Question 9: How do complex interactions affect the trajectory of ecosystem structure and function in the ABR and what will be the consequences for human societies within and beyond the region?

Scope and Justification of the Question

Changes in ecosystem structure and function in the ABR have varied consequences for services provided by these ecosystems to human societies depending on the rate, variability, and magnitude of these changes in space and time. Because the response of ecosystems depend on complex interactions among the dynamics of permafrost, hydrology, disturbance regimes, and ecosystem processes, ABoVE must develop a framework for integration and synthesis that will facilitate the ability to (1) project trajectories of change in ecosystem structure and function in the ABR over decadal time scales, (2) estimate the potential impacts of trajectories on the services provided to society, and (3) assess the consequences of changes in services for human societies.

The trajectory of ecosystem change in the ABR will affect regulatory and provisioning services for human societies both within and outside the ABR. For example, changes in ecosystem structure and function on the Seward Peninsula of Alaska have potential impacts on reindeer husbandry that will affect human societies that manage this important resource for native people. In contrast, substantial releases of carbon to the atmosphere from the thawing of carbon-rich permafrost across the ABR may have consequences for the global climate system and international policies directed towards climate regulation. These two examples illustrate the diversity of scales and ecosystem services that need to be assessed across the ABR, and the ABoVE integration and synthesis framework should be designed to support assessments at local scales within the ABR spatial domain, across the entire ABR, across the pan-Arctic/pan-Boreal region, and at the global scale. The nature and data requirements of models needed to address different issues across these scales are likely to be fundamentally different in terms of focus, scope, spatial scale, and temporal scale. Thus, the integration and synthesis framework for ABoVE needs to be flexible enough to support a diversity of modeling approaches and requirements.

Research Strategy

At the heart of most ABR-relevant assessment issues is the need to develop models of ecosystem structure and function that integrate and synthesize understanding on the dynamics of permafrost, hydrology, disturbance regimes, and ecosystem processes (Figure 9-1). In addition, some assessment issues may also require the development of impact models and human consequence models (see Figure 9-2 for a simplified model conceptual framework that might be appropriate to the assessment of climate change on reindeer husbandry). ABoVE needs to promote the development of a diversity of conceptual frameworks that are collectively capable of addressing a broad range of assessment issues relevant to the ABR. One mechanism to promote the development of conceptual frameworks is to fund short-term (perhaps two year) incubation studies to design conceptual

frameworks that could be considered in proposals focused on developing and applying such modeling frameworks.

Objectives

(1) Provide opportunities for research teams to articulate the design of frameworks capable of integrating and synthesizing information on complex interactions among the dynamics of permafrost, hydrology, disturbance regimes, and ecosystem processes from ABoVE and other programs with the purposes of representing (a) how specific ecosystem services are influenced by the trajectory of ecosystem structure and function in the ABR and (b) the consequences for human societies.
(2) Fund a subset of what are deemed compelling designs of conceptual frameworks that span a spectrum of ecosystem services that are considered important and feasible to address within the time span of ABoVE.

Research Requirements

The design of conceptual frameworks must clearly identify the scope and intended use of the conceptual framework. Key issues that need to be addressed in the design of conceptual frameworks for integration and synthesis include (1) connectivity among processes in the framework, (2) description of processes in the framework, (3) model parameterization, (4) model initiation, (5) model verification (reproducing data used in model development, (6) model validation (evaluation of model quality for independent data not used in model development), (7) model analysis (sensitivity/uncertainty analyses), and (8) data needed to drive model application. The design of conceptual frameworks will need to elucidate how information that will be forthcoming from ABoVE themes as well as information available and forthcoming from other research efforts in the ABR will be used address each of these issues. There are challenges that cutting across these issues that need to be addressed. Two key challenges for which strategies need to be articulated include scaling and model-data fusion. Finally, a major challenge is to bring together a collaborative team with the expertise and focus to successfully bring an integration and synthesis conceptual framework to fruition through the design, implementation, and application phases within a defined time window.

