Climate Change Implications for Yukon Flats National Wildlife Refuge

THE WILDERNESS SOCIETY

SNAP Scenarios Network for Alaska Planning

Climate Change and Alaska's National Wildlife Refuges

Alaska's 16 National Wildlife Refuges (NWR) were created to protect important fish and wildlife habitat. Some are already showing signs of climate change impacts, including wetland drying, spruce-bark beetle infestations, and increased fire frequency and intensity. A better understanding of where and when future changes might occur is needed to help refuge managers and the people that live in or near the refuges plan for change and make choices about how to manage refuge resources.

Yukon Flats NWR

The Yukon Flats NWR encompasses 11 million acres of the Yukon River basin and surrounding uplands in northeastern interior Alaska (Figure 1). Impacts from climate change could significantly alter refuge ecosystems, in turn affecting wildlife and the lifestyles of local human populations.

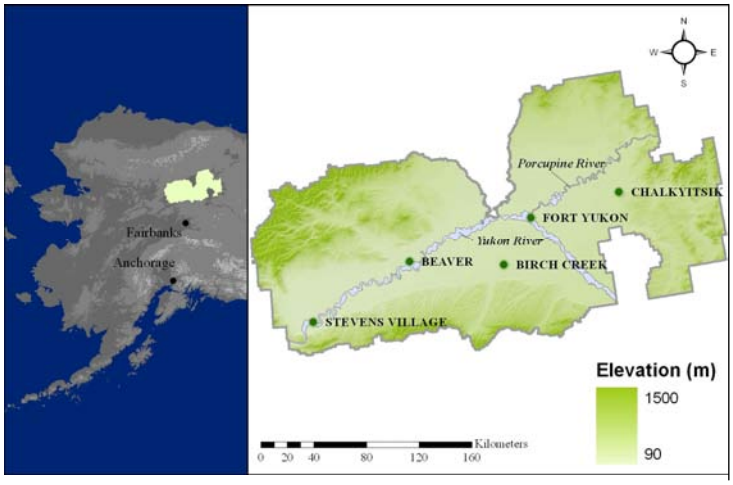


Figure 1. People living in villages located within the boundaries of the Yukon Flats NWR rely heavily on wildlife and other refuge resources to support their livelihoods.

In order to better understand what changes the Yukon Flats NWR may be facing, we used temperature and precipitation data from five down-scaled global climate models to estimate how climate variability, growing season length, and water availability might change within the refuge. We also applied data from another model to predicts how climate, fire and vegetation will shape the landscape in the future. The models assumed steady increases in CO_2 emissions for the first several decades of the 21st century, followed by a gradual decline in emissions as several kinds of low-carbon energy alternatives come into use. This emissions scenario is considered moderate. Other models predict much greater emissions levels and thus impacts.[1]

Temperature changes

Temperatures are predicted to increase by an average of 1°F per decade. This translates into a rise in average annual temperature of 5°F by 2040 and 9°F by 2080 (Figure 2).

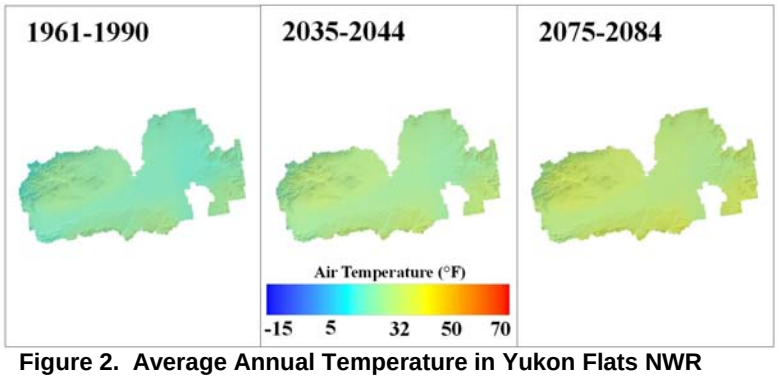


Figure 2. Average Annual Temperature in Yukon Flats NWR from modeled predictions of historical (1961-1990) and future averages.

Considering the natural variation in temperatures across the refuge, this increase is likely to result in a transition from average annual temperatures below freezing (~22°F) to near or above freezing (~32°F).

Furthermore, the time between the first freeze and first thaw date is predicted to lengthen by about 3 days per decade. Thus, by the end of the century, the growing season could be about 1 month longer. Such change would affect wildlife mating cycles, plant growth and flowering, hunting seasons, and the availability of water in soil and rivers.

[1] The emissions outlook is "A1B" scenario from the International Panel on Climate Change (IPCC) Fourth Assessment, published in 2007. The models used in this analysis included Echam5, Gfdl2.1, Miroc3.2MR, HadCM3, and CGCM3.1.

