

**ANNUAL REPORT ON VITAL SIGNS MONITORING OF THE EXTENT, SEVERITY
AND EFFECTS OF WILDLAND FIRE IN YUKON-CHARLEY RIVERS NP, DENALI
NP/P & WRANGELL-ST. ELIAS NP/P**

Jennifer L. Allen

**NPS Alaska Regional Office
4175 Geist Rd
Fairbanks, AK 99709**

2005

CENTRAL ALASKA NETWORK

Funded By: AK NPS Fire Management

Executive Summary

Fires can exert landscape-scale controls on vegetation structure and composition, permafrost dynamics, water quality, air quality, nutrient cycling, primary productivity for herbivores, and biodiversity. In addition, the natural fire regime (fire frequency, fire extent and severity) is likely to respond to local and global climate changes. The purpose of this report is to provide information for the Central Alaska Network Inventory and Monitoring program on the extent, frequency and severity of fires within the three network parks: Denali National Park and Preserve, Yukon-Charley Rivers National Preserve, and Wrangell-St. Elias National Park and Preserve.

Goal 1 - Annually track the location, extent, and severity of wildland fire in CAKN parks to determine annual fire frequency, average fire size and variability in burn severity.

- Fire extent, frequency and locations were determined park wide for Wrangell-St. Elias (WRST), Denali (DENA) and Yukon-Charley Rivers (YUCH). Aerial reconnaissance and MODIS heat detection maps were used for detecting and mapping fires from May until September.
- 2005 was the third largest fire year on record since 1950 statewide, 624 fires burned over 4.64 million acres in Alaska.
- 2005 was the 2nd largest fire year on record in Denali NP/P.
- 2005 fire records show that Denali had 7 fires and burned 47,550 hectares, Yukon-Charley had 3 fires in the preserve and burned 9,821 ha within the preserve boundaries, and Wrangell-St Elias had 1 fire at 22 ha.

Goal 2: Track the effects of fire and burn severity on species composition and structure of vegetation, active layer depth, and animal community habitats.

Results from the fire effects monitoring in Denali showed:

- Heterogeneous post fire vegetation, underlying drivers are still being determined.
- Increased shrub cover 15 yr post fire
- Increased moose browse availability 15 yr post fire

Key Words

- Alaska, fire, burn severity, monitoring, Picea, vegetation, browse, parks

INTRODUCTION

Wildland fire is one of the most influential disturbance processes in boreal ecosystems, and has been identified as a vital sign for the Central Alaska Network (MacCluskie and Oakley 2005). Fire affects all of the parks in the Central Alaska Network - over 630,000 hectares have burned within the three parks in the past 55 years. Fire is the dominant ecological process in YUCH and in the northwestern regions of DENA. Fire is also important in the non-maritime portions of WRST, although fire return intervals there are generally much longer than in DENA and YUCH. Fires can exert landscape-scale controls on vegetation structure and composition, permafrost dynamics, water quality, air quality, nutrient cycling, primary productivity for herbivores, and biodiversity. In addition, the natural fire regime (fire frequency, fire extent and severity) is likely to respond to local and global climate changes. Baseline monitoring of fire parameters such as the number of fires, fire extent and burn severity will provide explanatory variables for other ecological changes detected. Long-term monitoring of fire effects on vegetation will also provide a foundation to elucidate the complex relationship between fire and the landscape.

The purpose of Vital Signs Monitoring program is to provide park managers with natural resource information in a timely manner to assist in management decisions. The specific goals of this report are to:

- Annually track the location, extent, and severity of wildland fire in CAKN parks to determine annual fire frequency, average fire size and variability in burn severity.
- Track the effects of fire and burn severity on species composition and structure of vegetation, active layer depth, and animal community habitats.

METHODS and MATERIALS

Fire Extent and Occurrence

Fire location and extents were collected by NPS fire staff, BLM Alaska Fire Service, or State of Alaska -Division of Forestry for all fires occurring within the administrative boundaries of the CAKN parks. Final fire perimeters were mapped aerially for fires larger than > 40 ha. Basic fire occurrence data were collected for all fires, including: year, start/end date, fire number, fire cause (natural/human caused), acreage, vegetation types, fire management activities, and the following information 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.

