Section 2

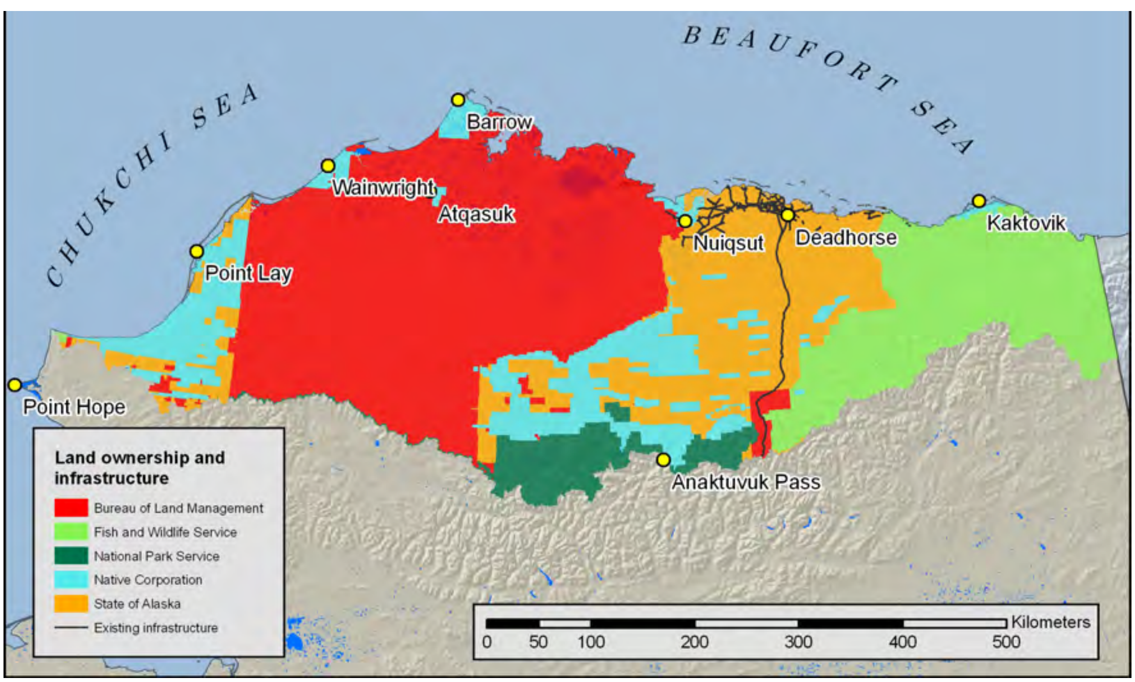
North Slope Ecoregions and Climate Scenarios

North Slope Ecoregions

The geographic/ecological scope of the workshop will be freshwater and terrestrial systems of the North Slope of Alaska, with a focus on the Arctic Coastal Plain and Foothills ecoregions. Montane areas and nearshore marine waters will also be included where there is an essential ecological or physical tie (e.g., glacial input of water into North Slope river systems; nearshore lagoons used by anadromous fish and molting/migrating water birds).

The North Slope covers approximately 204,000 km^2 of Alaska's arctic lands. Human population within the region is about 7,000 residents (2004 census), with activity and infrastructure concentrated within 6 small communities and the widespread industrial zone with a hub at Deadhorse. Land management and ownership is split among seven major entities (Figure 2.1). The Bureau of Land Management (Department of the Interior [DOI]) is responsible for management of a large portion for region—nearly 45% or the total area or roughly 91,000 km^2. The State of Alaska is the second largest landowner, responsible for 41,000 km^2 (20%). Fish and Wildlife Service (DOI) lands account for approximately 35,000 km^2 (17%), and Native lands encompass about 26,000 km^2 (13%). The remaining lands are held by the National Park Service (DOI), private owners, and the Department of Defense.

Figure 2.1. Land ownership and location of human infrastructure, Alaska North Slope.



The North Slope is divided into three ecoregions: Arctic Coastal Plain, Arctic Foothills, and Brooks Range (Figure 2.2). Information for each ecoregion is derived from the Circumpolar Arctic Vegetation Map (CAVM) Team (2003) and Gallant et al. (1995).