Winter temperatures are projected to change the most, increasing by as much as 12°F by 2080, which would raise the mean winter temperature from a historical -3°F to 9°F (Figure 3).

Summer temperatures will also increase, although not as much as winter temperatures. Temperatures are projected to rise by 6°F on average by 2080 (from ~52°F to ~58°F). Thus, temperatures in the lowland wetlands along the Yukon River and in many villages will reach highs rarely experienced before by approximately 2040.

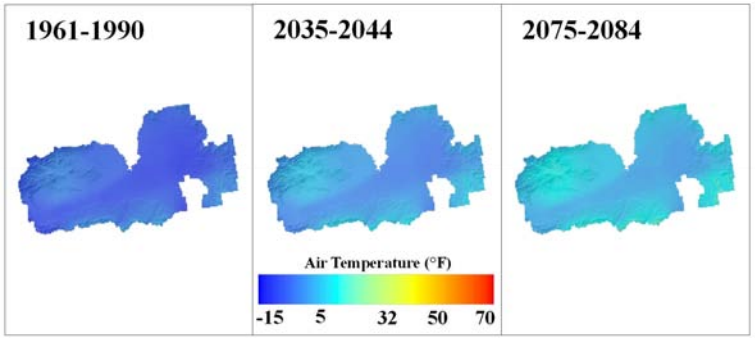


Figure 3. Winter Temperature in Yukon Flats NWR from modeled predictions of historical (1961-1990) and future averages.

Precipitation changes

Precipitation is predicted to increase across the refuge (Figure 4), with 63% more snowfall in the winter and about 33% more rain in the growing season.

The timing and intensity of precipitation will determine how these changes affect the landscape and hydrology of the refuge. Increased variability predicted for winter temperatures could result in more icing conditions.

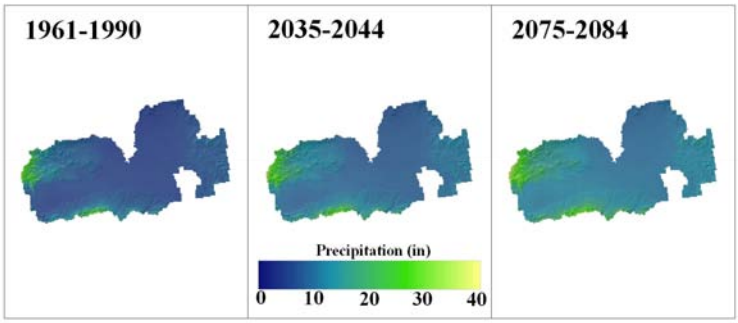


Figure 4. Annual Precipitation in Yukon Flats NWR from modeled predictions of historical (1961-1990) and future averages.

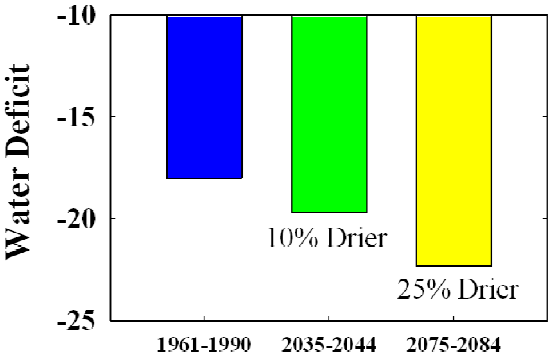


Figure 5. Historically, more water is lost to evapotranspiration than falls as precipitation on refuge lands and predictions suggest future conditions will become even drier.

Despite predicted increases in precipitation, conditions are expected to become substantially drier in the summer and fall due to warmer temperatures and a longer growing season--conditions which increase evapotranspiration (Figure 5). Growing season precipitation would likely have to double from historical levels to maintain current moisture conditions. Without this precipitation, refuge soils and rivers are likely to become drier, increasing the risk of fire and of wetlands, lakes and streams drying.

It is important to note that predicting changes in precipitation is difficult. When the data from the models used in this analysis were compared to actual historical measurements within the refuge, the models tended to overestimate precipitation. This could mean conditions will be even drier than we expect.

Summary of Climate Projections

The Yukon Flats NWR is likely to become warmer and drier over the next century. Warmer temperatures will cause changes in the condition and health of wildlife habitat. Despite modest increases in precipitation, conditions will become much drier due to warmer temperatures and a longer frost-free season, affecting soil moisture and river levels. Variability in spring and fall temperatures could also affect the amount of precipitation that falls as snow vs. rain.

Recommendations for Action

Increased monitoring of precipitation, temperature and streamflow within the refuge would help residents and land managers better understand future changes and help them plan for the future.

