Protocol Development Summary

July 10, 2008
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Protocol: Monitoring the extent, severity and impacts of fire (Fire Extent and Severity)

Parks Where Protocol will be Implemented: BELA, CAKR, GAAR, KOVA, NOAT

Justification/Issues being addressed:

Current and future climatic changes will impact the occurrence, extent, and severity of fires in the Arctic Network and will have cascading effects on other ecosystem processes. Fire can exert strong landscape scale effects on vegetation composition and distribution, permafrost dynamics, nutrient cycling, carbon gain or loss, and primary productivity. Wildland fire is one of the largest natural disturbance processes in the boreal and tundra ecosystems of the Arctic Network. Fire affects all of the parks within ARCN; in the past 50 yrs over 1 million acres have burned in the network. Fire influences not only vegetation succession and distribution, but also wildlife habitat, soil parameters (e.g. permafrost and nutrient cycling), hydrology, water quality and air quality. In addition, the natural fire regime (fire frequency, fire extent, and severity) and secondary fire effects are likely to respond to local and global climate changes (Rupp et al. 2000; Goetz et al. 2005). Baseline monitoring of fire parameters such as the number of fires, fire extent and burn severity will provide explanatory variables for ecological changes detected through the I&M program, while long term monitoring of fire effects on vegetation will provide a foundation to elucidate the complex relationship between fire and the landscape.

Specific Monitoring Questions and Monitoring Objectives to be Addressed by the Protocol
Monitoring Questions:

- What are the long-term trends and natural level of variation in the frequency, extent, and burn severity of fires?
- Is there a pattern between global climate change and frequency, extent, and burn severity of fires?
- How does the time since fire and burn severity affect the species composition, vegetation structure, and ground cover among varying vegetation types?
- How does the time since fire and burn severity affect soil parameters (soil temperature, soil moisture, depth of active layer, thermokarst development)?
- How does the time since fire and burn severity affect water quality and air quality? **
- How does the time since fire and burn severity affect the abundance, distribution and composition of the wildlife populations (i.e. moose, caribou, small mammals, birds)?**

** *Note: It is recommended that baseline fire parameters and fire effects on vegetation be monitored, however the remaining questions should be addressed through other protocols which utilize fire as an explanatory variable of change.*

Monitoring Objectives:

1. Determine annual variation and long term trends in fire frequency (number of fires/year), average fire size, maximum fire size, and total area affected by fire in our network parks.
2. Determine the trends and variability in burn severity on fires larger than 300 acres in ARCN.

3. Determine the effects of fire and burn severity on vegetation species composition (species and % cover), vegetation structure (tree diameters and heights), and ground cover (% cover and depth) of varying vegetation types. (Long term monitoring)

Basic Approach:

Fire Occurrence and Extent Monitoring

Fire location and extent are collected for all fires occurring within the administrative boundaries of the ARCN parks each year through the NPS fire management program. Fire extent of fire perimeters are measured by physical mapping (hand drawn or GPS) or with remote sensing platforms such as LandSat 7. The final perimeter are mapped for all fires greater than 100 acres. Basic fire occurrence data are collected for all fires, including: year, start/end date, fire number, fire cause (natural/human caused), acreage, vegetation types, closest weather station, fire management activities. The following information is collected for the origin of the fire: lat/long, topography, slope, aspect, and elevation. This data is stored in the DOI-1202 Individual Fire Report Database. The procedure for accessing and utilizing this data for the I&M program will need to be determined.

Burn Severity Monitoring

The heterogeneous pattern of fire (or 'fire mosaic') on the landscape results from varying burn severity within a fire. Burn severity is a measure of the ecological impacts of the fire, in terms of plant survivorship or mortality, depth of burn in the organic layers, or amount of biomass consumed. A method for mapping burn severity with Landsat satellite imagery has been developed by the USGS EROS Data Center (EDC) and the NPS fire management program. Burn severity maps are produced by applying the Differenced Normalized Burn Ratio (dNBR) to pre and post fire Landsat imagery (Sorbel and Allen, 2005; Key and Benson, 2006). The dNBR is calculated using an index of Landsat bands 4 and 7, the two bandwidths that show greatest response to burning. Currently a process is setup in which the NPS Fire Management notifies EDC of burns that it would like mapped. The EDC acquires and processes appropriate pre and post fire Landsat imagery to generate the following dNBR burn severity products: grid based dNBR severity data set, satellite-derived final fire perimeter, pre and post fire Landsat imagery, and associated metadata. It is recommended that burn severity maps be acquired for all fires occurring within ARCN that are greater than 300 acres. Burn severity maps can be used to identify unburned areas within the fire perimeter, as well as provide a measure of the likely effect of fire on the vegetation and soils. Trends or differences in burn severity can be detected among fire and years by averaging dNBR values or assessing the variability of the dNBR values among fires.

