of scope**	How will storm surges affect infrastructure? (Road to Council significantly eroded due to surges.)

24	Socioeconomic and population demographics	How is climate change likely to affect community water supply and quality? Sewage disposal?	**Out of scope**	How will Moonlight springs—be affected by climate change (main water supply to Nome)?
25	Socioeconomic and population demographics		**Insufficient data**	How will changes in water levels affect villages (e.g., Upper river villages are having a tougher time getting fuel barges up because the water is too low.)
26	Socioeconomic and population demographics	Where are sewage lagoons and dumps? Which are at risk by climate related ecological change?	**Out of scope**	How do sewage lagoons, wastewater systems, dumps, FUDS/Dewline, other hazardous sites, and air pollution impact species/habitats?
27	Socioeconomic and population demographics		**Redundant**	Where will increases or decreases in transportation corridors occur?
32	Socioeconomic and population demographics		**Redundant**	How will permafrost melt and other hydrological changes change overland or aviation transportation routes/airstrips on a seasonal and annual basis? Trails, roads, waterways (rivers/streams), and aviation facilities and transportation routes need to be considered.
34	Development		**Out of scope**	Blueberry/ptarmigan link and lead contamination?
35	Development		**Out of scope**	How does ocean acidification affect species?
36	Development	Where are lands that are and are not available for development?	**Out of scope**	Are we striking a good balance between development activities and habitat protection? and how do we do that?
37	Development	Where are areas that experience significant plastic on beaches?	**Out of scope**	How is all the plastic on the beaches of Kobuk Lake (and elsewhere) affecting species?
38	Development		**Redundant**	How will water quantity and quality change with climate change?
39	Development	Is there evidence of contaminants in subsistence foods? In which species/locations?	**Out of scope**	Unexplained potential anthropogenic impacts: milk production in male caribou; lesions on fish; persistent organic pollutant impacts, thickness of seagull eggshells?
40	Development		**Redundant**	What areas are or what criteria could be used to identify areas too valuable for development?
41	Development		**Redundant**	How will marine corridors, hydroelectric dams, port development, pipelines, the use of unmanned aerial vehicles, utilities impact subsistence species/habitat?
42	Development		**Out of scope**	How will fish populations moving north along with international commercial fishing, impact subsistence species?
43	Development		**Not included as MQ, but part of reporting**	How will cumulative impacts be accounted for in the REA?
47	Development		**Redundant**	Where are locations of mineral potential?
48	Development		**Redundant**	What is the foreseeable potential for mineral development?
54	Species		**Redundant**	Where are current locations of high priority species and habitat?
55	Species		**Redundant**	How will extreme climate/weather events affect species?
56	Species		**Part of methods discussion**	Are the assumptions that we have about how we're impacting these accurate?
57	Species		**Out of scope**	Are our mitigation efforts going to become ineffective as a result of climate change?

58	Species		**Out of scope**	Are our assumptions about how quickly a species will recover accurate?
59	Species		**Out of scope, partially redundant**	What are the thresholds for some species?
65	Species	What is the current distribution of the suitable habitats for each CE? *[A subset of CE to de proposed in Tasks 2 and 3]*	**Redundant**	What is the current status of occupied habitat, including seasonal habitat and specialty habitat (calving, insect relief, etc.), and movement corridors? Current status compared to historical?
66	Species	What habitats are critical for species sustainability?	**Redundant**	Where are habitats that may be limiting species sustainability?
67	Species		**Out of scope**	Are species and habitats adequately monitored to assess climate change in the study area?
69	Species		**Redundant**	What CE populations and movement corridors are potentially affected by climate change?
70	Species		**Redundant**	What are climate change impacts to wildlife habitat?
71	Species		**Redundant**	Is there expected loss of winter forage for caribou and reindeer? To what extent, where and what are the predicted trends?
72	Species	Where are moose, caribou and musk ox habitats likely to experience significant changes due to climate change?	**Redundant**	What are the predicted effects to moose habitat, specifically willow browse and what are the predicted trends?
73	Species	Is there a predicted increase in mosquito/insect populations and how will this affect the wildlife resources (insect relief areas)?	**Out of scope**	Is there a predicted increase in mosquito/insect populations and how will this affect the wildlife resources (insect relief areas)?
75	Species	What snowfall changes will occur and what affect will it have on wildlife (mobility, predation, habitat shifts)?	**Out of scope**	What snowfall changes will occur and what affect will it have on wildlife (mobility, predation, habitat shifts)?
76	Species		**Redundant**	What snowfall changes will occur and what affect will it have on subsistence
77	Species		**Insufficient data**	What will be the effects of potential changes in nutrient availability on productivity for species?
80	Species	How will icing events affect habitat availability?	**Out of scope**	How will icing events affect habitat availability?
81	Species		**Redundant**	What are the highest priority species.
82	Species		**Redundant**	Where are species populations at risk?
83	Species		**Redundant**	What/where is the potential for future change to species and populations?
85	Species		**Out of scope**	Are increased musk ox numbers the result of vegetation changes due to climate change or just lack of population management?
89	Native Plant Communities		**Out of scope**	
90	Native Plant Communities	Where are high priority native plant associations and ecological systems? (i.e. rare associations/ecological systems or associations that support species of concern)	**Redundant**	Where are intact CE vegetative communities located?
91	Native Plant Communities		**Out of scope**	Develop baseline data to monitor habitat change (e.g., drying wetlands).
92	Native Plant Communities		**Redundant**	How are the lichens changing? Species, growth rates, acreage, location? How will Lichen communities or specific species adapt in relation to having long reestablishment timelines?

93	Native Plant Communities		**Agreed to be unnecessary**	Where are the locations that most likely include the highest-integrity examples of each major terrestrial ecological system?
94	Native Plant Communities		**Redundant**	What is the location/distribution of sites/areas identified or designated for conservation?
95	Native Plant Communities		**Out of scope**	When should plant communities be allowed to change as a result of climate change? Is there an acceptable rate of change?
96	Native Plant Communities		**Redundant**	With respect to rate of change, will there be thresholds projected or tipping points that will occur for extensive vegetative shifts?
97	Native Plant Communities		**Redundant**	What/where is the potential for future change to these sites?
98	Native Plant Communities		**Redundant**	Where are intact CE vegetative communities located?
99	Native Plant Communities		**Redundant**	Can tipping points be predicted?
100	Native Plant Communities	Which native plant communities will likely experience climate completely outside their normal range?	**Redundant**	How will the distribution of native flora and fauna communities change with climate change (shrub habitat replacing sedge/lichen communities, extent of anadromy, diversity, areas with highest potential to change)?
101	Native Plant Communities		**Agreed to be unnecessary**	Given anticipated climate shifts and the direction shifts in distributions, where are areas of potential habitat fragmentation?
107	Livestock (Reindeer Grazing)		**Agreed to be unnecessary**	Are the impacts of overgrazing in certain areas accelerating the changes more than in areas that are not overgrazed? If so, what are these changes and how will they affect the health of the land and subsistence resources?
108	Aquatic ecological function and structure		**Redundant**	How will climate change affect our accessibility to these resources?
109	Aquatic ecological function and structure	How may climate change affect barge transportation to rural villages?	**Out of scope**	How may this affect barge transportation to rural villages?
110	Aquatic ecological function and structure		**Out of scope**	Will climate change lead to different background levels for water quality?
112	Aquatic ecological function and structure		**Out of scope**	Will there be positive impacts of new fisheries / waterfowl moving into an area?
115	Aquatic ecological function and structure		**Redundant**	Where are aquatic systems degraded (e.g., water quality)?
118	Aquatic ecological function and structure	Where will Essential Fish Habitat likely experience significant and abrupt deviations from normal temperature regime?	**Redundant**	Essential Fish Habitat - How will these areas be affected by the predicted changes, and within what timeframes?
119	Fire		**Redundant**	Is climate change going to change the periodicity of the fire regime?
121	Fire		**Redundant**	What can be predicted about the severity of fires?
123	Fire		**Out of scope**	How will climate change affect fire suppression strategy? What impact will these changes (when looking at existing data) have on fire policies?

