ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

Alaska Department of Fish and Game
Wildlife Restoration Grant

GRANT NUMBER: AKW-16

PROJECT NUMBER: 215647484

PROJECT TITLE: Kenai Moose Habitat Enhancement

PERIOD OF PERFORMANCE: May 3, 2016 – June 30, 2020

PERFORMANCE YEAR: July 1, 2018 - June 30, 2019; year 3 of a 4-year grant

REPORT DUE DATE: Submit to Coordinator August 30, 2019; due to FAC September 28, 2019

PRINCIPAL INVESTIGATORS: Sue Rodman, Program Coordinator; Dan Thompson, Wildlife Biologist

COOPERATORS: Mary Jo Hill, Wildlife Biologist II, and Miles Spathelf, GIS Analyst III, ADF&G; Nathan Lojewski, Chugachmiut; Michael Hill, Kenai National Wildlife Refuge USFWS; Hans Rinke, Division of Forestry State of Alaska

I. PROGRESS ON PROJECT OBJECTIVES DURING PERFORMANCE YEAR

OBJECTIVE 1: Construct fuel breaks to enable the use of prescribed and wildland fire to enhance habitat on a landscape scale.

ACCOMPLISHMENTS:

Concerning the proposed fuel break along the northwestern portion of the Refuge, the Fuel Break Working Group visited a site where Borough lands share a border with the Refuge. Tentative plans were made to address this site with either manual labor through Chugachmiut's Yukon Fire Crew or as a mechanized treatment area. No contracts were initiated in this performance period. The Kenai Peninsula Fuel Break Working Group will reconvene in fall 2019 after the Swan Lake Fire is contained for the season to re-assess the needs and priorities for action.

Discussion continues to develop a fuel break at intermittent locations between the Swanson River and Point Possession where private parcels and structures could be protected from planned prescribed fire or wildland fire that could be allowed to burn under appropriate conditions. An existing easement can be used to initiate this project in coordination with the Kenai Peninsula

Borough and private landowners. An outreach component would also be added to this project, as we did for the Sterling Fuel Break where homeowners receive information on Firewise Alaska and Division of Forestry targets properties for the Stewardship program.

OBJECTIVE 2: Enhance habitat through mechanical treatments and prescribed fire on public lands.

ACCOMPLISHMENTS:

ADF&G continued coordination with the Refuge Fire Management Staff to plan the 9,600-acre East Fork prescribed fire, designated for implementation in 2020. With respect to the federal government shutting down in January 2019 and staff commitments on other projects from the partnering agencies, we all agreed to postpone the ignition of the East Fork prescribed fire until 2020.

Prescribed fire and resource objectives were completed along with a communications plan with agency reviewed talking points. BLM provided a prescription for burn conditions through an agreement with ADF&G. State of Alaska archeologists prepared for field investigations in June 2019 to complete the cultural resource review.

Monitoring of the proposed fire burn unit was planned over the course of the winter with fire ecologists from BLM, USFWS, and ADF&G. Field preparations and logistics were coordinated to begin field measurements on June 10, 2019. On June 5, 2019, a lightning strike ignited a wildfire within the proposed burn unit and field work was cancelled as the fire progressed to burn the entire unit and an additional 90,000 acres to the east and north as of the end of this performance period on June 30, 2019.

OBJECTIVE 3: Monitoring moose movement, body condition and productivity, to specify best practices for managing fire on the landscape and mechanical enhancements for moose habitat.

ACCOMPLISHMENTS:

In November 2016 and March 2017, we successfully captured 50 adult female moose and deployed all 50 Global Positioning System (GPS) collars. Evaluation of GPS data from moose in GMU 15A indicates that 21 of the GPS collared female moose potentially utilize the area of the proposed East Fork prescribed fire, which is a small area of 9,600 acres within the currently burning Swan Lake Fire that exceeded 100,000 acres as of the end of this performance period.

Body condition measurements of adult cows were completed during captures in autumn 2016, and spring and autumn of 2017 and 2018. Rump fat depths were similar between GMU 15A and 15B through 2017; however, moose in GMU 15B had more rump fat that those in GMU 15A during the spring of 2018. In the autumn of 2018 rump fat was again similar between both populations.

Parturition surveys were completed in 2017, 2018, and 2019. In 2017, parturition rate and twinning rates were similar between GMU's. In 2018, estimates of parturition rate were higher

for GMU 15A; however, GMU 15B had a higher twinning rate. During 2019, parturition rates were similar between GMU's; however, a higher twinning rate was observed in GMU 15B. During March 2018 (n = 27) and 2019 (n = 30) we captured and weighed 10-month old calves and found no difference in mean body mass between GMU's or between years. We also deployed expandable GPS collars on female calves in 2018 (n = 15) and 2019 (n = 16).

As we assess moose movement across both 15A and 15B (separate funding sources), ADF&G maintains that we do not have yet a population response to the 2014 Funny River fire. However, that is likely to occur in the coming years with the expectation that forage availability and nutritional quality will increase. The higher twinning rates in 15B may not yet correlate to the fire effects: these signs of increase are not yet substantial in 15B post fire. Monitoring of cow movements in 15A shows current use of the East Fork proposed fire area and that area of the currently burning Swan Lake Fire; we expect to continue monitoring moose use of this area after the burn is complete.

While USFWS has collected data in the area of the 2014 Funny River Fire, we have not yet evaluated how vegetation response there may correlate to moose movement in that area. That information, a component of AKW-5, would have been used to analyze the pre-fire monitoring vegetation data within the East fork prescribed fire area. USFWS Fire Ecologist supported ADF&G in developing the monitoring protocol that would have been implemented in June 2019 if the Swan Lake wildfire had not ignited.

II. SUMMARY OF WORK COMPLETED ON PROJECT TO DATE.

The Kenai Peninsula All Lands All Hands interagency group approved the new 5-year Action Plan for implementation. ADF&G worked closely with Refuge fire management staff to plan monitoring, operations, and outreach for the East Fork prescribed burn. ADF&G biologists continued to measure rump fat and monitor movement and parturition for moose collared in GMUs 15A and 15B to compare fitness.

The US Forest Service completed the Kenai Peninsula Vegetation Map in March 2019. Field work to complete the statement of accuracy was completed in summer 2019. All final products will be delivered in December 2019. The Story Map describes the process and methods while also providing a view to the final products:

https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=4e21c25d5eac421babaef3222004cccf. ADF&G continues to communicate with Forest Service staff in Juneau to gain access to specific data products that will ultimately support moose movement research specific to this grant and AKW-5 (moose collared in GMU 15A and 15B).