Burn Severity Monitoring

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. The dNBR is calculated using an index of Landsat bands 4 and 7, the two bandwidths that show greatest response to burning (Sorbel and Allen, 2005; Key and Benson, 2006). Methods and data are archived at the following web site: http://burnseverity.cr.usgs.gov/fire_main.asp . Currently a process is setup in which the NPS Fire Management notifies EDC of burns that it would like mapped. In 2005, all fires over 300 acres in Denali and Yukon-Charley were requested to be mapped. An initial assessment map was prepared for

Denali NP/P. Extended assessments (1 year post fire) will be completed in 2006 if cloud-free imagery is available.

Fire Effects Monitoring

Two fire effects projects were monitored in Yukon-Charley (YUCH) and one fire effects and moose browse pilot study was initiated in Denali (DENA). We used the following methods for monitoring the effects of fires in YUCH and burn area inventory in DENA during 2005. These methods have not yet been documented in the CAKN Wildland Fire vital sign protocol. Each plot can be laid out and read by an experienced crew of two in less than 2 hours. Data was entered into the National Park Service fire effects sequel server database – Fire Effects Assessment Tool (FEAT).

1. PLOT DESCRIPTION

- 30-m x 1-m belt transect
- Topographic and general plot descriptions are collected
- Lat/Long, datum, error
- General vegetation type/fuel model
- Photo points on each end of the transect facing toward middle.

2. VEGETATION COVER (Point Intercept)

- Point intercept 30-m transect (60 points, every 0.5-m along 30-m baseline).
- Stake with chaining pins or permanently stake both ends with PVC conduit, fiberglass survey stakes or buried rebar stakes.
- Record all trees, shrubs, herbaceous species, include substrate or groundcover hits at each point.
- Read on right, walk on left of baseline.

3. TREE DENSITIES

- 1-m x 30-m belt transect rectangle for all trees >4.5' (1.37 m) in height.
- Tally trees >4.5' in height by species and diameter at breast height (DBH) size classes: (< 5 cm, 5.1-10 cm, 10.1-15 cm, 15.1-23 cm, >23 cm), and status (Live/Dead).
- Tally small trees (<4.5' tall) in 3 subplots, 1-m x 1-m located at 3, 18, & 27-m marks.
- For two trees of each species and size class record diameter at breast height (DBH), height, crown base height (CBH), ladder fuel heights, crown radius.
- For all trees > 23 cm DBH record species, DBH, height, CBH, ladder fuel heights, crown radius.

4. PERMAFROST DEPTH & BURN SEVERITY

- Measure the depth of the active layer every 3 m beginning at 3-m mark, for 10 total points.
- 1 yr post-burn: Record micro-site specific burn severity index, using a 5-class severity codes for substrate and vegetation, every 3 m beginning at 3-m mark, for 10 total points.

5. DUFF & LITTER DEPTH

- Measure the depth of the forest floor surface material (live moss, dead moss, upper and lower duff layers) at two places displaced at least 1 m off the transect which appear similar with respect to forest floor characteristics along the transect.

6. SHRUB DENSITY & MOOSE BROWSE (Denali plots)

- Shrub densities of 'preferred' moose browse species (*Salix*, *Betula papyrifera*, *Populus balsamifera*, *P. tremuloides*) were tallied along the 30-m x 1-m belt transect. We categorized each plant by browse categories developed Seaton (2002) and DNR Alaska Division of Fish & Games (ADFG) moose browse techniques.

The objectives of the Denali fire ecology pilot project were to test the use of videography as a method for fuels and landcover classification, validate successional patterns compared to burn severity, and identify fire effects on moose browse under varying age of burn. Digital videography was taken in the fall of 2004 (Sept) along two transects (~100 km each) in the NW section of Denali. During July of 2005, 43 ground plots were installed along the flight transect in two age classes of fires (15 and 5 years since fire) and stratified by 12 unsupervised vegetation classes.

Data analysis provided in this report address only the Denali ecology project. A comparison of vegetation succession by pre-fire vegetation type and moose browse availability and utilization was compared by the two age classes of fires.

RESULTS

Frequency, Extent and Burn Severity of Fires

Over the last 55 years, greater than 630,000 hectares have burned within the Central Alaska Network, with an average fire size of 1,476 hectares; 73% of the fires are caused by lightening (NPS Fire Records 1950-2005). The frequency and extent of the fires is variable within the park units (Table 1 and Figures 1 and 2), governed by vegetative, geographic and climatic factors.

Table 1. 1950-2005 Statistics of fires within the Central Alaska Network based on NPS fire record database and large fire polygon database. Fire sizes are based on area burned within parks.