124	Fire		**Redundant**	Will it change the volatility of future fires? How does this interact with permafrost structure and severity?
125	Fire		**Redundant**	What are the specific vegetative (tundra) fire regimes within the ecoregion and what is the paleo fire history?
127	Fire		**Out of scope**	What is the effect from smoldering tundra fires?
128	Fire		**Insufficient data**	In places that have experienced fire, with and without permafrost, where does the resulting vegetative structure and composition differ from the desired state, and what changes with permafrost melt? (relates to tundra fires vs. wood)
131	Fire		**Redundant**	What is the relationship with wildfire – especially forecasting habitat shift(s) related to changed fire regime ? Changes in burn severity…..
133	Fire		**Out of scope**	Will the changes in fire regime and intensity result in rapid landform change (i.e. mass wasting)?
135	Invasive species		**Redundant**	How is climate change going to affect invasive species?
136	Invasive species		**Out of scope**	What will be the vegetational shift in invasive species?
137	Invasive species		**Redundant**	What is the current distribution of invasive species and what are the ecological affects in these areas? (mentioned: alder sawflies, a lot of zoonotics are becoming more prevalent (giardia, trichinosis, brucellosis, etc.)
140	Invasive species	What areas (significantly affected by invasives) have restoration potential?	**Redundant**	
141	Invasive species		**Redundant**	Where are the areas of highest potential to change?
142	Invasive species		**Redundant**	How will climate change affect invasive species-plants and insects?
144	Invasive species		**Redundant**	What is the risk for changing populations?
145	Invasive species		**Redundant**	Eelgrass, weevils, native species range expansion or shifts due to changing conditions
146	Invasive species		**Redundant**	
146.3	Invasive species	What is the historic and current range of beaver?	**Out of scope**	
146.4	Invasive species	What are the potential impacts of beaver establishment on CEs, including subsistence species??	**Out of scope**	
146.6	Invasive species	What is the historic and current range of coyotes?	**Out of scope**	
146.7	Invasive species	What are the potential impacts of coyotes on CEs, including subsistence species?	**Out of scope**	
148	Hydrology, Sea Ice, Weather, Permafrost, Soils	What is the annual extent of sea ice and changes in proximity to shore by date and how is this changing?	**Out of scope**	What is the annual extent of sea ice and changes in proximity to shore by date and how is this changing?
149	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Insufficient data**	Where and how will river volumes change due to changes in climate?
150	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Redundant**	What is the likelihood of increased liquid precipitation in winter?

151	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Redundant**	What areas will experience significant “decreases” (change to “departures from normal”) in precipitation? evapotranspiration? How does precipitation link to conservation element?
152	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Out of scope**	What affect will salt water intrusion into fresh water have?
153	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Out of scope**	Monitor permafrost.
154	Hydrology, Sea Ice, Weather, Permafrost, Soils	How would the villages/communities deal with the effects of coastal erosion – what areas are in high risk for coastal erosion and sea level rise and what are the effects to coastal communities?	**Out of scope**	How would the villages/communities deal with the effects of coastal erosion – what areas are in high risk for coastal erosion and sea level rise and what are the effects to coastal communities?
155	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Redundant**	Drought – water balance issues?
158	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Out of scope, partially redundant**	How will permafrost degradation affect aquatic communities and to what extent?
160	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Redundant**	What is the timeframe forecast for loss of land on the shoreline and hydrological resources in communities/villages, specific to each community as a result of permafrost melt?
161	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Insufficient data**	What percent of lakes/ponds are expected to disappear with permafrost melt, and where are these changes expected? How will these hydrological changes affect water supply to villages and to wildlife?
162	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Insufficient data**	What are the areas at high risk from river erosion? What are the effects of river erosion on resource values?
163	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Out of scope**	How will permafrost degradation affect water quality?
164	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Out of scope**	YK Delta FWS. Data on contaminants in fish and marine mammals is needed (e.g., beluga is an important subsistence species for coastal communities).
165	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Insufficient data**	How will these hydrological and permafrost change affect water supply to villages?
166	Hydrology, Sea Ice, Weather, Permafrost, Soils		**Redundant**	How will the hydrology (ground water connectivity, permafrost, lake dehydration, change in precipitation quantity and season) be affected?

167	General questions or applicable to several MQs		**Redundant**	What resource values are regionally important - Why are these values important?
168	General questions or applicable to several MQs		**Redundant**	Where are these regionally important values located?
169	General questions or applicable to several MQs		**Redundant**	What is their current status? Current status compared to historical?
170	General questions or applicable to several MQs	What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)?	**Redundant**	What areas have been surveyed and what areas have not been surveyed (i.e., data gap locations)?
171	General questions or applicable to several MQs		**Redundant**	What is the status of populations and communities, and their dynamics and connectivity?
172	General questions or applicable to several MQs	What are the attributes and indicators of status?	**REMOVE - Part of the Assessment**	What are the attributes and indicators of status?
173	General questions or applicable to several MQs		**Redundant**	Where are regionally important aquatic ecological features, functions, and services?
174	General questions or applicable to several MQs		**Redundant**	What/where is the potential for future change to habitats/communities/landscapes/ecological
175	General questions or applicable to several MQs		**Redundant**	What/where is the potential for future change in status of resource values from change agents?
176	General questions or applicable to several MQs	What are the information/data gaps? What are the science needs? What are important research issues?	**REMOVE - Part of the Assessment**	What are the information/data gaps? What are the science needs?
177	General questions or applicable to several MQs		**Redundant**	How will these areas be affected by the predicted changes, and within what timeframes?

Appendix II. Summary of anticipated models and other products addressing MQs for the REA.

Table A-1. Coarse-filter terrestrial CEs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual CE.

The subset of MQs that are addressed by these terrestrial coarse-filter CE models and other deliverables are listed separately here for reference:

MQ #	Management Question
60	What is the current distribution of each CE?
62	Where do current CE distributions overlap with CA?
87	How will habitats that support terrestrial species of concern likely change due to fire over the next 15 and 50 years?