For monitoring moose movement with respect to Objective 3:

In November 2016 we successfully captured 30 adult female moose, assessed their body condition, and deployed 30 Global Positioning System (GPS) collars (GMU 15A: n = 15; GMU 15B: n = 15). Mean rump fat in November 2016 was similar between GMU 15A (3.1cm ± 1.2 SD) and GMU 15B (2.9 cm ± 1.3 SD). No capture related mortalities were observed. In March of 2017, we captured an additional 20 adult cow moose, assessed body condition, and deployed

the remaining 20 GPS collars (GMU 15A: n = 10; GMU 15B: n = 10). We also deployed vaginal implant transmitters (VIT) in all moose to assist with parturition surveys. Mean rump fat in March 2017 was similar between GMU 15A (1.4 cm ± 0.8 SD) and GMU 15B (1.6 cm ± 0.7 SD). No capture related mortalities were observed. In GMU 15B, one cow moose died (March 2017) after it fell through the ice in a small creek and could not get out. In GMU 15A, 4 moose died during the spring and summer of 2017: one from brown bear predation, two suspected wolf predations, and one with no indication of cause of death. Parturition surveys were flown from early May through the middle of June 2017, which provided estimates of parturition rates (GMU 15A: 70%; GMU 15B: 73%) and twinning rates (GMU 15A: 53%; GMU 15B: 46%). In November 2017 we captured 36 moose to assess body condition, and we redeployed the 5 GPS collars from mortalities from the prior year. Mean rump fat in November 2017 was similar between GMU 15A (3.4 cm ± 1.2 SD) and GMU 15B (4.0 cm ± 1.7 SD). One capture related mortality was documented for an adult cow in GMU 15A from the November 2017 captures and the collar was retrieved at the end of the captures. From November 2017 to March 2018, we retrieved 2 collars because of collar release or nut failure. In that same time frame, we had 2 mortalities, one a result of roadkill, and the other had no indication of cause of death.

In March 2018 we successfully recaptured 20 moose for body condition assessment. We also redeployed 5 GPS collars and deployed 5 VIT's to assist with parturition surveys. Mean rump fat in March 2018 was lower ($t_{18} = -3.24$, $P = 0.004$) in GMU 15A (1.0 cm ± 0.5 SD) than GMU 15B (1.8 cm ± 0.5 SD). We also captured 27 calves during March 2018 (GMU 15A: n = 12; GMU 15B: n = 15) and weighed them. Weights of 10-month old calves were similar between GMU 15A (196.6 kg ± 16 SD) and GMU 15B (192.4 kg ± 20.7 SD). In addition, we deployed expandable GPS collars on 15 female calves (n = 7 in GMU 15A; n = 8 in GMU 15B). Parturition surveys were flown from early May through the middle of June 2018, which provided estimates of parturition rates (GMU 15A: 87%; GMU 15B: 76%) and twinning rates (GMU 15A: 40%; GMU 15B: 63%). Since March 2018, we have had 3 mortalities: one adult female was caught and killed in an illegal snare trap in GMU 15A. Another adult female (GMU 15B moose but moved into GMU 15A) was observed during parturition surveys to show behavior of parturition, but no calf was observed, the moose was accessible by ground, and upon investigation was in poor condition and euthanized. Necropsy analysis indicated the moose had severe endometritis from a retained placenta. Lastly, one female yearling died (GMU 15B), field necropsy indicated it had been bitten on the hind leg and developed septicemia. These 3 collars will be redeployed in November 2018 (cow) and spring 2018 (calf).

In November 2018 we recaptured 27 adult female moose for body condition assessment and to draw blood for pregnancy status. 25 of these moose already had GPS collars, while 2 new moose were captured to redeploy GPS collars. Mean rump fat of adult cows in November was not different ($t_{25} = -1.58$, $P = 0.127$) between GMU 15A (3.1 cm ± 1.5 SD) than GMU 15B (4.2 cm ± 1.9 SD). We captured 30 calves during March 2019 (GMU 15A: n = 15; GMU 15B: n = 15) and weighed them. Weights of 10-month old calves were similar ($t_{28} = 0.85$, $P = 0.405$) between GMU 15A (193.6 kg ± 19.3 SD) and GMU 15B (188.2 kg ± 16.0 SD). We also found no difference ($t_{55} = 0.696$, $P = 0.490$) in body weights of short yearlings between 2018 and 2019. In addition, we deployed expandable GPS collars on 15 female calves (n = 8 in GMU 15A; n = 8 in GMU 15B). Parturition surveys were flown from early May through the middle of June 2019, which provided estimates of parturition rates (GMU 15A: 68%; GMU 15B: 72%) and twinning rates (GMU 15A: 47%; GMU 15B: 59%). One capture related mortality was documented for an adult cow from the November 2018 captures. One female calf was either killed or died within 7

days of capture, a wolf pack was observed on the carcass immediately after the mortality signal was detected. We also investigated 9 other mortalities from collared moose. Three mortalities were potential brown bear kills, while one was an apparent wolf kill. One old female (age 18) died of malnutrition after analyzing bone marrow content. The other 4 mortalities we could not determine cause of death.

GPS location data from the deployed GPS collars is offloaded every 2 months via the Iridium network, providing us up to date locations of these animals. We created minimum convex polygon home ranges for all moose in GMU 15A for the last year (July 2017-July 2018). We then overlaid these home ranges with the East Fork prescribed fire boundary delineated by ADF&G staff and the Kenai National Wildlife Refuge Fire Management Staff. We determined that 21 of the GPS collared female moose (adult: n = 17; yearling: n = 4) potentially utilize the area of the proposed East Fork prescribed fire, ranging from significant home range over lap to other moose who only pass through the area migrating to and from the coast. The current Swan Lake Fire (estimated footprint ~150,000 acres as of August 26, 2019), which encompasses the proposed East Fork prescribed fire, is burning in habitat that is used by moose that currently have a GPS collars. Evaluation of moose movement in response to the fire will be analyzed once the fire is complete, and GIS layers are available from State Forestry.

III. SIGNIFICANT DEVELOPMENT REPORTS AND/OR AMENDMENTS.

Not applicable.

IV. PUBLICATIONS

ADF&G and USFWS completed a monitoring plan and a communications plan for the East Fork prescribed fire as grey literature for internal use. The 2018 5-year action plan for the Kenai Peninsula All Lands All Hands group was noted in the FPR for Fire Management Planning as published at https://www.kpb.us/images/KPB/OEM/AHMP/Annexes/Annex_H_All_Lands_All_Hands_Action_Plan.pdf.

The Kenai Vegetation and Story Map are available for viewing:

https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=4e21c25d5eac421babaef3222004cccf.

V. RECOMMENDATIONS FOR THIS PROJECT

While this project is in year 3 of a 4-year timeline, and the primary project (East Fork prescribed fire) was burned by a wildfire, ADF&G will be seeking opportunities for vegetation treatment as direct habitat enhancement and fuel breaks in various areas of GMU 15A and 15C.

Reconnaissance will take place in fall and winter of 2019. With the expiration date of this grant set for June 30, 2020, ADF&G expects to request an extension to continue habitat enhancement treatments with the remaining budget.

Prepared by: Sue Rodman and Dan Thompson

Date: August 30, 2019

This document is intended to form the basis of the 1) project flyer for public distribution, 2) joint KNWR and ADF&G news release, and 3) Project description for Alaska Fish & Wildlife News (and similar outlets). Review of the document is tracked on the last page. The map will be improved for the flyer and distribution. Communication schedule is proposed, and intended to be coordinated with the partnering agencies.