Unit	Total hectares burned	Average hectares burned/yr	Average fire size (hectares)	Fire frequency (# of fires)	Average frequency of fires/yr
DENA	237,441	4,240	1,224	193	3.4
YUCH	384,402	6,864	2,512	153	2.7
WRST	8,492	153	106	80	1.4
Total CAKN	630,335	10,042	1,476	426	7.6

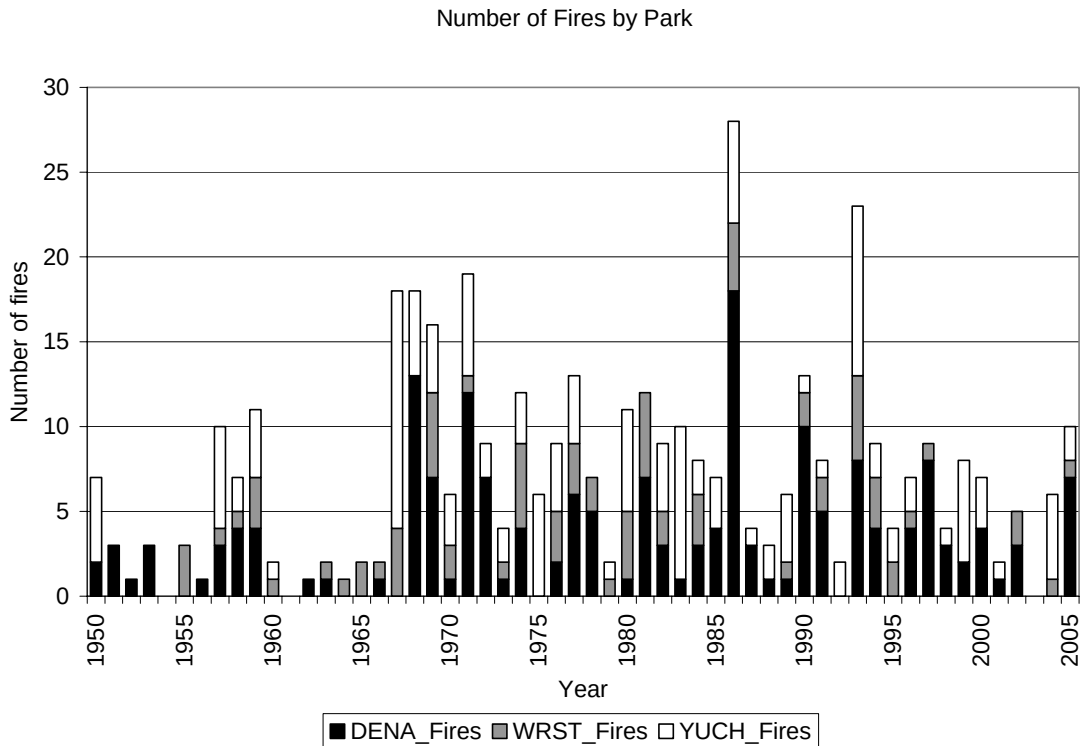


Figure 1. The number of fires each year for the Central Alaska Parks (DENA = Denali NP/P, WRST = Wrangell-St. Elias NP/P, YUCH = Yukon-Charley Rivers NP) from 1950-2005.