Fire Effects Monitoring

There are several sets of fire effects plots that have already established in the Arctic Network. Re-measurement of pre-existing ground based plots or establishment of new plots in fires or fire-prone areas needs to be determined by ARCN. The basic methods for the pre-existing plots are described below.

2004 Uvgoon Fire (NOAT)- NPS fire staff established 6 plots in 2004 on the Uvgoon Creek Fire in Noatak. There are 3 pairs of burned and unburned plots. This area has had 3 fires in the last 20 years. Plots were established in 2004 immediately after the fire and re-measured in

2005 and 2007. Plots are 30-m x 1-m belt transects. Plot data collected includes: ocular estimates of vascular and non-vascular species cover, point intercept along a 30-m transect (includes ground cover, vasculars and basic non-vasculars), tree density by size class and species within 30-m^2 belt transect, shrub density by species for Alder, willow and dwarf birch within 30-m^2 area, thaw depth measurements (10 per plot), burn severity at 10 points along transect, and photos. Methods follow a protocol developed by the Alaska Interagency Fire Effects Task Group (2007).

Fire Effects Paired Plots -Three of the parks (NOAT, BELA, GAAR) have historic fire effects plots ("Paired Plots") that were established during the 1980's. Fire staff established paired vegetation plots in burned and representative unburned habitat adjacent to the burned areas of varying ages. Some plots were established in front of active wildfires. Between 1983 to 1988, approximately 485 plots were installed across 9 different parks in Alaska; a total of 198 plots were established in the Arctic Network. Plot data collected include: photographic slides of plot, tree density by size class and species on 15-m x 30-m quadrats, vegetation cover class for 30 Daubenmire frames (20 x 50 cm), tree cores/cookies, fuels and soils data (on some plots), and general plot location descriptions. We are working on entering the plot data into an Access database and digitizing plot locations off of hard-copy maps and aerial AHAP photos that had the plots pin-pricked on the location. Some of the plot locations were permanently marked. None of these plots have been re-measured since the late 1980s, but we are interested in re-visiting plots that may be accessible or re-locatable based on permanent markers or good photography of the site. The data and photos would need to be assessed to determine if it is possible to revisit these plots

Racine Plots (NOAT, BELA) - Between 1978-1982 Dr. Charles Racine and colleagues established a series of plots for monitoring vegetation and permafrost recovery post fire in Noatak National Preserve and Bering Land Bridge National Preserve. In 1978 Racine and others established 8 permanently marked plots in a 1977 fire along a topographic gradient on Nimrod Hill, on the east side of Imuruk Lake in Bering Land Bridge. Pre-fire data was available from a 1973 soils and vegetation survey. The plots have since been re-measured in 1978, 1979, 1981, 1983, 2001 and 2002 (Racine et al. 2004).

During 1981 and 1982, eight tundra post-fire plot sites were established by Racine and others in the Noatak NP in burned areas of varying ages, ranging from 2-4 wks post fire, 4-5 years and 10 years post fire (1972, 1977 and 1982 fires). As part of the Arctic Network Inventory & Monitoring Program, Racine and NPS personnel relocated and re-measured the Noatak fire plots established in 1981-82. At each site ten 1-m x 1-m plots were sampled. Data collected include: ocular estimates of vascular and non-vascular species cover, maximum height and stem density estimates of shrubs, thaw depth measurements, site descriptions (soil samples in 1981-82), and photographs.

Principal Investigators and NPS Lead:
The P.I. for protocol development is Jennifer Allen, Alaska Region NPS, Regional Fire Ecologist, 907-455-0652.

Development Schedule, Budget, and Expected Interim Products:
Regional protocols already exist for collecting fire occurrences, extent, and burn severity. A protocol for the NPS Fire Plots has been completed. Site selection of the fire plots and historic plots needs to be assessed statistically. Protocol development will not require field research and will consist primarily of writing a protocol that meets NPS standards (Oakley et al. 2003) and incorporates existing standard protocols.

The P.I.'s will produce draft protocols ready for external peer review by December 1, 2009. After peer review, revision and approval, we hope to implement the protocol in June 2009. $20,000 has been requested for development and assessment of this protocol in FY08.

References:

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