Figure 9-1. Models of ecosystem structure and function that integrate and synthesize understanding on the dynamics of permafrost, hydrology, disturbance regimes, and ecosystem processes will need to be developed by ABoVE for projecting how ecosystem responses to climate change will influence the services provided by ecosystems in the ABR.

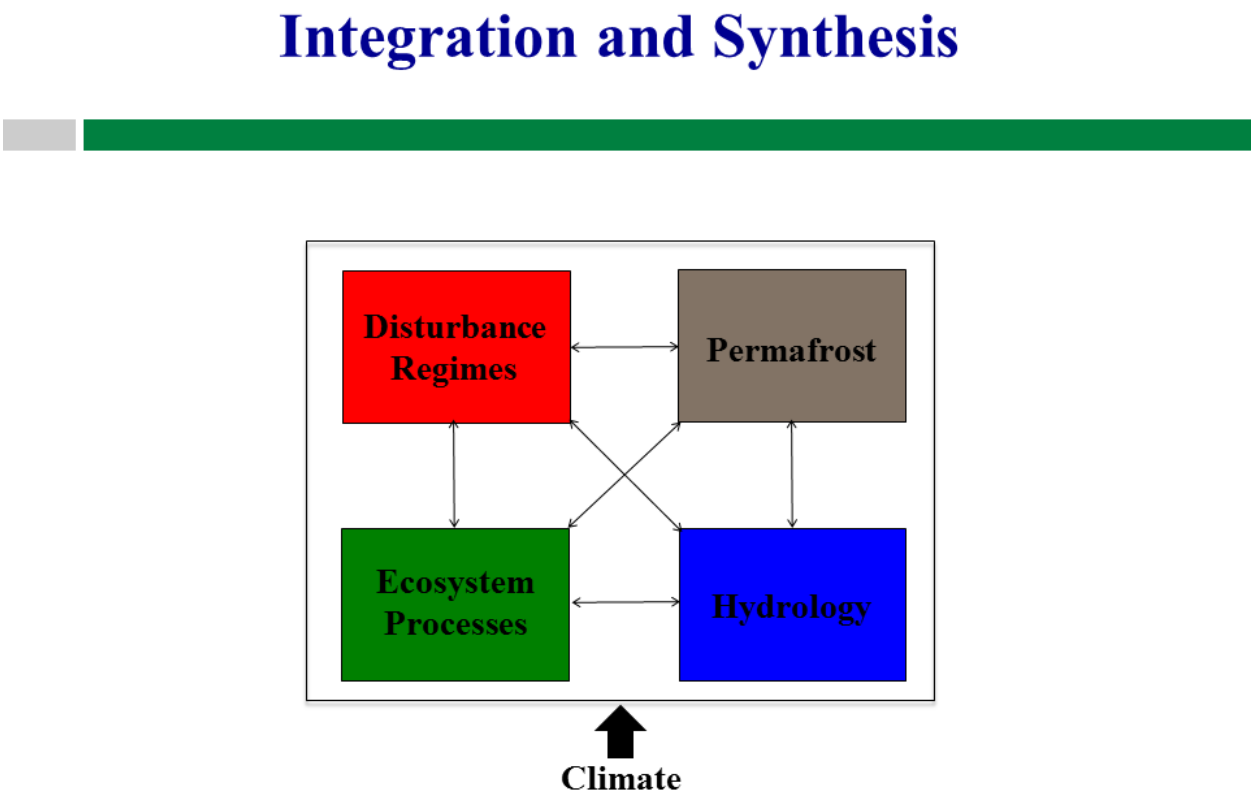

Figure 9-2. An example of a generalized conceptual framework that might by designed, implemented, and applied for assessing the effects of climate change on reindeer husbandry of the Seward Peninsula of Alaska and the consequences for human societies that are influenced by the reindeer husbandry industry.