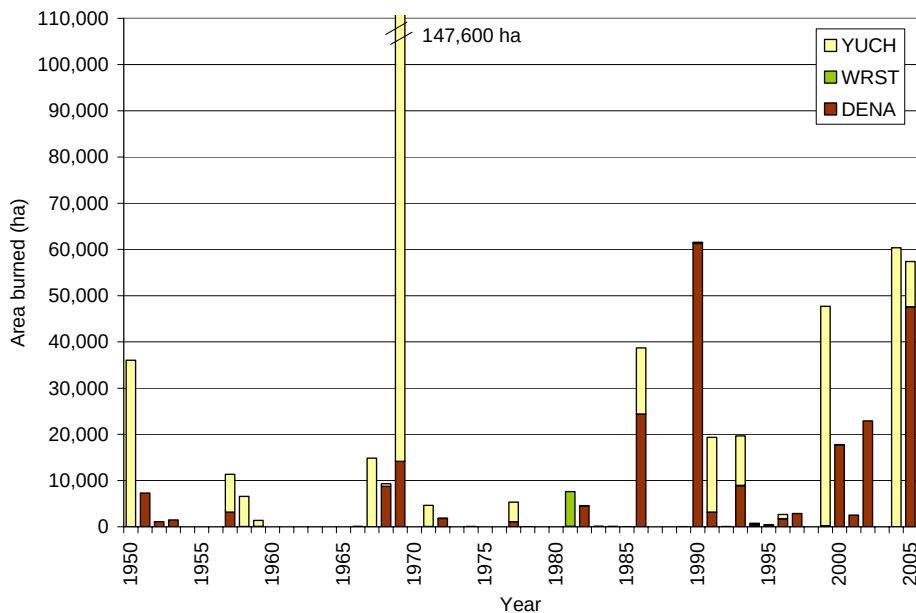


Figure 2. The total hectares burned within each park unit in the Central Alaska Network (DENA = Denali NP/P, WRST = Wrangell-St. Elias NP/P, YUCH = Yukon-Charley Rivers NP) from 1950-2005.

During 2005, 624 recorded fires burned over 4.64 million acres in Alaska. This was the third largest fire year on record since 1950 statewide, and the 2nd largest fire year in Denali NP. In 2005, 7 fires were detected in Denali NP/P with a total of 47,554 hectares burned, the largest fire was High Power Cr (Fire #) at 45,995 ha. Yukon-Charley had three fires and burned 9,821 ha within the preserve boundary. Only 2 of the 3 fires in Yukon-Charley originated in the preserve. The Trout Cr fire burned within a large 1969 fire, resulting in a shorter than expected fire return interval (36 years FRI). Wrangell's had a 21 ha lightning caused fire on the north side of Sanford River. A summary of the 2006 fires is provided in Table 2.

Table 2. Summary of individual fires in the Central Alaska Network during 2005. Data was taken from NPS Alaska Regional Fire Database. Acres NPS are the number of acres within the park administrative boundary. The end date of fires is the administrative reported end of the fire, which may not reflect the actual date the fire stopped burning.

Park	Fire Name	Fire Code	Ref. #	Cause	Acres Total	Acres NPS	Date Discovered	End Date (Admin)
DENA	Highpower Creek	BUB9	226	Lightning	114,444	113,655	6/14/2005	9/30/2005
DENA	Herron River	BUC0	227	Lightning	3,653	3,653	6/14/2005	7/12/2005
DENA	McKinley River	BUH5	238	Lightning	91	91	6/15/2005	7/12/2005
DENA	Bear Creek	BU13	296	Lightning	25	25	6/17/2005	7/09/2005
DENA	Wigand Creek	BVG2	324	Lightning	0.3	0.3	6/21/2005	6/21/2005
DENA	Muddy River	BW1X	358	Lightning	12	12	6/28/2005	7/04/2005
DENA	Birch Creek	B14Y	517	Lightning	73	73	7/26/2005	8/27/2005
WRST	Fox Farm Lake	BWG0	339	Lightning	53	53	6/26/2005	7/05/2005
YUCH	Charley Cr C1	BT43	192	Lightning	73,346	18,345	6/11/2005	9/26/2005
YUCH	Trout Creek	BT8C	218	Lightning	5,862	5,862	6/13/2005	9/26/2005
YUCH	Hosford Creek	BU1Y	294	Lightning	60	60	6/17/2005	6/28/2005

Table 3. Comparison of burn severity for two fires in Denali NP/P. Percent of fire areas within burn severity classes is based on dNBR values for the 2005 High Power Cr fire and 2000 Foraker fire.

Burn Severity Level, by dNBR range	Percent of Highpower Cr Fire, 2005	Percent of Foraker Fire, 2000
Low severity (50-300)	23.3	16.0
Moderate low severity (301-550)	34.2	47.1
Moderate high severity (551-800)	29.5	30.1
High severity (>800)	8.3	5.8
Unburned within perimeter (<50)	4.7	0.9