MQ #	Terrestrial Coarse-filter CEs (Land Cover Classes)	Land Cover Map	Land Cover Descriptions	Succession Literature Review	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Ecological Status Assessment	Total # of Proposed Models and Products
60, 62	**Black Spruce (Open)**	Yes (1)	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Black Spruce (Woodland)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Black Spruce/Lichen (Woodland)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Black spruce/Tussock (Woodland)**	Yes (1)	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Deciduous (Open-Closed)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Dwarf shrub**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62, 87	**Dwarf shrub-Lichen**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62, 87	**Dwarf shrub-Lichen-Sphagnum (Permafrost plateau)**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62	***Elymus* (Coastal)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Herbaceous (Marsh)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Herbaceous (Mesic)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Herbaceous (Wet)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62, 87	**Lichen**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62, 87	**Low Shrub birch/Lichen**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62, 87	**Low Shrub Birch-Ericaceous-Willow**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62, 87	**Low Shrub-Tussock Tundra**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62, 87	**Low Willow**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 62	**Moss**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Needleleaf-Deciduous (Open-Closed)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Pondlily**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62, 87	**Salix-Sedge (Tidal)**	Yes (1)	Yes (1)	Yes (1)	No	No	No	3
60, 62, 87	**Sedge (Tidal)**	Yes (1)	Yes (1)	Yes (1)	No	No	No	3
60,62	**Sedge-Dwarf shrub (Peatland)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**Sparse Vegetation**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62, 87	**Tall Shrub (Open-Closed)**	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	6

MQ #	Terrestrial Coarse-filter CEs (Land Cover Classes)	Land Cover Map	Land Cover Descriptions	Succession Literature Review	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Ecological Status Assessment	Total # of Proposed Models and Products
60, 62, 87	**Tussock Tundra**	Yes (1)	Yes (1)	Yes (1)	No	No	No	3
60, 62	**White Spruce (Open)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**White Spruce (Woodland)**	Yes (1)	Yes (1)	No	No	No	No	2
60, 62	**White Spruce/Lichen (Open)**	Yes (1)	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**White Spruce/Lichen (Woodland)**	Yes (1)	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5

Table A-2. Fine-filter terrestrial CEs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual CE.

Table 2a. Animal species CEs and their corresponding models and products.

MQ #	MQ(s) Addressed	Fine-filter Terrestrial CEs (Animals)	CE Treatment	Taxonomic Group	Current Distribution Models	Future Distribution Models	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersections	Ecological Status Assessment	Total # of Proposed Models and Products
60, 62, 64	(MQ60) What is the current distribution of each CE?, (MQ62) Where do current CE distributions overlap with CA?, (MQ64) Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?	**Polar bear**	Coarse-filter; sea ice-associated habitats	Mammals	No - will be included in coarse-filter, sea ice-associated habitats	No	No - will be included in coarse-filter, sea ice-associated habitats	No - will be included in coarse-filter, sea ice-associated habitats	No - will be included in coarse-filter, sea ice-associated habitats	No	No	0
60, 62, 64	same	**Marine Mammal Haul-Out Sites**	Ecological Assemblages	Mammals	EO Point locations and/or polygon range maps by HUC (1)	No	Yes (1)	Yes (1)	Yes (1)	No	No	4
60, 62,64	same	**Migratory Bird Habitats**	Ecological Assemblages	Birds	Point and polygon locations (1)	No	Yes (1)	Yes (1)	Yes (1)	No	No	4
60, 62,64	same	**Seabird colony sites**	Ecological Assemblages	Birds	EO Point and polygon locations by HUCs (1)	No	Yes (1)	Yes (1)	Yes (1)	No	No	4
60,62,64	same	**Pacific walrus**	Ecological Assemblages, included with marine mammal haulouts	Mammals	No - included with Ecological Assemblage for Marine Mammal Haulouts	No	No - included with Ecological Assemblage for Marine Mammal Haulouts	No - included with Ecological Assemblage for Marine Mammal Haulouts	No - included with Ecological Assemblage for Marine Mammal Haulouts	No	No	0
60, 62,64	same	**Aleutian Tern**	Ecological Assemblages; can be included in seabird colony sites associated with coastal cliffs and estuaries/lagoons	Birds	No - included with Ecological Assemblage for Seabird Colonies	No	No - included with Ecological Assemblage for Seabird Colonies	No - included with Ecological Assemblage for Seabird Colonies	No - included with Ecological Assemblage for Seabird Colonies	No - included with Ecological Assemblage for Seabird Colonies	No	0
60,62,64	same	**Alaskan hare**	Landscape	Mammals	GAP Raster Model (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Landscape Condition Model (1)	Yes (1)	No	Yes (1)	7
60, 62,65	same	**Arctic Peregrine Falcon**	Landscape	Birds	GAP Raster Model (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	7

MQ #	MQ(s) Addressed	Fine-filter Terrestrial CEs (Animals)	CE Treatment	Taxonomic Group	Current Distribution Models	Future Distribution Models	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersections	Ecological Status Assessment	Total # of Proposed Models and Products
60, 62,66	same	**Bar-tailed Godwit**	Landscape	Birds	GAP Raster Model (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	7
60, 62,67	same	**Black Scoters**	Landscape	Birds	GAP Raster Model (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	5
60, 62,68	same	**Bristle-thighed Curlew**	Landscape	Birds	GAP Raster Model (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	7
60, 62,69	same	**Common Eider**	Landscape	Birds	GAP Raster Model (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	5
60, 62,64	(MQ60) What is the current distribution of each CE?, (MQ62) Where do current CE distributions overlap with CA?, (MQ64) Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?	**King Eider**	Landscape	Birds	GAP Raster Model (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	7
60,62,64	(MQ60) What is the current distribution of each CE?, (MQ62) Where do current CE distributions overlap with CA?, (MQ64)Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?	**Yellow-billed Loon**	Landscape	Birds	GAP Raster Model (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	No	Yes (1)	7
60	(MQ60) What is the current distribution of each CE?	**Emperor Goose**	Local	Birds	GAP Raster Model (1)	No	No	No	No	No	No	8
60	same	**Hudsonian Godwit**	Local	Birds	GAP Raster Model (1)	Yes (2)	No	No	No	No	No	3
60	(MQ60) What is the current distribution of each CE?	**Kittlitz's Murrelet**	Local	Birds	GAP Raster Model (1)	Yes (2)	No	No	No	No	No	3
60	same	**McKay's Bunting**	Local	Birds	GAP Raster Model (1)	No	No	No	No	No	No	8
60	same	**Red Knot**	Local	Birds	GAP Raster Model (1)	Yes (2)	No	No	No	No	No	3

MQ #	MQ(s) Addressed	Fine-filter Terrestrial CEs (Animals)	CE Treatment	Taxonomic Group	Current Distribution Models	Future Distribution Models	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersections	Ecological Status Assessment	Total # of Proposed Models and Products
60	same	**Spectacled Eider**	Local	Birds	GAP Raster Model (1)	No	No	No	No	No	No	1

Table 2b. Vascular plant species CEs and their corresponding models and products.
The subset of MQs that are addressed by these plant species CE models and other deliverables are listed separately here for reference:

MQ #	Management Question
60	What is the current distribution of each CE?
62	Where do current CE distributions overlap with CA?

MQ #	Fine-Filter Terrestrial CEs (Vascular Plants)	Current Distribution	Descriptive Models	Total # of Proposed Models and Products
60, 62	***Artemisia globularia ssp. lutea***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Artemisia senjavinensis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Cardamine microphylla ssp. blaisdellii***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Carex heleonastes***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Claytonia arctica***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Douglasia alaskana***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Douglasia beringensis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Gentianopsis detonsa ssp. detonsa***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Lupinus kuschei***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Oxytropis arctica var. barnebyana***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Oxytropis kokrinensis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Papaver walpolei***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Parrya nauruaq***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Potentilla rubricaulis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Potentilla stipularis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Primula tschuktschorum***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Puccinellia vahliana***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Puccinellia wrightii***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Ranunculus auricomus***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Ranunculus chamissonis***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Ranunculus glacialis var. 1***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Rumex krausei***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Saussurea triangulata***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Smelowskia johnsonii***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Symphyotrichum yukonense***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2
60, 62	***Taraxacum carneocoloratum***	EO locations by 5th Level HUC (1)	Brief description of habit associations (1)	2

Table A-3. Coarse-filter aquatic CEs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual CE.

The subset of MQs that are addressed by these coarse-filter aquatic CE models and other deliverables are listed separately here for reference:

MQ #	Management Question
60	What is the current distribution of each CE?
62	Where do current CE distributions overlap with CA?

