OBJECTIVE: Review the inventory of existing tundra fire studies, datasets, and tools & identify knowledge gaps and research needs.

Background: The IARPC Wildfire Implementation Committee took on the task to "Identify existing knowledge and quality of data on wildfire frequency, extent, and severity in the Arctic. If needed, develop strategies/projects to improve data to monitor changes in wildfire frequency, extent, and severity in the Arctic." The WIC agreed that it would be useful to develop a summary of existing knowledge and quality of data on wildfire frequency, extent, and severity in Arctic Alaska as a precursor to identifying significant gaps data, tools, and ecological knowledge to manage fire disturbance in tundra. Such a summary would be useful to program managers to assist funding allocation. The WIC drafted tables summarizing the state of knowledge in 1) Existing datasets on wildfire in the Arctic (Table 3.2.4c), 2) Summarized legacy and current studies on plant community succession after tundra fire (Table 3.2.4e) 3) Community collaboration and outreach efforts by agencies , and 4) Satellite and Airborne Fire Sensor Systems for Arctic Wildfire Observations. *(Reference Tables associated with Milestones 3.2.4.a-e {Links}).*

1. Weather stations and synoptic weather patterns in northern Alaska in relation to fire:

There is a need for better understanding of large-scale (1000-km) weather patterns and their influence on fire weather, fire occurrence and fire regime (over time). Synoptic weather patterns have been shown to be tightly linked to annual wildfire extent in interior Alaska[1,2]but less is known about tundra regions. For example: what are the differences in climate/weather that make the fire regime in the western arctic different from the North Slope? Which large-scale weather patterns are most likely to elevate fire risk in arctic tundra?
Secondly, there seem to be many different types of weather stations in tundra areas for different purposes and agencies yet fire and land managers do not have adequate consistent weather data to analyze for management or research—particularly real-time data. (*Note: there are currently only 3 stations reporting north of the Brooks range: Barrow, Inigok, and Umiat*). The issue is probably two parts 1.) adequate coverage in remote locations and 2.) Lack of standard data formats and access to various weather stations that are owned and operated by different agencies including the State of Alaska and USGS. Most North Slope weather data is project-specific can't be used by the National Weather Service to improve forecasts or by fire management agencies to model fuel conditions or fire danger.

2. Characterization of tundra fuel loading and seasonal fuel moisture trends:

The vast majority of fire fuel characterization and inventory has been for forested regions of Alaska. Although field operatives have anecdotal experience in tundra fuels, basic information on fuel loadings (burnable biomass), carrier fuels, differential flammability of tundra plant species and of stand ages, etc. are poorly documented. The most detailed fire fuel-specific data collection (from 2011, Miller) has yet to undergo analysis and reporting. Some specific data gap questions are: *What are the seasonal fuel moisture patterns that the carrier fuels undergo? How does fuel moisture differ between western and northern regions of Alaska? Does NDVI (Normalized Difference Vegetation Index) "greenness" from AVHRR satellite accurately reflect fire fuel moisture changes over a season? Does NDVI indicate the ratio of live to dead fuel? Can it correlate to the moisture content of live and dead components?* Fire professionals (smokejumpers, crew chiefs) know a lot about tundra fire fuels and fire behavior: none of this is captured/documented/published. A published summary of regional tundra fuel loadings (biomass) is lacking.

3. Plant successional pathways in tundra following fire—historic and "novel":

There are few published studies successional patterns following fire that are of sufficient duration to tell the complete story of tundra response to fire disturbance. Reasons for this include the slow growth of plants (especially bryophytes) in the Arctic and the slow but insidious physiographic and hydrologic effects of disturbance. Even less is known of potential "novel" successional pathways that contemporary studies have highlighted such as "shrubification", and "steppefication". The potential for fire disturbance to trigger conversion of lichen tussock tundra or graminoid tussock tundra to shrub tundra has been documented by multiple studies[3,4] but the significance of this pathway, feedback to future fire regime and linkages to climate warming require further study.

"Steppefication", a term loosely coined to capture the process of shrub tundra converting to a grassland-like steppe state more like it existed during the Pleistocene. Indications are that complete consumption of the duff layer may trigger such a pathway[5] but many questions remain: What is the mechanism? Is organic layer sequentially reduced by repeat burning? Does frequent fire lead to "steppefication" or is there an equilibrium? When does duff consumption exceed duff production? Can pre-historic pollen signatures help inform/support current modeling and observations of vegetation change under warmer climate (i.e. grasses)?

4. Shortage of baseline monitoring data and strategy to detect long-term changes in Arctic vegetation; existing studies do not recognize the importance of post-fire monitoring for community shift due to fire catalyst:

Although the *North Slope Science Initiative (NSSI) website* lists many of the agency monitoring studies in the arctic region of Alaska, few of these studies (but see ITEX study #94) include baseline monitoring of vegetation with intent to detect stand conversions that may be induced by climate change (and that fire may trigger). Only one (#122) of about 150 studies listed involves ground-based monitoring of post-fire disturbance. Site and agency-specific studies also are not standardized or coordinated to monitor changes at a regional scale. The lack of a cohesive interagency monitoring strategy and paucity of permanent baseline monitoring plots hampers the ability to detect climate-induced change across arctic tundra. *Action item: Existing plots, even if not designed for fire effects monitoring should be targeted for re-survey in the event of fire disturbance, and then should be added to the database of Alaska fire research plots (www.frames.gov/afsc/map). Justification: Fire entry to ongoing study plots is a relatively rare event carrying high value for fire management, e.g., Joly caribou plots with biomass data that burned and Yokel/Urban veg plots near weather stations.* It would be helpful to have a map illustrating locations of permanent vegetation plots across the North Slope, for management agencies to recognize when they might be fire-affected: might LTER be able to manage a plot database? Invasive plant potential is another variable likely to be strongly influenced by fire disturbance[6].

5. Fire Effects on Wildlife:

There are many monitoring studies on wildlife species (the majority of some 150 fore-mentioned studies listed on *www.northslope.org/monitoring*) but again, almost none of the studies recognize the impact that fire disturbance may play in long-term effects on available forage (e.g. terricolous lichens, willows) and cover. The WIC addresses these fire effects as part of Milestone 3.2.4 c. under a broad interpretation of "tundra communities" to include vegetation and animals, including: insects/pollinators; predators such as bears and wolverine; caribou migrations. A synthesis of existing data on fire effects on fauna in arctic regions would be useful. Also, the observations of local people may add to the body of knowledge on fire impacts on wildlife.

6. Strategies for predicting climate change effects on tundra and mechanisms (including fire) for the changes:

It could be useful to focus on the differences between W and N arctic fire regimes. Can the Western arctic serve as a model for a future North Slope? What are the major weather pattern differences between the Western and Northern arctic and how do these influence fire weather? What does duff consumption in repeat burns in the higher-fire-frequency western tundra tell us about the future of northern tundra?

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