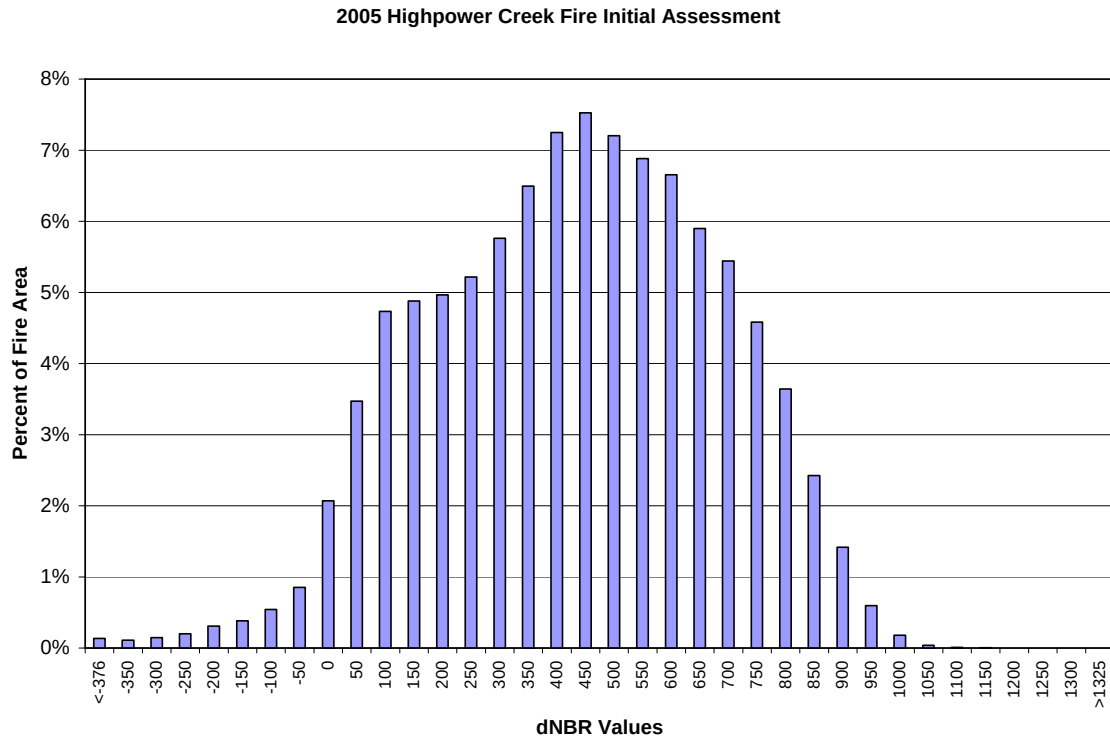


Figure 3. Histogram of initial assessment dNBR burn severity for Denali's 2005 Highpower Creek Fire. A relative scale of severity levels and the dNBR values are shown in Table 2.

Burn Severity

Burn severity mapping is generally completed Initial burn severity mapping was completed for Denali NP. Cloud and smoke free imagery was not available for Yukon-Charley by the end of the year, therefore burn severity maps will be completed next summer for this area (extended assessment). The Highpower Cr. fire burned 45,995 hectares in northwest Denali; a histogram of the dNBR values for the fire is shown in Figure 3. A comparison of burn severity by area for two fires in Denali is shown in Table 3.

Fire Effects Monitoring

Denali Fire Effects

The lowland black spruce forests of the Minchumina basin in Denali National Park & Preserve experience large natural fires almost yearly. Forty-three fire effects plots were measured in 2005. Plots were established in two age classes of time since fire (<5 yrs and 15-19 yr). On the ground we found that only 35 of the 43 plots were burned, resulting in 14 plots <5 yrs since burn, 21 plots >15 yrs since burn, and 8 plots unburned recently. The dominant post fire vegetation type in both age classes of fires was low mixed shrub-sedge tussock tundra (26% of the 35 burned plots), followed by low mesic birch-ericaceous shrub types (17%) and deciduous-spruce mixes on upland landforms (17%). A matrix showing the number of plots sampled by general pre-fire vegetation type and post-fire vegetation type generalized and specific Viereck vegetation type is shown in Table 4.

Preferred moose browse species availability varied between fire ages, with an average of 1,569 stems/ha in recent fires and 3,244 stems/ha in 15 year post fire plots. Only 65% of the plots had preferred moose browse species present (*Salix*, *Populus* or *Betula papyrifera*). Of these plots 44% of the preferred species were browsed in 15 yr old stands and only 25% were browsed in 5 yr old stands.

Table 4. A matrix showing the number of plots sampled by general pre-fire vegetation type and post-fire vegetation type generalized and specific Viereck level IV vegetation type.