Arctic Coastal Plain

The 50,000 km^2 Arctic Coastal Plain is the northernmost ecoregion in Alaska. The Coastal Plain is bounded on the west and north by the Chukchi and Beaufort seas and extends east nearly to the U.S.-Canada border. The region is underlain by thick permafrost, up to 660 m deep (at Prudhoe Bay). Permafrost-related surface features, such as pingos, ice-wedge polygons, oriented lakes, peat ridges, and frost boils, are common. The major vegetation communities on the Coastal Plain are:

- nontussock sedge, dwarf-shrub, moss tundra;
- tussock-sedge, dwarf-shrub, moss tundra;
- sedge/grass, moss wetland; and
- sedge, moss, dwarf-shrub wetland.

The Arctic Coastal Plain contains a large portion, roughly 22%, of all the sedge, moss, dwarf-shrub wetland habitat mapped by the CAVM Team (2003). Most major streams originate from other ecoregions in the south. Streams west of the Colville River are interconnected with lakes and tend to be sluggish and meandering while those east of the Colville River are braided and build deltas in the Arctic Ocean. Most of the smaller streams dry up or freeze during winter.

Arctic Foothills

The Arctic Foothills is a 96,000 km^2 band of rolling hills and plateaus that grades from the Coastal Plain to the Brooks Range. The Foothills stretch from the Chukchi Sea on the west to the U.S-Canada border on the east. The ecoregion is underlain by permafrost, and permafrost-related surface features are common on the landscape. Vegetation communities in the Arctic Foothills are described as:

- nontussock sedge, dwarf-shrub, moss tundra;
- tussock-sedge, dwarf-shrub, moss tundra;
- erect dwarf-shrub tundra;
- low-shrub tundra;
- sedge, moss, dwarf-shrub wetland; and
- sedge, moss, low-shrub wetland.

The ecoregion also contains both noncarbonate and carbonate mountain complexes. The Arctic Foothills represent a large portion, roughly 16.8%, of all the tussock-sedge, dwarf-shrub, moss tundra mapped by the CAVM Team. The Foothills have better defined drainage networks than the Arctic Coastal Plain. Most streams tend to be swift, but portions may be braided and smaller streams dry up or freeze during winter. Flooding and channel shifting is common during breakup of river ice. Oxbow lakes, located along major streams, are the predominant type of lake in the region.