Main Points - REVISED

1. ***Prescribed fire planned to mitigate wildland fire hazard and enhance wildlife habitat.*** The Alaska Department of Fish & Game (ADF&G) and the US Fish & Wildlife Service - Kenai National Wildlife Refuge (KNWR) are working together by leveraging staff, funds, expertise, and coordination to conduct a prescribed fire northeast of Sterling as early as 2020, considering weather and other variables. The 9,600-acre project is directly adjacent to the 1,100-acre 2017 East Fork wildfire burn scar where fire lines have already been constructed. The burn scar, fire lines, cleared gas line right-of-way and extensive wetlands will form a robust perimeter of the planned burn.
2. ***Prescribed fire is a tool to create 'A Catcher's Mitt,' or a network of fire breaks around communities.*** Through the use of prescribed fire and mechanical treatments, land managers can reduce the risk and hazard to communities of a large wildland fire. The Sterling Fuel Break, Lilly Lake treatment area, East Fork wildfire, past wildfire and prescribed fire scars, along with other treated forest areas can moderate fire behavior and limit spread of a wildfire toward communities. The East Fork prescribed fire is intended to act in a similar way: its location north and east of Sterling disrupts the continuity of mature spruce forests in the Mystery Creek area. When completed, this prescribed burn area will provide enhanced opportunities to allow naturally-ignited wildfires to burn on the landscape ~~to~~ and benefit ecosystem functions such as wildlife habitat.
3. ***Fire supports wildlife habitat for many species.*** To protect expanding communities over the decades, wildfire suppression has been critical for people, homes and infrastructure. As a result, where natural fire used to create a mosaic of variable aged stands, young hardwood trees have now grown out of reach for moose to browse upon, and black spruce dominates many lowland acres in this portion of the peninsula. Of particular concern to Peninsula residents, moose populations in Game Management Unit (GMU) 15A have declined due to loss of available forage. Many species of wildlife benefit from mixed aged forest habitat created by disturbances such as fire: wolves, hare, spruce grouse, songbirds, raptors, moose, lynx, coyote, and others.
4. ***After the fire, hardwood regeneration will help mitigate fire hazard and provide ~~moose~~ forage.*** Spruce forests are the primary fuel for wildfires. This project is intended to burn a mix of spruce and hardwood stands, stimulating aspen, birch, willow, and cottonwood to regenerate. While these species are beneficial as moose forage, they also serve to reduce fire risk as

hardwoods are less effective at carrying fire than spruce. On a small scale, this prescribed fire may make a difference for habitat.

5. ***Long term, landscape level disturbances are needed to influence the abundance of moose in GMU 15A.*** *While this prescribed burn is expected to produce many acres of regenerating trees and shrubs that are attractive to moose, an increase in the moose population is not necessarily expected. In order to improve enough acreage to benefit moose abundance,* landscape level wildfires are necessary to create a mosaic of variable aged hardwood stands. In turn, these regenerating areas will break up fuel continuity in the Peninsula's spruce forests, reducing overall fire hazard.
6. ***Smoke will be present during the burn.*** In writing the prescription for implementation, fire behavior analysts will consider wind direction as it relates to the location of communities, airports, highways, and other infrastructure. From there, the prescription will define the weather conditions suitable for igniting the burn. The benefit of prescribed fire is that we will know when the smoke is expected and can communicate with residents and visitors who may be affected beforehand. When wildfires occur, we can only react to smoke and its impacts on communities, business, and recreation. Managing smoke within a defined scale during a planned timeline gives residents and businesses time to prepare.

Supporting Information for Staff

1. ADF&G and KNWR are cooperating agencies in the **Kenai Peninsula All Lands All Hands** group. State, federal, and local governments meet biennially to share land management updates and leverage opportunities for forest and fire management. This group also includes stakeholders such as Chugachmiut, CIRI, Division of Forestry, US Forest Service, and the Kenai Peninsula Borough.
2. The **proposed project is 9,600 acres** between the Mystery Creek Road and Sterling. The perimeter is defined by the 2017 East Fork wildfire burn scar, fire line built for suppression, a road that parallels the gas pipeline, the Moose River, and an extensive muskeg to the north. Part of every prescribed fire plan is a Maximum Management Area (MMA) which defines the maximum geographic limits of spread within which a fire is allowed to spread. In this case, the MMA aligns with the Moose River, the Moose Research Center, Chickaloon River, topographic features with less flammable vegetation and muskegs, and the East Fork of the Moose River. In the event that the fire exceeds the perimeter of the designated area, managers may decide to allow the fire to burn within the confines of the MMA if smoke and wind conditions do not present additional risk to the operation or the neighboring communities. ***Need to define distances of the burn to Sterling Fuel Break and Sterling Highway on the map.*
3. **Prescribed fire serves as a fire surrogate**: Taking the place of a naturally ignited wildfire, it supports ecosystem function and forest health. This landscape is part of a dynamic fire regime where intermittent burns supported mixed forest cover types and age classes. This process benefits any species that thrives in a mixed forest habitat. ***Take caution in stating that this ecosystem is necessarily dependent on lightning-strike fires. The number of human caused*

ignitions with respect to recent large wildfires on the Kenai needs to be included in this section to normalize the ratio of fire causes and ecosystem dependency on fire.

4. **Moose Vehicle Collisions** average 90 confirmed deaths per year in GMU 15A since 2012. To date in August 2018, 93 moose have been hit on the road system. Most of the mortality impacts cows and calves, which reduces recruitment of moose into the population over time. In assessing collared moose movement, road crossings occur between treated areas where forage plants are regenerating after mechanical treatments. For example, Skilak Lake Road aspen 'crushing' is south across the Sterling Highway from the Lilly Lake treated area. As we look to the future, it will likely be beneficial to keep habitat enhancement projects on one side of the road. Further, it is important to align the timing of habitat treatments with road corridor improvements to reduce vehicle collisions, e.g. road contouring and vegetation management in the Right of Way.
5. **Trade Offs**: short term, negative impacts compared to long term, positive impacts. Smoke from this project may likely impact residents and recreationists in the vicinity. While the charred landscape may not be aesthetically pleasing to view, the potential benefits of wildfire mitigation to communities, enhanced wildlife habitat, and restoring fire's role on the landscape may alleviate the problems associated with long-term fire suppression: high fuel loading leading to catastrophic wildfire, decreased wildlife diversity and degraded habitat, and re-setting the successional clock for area forests to cycle nutrients which helps maintain vigor in tree growth and health.
6. The **catcher's mitt concept** creates a network of safeguards against high intensity fire impacts to values at risk such as communities, power infrastructure, and major roadways. Using prescribed fire to create a mosaic of forest cover types on the landscape mimics natural fire, and thereby increases the resilience of the landscape to adapt after disturbance. Variety in the cover types means that large contiguous blocks of black spruce are broken into smaller stands of hardwood and spruce of different age classes.
7. ***Add a paragraph on **spruce bark beetles** and the outlook for the next 5-10 years with respect to changes in fuel types after mortality, flammability of recently dead trees (red needle phase) vs. lower flammability of dead trees after they lose their needles, unraveling on the forest and jackpot fires that are hazardous to firefighters.*

Comments on the map are welcome! We will add a legend and scale. Labeling will be clear. Inset location map will be added too.

Legend: Kenai NWR boundary, Proposed East Fork Rx, Maximum Management Area, gas pipeline, community and road labels, stream and river labels.