MQ #	Coarse-filter Aquatic CEs	Current Distribution Models	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Ecological Status Assessment	Total # of Proposed Models and Products
60, 62	**Estuary and Lagoon**	Yes, will be from ESI or NWI datasets.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Freshwater Lake – large, connected**	Yes, from NHD. Use size cutoff and intersection with streams layer.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Freshwater Lake – large, isolated**	Yes, from NHD.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Freshwater Lake – small, connected**	Yes, from NHD.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Freshwater Lake – small, isolated**	Yes, from NHD.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Headwater stream**	Yes, from NHD.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Hot Spring**	Yes, from NGDC dataset.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**Lowland stream and slough**	Yes, from NHD, may require a spatial model based on stream gradient.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62	**River**	Yes, from NHD.	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5

Table A-4. Fine-filter aquatic CEs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual CE.

All fine-filter aquatic CEs are fish species and are being treated in the REA as Landscape Species. The subset of MQs that are addressed by these fish species models and other deliverables are listed separately in this table for reference.

MQ #	Management Question
60	What is the current distribution of each CE?
61	What areas have been surveyed (i.e., inventoried) for each CE and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region?
62	Where do current CE distributions overlap with CA?
64	Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?
113	Where are the important aquatic resources, such as spawning grounds and other fish habitats? (herring spawning grounds and areas used by waterfowl?)
114	What is the condition of these various aquatic systems?

MQ #	Fine-Filter Aquatic CEs	Current Distribution Models	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Ecological Status Assessment	Total Number of Proposed Models and Products
60, 61, 62, 64, 113, 114	**Alaska Blackfish** (*Dallia pectoralis*)	Yes, using AFFID and CART model (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
60, 62, 64, 113, 114	**Arctic lamprey** (*Lampetra japponica*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Bering cisco** (*Coregonus laurettae*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Broad whitefish** (*Coregonus nasus*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Humpback whitefish** (*Coregonus pidschian*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Pacific lamprey** (*Lampetra tridentata*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Rainbow smelt** (*Osmerus mordax*)	No, data gap	Yes (1)	No	No	No	1
60, 61, 62, 64, 113, 114	**Round whitefish** (*Prosopium cylindraceum*)	No, data gap	Yes (1)	No	No	No	1

Table A-5. Subsistence CEs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual CE.

The subset of MQs that are addressed by these various subsistence CE models and other deliverables are listed separately in this table for reference.

MQ #	Management Question
3	What is the current population and range of moose?
10	What are the current ranges of subsistence species? Where are the subsistence communities?
60	What is the current distribution of each CE?
61	What areas have been surveyed (i.e., inventoried) for each CE and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region?
62	Where do current CE distributions overlap with CA?
63	Where will the distribution of CEs and wildlife ranges likely experience significant change in climate?
64	Where are CEs whose habitats are systematically threatened by CAs (other than climate change)?
68	What CE populations and movement corridors overlap with CA?
84	With recent science concluding that musk ox are eating lichens now, how is this going to affect winter range availability for reindeer and caribou?
102	Where are the current populations of Reindeer? What is the current and historic herd size?
103	Will suitable habitat for caribou be available with climate change?
104	Where will current Reindeer grazing areas experience climate completely outside their normal range?
105	Where will current populations of Reindeer experience overlap with Change Agents?
113	Where are the important aquatic resources, such as spawning grounds and other fish habitats? (herring spawning grounds and areas used by waterfowl?)
114	What is the condition of these various aquatic systems?
178	For game units that overlap REA, what are the current populations and trends in population for musk-ox, caribou, and moose?

MQ #	Subsistence CEs	CE Treatment	Taxonomic Group	Current Distribution Models	Distribution Models (2025, 2060)	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersection Models	Ecological Status Assessment	Total # of Proposed Models and Products
10,60,62,63,64	**Blueberry** (*Vaccinium uliginosum*)	Coarse-filter	Plants	No	No	No	No	No	No	No	0
10,60,62,63,64	**Cloudberry/ Salmonberry** (*Rubus chamaemorus*)	Coarse-filter	Plants	No	No	No	No	No	No	No	0
10,60,62,63,64	**Crowberry/ Blackberry** (*Empetrum nigrum*)	Coarse-filter	Plants	No	No	No	No	No	No	No	0
60,62,64	**Willow Ptarmigan**	Coarse-filter, wet-willow shrubland habitats	Birds	No- will be included in coarse-filter, wet-willow shrubland habitats	No	No- will be included in coarse-filter, wet-willow shrubland habitats	No- will be included in coarse-filter, wet-willow shrubland habitats	No- will be included in coarse-filter, wet-willow shrubland habitats	No	No	0
60, 61, 62, 64, 113, 114	***Arctic char*** (Salvelinus alpinus)	Local	Fish	Yes, from BLM lake survey (1)	No	Yes (1)	No	No	No	No	2

MQ #	Subsistence CEs	CE Treatment	Taxonomic Group	Current Distribution Models	Distribution Models (2025, 2060)	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersection Models	Ecological Status Assessment	Total # of Proposed Models and Products
60, 61, 62, 64, 113, 114	**Arctic grayling** (Thymallus Arcticus)	Landscape	Fish	Yes, using AFFID and CART model (1)	No	Yes (1)	Yes, Dendritic Connectivity Model (DCI) for ESA (1)	Yes (1)	Yes (1)	Yes (1)	6
10,60,62,63,64	***Beavers***	Landscape	Mammals	GAP Raster Models (1)	Possibly (2). Species models based on associations with treeline. Model may simply be descriptive based on Rupp. et al. paper.	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	Subsistence species range maps + subsistence use areas (1)	Yes (1)	6 (possibly 8)
10,60,62,63,64	***Black bear***	Landscape	Mammals	GAP Raster Models (1)	Possibly (2). Species models based on associations with treeline. Model may simply be descriptive based on Rupp. et al. paper.	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	Subsistence species range maps + subsistence use areas (1)	Yes (1)	6 (possibly 8)
10,60,62,64	***Brown bear***	Landscape	Mammals	GAP Raster Models (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)		Yes (1)	5
10, 60,62,64	***Canada Geese***	Landscape	Birds	GAP Raster Model (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	Subsistence species range maps + subsistence use areas (1)	Yes (1)	6
60, 61, 62, 64, 113, 114	***Chinook salmon*** (*Oncorhynchus tshawytscha*)	Landscape	Fish	Yes, from AWC (1)	No	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5

MQ #	Subsistence CEs	CE Treatment	Taxonomic Group	Current Distribution Models	Distribution Models (2025, 2060)	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersection Models	Ecological Status Assessment	Total # of Proposed Models and Products
60, 61, 62, 64, 113, 114	***Chum salmon*** (*Oncorhynchus keta*)	Landscape	Fish	Yes, from AWC (1)	No	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 61, 62, 64, 113, 114	***Coho salmon***(Oncorhynchus kisutch)	Landscape	Fish	Yes, using AFFID and CART model (1)	No	Yes (1)	Yes, Dendritic Connectivity Model (DCI) for ESA (1)	Yes (1)	Yes (1)	Yes (1)	6
60, 61, 62, 64, 113, 114	***Dolly Varden*** (Salvelinus malma)	Landscape	Fish	Yes, using AFFID and CART model (1)	No	Yes (1)	Yes, Dendritic Connectivity Model (DCI) for ESA	Yes (1)	Yes (1)	Yes (1)	6
3A,10,60,61,62,64, 68	***Moose***	Landscape	Mammals	GAP Raster Models (1)	No	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	Existing data or distribution model (potential habitat) + intersect scenarios (MQ68)	Yes (1)	6
10,60,62,63,64	***Muskox***	Landscape	Mammals	GAP Raster Models (1)	Yes (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)		Yes (1)	7
60, 61, 62, 64, 113, 114	***Pike*** (Esox lucius)	Landscape	Fish	No, data gap	No	Yes (1)	No	No	No	No	1
60, 61, 62, 64, 113, 114	***Pink salmon*** (Oncoyhynchus gorbuscha)	Landscape	Fish	Yes, from AWC (1)	No	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 61, 62, 64, 113, 114	***Sheefish*** (Stendous leucichthys)	Landscape	Fish	Yes, from AWC (1)	No	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5
60, 61, 62, 64, 113, 114	***Sockeye salmon*** (Oncorhynchus nerka)	Landscape	Fish	Yes, from AWC (1)	No	Yes (1)	No	Yes (1)	Yes (1)	Yes (1)	5