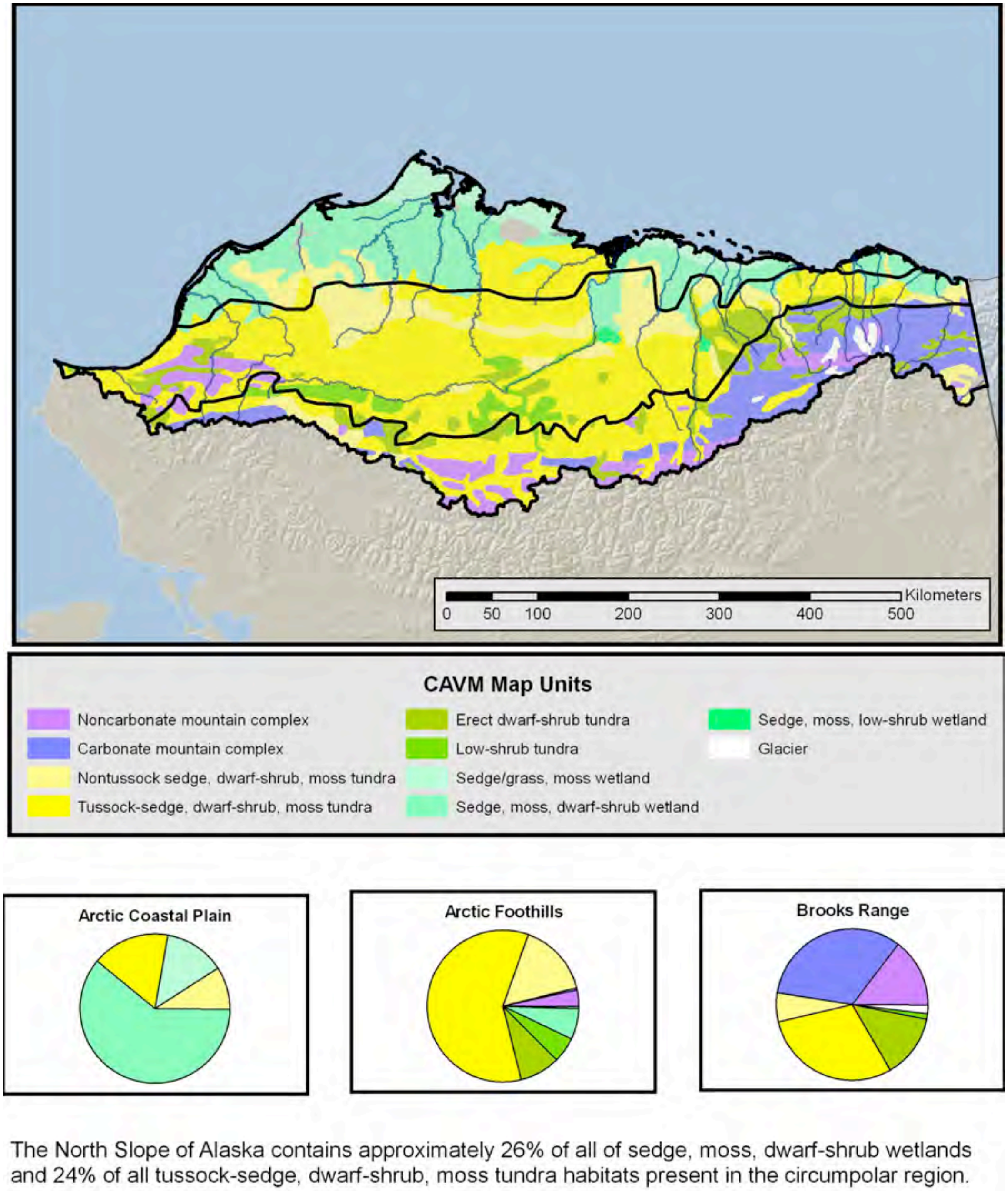
Brooks Range

The Brooks Range is the Alaskan extension of the Rocky Mountains, of which 58,000 km^2 lies north of the continental divide. The ecoregion covers most of the east-west extent of Alaska—from the U.S.-Canada border to within 100 km of the Chukchi Sea. In contrast to the Arctic Coastal Plain and Arctic Foothills, this ecoregion was extensively glaciated during the Pleistocene epoch. However, only a few scattered glaciers still persist. The terrain is dominated by steep, rugged mountain complexes, and continuous permafrost underlies the region. The combination of harsh climate, shallow soils, and highly erodible slopes result in sparse vegetation cover that is generally limited to valleys and lower hill slopes. Those vegetation communities present are described as:

- nontussock sedge, dwarf-shrub, moss tundra;
- tussock-sedge, dwarf-shrub, moss tundra;
- erect dwarf-shrub tundra; and
- low-shrub tundra.

In general, the ecoregion has few lakes. These lakes tend to occur in rock basins at the mouths of large glaciated valleys, in areas of ground and terminal moraines, and on floodplains of major rivers. Streams in the Brooks Range often have braided drainage patterns.

Figure 2.2 Vegetation of arctic Alaska based on the Circumpolar Arctic Vegetation Map (CAVM).



References

CAVM Team. 2003. Circumpolar Arctic Vegetation Map. Scale 1:7,500,000. Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska.

Gallant, A.L., Binnian, E.F., Omernik, J.M., and Shasby, M.B., 1995. Ecoregions of Alaska: U.S. Geological Survey Professional Paper 1567, 73 p., 2 sheets, scale 1:5,000,000.