Climate Change, Fire Severity and Plant Communities

In order to further explore the interactions and feedback between fire, climate, and vegetation in interior Alaska and better understand future conditions in the Yukon Flats NWR, we have applied a vegetation succession model called ALFRESCO[2] and examined future landcover scenarios for the refuge.

The ALFRESCO model considers plant community type (tundra, dry grassland, black spruce, white spruce and deciduous forest) and climate as primary drivers to determine the probability of a landscape unit burning. Although ALFRESCO does not predict the exact location of future fires, it does characterize areas that are likely to burn and fire severity.

Estimated Burned Area

Scientists have already shown that much of Interior Alaska is likely to burn in the next 30 years[2] and the Yukon Flats NWR is no exception. By approximately 2040, ALFRESCO estimates that 11,000 km,[2] or 25% of the refuge will burn, with some areas re-burning within that time frame. By 2080, a total of 42,000 km^2 will burn and the equivalent of 70% of the Refuge will experience new burns between 2010 and 2080. Climate extremes, particularly mid-summer temperatures and drought, as well as insect infestations may increase future fire likelihood beyond what ALFRESCO currently predicts based on historical conditions.

Changes in Plant Communities

As a result of this dramatic increase in fire in the immediate future and subsequent re-burning and spread of fire on the landscape, the refuge will experience a dramatic shift in landcover and transition towards younger, earlier successional communities. Currently, approximately equal distributions of coniferous and deciduous vegetation are spread across the refuge (Figure 6, left). By 2050, with warmer drier conditions and a concomitant increase in fire probability, much of the black and white spruce forest will burn and be replaced by deciduous forest. The impact on the landscape will be significant, with over a 50% decline in coniferous forest (Figure 6 center). Towards the end of the century, spruce forests are not predicted to recover, and will continue to decline (Figure 6 right).

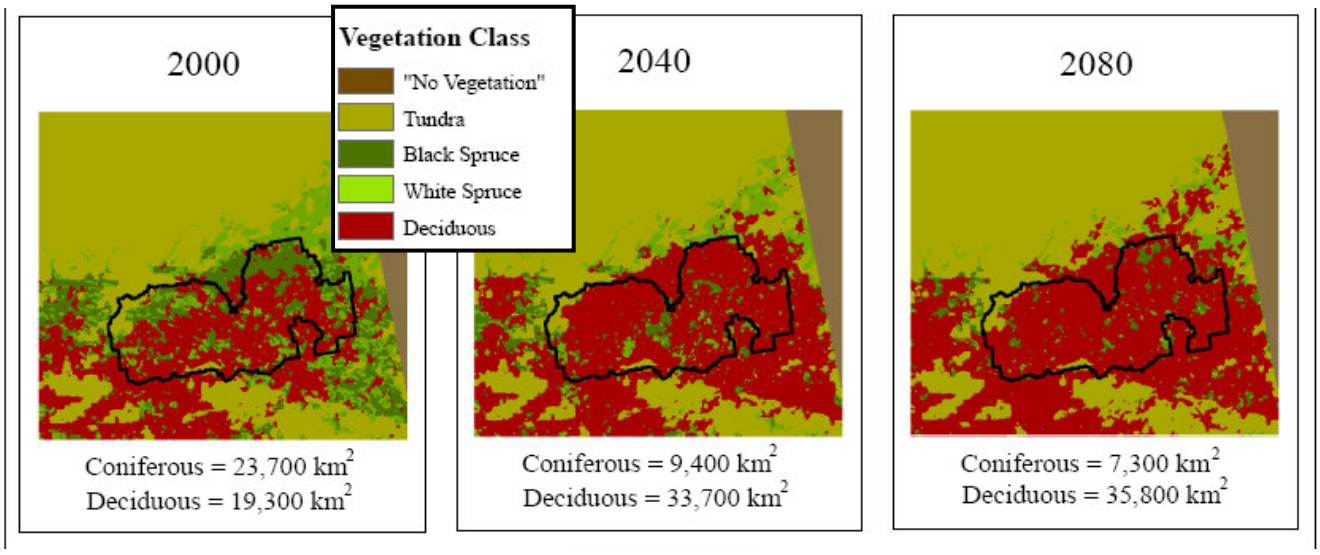


Figure 6. Plant community changes resulting from fire and climate change in Yukon Flats NWR as simulated by the ALFRESCO model.

[2]Rupp, T.S., et al.2006. Simulating the influences of various fire regimes on caribou winter habitat. Ecological Applications 16:1730-1743.

Forest Age

Severe and frequent burns will alter not only the landcover, but the age of the forest. At present, mature forests (>80 yrs) occupy approximately 26,000 km^2 (~57%) of the refuge, while only 11,400 km^2 of refuge forest land is less than 40 yrs old (Figure 7 left). With increased fire activity in the next several decades, the landscape will transition to more than 25,000 km^2 of young (<40 yrs) forest while mature forest will decrease by 50% (Figure 7 center). By approximately 2080, only 8,200 km^2 (~18%) of the refuge will contain mature forest (Figure 7 right).

