



# Climate Change, Wildfires and Reindeer in Northern Eurasia: Modeling Impacts of Possible Wildfire Increase on Domestic and Wild Reindeer Habitats in Yamal-Nenets and Taimyr Regions

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## Abstract

An increased wildfire activity and shifts in wildfire seasonality have considerable effects on arctic ecosystems and livelihoods of people in the Arctic. This paper provides spatial and temporal analysis of wildfires occurrence and intensity Arctic tundra using satellite data for five seasons between 2000 and 2010. We analyze spatial expansion and temporal dynamics of wildfires, and their connections with usual phenological events and human activities. We explore a possible relationship between increased fire incidence, changing climate and increasing anthropogenic disturbance. Since a growing prevalence of wildfires in tundra is expected to become one of the defining trends in a warming Arctic, we attempt to define and analyze impacts that wildfires could have on land-based activities. Specifically we examine the impacts of wildfires on domestic and wild reindeer forage stock in Yamal-Nenets and western Taimyr regions as well as their possible implications for reindeer husbandry and hunting. The analysis of MODIS-derived active fire data shows that in 2000-2010 most fires were occurring in July and August, although in some years a fire season either started earlier (in June) or lasted longer (in to September). A majority of fires interact with the domestic and wild reindeer winter grounds, especially affecting migration routes/calving areas as they coincide with migratory routes. We clearly observe an increase in wildfire activity in tundra, although most fires occur in taiga. An increase in wildfires occurrence and intensity near settlements is also evident. We analyzed relationships of wildfires with change in temperature and precipitation that confirmed earlier observations that dryer and warmer conditions, especially at the end of growing season are associated with more frequent and intensive fires. Based on the dynamics of fire occurrence propensities and relationships between fire prevalence, intensity and climatic characteristics we developed wildfire risk models for different seasonal reindeer habitats. In addition to winter and summer areas, we focus on migration routes, which represent the most vulnerable areas for wildfire impacts and, at the same time, have a profound importance for domestic and wild reindeer population wellbeing. These migration areas intensively used by reindeer in spring and fall are occupying vast areas in tundra and forest-tundra with vulnerable, slow-to-recover ecosystems and limited forage. Since migrations of domestic reindeer are somewhat fixed in space by existing herding districts, a possibility of a sudden fire-related forage shortage in certain portions of the migration areas is even more alarming. Our models estimate that the increased impacts of wildfires due to possible climate change will be especially noticeable in eastern Yamal and western Taimyr, where they will mostly affect migration routes and winter habitats.

## Research Objectives

- Identify spatial and temporal patterns of wildfire events and their intensity characteristics in Yamal-Nenets Okrug as well as Taimyr
- Analyze existing and potential impacts of wildfires on socio-ecological systems, especially reindeer husbandry

## Data

### Wildfire data [FIRMS]:

- Fire events:** detected fire occurrences (confidence  $\geq 50$ )
- Fire Radiative Power (FRP):** a measure of radiant heat output of detected fires in MegaWatts (MW) derived from MODIS Data Processing System (MODAPS) Collection 5.1 Active Fire Products