Outreach Schedule

2019 August
Tier 1: Internal Agency leadership and personnel within KNWR-USFWS and ADFG

- ADFG Division of Wildlife Conservation leadership
- KNWR leadership
- Meeting with Kenai NWR and ADFG Region II
- Briefings for agency staff

2019 September October
Tier 2: Government

1. State of Alaska: Department of Environmental Conservation, Division of Forestry, Department of Transportation
2. Kenai Peninsula Borough: Mayor's Office, Central Emergency Services, Emergency Planning Committee, Kenai Peninsula Fire Chief's Association
3. Municipality of Anchorage: Mayor's Office, Anchorage Fire Department, Emergency Operations Center, Merrill Field, Ted Stevens International Airport
4. Agency Partners: Alaska Wildland Fire Coordinating Group, US Forest Service, Bureau of Land Management, National Park Service, Kenai Peninsula All Lands All Hands

2019 November – December
Tier 3: Landowners & Stakeholders (community and organizational meetings)

1. ADFG Board of Game, Alaska State Troopers, Advisory Committee
2. Girdwood GBOS, Cooper Landing, Moose Pass, Seward, Sterling, Soldotna, Nikiski, Kenai, Homer
3. Tribal lands: Salamatof, KNA, CIRI, Tyonek, Kenaitze;
4. Enstar natural gas company, Homer Electric – Chugach Electric (highway corridor)
5. Local Residents, Homeowner Associations, CWPP Communities, Community Organizations, landowners along north coast to Point Possession, Hope, Cooper Landing

2020 March – April – May – June – July
Tier 4: News Media

1. Peninsula Clarion, Anchorage Daily News, Girdwood Gazette (includes Hope and Cooper Landing)
2. ADFG Press Release, Alaska Fish & Wildlife News
3. KNWR Refuge Notebook
4. Recreational users of KNWR, Kenai River, Resurrection Trail
5. Identify event schedule for the area, including trail races, Kenai Lake, fishing season
6. Highway users: notification through media, Alaska 511, DOT highway signs

Key Contacts

- Track communications by contact
- Fields: Date, Name, Agency, Notes, Follow-up
- Ken Marsh & Brenda Duty, Brenda Ahlberg, Leah Eskelin, Tim Mowry to review talking points and be in contact with PIOs from KPB and MOA
- Need a series of outreach products to correlate with various target audiences and timing
- Notification methods, Involvement of CES and DOF, others

Review

1. Draft main points 7/25/18 - Jeff Selinger
2. 2nd Draft main points 8/2/18 – Mary Jo Hill, Kristi Bulock, John Crouse, Ken Marsh (Mike Hill, Jeff Selinger)
3. 3rd Draft 8/8/18 – Mike Hill, Brenda Ahlberg, Leah Eskelin, Ken Marsh
4. 4th Draft 10/3/18 – Sue Rodman
5. 10/3/18 Submitted to Howie Kent, Hans Rinke, Robert Schmoll
6. 12/17/2018 Kristi Bulock, Fire Management Officer at KNWR, provided revised language for the main points; those comments are added below in red. Note that the prescribed fire implementation will be managed by the Kenai National Wildlife Refuge. ADF&G is supporting this operation along with communications, outreach, logistics, and funding based on its intended benefit for moose habitat. Noteworthy are a few key points: 1. The Refuge must operate based on its 2009 Comprehensive Conservation Plan & EIS (including 2013 EA Fire Management Plan); 2. “The Purposes of the proposed FMP for the Kenai NWR are to 1. Protect life, property, human improvements, and cultural resources from the threat of wildland fire through prevention, education, mitigation, and restoration actions on and adjacent to the Kenai NWR; and 2. Maintain the ecological integrity of the Kenai NWR by using prescribed fire (planned ignitions), wildfire, and mechanical treatment methods.” The Refuge has clearly stated that they are not intending to develop a prescribed fire program that would design and implement habitat enhancement burns across this area into the future. ADF&G understands that this project is a one-time event.
7. 2/11/19 Main points revised to reflect Refuge’s comments.
8. 2/21/19 Refuge updates on main point revisions and timeline –Andy Loranger, Kristi Bulock

DRAFT

East Fork Prescribed Burn

Fire and Fuels Circular Plot Monitoring Protocol

L. Saperstein and Mary Jo Hill

June 3, 2019

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Introduction

This document provides methods for monitoring the effects of the ~9600 acre East Fork prescribed fire on the Kenai NWR, Alaska, scheduled for summer 2020 (Fig. 1). Methods are from the Alaska National Park Service (NPS) Fire and Fuels Circular Plot Monitoring Protocol (Barnes and McMillan 2012), incorporating changes as needed to better meet project objectives The NPS protocols include modifications of field-tested methods documented in the Fire Effects Monitoring Protocol (Alaska FETG 2007), the US Forest Service (USFS) FIREMON fire effects monitoring and inventory system (Lutes et al. 2006), and the NPS Fire Monitoring Handbook (2003).

A standardized approach to monitoring the effects of wildfire, prescribed fire, and fuels projects in areas administered by different management agencies increases overall sample sizes for different vegetation types and facilitates comparison within and among regions (e.g., southcentral, interior, southwest, and northern Alaska). Standardized data increases our ability to incorporate science-based information into fire and land management planning and practices and enhances our ability to understand fire adapted ecosystems in Alaska.

The overarching goal of the East Fork prescribed fire is to: "Mitigate the risk and hazard of wildfire threat to the community of Sterling and surrounding infrastructure. Within a current contiguous late successional spruce forest, create an early successional, post-fire forest habitat that establishes a wide buffer likely to moderate future wildfire's behavior as it nears the community of Sterling. **Overall enhancing the landscape's resilience to fire-related disturbance by allowing for fire's natural role to create a mosaic of variable cover types" (draft burn plan).**

Within this goal are 7 broad objectives identified by US Fish and Wildlife Service (FWS) and Alaska Department of Fish and Game (ADFG) staff. The first five objectives are the original objectives defined by ADFG and FWS staff developing the burn plan; they are primarily concerned with reduction of hazardous fuels and successful implementation of the prescribed burn. Objectives 6 and 7 were defined later by ADFG biologists and the FWS fire ecologist; they pertain to increased moose habitat and long term monitoring of vegetation and fuels characteristics.

OBJECTIVE 1: Area burned (surface fuels) is at least 75% of targeted acreage and burn stayed within defined project area.

OBJECTIVE 2: Achieve a mortality of 70-90% in spruce trees throughout all vegetation classes.

OBJECTIVE 3: Within 5 years post burn, increase the acreage of mixed/hardwood forest type component by 10% or greater.

OBJECTIVE 4: Achieve a mosaic pattern of burn severity to diversify the age classes of vegetation and to allow for regeneration of hardwood tree and shrub species through sprouting and seeding.

OBJECTIVE 5: Protect existing cabins, inholdings, sensitive natural features, and cultural sites within the MMA from damage during the implementation of the prescribed fire.

OBJECTIVE 6: Provide habitat enhancement for moose by increasing the quantity of winter browse species (paper birch, aspen, and willows) 0.5 - 3 meter above ground.

- Top -kill at least 60% of existing willow and deciduous trees within study plots within 2 years post fire.
- Increase density (stems/acre) of winter browse species in plots that are 0.5 - 3 meter above ground within 5 years post fire.

OBJECTIVE 7: Estimate vegetation and duff parameters in pre-fire forest stands and at different time-steps post-fire (1, 3, 5, and possible more years) to provide information on: characteristics that can potentially be used to explain burn severity patterns; serve as a baseline against which to assess changes in vegetation and fuels accumulation over time post-fire; predict successional trajectories, and inform future prescribed burn efforts. Estimates should have 25% precision at the 90% confidence interval.

Project Location

The prescribed burn unit is within the Kenai National Wildlife Refuge (NWR). Sterling is about 14.5 km (9 miles) southwest of the unit's western edge and about 21.7 km (13.5 miles) from camp, as the crow flies. The site is dominated by ~ 70-year-old spruce forest and the 2017 East Fork wildfire forms part of the unit's northwest boundary.