General Pre-fire Vegetation	General Post Fire Vegetation	Viereck IV Vegetation Type Post-Fire	< 5 yrs post fire	15 yrs post fire	Total Number of Plots
Black Spruce Forest	Dry-Mesic Herbaceous/Grass	Fireweed	1		1
	Dry-Mesic Herbaceous/Grass	Mesic Forb Herbaceous	1		1
	Closed low ericaceous (Labrador tea)	Closed Low Ericaceous Shrub		3	3
	Low mixed shrub-tussock tundra	Open Low Mixed Shrub-Sedge Tussock Tundra	4	5	9
	Low shrub birch-ericaceous	Open Low Mesic Shrub Birch-Ericaceous Shrub	4	2	6
	Shrub alder	Open Tall Alder Shrub	1		1
	Shrub birch-willow	Closed Low Shrub Birch-Willow Shrub		1	1
	Shrub birch-willow	Open Tall Shrub Birch-Willow Shrub		1	1
	Black spruce woodland-open	Black Spruce Dwarf Tree Woodland		1	1
	Black spruce woodland-open	Open Black Spruce Forest	1		1
	Mixed deciduous-spruce forest	Open Quaking Aspen-Spruce Forest		2	2
	Mixed deciduous-spruce forest	Closed Mixed Forest		1	1
Mixed Deciduous-Spruce Forest	Dry-Mesic Herbaceous/Grass	Bluejoint-Herb	1		1
	Aspen forest (regen)	Closed Quaking Aspen Forest		2	2
	Mixed deciduous-spruce forest	Open Spruce-Paper Birch Forest		1	1
	Mixed deciduous-spruce forest	Spruce-Paper Birch Woodland		1	1
White Spruce Forest	Mixed deciduous-spruce forest	Spruce-Paper Birch Woodland		1	1

DISCUSSION

Climate, terrain, and vegetation strongly influence the occurrence and extent of fires within the Central Alaska Network. The impacts of wildland fire in northern latitudes are well documented for boreal forests; however, the processes and variability underlying ecosystem response are still under study.

Monitoring of fire locations and burn severity was accomplished by the NPS fire management and fire agencies within Alaska. The data has been presented in this report and is also available on the Alaska Regions GIS permanent data set. Overall the number of fires and area burned was high for 2005 within the Central Alaska Network, and reflects statewide fire records.

Preliminary data from the fire effects monitoring in Denali National Park indicate that several successional pathways are potential for vegetation, and are probably dependent on topographic position, soils and burn severity.

Plans for Coming Year

Alaska NPS Fire Management program will continue to map and document fire extent, frequency, and location of all fires in the Alaska NPS Region. Burn severity maps will be acquired for all fires larger than 300 acres. It is recommended that fire management staff, regional fire ecologist, and CAKN staff should discuss how the data collected is input into Inventory and Monitoring databases, and if more information is need for individual fire reports.

Ten of the 43 plots that were established in Denali 2005 project were burned again by the 2005 Highpower Creek fire. The fire ecology program intends to re-measure and mark these plots in order to determine the impacts of increased fire frequency on vegetation and soils. It is recommended that discussions should be made to determine if the fire effects data collected by NPS fire staff can be integrated into the CAKN monitoring data collections.

Acknowledgments

I would like to thank the NPS fire staff: Larry Weddle, Charlie Reynar, Dan Ostmann, Reid Parker, Andrew Stinchfield and Eric Olsen from the NPS Western Area Fire Management (DENA, WEAR, and LACL) and Kristi Bullock, Katja Mocnik, and James Savage from the Eastern Area Fire Management (YUCH, WRST, and GAAR) for their work in the field, both monitoring fire effects and mapping fires. Thanks to Karen LaMay at the regional office (ARO) for keeping the NPS fire database up to date and garnering all the data from various places. Thanks to the Central Alaska Network for continued interest and interactions with the fire management program.

Literature Cited

- Key, C. H. and N. C. Benson. 2006. Landscape Assessment (LA) *In*: Lutes, Duncan C.; Keane, Robert E.; Caratti, John F.; Key, Carl H.; Benson, Nathan C.; Sutherland, Steve; Gangi, Larry J. 2006. FIREMON: Fire effects monitoring and inventory system. Gen. Tech. Rep. RMRS-GTR-164-CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. LA-1-55.
http://www.fs.fed.us/rm/pubs/rmrs_gtr164/rmrs_gtr164_13_land_assess.pdf
- MacCluskie, M. and K. Oakley. 2005. Central Alaska Network, Vital Signs Monitoring Plan. National Park Service, Fairbanks, Alaska. 304 pp.
- Seaton, C. T. 2002. Winter foraging ecology of moose in the Tanana Flats and Alaska Range foothills. MS Thesis, University of Alaska, Fairbanks. 102 pp.
- Sorbel, B. and J. L. Allen. 2005. Space-based burn severity mapping in Alaska's National Parks. *In*: Alaska Park Science. June 2005 Issue. Anchorage, Alaska. pp. 4-12