### Reindeer habitat data:

- Extreme North Arctic Research Institute, Norilsk

### Other data:

- Vegetation and bioclimatic variables
- Settlements and Infrastructure

## Methodology

### Analysis of spatial distribution and change:

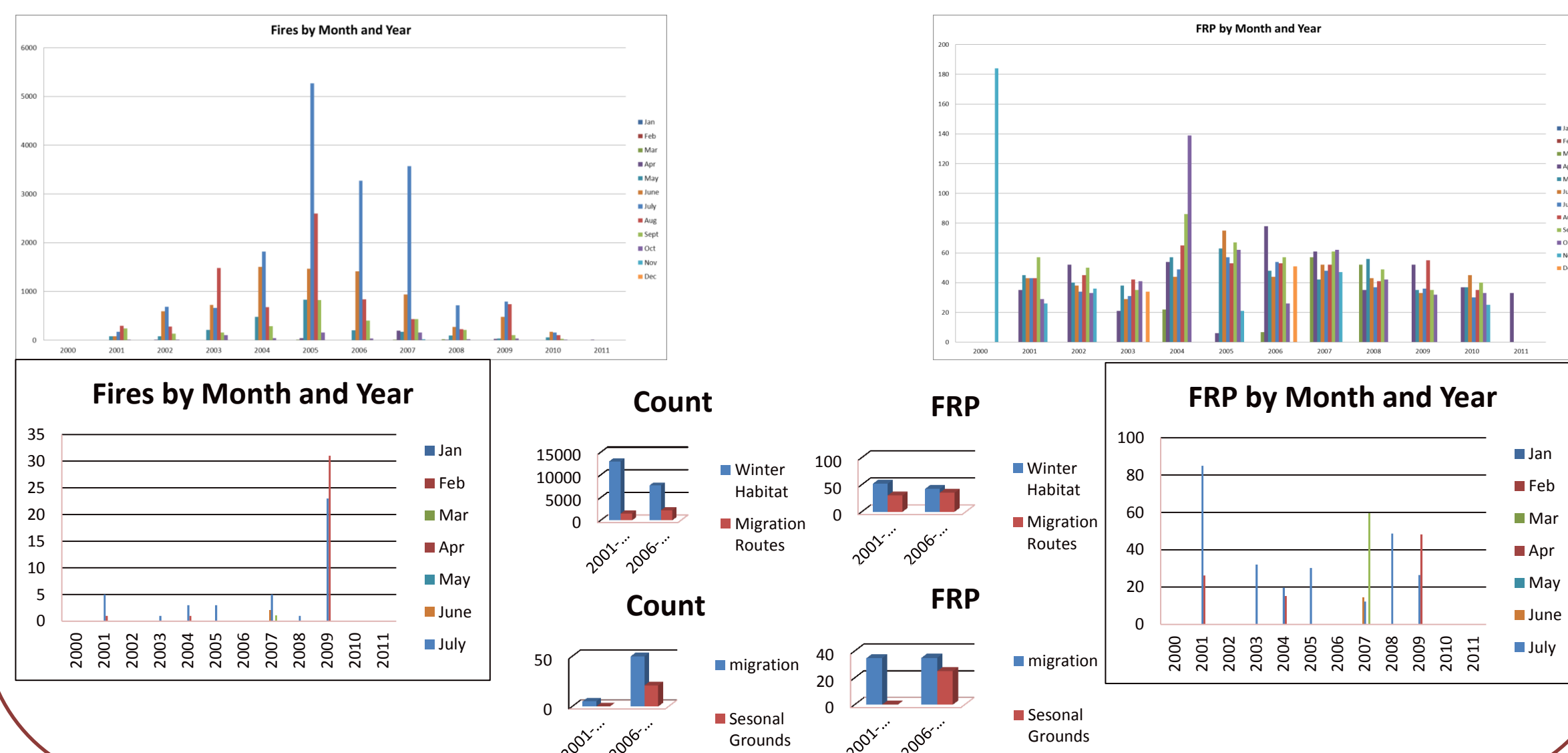
- Time series analysis: character and fluctuations in seasonality and multiyear patterns – trends between 2001-2005 and 2006-2010
- Analysis of spatial distribution : evidence of spatial clustering, spatial autocorrelation and fire hot-spots

### Analysis of current and potential risks:

- Hot spots of wildfire around habitats, migration route of domestic reindeer and settlements
- Measure areas of registered increase in wildfire activity
- Multicriteria models of wildfire risks in domestic reindeer habitats and settlements