Methods

Methods and datasheets were derived from the NPS circular plot monitoring protocol. The NPS protocol includes methods that were not used in this project; these were omitted. Plot locations overlain on imagery with GPS coordinates can be found in Appendix 1. Datasheets, checklists, and cheat sheets can be found in Appendix 2.

PLOT SELECTION/LOCATION

Potential sampling points were randomly located within planned treatment areas using ArcGIS. Vegetation in the burn unit was grouped into the following 3 strata based on a newly developed Kenai vegetation map (USFS 2019) and fuel types developed for Alaska vegetation and crosswalked to standard fuel models (Scott and Burgan 2005, AWFCG 2018):

1. Coastal boreal transition forests and mixed spruce/hardwood forest (1,356 acres)
2. Black spruce peatland (1,013 acres)
3. Open and closed forest (>25% canopy cover), over 75% of canopy dominated by white/Lutz or black spruce (6,139 acres)

A stratified random sample of 50 plots was selected with the following distribution: 10 boreal transition/mixed, 10 black spruce peatland, and 30 open/closed spruce (Fig. 1). Plots in different vegetation/fuel types were given the following designators: M = mixed forest, P = peatland, and S = spruce forest.

PLOT NAMING CONVENTION

The plot names will follow this naming convention: NWR- PPP- ###, where the first three letters (NWR) is the refuge identifier (i.e. KEN, YKF), the next letters (PPP) are the project identifier, and the last three are plot identifiers, starting with the vegetation designator. For the EFRX plots, an example of the project identifier will be: KEN-EFRX-S10, which is for plot #10 in spruce forest.

PLOT LAYOUT
Standard plot configuration is depicted in Figure 2. A 15-m radius circular plot (30-m diameter) will be laid out based on a center-point coordinate. Plot azimuth will always be north-up so that the 30-m end of transect is due north of plot center, 15-m is at the center point, and the 0-m end of transect is due south of center. Likewise, 0-m will be at the western end of the perpendicular transect and 30-m at the eastern end. Ensure that the compass declination is set correctly for the study site.

Repeated visits are planned for this project, so the transect center and end points will need to be marked on the initial visit. The center rebar (~18" long, ½" diameter) will be topped with an aluminum monument. End points will be marked with thick 12" nails. Markers should be installed so that the middle of the center marker lies on the 15-m mark and the nails are at the 0 and 30-m marks. Make sure the nails are at the 30-m mark, not at the location where the spool was secured to the ground since tapes may be extended beyond 30 m.

Establish the plot as follows:

- Keeping the tape as low to the ground as possible, pull the 0-m end of measuring tape due south 15-m (with declination set on compass to 15.5° E) so that the center point is at 15-m on the tape; use a chaining pin to secure the southern end of the tape.
- Then pull the end of the tape in a 30-m straight line to the north and use a chaining pin to stake the 30-m end of the transect. Flag the northern end with a pin flag for reference.
- If the center and endpoints have been previously marked, use the markers to align the tape. Double-check that the center is at 15-m and the ends are at 0 and 30-m as noted above. Check that the orientation of the transect is correct. If not, make a note on the data sheet but do not move the stakes if the transect has been previously surveyed.

The best way to firmly secure the spool end of the tape is to lock the handle, set the tape vertically, and insert the chaining pin through the opening, behind the spool (Figure 3). The spool should be secured as close to the 30-m mark as possible, but it may sometimes be necessary to pull the tape further in order to find solid ground for the chaining pin or to avoid obstructions.

Use a second tape to similarly find the eastern and western ends of the plot. When laying out and moving within the plot, avoid walking or trampling on the right side of the transects where vegetation point-intercept data are collected.

For all plots record the coordinates of the transect center-point. The NAD-83 (2011) Datum will be used in the GPS receivers. ArcGIS projects will use the Alaska Albers projection. Ideally, a mapping grade GPS will be used and the positions will be georectified later. If using a Trimble GeoExplorer or similar device with a data dictionary, record the rover file name rather than coordinates. If using a recreational grade GPS, record the coordinates and associated error. Take an average of at least 20 points for each location. Pay attention to the reported error to determine if more points will be needed; the error should stabilize. If the error increases due to satellite movement, wait and see if it comes down to previous estimates. Record coordinates or rover file name on the SITE DESCRIPTION datasheet.

PHOTOGRAPHS *(Photo Datasheet)*
A minimum of 14 photos are taken for each plot. Two photos (one horizontal and one vertical) in each cardinal direction (N, E, S, W) are taken from the center the circular plot. Photos are than taken from each end of the transect looking toward the center (landscape orientation only). In open areas, the

photo should show the full transect (e.g., north, center, and south markers all visible). In plots with denser vegetation, attempt to include both the end and center markers in the photo if possible. A photo is taken of the ground at the center point. The final photo is of the completed photo datasheet.

Following are instructions for taking the photos. Examples of photos, good and bad, can be found in Figure 4.

- Do not zoom in
- It is important to include reference points for the transect in the photo such as the center and end points.
- Use a small dry-erase board (whiteboard, chalkboard) to write plot information, date, sampling event (eg. pre-fire, YR1, YR5, etc.), and azimuth (direction facing) of photo. Formatting should be as follows: plot ID = KEN-EFRX-P01), azimuth = CP (center point) to N, CP to S, N to S, etc.
- Minimize inclusion of the person holding the whiteboard in the photo. Bring a rag and ziplock bag for rainy days to keep board dry Hold the board to the edge of the photo view within 1.5 - 2 m of the photographer. Hold the camera at a height of about 5 ft above the ground. Record photo subject, number, and time on the Photo Datasheet.
- Alternatively, do not use a board and rely on the detailed data on the photo datasheet so that photos can be labelled digitally (Figure 5). This technique is useful on rainy days when it can be difficult to write on a wet board. It is particularly important to photograph the completed photo datasheet if using this method.
- The ground photo should include the plot marker but does not require a photo board.
- Make sure the photos are not blurry! You will need to review the photos in order to record the time and number on the photo datasheet; look at the photos while doing this and retake them as needed.

SITE DESCRIPTION *(Site Description Datasheet)*

General site information is recorded for each plot on the *SITE DESCRIPTION* Datasheet. More information about plot location descriptions, diagrams of plots, and additional notes can be written on the back of the datasheet. Detailed information on the datasheet fields is provided below. If the plot has been previously visited and staked, only items noted with a * need to be filled out.