MQ #	Subsistence CEs	CE Treatment	Taxonomic Group	Current Distribution Models	Distribution Models (2025, 2060)	Descriptive Models	CA Intersection Anthropogenic Activities	CA Intersection Non-Native Species	Other Intersection Models	Ecological Status Assessment	Total # of Proposed Models and Products
10,60,62,63,64,6884,102,103,104,105, 178	***Western Arctic Caribou Herd***	Landscape	Mammals	GAP Raster Model (1), Seasonal use/range (2 or 3)	Yes (4) = winter range (2), calving grounds (2)	Tabular and descriptive characterization summary (1)	Yes (1)	Yes (1)	Yes (2) total: Subsistence species range maps + CA scenarios (MQ68); Winter range of caribou and reindeer + lichen layer + future distribution model for muskox (MQ84)	Yes (1)	13 (possibly 14)

Table A-6. Subsistence-related assessments that are not specific to an individual CE.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual Management Question (MQ).

MQ #	MQ(s) Addressed	Descriptive Models or Products	Dynamics Models	Tabular Data Products	Other Intersection Models	Total # of Proposed Models or Products
2	How could changes in sea mammal harvests potentially affect land based hunting and fishing?	Overlay community locations, range data for 5 highest harvest subsistence species, and access. Use traditional knowledge about hunting and harvesting practices to estimate access to animals.		ADFG harvest data. Literature to understand how far people go to hunt, and under what conditions (weather, abundance)	Subsistence model	1 map of community locations overlaid with maps for the 5 highest harvest subsistence species; tabular summary of access information
4	How much have harvests (lbs.) changed over the past 20 years?	Summarize harvest lbs of 5 top species x community for 2000-2010, and 1990-2000		ADFG harvest data		Tabular summary of harvest lbs by community by species
6	Which species make up the largest share (lbs.) of subsistence harvests? How is this changing?	Total pounds per species, identify top 5 species.		ADFG harvest data		Tabular summary of harvest lbs by species by time periods
7	Given current and estimates of future subsistence species populations, are harvest regulations adequate to protect subsistence species populations?	Literature to estimate the effect of regulations on 5 top subsistence species harvests.		ADFG harvest data		1
9	How have hunting and fishing regulations affected general hunting and fishing harvests?	Literature to estimate the effect of regulations on harvests.		ADFG hunter harvest data.		1
11	In which locations are climate change events likely to affect subsistence species?		Map overlay of climate change and habitat ranges for 5 top subsistence species.	ADFG subsistence harvests.		15
28	What types of traditional and local knowledge data exist for the region? How can these data be best incorporated into management decisions?	Literature relevant to subsistence species and harvest practices.			Will provide rules for subsistence models and scenario development.	1

MQ #	MQ(s) Addressed	Descriptive Models or Products	Dynamics Models	Tabular Data Products	Other Intersection Models	Total # of Proposed Models or Products
102	Where are the current populations of Reindeer? What is the current and historic herd size?		Existing data, range map			1
103	Will suitable habitat for Reindeer and caribou be available with climate change?		Future distribution models + ALFRESCO future vegetation models (CA Scenarios) based on non-spatial averaging of mean outputs from multiple runs.			1
104	Where will current Reindeer grazing areas experience climate completely outside their normal range?		Current distribution model or grazing allotments + Climate space trends			1
105	Where will current populations of Reindeer experience overlap with Change Agents?		Current distribution model or grazing allotments + CA Scenarios			1

Table A-7. Other assessments that are not subsistence-related and not specific to an individual CE.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual Management Question (MQ).

MQ #	MQ(s) Addressed	Taxonomic Group	Descriptive Models or Products	Intersection Models	Total # of Proposed Models or Products
78	Which CE's are likely to be more vulnerable due to dispersal barriers?	Birds, mammals		Future distribution models + Existing data or distribution models	1
74	Will climate change cause increased chance of disease in wildlife populations? What disease(s) are likely to be introduced or increase?	Birds, mammals	Literature review		1
61	What areas have been surveyed (i.e., inventoried) for each CE and what areas have not been surveyed (i.e., data gap locations)? How does survey intensity vary across the region?	Plants (Fine and Coarse Filter), Birds, Mammals, Fishes		Intersect survey efforts + EO Locations	5
63	Where will the distribution of CEs and wildlife ranges likely experience significant change in climate?	Birds, mammals	Summary of climate space trends observed in relation to taxonomic groups		1
86	What habitats support terrestrial species of concern (rare plants, rare animals, and subsistence species)?,	Plants (Fine and Coarse Filter), Birds, Mammals, Fishes		Intersect coarse filter units + EO Locations	1
116	Where are predicted changes in hydrologic regime associated with important aquatic resources?	Fish	Literature review to describe impacts to fish resources by ecoregion.	overlay changes in hydrologic regime	1
117	Where are predicted changes in air temperature associated with important aquatic resources?	Fish	Literature review to describe impacts to fish resources by ecoregion.	overlay changes in air temperature	1
157	Where are predicted changes in soil thermal regimes associated with aquatic communities?	Fish	Literature review to describe impacts to fish resources by ecoregion.	overlay changes in soil thermal regime	1
138	What is the current distribution of invasive species included as CAs?	Fish, Birds, Mammals, Plants	Literature review to describe aquatic and terrestrial invasives in Alaska where existing data is not available.	No	1
139	Given current patterns of occurrence, what is the potential future distribution of invasive species included as CAs? [From narrow list of species that are CA.]	Fish, Birds, Mammals, Plants	Literature review to describe aquatic and terrestrial invasives in Alaska where existing data is not available.	No	1
140	Which CEs are likely to be most affected by invasive species	Fish, Birds, Mammals, Plants	Literature review to describe the species most susceptible to invasives documented in Alaska.	No	1
143	What are the known and likely introduction vectors of invasive species?	Fish, Birds, Mammals, Plants	Literature review to describe potential vectors for movement of invasives into the REA study area.	No	1
88	What are the proportions of CEs that coincide with different management areas?	Terrestrial Coarse Filter Units		CEs intersected with land management areas	4

Table A-8. CAs and their corresponding models and products.

The number of proposed models or products for each column is indicated in parentheses. The last column lists the total number of models/products for each individual Management Question (MQ).