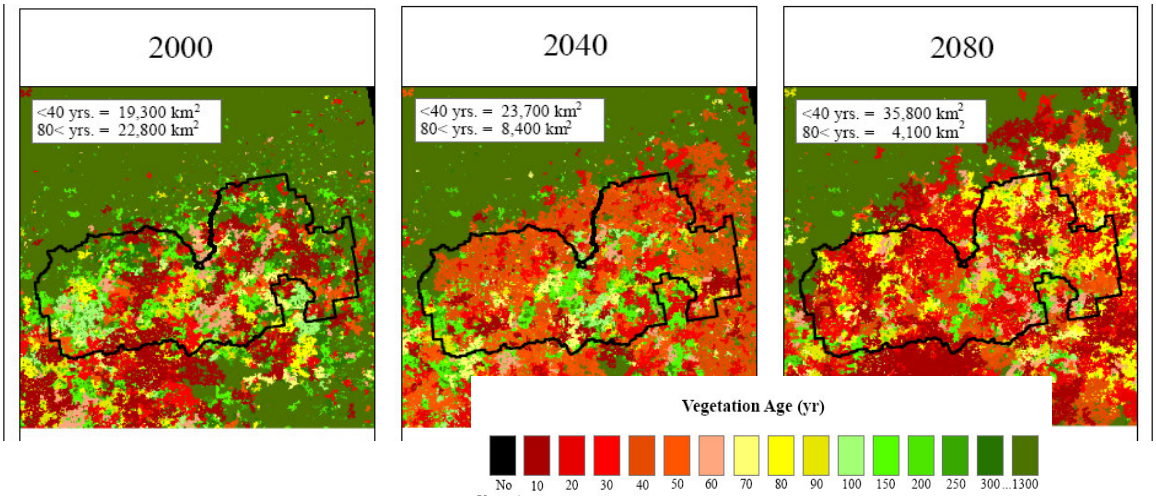
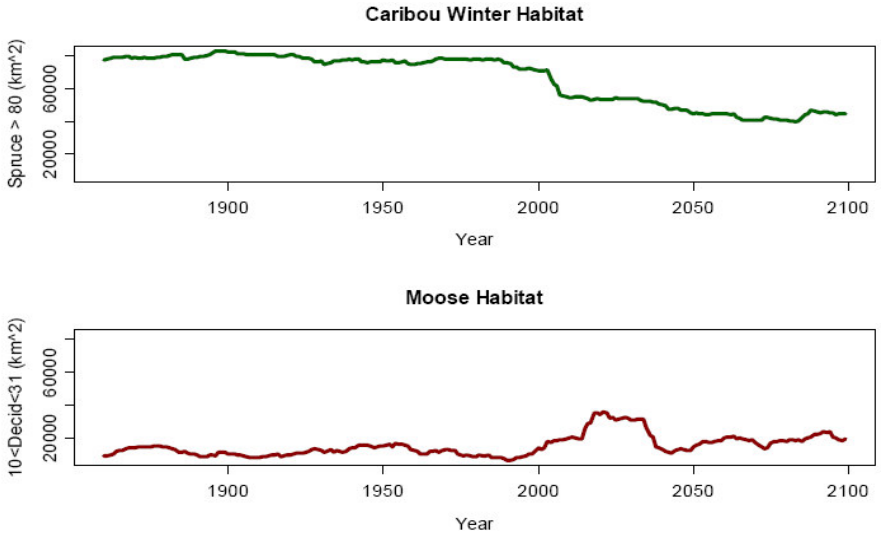


Figure 7. Predicted plant community age for Yukon Flats NWR based on the ALFRESCO model.

Wildlife Habitat

The habitat implications of this shift in forest community type and age are significant. Our analyses suggest that suitable habitat for caribou (spruce forests >80 yrs old) has already been significantly diminished and will continue to decline in the future (Figure 8 top). On the other hand, deciduous forests growing after fire will quadruple in area, providing abundant habitat suitable for moose (Figure 8 bottom). Whether the moose population will respond to this increase in habitat cannot be predicted, as population dynamics are a function of much more than habitat availability.

Figure 8. Caribou and moose habitat area in Yukon Flats based on the ALFRESCO model.



Summary of Findings

To help species adjust to the kinds of dramatic and rapid changes predicted for Yukon Flats NWR, federal land management plans should focus on reducing other anthropogenic stressors and protecting adequate habitat to give plants and animals the space they will need to migrate and otherwise adapt to changing conditions.

For more information:

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