Section: General Site Description

- ***Unit** – land unit identifier: Kenai NWR is KEN
- ***Project** – description of project: RX in this case. Other common codes are CBI (burn severity), HZF (for hazard fuels), PP (paired plots), etc. A project may include more than one of these descriptions, so there is some flexibility with what to use. Also include an identifier for the area, such as a fire name or treatment name, EF in this case.
- ***Plot ID** – the full identifier for the plot within the project. This is what will also be written on the whiteboard in photos; it includes the refuge unit, project name, plot unique identifier. For this project, an example ID would be KEN-EFRX-M07.
- ***Date** – sample date

- ***Field Crew** – names of all crew members. On data sheets for other activities, only include names of people actually doing the work for that particular activity.
- ***Plot Markers** – type of marker used to mark plot. If a revisit, note if previously installed markers had been removed and if new ones were installed
- **Transect Azimuth** – record the azimuth of the transect facing from the zero end to the 30-m end, recorded in true north (declination set). In almost all cases, this will be to the north.
- **Transect slope –** % slope from the 0 to 30 m direction, looking down the transect
- **Plot dimensions-** plot radius, record units in meters
- **Slope** –% slope of the *site*, use clinometer. May or may not differ from transect slope
- **Aspect** – slope aspect (facing downhill). Record azimuth (degrees) based on true north compass setting. May or may not differ from transect aspect.
- ***Declination used** – 15.5° E for this project. Ensure that all compasses are set to the same declination. For future visits use the declination used for the initial set up of the plot- do not adjust for change in declination over time.
- **Elevation** – record elevation at center-point of circular plot (m) from GPS.
- ***Soil** – record estimate of soil drainage (wet, moist, or dry). Wet soils must have some visible evidence of water (not including temporary puddles from recent rain), dry soils must be without moisture entirely (e.g. dry sand). The vast majority of soils will be categorized as moist.
- ***Disturbance** – general notes about disturbance to plot and in general area (provide more detail including estimated disturbance date in notes where applicable).
- ***Fire Indicators** – record visible evidence of fire (provide more detail in notes where applicable). General fire history can be obtained from fire perimeter maps, but these may not include unburned portions within the perimeter so it is important to note any signs of fire.
- ***Estimated time since fire** – where fire indicators are noted, provide rough estimate of years since plot area burned. Record known fire year if derived from fire history database. If unsure of time since fire, mark "UNK."

Section: Treatment/Fire Description

- ***Plot Type** – indicate whether a plot is a wildfire, hazard fuels (thinning, masticated, or prescribed fire), or control plot.
- ***Treatment Phase** – Indicate if pre- or post-treatment and time since treatment date. Indicate that it is a maintenance treatment if second or later time the treatment has been implemented.
- ***Treatment Year** – Record the year the hazard fuels reduction occurred (may need to check with refuge staff for information). Leave blank if treatment has not yet occurred
- ***Treatment Type** – Circle the type of fuels treatment and provide additional information in comments as applicable (e.g. 5 ft bole spacing, limb to 5 ft, prescribed fire, etc.).
- ***Fire Number and Fire Name** – prescribed or wildfire fire name and number
- ***Fire Year** - date of prescribed or wildfire fire (year). Leave blank if pre-treatment for prescribed burn

- ***Pre or Post yrs.** – time since wildfire or prescribed fire (years or months). Indicate if pre-fire.

Section: Latitude/Longitude

- **GPS Type** – type of GPS used to collect location information (e.g. Garmin 76CSx Map, Trimble GeoXT)
- **GPS Identification** –GPS unit identifier, if applicable (person's name or unit number if there are more than one of the same type)
- **GPS Datum** – GPS datum used; NAD-83 (use NAD83 (2011) if available)
- **Description** – description of where coordinates recorded (e.g. center-point of circular plot, Landing Zone [LZ], or other pertinent coordinates). If using a GPS integrated with a computer, this may be entered in the unit rather than on paper.
- **Latitude/Longitude** – Use decimal degrees.

  If using a GPS integrated with a computer these data will be stored in the GPS and the file name (rover file for Trimble) will be entered on the datasheet.

  For other GPS units, record the coordinates in decimal degrees (e.g. Latitude: N65.634891°, Longitude: W142.982340°) on the datasheet in addition to storing the waypoint on the GPS. Coordinates need only be recorded if it is the first visit, if permanent markers were not established on an earlier visit, or if plot needs to be shifted for some reason.

  The GPS will already have a plot waypoint stored for navigation; the actual plot center must have a slightly different name in the GPS to distinguish it from the navigation waypoint derived from GIS. Add a "C" after the plot number to indicate plot center recorded in the field. An example of field waypoint name: P09C (*Peatland plot #09, center*).
- **GPS Error** – before saving the coordinate allow the GPS to average for a minimum of 20 points. Record the error and units (m) if not using a GPS/computer.

Section: Vegetation Class

- ***Vegetation Class -** for the 15-m radius circular plot area use the Alaska Vegetation Classification (Viereck et al. 1992) to determine the current vegetation class. Describe to Viereck Level IV or V if possible- see "cheat sheet" in Appendix 3. Note that there are not many disturbed vegetation classes included in the Alaska Classification, so assigning a class may be difficult or not possible after the fire. If this is the case, write "burned in 20xx" on the data sheet. If the plot class differs from the surrounding area, provide notes on the back of the datasheet.
- ***Canopy height:** Record the average height of the live tree canopy by crown class (Table 2) and indicate tree species. There are four crown classes, and there may be more than one class in the plot and a class may include more than one species. *Open grown* crowns receive light from above and all sides much of their life, without influence from other trees. *Dominant trees* extend beyond the general level of other trees in the canopy; they are generally larger than the average trees in a stand and receive full light from above and partly from the side. *Codominants* are trees that form the general level of the canopy, receiving light from above but little from the sides. *Overtopped* trees have their crowns entirely below the general canopy level; they are clearly a younger cohort of trees coming up under the taller canopy.
- ***** **"Circle if Appropriate":** Many plots do not have tall shrubs or seedlings in them, making it easy to simply not fill out the *Tall Shrub/Moose Browse Density Datasheet* or the seedling section of the *Tree*

Density Tally Datasheet. When nothing is written on these sheets, it is impossible to tell if there were no tall shrubs or seedlings or if observers forgot to record data. This section is a way to doublecheck whether this vegetation was indeed absent or just not recorded.

- ***Plot Layout and General Notes** – use back of page to describe how to get to site, landing zones, disturbance, habitat use and any other pertinent observations. Draw maps, diagrams and sketches where applicable.

VEGETATION COVER *(Vegetation Point Intercept Datasheet)*
Along the 30-m transects, the point intercept method will be used to determine plant and ground cover. A rod equipped with a vertically mounted laser pointer (Fig. 5) will be held normal to the ground and all vegetation, live or dead, and substrate type (e.g., duff, mineral soil, rock, ash) intercepted by the laser will be considered a "hit" and will be recorded. Be careful not to point the laser at anybody. For tree cover above the observer's head, use the periscope shaped GRS densitometer (Figure 6) to determine if vegetation is intercepted. When looking through the densitometer, you will see levels and a center point (newer models may have a cross hair). Level the instrument, and record species intercepted by the cross-hair; do not include vegetation that is not a direct hit.

Be sure to record which transect is being sampled (S-N or W-E) in the top section of the datasheet, along with plot, date, and observers. Collect data on right side of tape while walking on the left side of tape. Every 1 m, starting at the 0.1-m mark (offset from 0 to avoid disturbance from securing the tape), record all plant species and types of surface cover (e.g. mosses, lichens, substrate) intercepted. The center point will not be sampled due to trampling, so there will be a total of 56 points sampled per plot.

At each stop, record hits from top to bottom. For example, if black spruce was the tallest vegetation hit at that point (touching laser or detected in the densitometer), black spruce would be recorded first. Similarly, ground cover will always be recorded last. A species can occur more than once at a point due to layering of vegetation. Non-living material can be a little trickier. Litter is defined as dead herbaceous material (leaves, cones, needles, etc.) that is detached and lying on the ground but does not include woody material. There can only be one litter hit at a point, if any. Litter is divided into different types in the database- see below for definitions. Mosses and lichens are broken into several types (see below) and each should have only one hit at a point. Woody material will be classified by fuel time lag class (1 hr., 10 hr., etc.; see below). Standing dead material will be recorded by species (if known) with a "D" superscript. Do not move litter or woody material to see what is underneath; only record hits below if vegetation if it is clearly visible (e.g., the point hits a dead leaf lying on a carpet of feathermoss). Live vegetation can be gently moved to see if other layers are intercepted below it.