	MQ #	MQ(s) Addressed	Current Distribution	Future Distribution (2025, 2060)	Descriptive Models	Intersection with CEs	CA (Climate Change) Intersection	Total # of Proposed Models and Products
Wildfire	129	What is the known fire history of the region and what is the potential future fire regime? and What are the implications for vegetation?	Maps showing observed fire perimeters and observed vegetation class, summarized by ecoregion (2)	Maps showing the simulated distribution of the probability of a pixel burning in any one year (= Fire Return Interval) and probability of a particular vegetation class, summarized by ecoregion (4)				6
Wildfire	122	Where are predicted changes in future fire regime associated with rivers?		Intersect fire projections with rivers (2)				2
Wildfire	130	Where are areas of predicted high future fire risk associated with current caribou habitat, winter range, and calving sites?		Intersect fire projections with caribou range areas (2)				2
Wildfire	132	What is the probability of fire, based on model scenarios, near existing [human] communities?		Intersect fire projections with existing communities (2)				2
Wildfire	120	How is the potential future fire regime anticipated to impact permafrost?			Literature review			1
Wildfire	126	What is the known lightning strike frequency? Do these data show a significant trend over time?			Statistical analysis of lightning strike frequency data from Alaska Fire Service showing whether trend over time is present (1)			1
Wildfire	129.5	What does the paleorecord reveal about fire history?			Literature review			1
Community Development	16	(A) What is the current socio-economic profile for each community? (B) How are they likely to change under development and climate scenarios?	Maps of communities with population change over time.	Maps with forecast populations, new sites and former sites. Small area population forecast models.			Yes (1)	78 (current, 2025, 2060 for 26 communities)
Oil and Gas Development	46	Where are current and planned oil/gas activities located and where do they overlap with CEs or other relevant habitats?	Maps.	Development plans are for off-shore fields north of the region.				1
Recreation	45	How are transporters/tourism/sport hunt and fishing affecting the migration patterns of caribou?	Map instances of human intervention shifting migration.		This will provide qualitative information. Possible use in the subsistence model.			1

	MQ #	MQ(s) Addressed	Current Distribution	Future Distribution (2025, 2060)	Descriptive Models	Intersection with CEs	CA (Climate Change) Intersection	Total # of Proposed Models and Products
Recreation	15	What are patterns of current tourism including hunting and fishing (e.g., total revenue, total visitors, types of ecotourism)?	Maps noting destinations with tourism data.					1
Recreation	18	How are changes in climate likely to affect tourism destination sites, numbers		Maps with 3 levels forecast of visitors. Tourism forecast models			3 climate change scenarios	6
Forage	106	How have the reindeer herds changed over time? How do herds affect grazing areas?	Maps of herding areas and population changes. Literature to understand causes of declining herd size, migration with caribou. Not necessarily due to lack of forage or overharvesting.	Dependent on MQ103 Overlay change in forage with herd areas (3 scenarios)			Climate change can affect availability of forage (#103)	1
Transportation Infrastructure	50	Where are current and planned roads located, and where do they overlap with CEs or other relevant habitat?	Current road maps	Proposed route maps for road to Nome and Ambler road.	Literature on effects of permafrost on roads.	Overlay current roads with relevant CEs Overlay proposed roads with relevant CEs		3 maps for roads (current + 2 future) Tabular summaries of CEs intersected by the roads for each time period.
Energy Development - Extractive energy development	44	Where are historic, current and potential mining activities located, and where do they overlap with CEs or other relevant habitat?	3 maps - historic, current, potential	Maps of mines under 3 road scenarios for Nome and 3 scenarios for Ambler. Overlay with habitat maps				3 maps of mines (historic, current, future); tabular summaries of CEs intersected by the mines for each time period.
Energy Development - Alternative Energy Development	52	Where are potential renewable energy sites located and where do they overlap with CEs or other relevant habitats?	Map with current renewable sites.	Maps showing energy potential - wind, geothermal, ocean currents, biomass.				1
Military Constrained Areas	51	Where are historic, current and planned military sites located, and where do they overlap with CEs?	Map information showing military sites (most closed) overlay with CE maps.	No new sites are planned. No closures are planned.				2 maps of military sites (historic, current); tabular summaries of CEs intersected by the military sites for each time period.
Contaminants	111	Where are hazardous waste sites?	Point data. Estimate footprint of sites. Contaminated sites. Access database of site characteristics.					1
Non-Native Plants	138	What is the current distribution of invasive species included as CAs?	AKEPIC (26 species)					1 map of current invasive plant occurrences
Non-Native Plants	139	Given current patterns of occurrence, what is the potential future distribution of invasive species included as CAs? [From narrow list of species that are CA.]		Four invasive plants will get projected future distributions? (4)				4

	MQ #	MQ(s) Addressed	Current Distribution	Future Distribution (2025, 2060)	Descriptive Models	Intersection with CEs	CA (Climate Change) Intersection	Total # of Proposed Models and Products
Non-Native Plants	140	Which CE's are likely to be most affected by invasive species			Literature review for *Cirsium arvensis, Hieracium aurantiacum, Melilotus alba,* and *Phalaris arundinacea* (4)	Specific descriptions of CE susceptibility to invasive species		4
Pests and Diseases	134	Where have recent beetle outbreaks occurred?	State and Private Forestry Insect Forest Damage (1969-2011)					1
Temperature and Precipitation	147	What are the potential future climate scenarios for temperature and precipitation?	Maps showing historical and current mean temperature and precipitation, summarized by ecoregion (2)	Maps showing projected annual mean temperature and precipitation summarized by ecoregion (4)			N/A	6
Permafrost	156	What are the current soil thermal regime dynamics and how are these predicted to change in the future?	Maps showing current active layer thickness and mean annual ground temperature summarized by ecoregion (2)	Maps showing projected active layer thickness and mean annual ground temperature summarized by ecoregion (4)				6

Appendix III. Assessment Team Responses to AMT and USGS Comments.

PI	Source	Comment	Response
Becky	USGS Review	MQ117 Where are predicted changes in air temperature associated with important aquatic resources? and MQ157 Where are predicted changes in soil thermal regimes associated with aquatic communities? : Isn't this a spatial assessment?	Spatial assessments were restricted to datasets that could be projected at the 10-digit HUC level. Predicted changes to air temperature and soil thermal regimes will be provided for future scenarios at the ecoregion level. Based on the amount of predicted change, a literature review will be conducted to describe the potential impacts to aquatic resources that occur in the ecoregion of change.
Becky	USGS Review	The approach to identify aquatic ecosystems is heavily biased towards fish.	All coarse filter aquatic CEs (habitats) will be mapped across the REA study area and assessed using the ecological status assessment methods similar to the fine-filter CEs (fish). The "Fish stock of concern" indicator is only for the fine filter CEs (fish). Data do not exist in the REA study area for the types of ecosystem functions described, such as composition of macroinvertebrate communities, buffering of sediment loads or cycling nutrients. The conceptual models will be used to review the literature and describe how each of the coarse filter aquatic CEs function in the landscape.
Becky	USGS Review	Concern about the potential to omit Low-order Streams	Low order and temporal streams could be assessed by building a stream network using the ASTER DEM and Archydro. But, it is unlikely that a coarse DEM would provide better data than the NHD and there would be no way to verify the accuracy of the small streams identified. Instead of trying to model these habitats, the ecosystem functions provided by low order and ephemeral streams can be described in the headwater streams conceptual model.
Becky	USGS Review	Concern about omitting the temporal variability in stream presence and function	The ecosystem functions provided by ephemeral streams can be included in the headwater stream conceptual model.
CAS	USGS Review	Given the wide differences between the circulation models, wouldn't the modeled range "shifts" vary dramatically? Clearly you can portray a range of species responses based on the best and worst case scenarios in temperature regimes, but if this range is quite large, how valuable is the exercise?	Although global climate models vary, modeling with each GCM is beneficial because we can look at the degree of agreement among them when modeling suitable bioclimate. There is more certainty with a range shift result if all GCMs agree that an area will retain suitable bioclimate in the future, than if only one model predicts suitability.
CAS/Tracey	USGS Review	Given the size of the REA area and the broad distribution of some of fine-filter/subsistence elements (e.g., caribou), the formulation and the fine envelopes to this REA may not be valid. We continue to strongly suggest that species experts be included in critical evaluation of the AK Gap distribution data and subsequent climate-envelope models.	1. In talking to Dave Gustine during the last AMT, I suggested that he and others get together a group of experts for the 25 terrestrial vertebrate FF CEs on our list and I will send over draft distribution models for them to review in-house. Pending their review, we will try to address any comments on the distribution models prior to them being used in future analysis in the REA. However, they (USGS) would need to be responsible for organizing the expert review, as this is way beyond the scope of work for this project, although I am happy to go over and present our methods to the review team and answer any questions. During our last group conference call, Patrick stated that it was beyond the scope of work to review any of the GAP models and I agree, but just trying to find a balance here somewhere. 2. Alternatively, we could use only the inductive component of the GAP models - which are seemingly the least controversial and follow the methodologies they are using for the CBR MBR REAs. The inductive models are validated (30% of the data is withheld to test the models), and they have modeling metrics associated with each model (AUC values) that explain how good or bad the model is performing. I was going to call Pat and Patrick once I return from NC to discuss this option. I sat in on Pat's webinar last Friday and nobody seemed to have a problem at all with this approach.