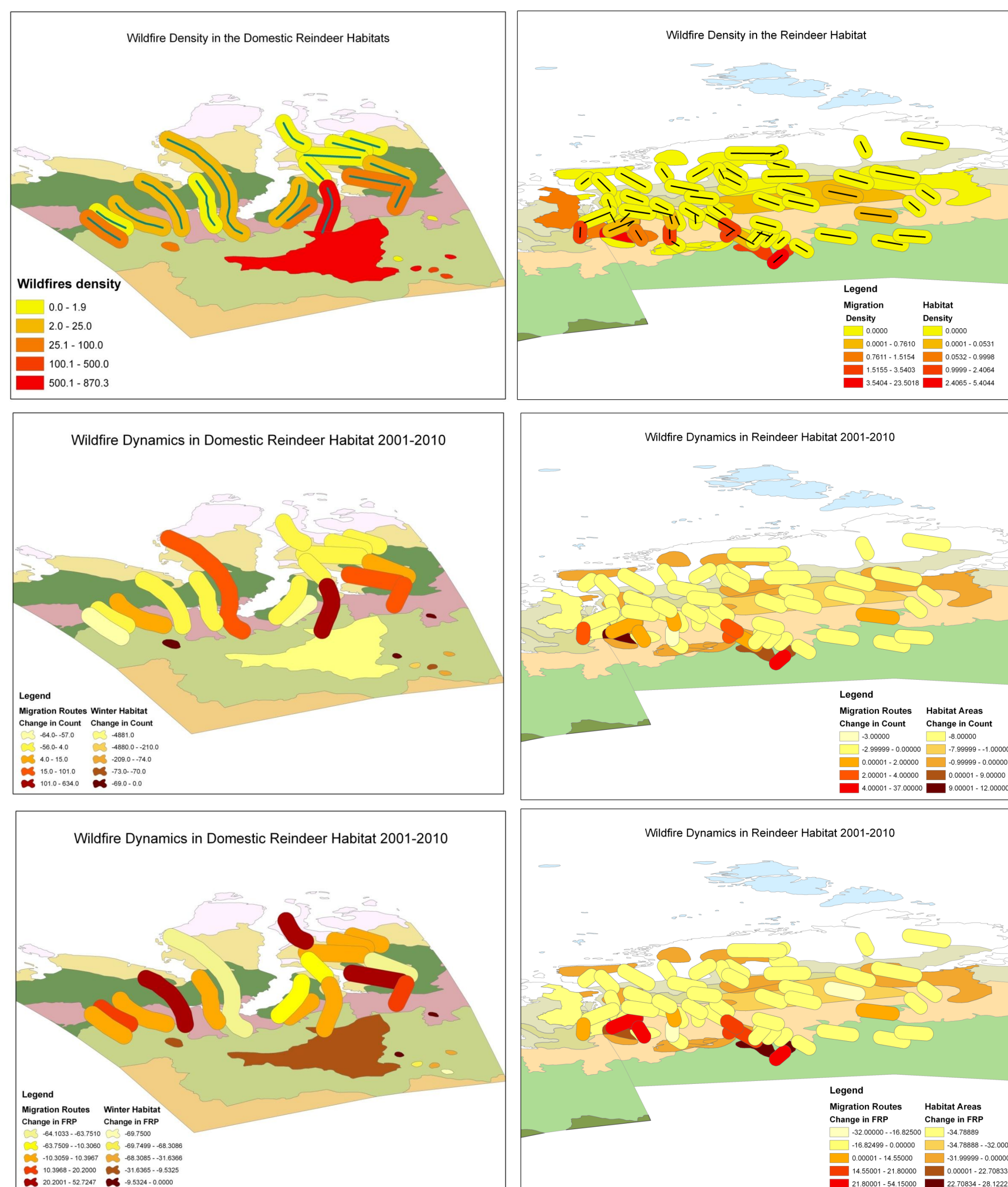
## Results

### ARCTIC FIRES SPATIAL AND SEASONAL DISTRIBUTION



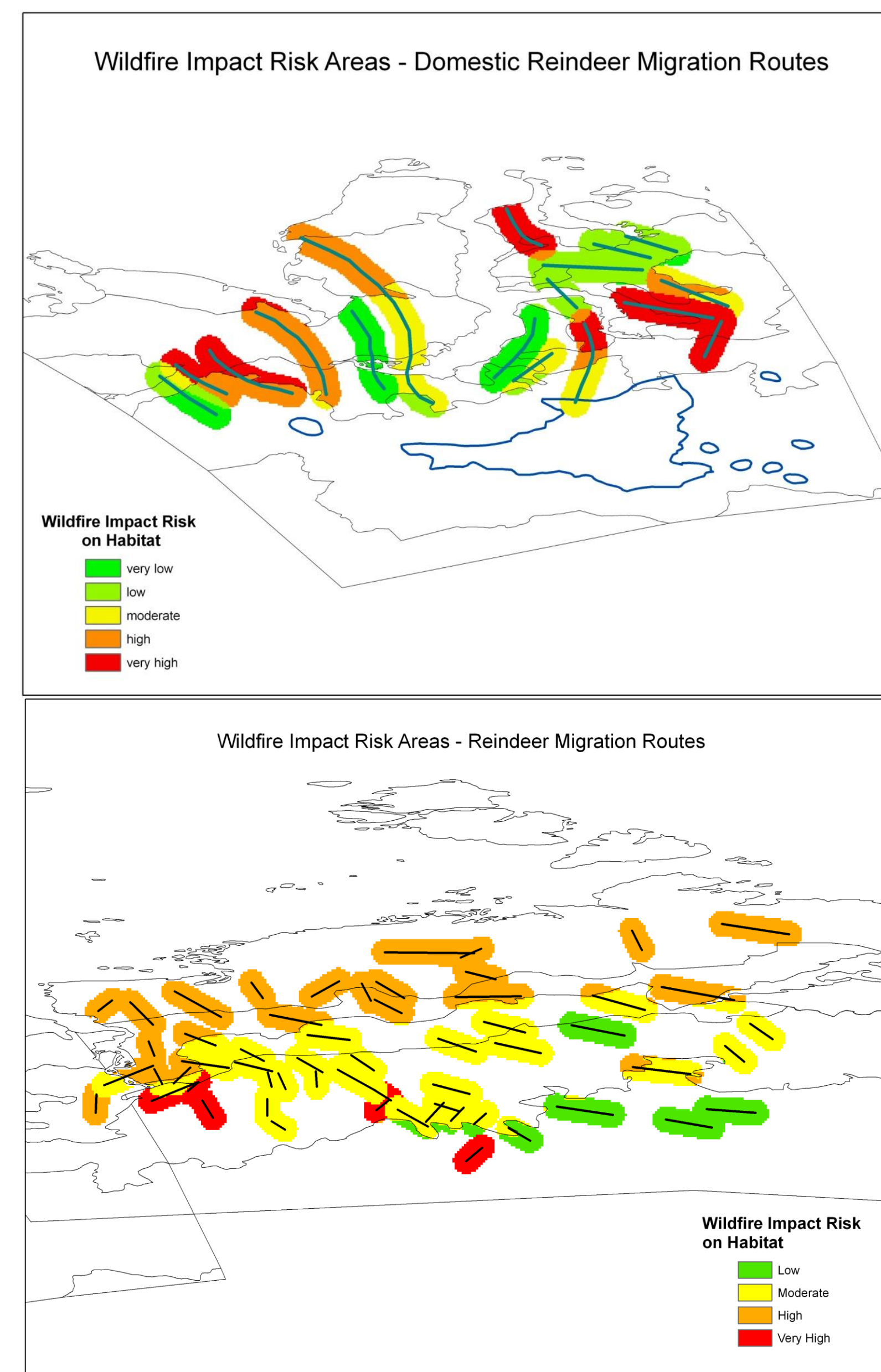
## Results

### WILDFIRES AND DOMESTIC REINDEER HABITATS



## Results

### WILDFIRES DYNAMICS AND RISKS TO ARCTIC LIVELIHOODS



## Summary

- Seasonality with most fires occurring in July and August. In some years a fire season either started earlier (in June) or lasted longer (in to September).
- A majority of fires interact with the domestic reindeer winter grounds and especially affecting migration routes/calving areas as they coincide with migratory moves.
- Observe increase in wildfire activity in tundra, although most fires occur in taiga
- Both western Taimyr and western Yamal-Nenets okrug are more vulnerable for increased wildfire activity
- If fires continue to increase slowly overtime in these areas it could have a dramatic impact on the reindeer in this area, especially migratory routes in tundra.

More information:  
Arctic Social and Environmental Systems Research Lab (ARCSSES), University of Northern Iowa  
[www.uni.edu/apetrov/arcses](http://www.uni.edu/apetrov/arcses)