- *Species Codes:* Record species using the USDA Plants Database species codes (http://plants.usda.gov/). Generally, the codes are the first two letters of the genus name and the first two of the species. For example, for *Salix glauca* the code is SAGL. Numbers are frequently used to differentiate species with alphabetically similar codes (e.g. *Calamagrostis canadensis* code is CACA**4**), but if exact code is not known then write the species' full name and the temporary code used on the datasheet. Refer to the USDA plants database for the most current species codes.
- *Unknown Species:* If common but unknown species are encountered, collect for later identification, record on the datasheet using an identifiable acronym (e.g., UNKN1) and note a description of the species and whether it was collected.

- *Dead trees:* For dead standing trees, record species and indicate that it is dead by adding a D after the species code as a superscript. For dead branches on a live tree, record as live.
- *Moss types:* Mosses are divided into 3 classes: SPHAG=Sphagnum, FMOSS=branched, feathermoss (pleurocarpous moss), and MOSS=Upright, unbranched (acrocarpous moss). Record to species if known.
- *Lichen types:* Separate based on growth form (FOLIOSE, FRUIT, or CRUST) or use LTRL for dead lichen
- Litter codes: LTRH=Herbaceous litter (leaves (including tree leaves), seeds, etc.), LTRNDL= Needleleaf litter (needles, cones); LTRL= Lichen litter
- For woody debris, fuel time lag class should be recorded based on diameter (1 hr. = 0-0.25", 10 hr. = 0.25-1", 100 hr. = 1-3", and 1000 hr. >3").

TREE DENSITY *(Tree Density Tally Datasheet)*
Record the total number of trees taller than 1.37 m (4.5 ft) that occur within the 8-m radius subplot by species, status (live/dead), and Diameter at Breast Height (DBH) size class (< 5 cm, 5.1 - 10 cm, 10.1 - 15 cm, 15.1 – 23 cm, > 23 cm). Only include tree species, not tall willows or alders.

A tree is considered "in" if the center of the trunk is within the plot. If a tree lies near the edge of the plot, use a rangefinder or tape measure to determine if the center of the tree trunk lies within it. Note that a rangefinder will measure to the edge of the trunk, not the center, so a tree with a rangefinder distance of 8 m will be out of the plot. Disease or insect damage code (Appendix 2.1) should be identified on the tally sheet. Separate rows will be required for different life status (live or dead) of a given tree species. For each coniferous tree species/size/status bin, record the average height to dead and live ladder fuels in meters.

"Seedlings" are all trees that are less than 1.37 m tall, regardless of age. Count all live "seedling" trees by species in four 1-m radius circular subplots located 6-m from the end of each transect arm (at the 6 or 24 m marks, total "seedling" area of 12.6 m^2 or .003 ac).

- **Species** - record the species of the tree using the NRCS species codes (see *Species Code* section above). Tree-sized shrubs, such as willows or alders are *not* considered trees.
- **Diameter at Breast Height (DBH)** - measure the diameter of the tree trunk in centimeters at 1.37 m from the ground using a metric diameter tape or calipers to determine what size class it belongs in. See the back of the Tree Density Tally data sheet and Appendix 2.1 for tips on measuring DBH.
- **Height to live ladder fuel** (conifers) – For a representative tree in each species/size/status class, measure the height to the nearest 0.01 m from the forest floor to the lowest point of a live branch with a tape measure or ruler.
- **Height to dead ladder fuel** (conifers, live and dead)– For a representative tree in each size/status class, measure the height in meters from the forest floor to the lowest point of a dead branch to the nearest 0.01 m**.** Dead ladder heights are often close to the ground, especially on black spruce.
- **Comments –** use this field to describe notable aspects of the tree including location along transect and damage (use damage codes where possible).

DOWN WOODY FUEL LOADING (*Down Woody Debris Datasheet***)**
Tally the number of woody debris particles of different diameters along the two 15-m transects using the planar intersect method outlined by Brown (1974) and the NPS Fire Monitoring Handbook (National Park Service 2003). A separate data sheet will be used for each transect. Transects will start at the western and southern ends of the tapes and finish at the center of the plot. Tally dead and down woody materials only; do not include cones, needle litter, leaf litter, and bark, or stems and branches that are attached to standing trees or shrubs. Down woody fuel loads are measured in standard time lag units (Table 3). For each size class, tally the number of times down woody debris intercepts (crosses) the transect line. A "go-no-go" gauge with openings of 0.25, 1 and 3 inches is used for determining size classes (gauge is not available in metric). If a gauge is not available, a caliper or ruler can be used. Measurements are taken where the wood crosses the transect.

1-hour and 10-hour fuels are tallied along the first 1.82 m (6 ft) of the transect. 100-hour fuels are tallied along the first 3.66 m (12 ft) of the transect. 1000-hour fuels are tallied along the whole 15 m (49.2 ft). *For 1000 hr. fuels, measure and record the diameter where the transect crosses the fuels and record as solid or rotten and also record tree species, if identifiable.* **Record as "NONE" if there are no woody fuels intersecting the transect.**

TALL SHRUB AND MOOSE BROWSE DENSITY *(Tall Shrub and Moose Browse Density Datasheet)*

This method combines measurement of: 1. all tall shrubs (≥1.5 m) and 2. broadleaf species preferred by moose for forage at different height classes in the 8 m radius subplot.

Common tall shrubs on the Kenai Peninsula include alder (*Alnus* spp.), rusty menziesia (*Menziesia ferruginea*) and willow (*Salix* spp.)

Preferred Moose Browse: Not all tall shrub species are foraged on by moose. Willow is considered preferred moose browse as well as the following tree species: paper birch (*Betula neoalaskana* or *B. papyrifera* var. *Kenaica*, aspen (*Populus tremuloides*), and balsam poplar/black cottonwood (*P. balsamifera*) when they are within reach.

Density Counts
Tally tall shrubs and preferred moose browse stems by species, status and height class. See Table 4 for moose browse species. A stem is defined as stems originating at the ground surface level with no visible connection to a neighboring stem.

Status Classes
Resprout - live stem clearly resprouted from a fire or other disturbance top-killed plant.
Live – live stem (non-resprout).
Dead – stem with no sign of living material.

Plant Architecture
Within the 8m radius plot, by species, estimate the percentage of individual plants less than 3m tall that fall within each architecture classification based on moose browse evidence. For determining architecture, an individual plant is defined as a stem or group of stems that are rooted less than 10 cm apart. Stems that arise more than 10 cm from these stems will be considered a separate individual. Note that this differs from the density procedure above, which counts stems rather than individual plants.

Architectural classifications:

a. Broomed – has been extensively affected by browsing activity so that growth form is permanently affected (Fig. 7):
    i. sapling type plants- the main apical stem has been broken by moose. It is important to look at the history of the plant to ensure that; this may have happened 2–10 years before you measured it;
    ii. bushy type plants - more than half of the current annual growth (CAG) stems arise from lateral stems that were produced as a result of browsing. Look back through stems that are many years old.
b. Browsed - has been browsed some in the past, but browsing has not significantly affected its growth. Less than half of CAG twigs between 0.0 and 3.0 m arise from lateral stems that were produced from browsing.
c. Unbrowsed - There is no visible evidence that moose have ever browsed this plant.