PI	Source	Comment	Response
CAS/Tracey	USGS Review	Given the lack of or coarseness of the data sets available in the area, the analysis at the 5th level HUC watersheds may not be appropriate (e.g., AK Gap vertebrate species models).	The AK GAP vertebrate models are 60 m pixel resolution, which is much finer resolution than 5th level HUCs. 5th level HUCs will therefore be used to summarize the distribution models. For some species there is a lack of data - agreed, but we have tried our hardest to gather as much existing data as possible and for species that are data deficient, we have categorized them as local species or dropped them from our analyses (e.g. raptor concentration areas).
CAS/Tracey	USGS Review	Bio-climatic niche modeling for some of these fine filter/subsistence species is a stretch given nature of the species and (or) the quality of the data, let alone projecting distributions 15 to 50 yrs ahead.	There will be scrutiny as to which species are appropriate for this type of modeling. However, niche modeling is not projecting where species will be in the future, but identifying areas of change and stability of suitable bioclimate. Many more factors play into a species distribution that we cannot predict.
CAS/Tracey	USGS Review	Bioclimatic Niche Modeling: How valuable is this approach for species that can be found throughout Alaska and possibly Canada? For example, given the high behavioral plasticity and associated broad distribution (circumpolar) of caribou, may this limit the applicability to a species with such a large niche? Although a product of shifts in a climate regime, surely fire will play a larger role in affecting the distribution and, possibly, the abundance of caribou in the REA?	CAS response: Modeling generalist species is difficult because they have such a broad niche. Which is why with species such as Caribou we will break up their niches into calving and winter. Also, range data from outside the REA will be used in most cases to get meaningful results. Tracey response: Terrestrial vertebrate species were selected for bioclimatic niche modeling because we felt we had adequate representation for each species across their entire range in AK, not just the Seward Peninsula. We also felt that we selected species that were somehow constrained ecologically due to complex habitat characteristics. Our selection of species could be criticized, but if so, it would be nice to know which species and why and what would they offer up as alternatives.
Keith/Monica	AMT 4	Need to discuss accuracy of all land cover maps in the land cover mosaic.	The accuracy assessment reports are documented for all land cover maps during the data quality evaluation process.
Keith/Monica	AMT 4	How will the ecological integrity roll-up occur using a coarser level classification for the coarse filter units?	Currently we have not resolved this. The upland and lowland classes cannot be extracted and would have to be hand delineated from the imagery. This is outside of the scope of the project and needs to be resolved. Our plan is to hold a webinar sometime in January when we have ecological status work completed for a cross-section of the CEs, to demonstrate those results and also present some of the options for the IEI roll-up.
Matt	USGS Review	Given the biased and generally poor sampling effort for invasive plants over the extent of the REA (as noted in memorandum I-2-C), these are not presence/absence data, but are rather a poor record of occurrence. why proceed with estimating the Landscape Condition Index? Although after the AMT meeting, we understand this is to be estimated from suitability models (potential distribution), correct?	Reid: we do not intend to use the invasive plant distributions in the Landscape Condition Index; they can be used as a "stand-alone" indicator, the results of which will reflect current known distributions. With additional data in the future, the indicator can be reapplied as relevant. Data gaps, such as lack of survey effort, recording of populations, or surveyed-but-absent, will be documented for future work.
Matt	AMT 4	Invasive species index does not include absence data.	We are aware of this. Data gaps, such as lack of survey effort, recording of populations, or surveyed-but-absent, will be documented for future work.
Monica	AMT 4	Term "CE" needs to be included in the workplan tables.	We will update this in the final workplan.

PI	Source	Comment	Response
NatureServe	USGS Review	We strongly suggest that data quality evaluation period (early in Task 5) include peer review of the data sources	Peer review is not something we've planned on for the source datasets. Above, Tracey addressed the peer review request for the species distributions, which she will try to accommodate without slowing our Task 5 work. Review of the land cover map is also something we can envision, by holding a webinar specific to that map, and also by providing the spatial layer itself. Review of very many other input/source datasets is probably not feasible, given the rapid nature of the assessment tasks and the abundance of those datasets. We will provide a table listing all of our source datasets with our data quality evaluations for them, sometime in late October. Most, if not all of the source datasets, have been discussed in the Memos for Tasks 1, 2, and 3.
NatureServe	USGS Review	We believe that it will be necessary to rigorously quantify errors and uncertainty in the REA output	Our approach to address uncertainty is described in the workplan (see Data Management Section). It is not feasible in most instances in an REA to rigorously quantify errors as the input information is not available and resources and time to do this for the breadth of REA outputs is insufficient. The approach we have described has been approved by BLM in other REAs.
NatureServe	USGS Review	The assessment considers several CEs and CAs and projects changes into the future without considering the integrative effect of multiple interacting CEs and CAs.	That analysis is not feasible or within the time, resources, and scope of an REA as outlined in BLM REA technical guidance.
NatureServe	USGS Review	If data quality varies considerably, and data are deemed of poor quality, why continue with the modeling process? Why proceed with the evaluation in these cases? Of what value are modeled products based on inadequate data with little to no reasonable estimates of uncertainty? Yes, the AMT can identify and eliminate products deemed insufficient, but this seems woefully misplaced as it is at the end of the REA process (Fig. 11)! Additionally, based on the plethora of spatial outputs and products, it may also be unreasonable for the AMT to provide critical reviews of every single product.	Concur, it is not our intent to use inputs of poor quality. It is a judgment call about what inputs are sufficient to provide some useful outputs requested by the AMT. We have endeavored to provide the AMT with sufficient information to provide guidance and continue to refine and in some cases eliminate assessments as we learn more about certain inputs and modeling methods. Some datasets were dropped from further consideration for use in the REA during Tasks 2 and 3. While the BLM flow diagram (Fig 11) shows that as a step in Task 7, in reality it is occurring throughout all tasks in the REA.
NatureServe	AMT 4	Confusion about the term "model". Currently modeling includes conceptual and spatial models. Suggests changing term to product.	We agree. "Model" should be reserved for the spatial analyses required to build a "model" for a distribution or a predicted outcome. However, conceptual "models" are still models, used to document current knowledge and assumptions about ecology, dynamics and stressors. We will clean up the use of model in the work plan and tables to reflect this. The terms "outputs" or "products" provide a more generic view of the work products.
SNAP	USGS Review	Modeling the presence, depth, and thickness of permafrost is no simple task. Given the dearth of subsurface geology and stratigraphy data for the state of Alaska, it is unlikely that the model can be correctly parameterized for such a large region.	SNAP Response: We recognize modeling future scenarios for permafrost is not a trivial task. This is stated in the 'major concerns' section of the Work Plan for this CA. Even so, this is the best available tool and we believe by clearly stating the uncertainties associated with the model it is still a valuable exercise.
SNAP	USGS Review	Outside of the fire probability coverage, given that ALFRESCO does not provide predictions on where fires or specific vegetation types may occur, how can this list of outputs be provided spatially and intersected with the appropriate CEs?	SNAP Response: We can provide spatial outputs that show probabilities for where fires or vegetation classes may occur. This section of the Work Plan was revised to better explain how this is done using ALFRESCO.
SNAP	USGS Review	I would add that in its current form, ALFRESCO can account for successional changes in tundra vegetation after a fire. Successional work on the Seward Pen is fairly clear (at least up to 30 yrs after a fire), and that is that shrubs and graminoids are excellent colonizers of tundra fires. A simulated fire in ALFRESCO within the tundra vegetation type will stay tundra following a fire. It's more likely that both vegetation composition and flammability will change following tundra fires (see Kyle Joly's dissertation).	SNAP Response: Yes, we may have poorly portrayed just how well ALFRESCO does perform for tundra regions. Kyle Joly's dissertation research is a good example of this. In previous memos, we have referenced this work. We still list this as a limitation, however, because of the coarse resolution of tundra succeeding to tundra.