Climate Scenarios

For the purpose of discussion, the workshop will consider two provisional climate change scenarios, consistent with projections based on a composite of the five best-performing General Circulation Models for the Arctic (Walsh et al 2008, http://www.snap.uaf.edu/about), based on the IPCC A1B scenario (IPCC 2007), an intermediate emissions scenario that assumes a steady increase in CO_2 emissions for several decades, followed by a gradual decline as more efficient technologies are implemented. Model outputs were applied to a baseline dataset consisting of a 2-km resolution PRISM (Parameter-elevation Regressions on Independent Slopes Model) grid of mean monthly temperature and precipitation data for the period 1961–1990. This effectively "down-scaled" the GCM output to a 2-km resolution. There is considerable uncertainty associated with the point estimates for projected temperature and precipitation, deriving from both within- and among-model variation.

Projected average temperature and precipitation values (The Wilderness Society, unpublished) for the decade 2075–2084 are presented in Table 2.1. Climate scenario II is most consistent with these projections. Although precipitation is forecast to increase, there is considerable uncertainty associated with this prediction, and therefore we have chosen to also consider Scenario I, in which precipitation remains constant.

I. Warming Temperatures, Precipitation Constant

Mean annual temperatures increase 5–6 °C by the year 2080. Warming is more pronounced in winter (7.6–8.6 °C) than in summer (2.5–2.9 °C), with the range representing variation among ecoregions. Growing season length is expected to increase at a rate of 1.3, 2.4, and 3.0 days per decade for the northern Brooks Range, Arctic Foothills, and Arctic Coastal Plain, respectively, with a skew toward greater change in the fall (Table 2.2).

II. Warming Temperatures, Precipitation Increase

Mean annual temperatures increase 5–6 °C by the year 2080. Warming is more pronounced in winter (7.6–8.6 °C) than in summer (2.5–2.9 °C), with the range representing variation among ecoregions. Mean annual precipitation increases by 22%, 35%, and 43% for the northern Brooks Range, Arctic Foothills, and Arctic Coastal Plain, respectively. Precipitation increase is more pronounced in winter (31–60%) than in summer (16–30%), with the range representing among-ecoregion variation that mirrors the pattern for annual precipitation. Change in growing season as in the above scenario.

Table 2.1. Projected magnitude of change from historic[1] values for temperature and precipitation, Year 2080, by ecoregion and season[2].

Ecoregion	Temperature (Δ °C)		
	Winter	Summer	Annual
Arctic Coastal Plain	8.6	2.5	6.1
Arctic Foothills	8.1	2.8	5.9
N. Brooks Range	7.6	2.9	5.6
	Precipitation (% increase)		
	Winter	Summer	Annual
Arctic Coastal Plain	60	30	43
Arctic Foothills	45	27	35
N. Brooks Range	31	16	22

2. Summer (growing-season) is calculated as the average of May through September. Winter is calculated as the average of October through March.

1. Baseline temperature and precipitation values are based on the Parameter-Elevation Regression on Independent Slopes Model (PRISM) dataset created by the PRISM Group (Oregon State University, www.prism.oregonstate.edu). These data consist of 12 gridded mean maximum temperature, mean minimum temperature, and total precipitation files at 2-km resolution, one for each month averaged over 1961–1990 for the state of Alaska. This dataset was created using observational data from weather stations across the state and spatially interpolated over Alaska using weighted regression incorporating elevation and terrain effects on climate (Daly et al. 2002, Simpson et al. 2005). We averaged the minimum and maximum temperature grids together to create a dataset of mean monthly temperatures.

Table 2.2. Modeled change in growing season, from 2010 to 2080, rounded to nearest day.

Ecoregion	Growing Season Length	Advance in First Date Above Freezing (Spring)	Delay in First Date Below Freezing (Fall)
Arctic Coastal Plain	21	5	16
Arctic Foothills	17	6	11
N. Brooks Range	15	6	9

References

IPCC. 2007. http://www.ipcc.ch/ipccreports/ar4-syr.htm

Walsh, J.E., Chapman, W.L., Romanovsky, V., Christensen, J.H. and Stendel, M. 2008. Global climate model performance over Alaska and Greenland. Journal of Climate.