PI	Source	Comment	Response
SNAP	USGS Review	Please remind reader why this emissions scenario is being used. Are these circulation models all within the A2 emissions scenario or across scenarios? It reads as if the models are done by GCM x emissions scenario x species, if this is not correct, please change.	SNAP Response: Nancy revised this section of the Work Plan to explicitly state why the A2 emission scenario was chosen.
SNAP	USGS Review	MQ50: Shouldn't the analytic process be a literature review to estimate the effects of roads ON permafrost? Why just permafrost? Other CEs?	SNAP Response: I think this was a typo. This is better addressed by Stephanie because the original question does not reference permafrost.
SNAP	USGS Review	MQ 103: Are these future vegetation models derived from ALFRESCO? Does ALFRESCO estimate future vegetation distribution or are these derived from ALFRESCO outputs as the most likely or representative outcome given the simulations?	SNAP Response: The future vegetation models will be derived from ALFRESCO based on non-spatial averaging of mean outputs from multiple runs.
SNAP	AMT 4	Also concerned that the change agents are very stove-pipe. E.g., fire and how it effects permafrost, but is also important in the context of how it affects hydrology - which is not being addressed. Would suggest more of an ecosystem approach that integrates multiple factors simultaneously, especially for hydrology.	SNAP Response: Yes, we agree an ecosystem approach that integrates multiple factors (fire, permafrost, hydrology, vegetation) would be the better tact. A better modeling approach, however, is not available at this time. We (SNAP, UAF Spatial Ecology & Permafrost Labs) are currently developing a fully coupled Alaska Integrated Ecosystem Model (IEM) to work toward remedying this issue.
Stephanie	USGS Review	Is this the road to Ambler from the Dalton highway? If so, this is not in the REA area, why is this included in the assessment?	
Tracey	USGS Review	MQ63: Where will the distribution of CEs and wildlife ranges likely experience significant change in climate? Isn't this a spatial assessment?	Reid response: this is spatial in that the CE distributions are spatial, and the climate change is spatial as well. However the climate change projections will be summarized to the Nowacki ecoregions within the REA, very large areas. We do not intend to overlay CE distributions with "climate change" per se, but rather will report in a table what CEs are within each Nowacki ecoregion. There will also be a table reporting the climate variables (avg precip and mean monthly temperature, by month) summarized to Nowacki ecoregion.
Tracey/ISER	USGS Review	Location and harvest data for individual subsistence species: harvest data is notoriously incomplete and (or) biased, how will these factors, if at all, be incorporated into spatial analyses (e.g., intersection of habitat distribution maps)?	Stephanie can probably speak to this as well, but it is my understanding that harvest data will be used to answer specific management questions, e.g. #178: For game units that overlap the REA, what is the current population and trend in population for musk-ox, caribou, and moose? I do not plan on using it to develop habitat distribution models.
Tracey	USGS Review	Given the stage of this assessment, how likely is it that NatureServe will gain access to the locational database for the Western Arctic Caribou Herd?	I submitted a formal data request to Paul, which he submitted to Doug Vincent Lang, ADF&G, of the AMT. Paul can probably speak more directly to this, but it seems highly unlikely at this juncture that we will be able to access any of that data.
Tracey	USGS Review	Dispersal barriers, Inputs required: is this the 60-m Digital Elevation Model?	ADDRESSED IN WORKPLAN
Tracey	USGS Review	MQ104: What is the normal range of climate for reindeer? Rangifer?	I think this could simply be reworded as current range for clarification. Reindeer grazing only.
Tracey	USGS Review	MQ3 and 79: these data are available at the 5th level HUC? Possibly for Muskoxen; maybe for moose in the Selawik Refuge or along the Kobuk; but not certainly not for caribou.	I'm confused by this question. MQ3 reads What is the current population and range of moose? and MQ 79 is out of scope and won't be answered. I don't see any reference for caribou in MQ3.
Tracey	USGS Review	Western Arctic Caribou: How are the lichen layers and the future distribution model for muskoxen derived? We assume the lichen layer includes coarse filter vegetation types that are deemed suitable for lichen productivity, and that the future muskoxen model is from the bio-climatic Maxent effort, is this correct?	ADDRESSED IN WORKPLAN TABLE.

PI	Source	Comment	Response
Tracey	USGS Review	MQs 122, 130, and 132: Dr. Kyle Joly has done a fair bit of this work for the WAH winter range, will you summarize his work? This is not noted here in the following columns. Why do this for calving areas? Although the fire return interval for the North Slope tundra type is likely to increase in the future, the fire return interval is still very low. Even if it the fire return interval does increase, what impact would it have on calving habitat? Fire likely will have a beneficial nutritional effect to the summering habitats of caribou on the North Slope, as burned areas commonly experience advanced phenology, higher forage quality, and increased productivity. The link among climate, fire, and wintering range, however, is much clearer, particularly for the WAH with a high proportion of spruce/lichen types within their historic winter range.	
Tracey	USGS Review	MQ 45: Although this is a large concern for communities and the BLM, the temporal and spatial scale of either the distribution or satellite telemetry data seems incapable of answering this question. What is the approach here?	
Tracey	USGS Review	MQ 106: How have the reindeer herds changed over time? How do herds affect grazing areas? Due to the seasonal effects, clarification on “change in forage” and “availability of forage” is needed to properly evaluate this question.	
Tracey/ISER	USGS Review	What are the “forage” data? These data are not described in Memorandum I-2-C. NRCS? Finstad’s dissertation?	I think the forage data showed up after AMT2. This is a point and polygon dataset provided to us by Lauri Thorpp, BLM and depict lichen utilization/grazing on a scale of 1-5 (most disturbed). The associated report that describes the techniques used to evaluate utilization is titled: D. Swanson and L. Knapman. 2001. A procedure for evaluating lichen utilization on reindeer ranges. NRCS and BLM. This report will be added (if not already) to the Master Data List - Kelly is currently double-checking to make sure that all the data sources we are planning to use are included on the list.