Architectural classifications derived from the general methodology outlined by Seaton (2002).

Record percentages of each architectural class by the following ranges: 0%, 0-25%, 26-50%, 51-75%, 76-100%.

BURN SEVERITY AND DUFF CONSUMPTION

Burn severity is defined by the National Wildland Fire Coordinating Group as "a qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts" (https://www.nwcg.gov/glossary/a-z#letter_b). Burn severity can be measured in several ways, each method contributing slightly different information. We will be documenting burn severity by assigning a severity index to specific points in the plot, directly measuring depth of consumption at points established pre-fire, and by assigning a burn severity index for the entire plot, the Composite Burn Index (CBI). CBI data are generally used to ground-truth burn severity maps developed using pre- and post-fire LANDSAT satellite imagery. They can also, as in this project, be used to provide an index of burn severity to serve as a baseline from which to correlate recovery. The first step in assessing burn severity, however, is to get an idea of duff layer thickness by collecting duff plugs.

1. FOREST FLOOR DUFF THICKNESS – DUFF PLUGS

Duff plugs provide baseline information about forest floor fuels related to fire behavior and Canadian Forest Fire Danger Rating System indices. Duff plugs will be examined pre-fire. They require destructive sampling and must therefore be dug up outside of the plot. Duff plugs will be used as surrogates to assess the pre-fire duff characteristics around burn pins within the plot (see #2 below).

Duff layer thicknesses are recorded on the *Duff Thickness* datasheet. Remove duff plugs from at least 2 sites located at least 1-m away from the plot perimeter. Four plugs should be examined in variable areas. Choose collection sites that appear to be representative of the forest floor in the larger plot area, especially for points where burn pins will be located. If the plot contains both *Sphagnum* and feather moss, at least one duff plug should be measured in each moss type. If a plot does not have moss/duff ground cover, record litter, upper duff, and lower duff depths at 2 – 4 locations within the plot.

Detailed instructions and illustrations of the different duff layers can be found in Appendix 4.To extract a plug, carefully cut down through the forest floor using a compass saw or other tool to either mineral soil or permafrost. If permafrost or other obstructions limit the depth of the duff plug then measure the layers available and indicate the type and depth of obstruction. Record the thickness of forest floor layers down to mineral soil (live moss, dead moss, upper and lower duff layers) to the nearest 0.5 cm. Note any observations such as charcoal layers, volcanic ash layer, etc.

2. BURN PINS and BURN SEVERITY CODES

The amount of duff consumed during a fire usually has to be reconstructed post-fire using various clues on the plot. Prescribed fires provide a unique opportunity to directly measure duff consumption by measuring how much duff was burned at pins inserted into the ground prior to the fire. In addition to obtaining a burn depth, burn severity codes for vegetation and the substrate will be recorded at each pin location post-fire.

Ten steel welding pins will be used to mark locations for measuring duff consumption. The pins will only be deployed as close to the actual prescribed fire as possible, and duff consumption will be measured as soon after the fire as possible. If they are left in the ground over winter, they may be disturbed by freeze/thaw action. The duff plugs measured outside of the plot will be used to approximate pre-fire duff layer depths because destructive sampling cannot take place within the plot. Measurements from the nearby Mystery Creek prescribed fire indicated that the average sum of duff and live moss depths in feather moss was almost 16 cm and average depth for *Sphagnum* dominated sites was 34 cm (Olson et al. 2003). Consumption of the forest floor for both moss sites combined averaged around 5.6 cm. It is therefore recommended that the pins be at least 20 cm (8 inches) long so that they are likely to extend through the duff profile in a feathermoss dominated site.

Pins will be placed at approximately 6 m intervals on each transect (6, 12, 18, 24, and 29 m marks – last off set from 30 to avoid area disturbed by plot establishment) for a total of 10 points per plot. Place pins flush with the surface material, usually moss, lichens, or litter. If the pin cannot be placed flush to the surface due to ice or rock below, either cut the section extending above ground or record the remaining height on the data sheet. Note the type of surface material on the *Point Burn Severity* data sheet. Pins will be revisited as soon after the fire as possible. Visiting the same growing season post-fire will minimize the chance that exposed pins will fall over during winter; otherwise, measure the following year. Record the length of the exposed pin in cm and document which duff layer is exposed (e.g., dead moss, upper duff, etc.)

Point burn severity will be measured at the same locations along the transects as the pins. Severity will be measured according to the Alaska Fire Effects Monitoring Protocol (2007), which was modified from the Fire Monitoring Handbook (USDI NPS 2003). This method identifies 5 levels of severity for substrate and vegetation (Table 5). Note that the codes are in reverse order from what might be intuitively expected: a score of 5 indicates unburned, 1 indicates a severe burn, and 0 indicates an absence of burnable material. Data will be collected when the pins are revisited and recorded on the *Point Burn Severity* datasheet.

3. COMPOSITE BURN INDEX (CBI)

The CBI will be assessed during the first growing season post-fire to obtain an overall burn severity score for each plot using methodology described in FIREMON (Lutes et al. 2006). The technique uses visual estimates of the degree of change caused by fire to the substrate (surface) and different vegetation

layers. It therefore helps to be familiar with the forest characteristics of an area in order to assess changes caused by fire. For this project, we will have the advantage of visiting the plots prior to the fire, allowing a better assessment of changes.

The *Composite Burn Index (CBI)* datasheet has been modified from the nationally used sheet to accommodate certain Alaskan features, such as tussocks. The CBI score is assessed for the following strata:

- **Substrates** - inert surface materials (soil, duff, litter, and downed woody fuels) and mosses/lichens
- **Herbs, low shrubs and trees < 3 ft (1m) -** grasses and forbs, as well as shrubs and small trees <3 ft (<1m) tall.
- **Tall shrubs and trees 3-6.6 ft (1-2 m)-** tall shrubs and trees
- **Intermediate trees (subcanopy and pole-sized trees)** - trees canopy layer situated between "tall shrubs and trees" and "big trees" layers, ~ 4–10 inches (10–25 cm) DBH. Trees may be of stratified heights and extend to upper canopy, but crowns receive little direct sunlight.
- **Big trees (upper canopy, dominant, and codominant trees)** - Tree layer taller than intermediate canopy layer which occupies the upper canopy and receives direct sunlight.
- **Total Plot, or Overall** - All strata of the plot combined for assessment of total burn severity.

Within each strata there are at least 4 rating factors that are scored on a scale of 0 – 3 with 0 being unburned and 3 being high burn severity. Strata can be assessed individually or combined for an overall plot score. More detailed descriptions of the strata and how to rank them are included on the back of the data sheet. In addition to scoring variables within strata, there are spaces on the data sheet for things like cover estimates, number of trees alive pre-fire, etc. Be sure to fill out all information on the data sheet. One exception is the photo information as we will be following the photo protocol and recording the information on a separate data sheet.

References

Alaska Interagency Fire Effects Task Group (FETG). 2007. Fire Effects Monitoring Protocol (version 1.0). Editors: J.L. Allen, K. Murphy and R. Jandt. Unpublished report. http://fire.ak.blm.gov/content/admin/awfcg/C. Documents/Monitoring Protocols/Fire Effects Monitoring Protocol v1.pdf

AWFCG Fire Modeling and Analysis Committee 2018. Fuel model guide to Alaska Vegetation. Unpublished document. https://www.frames.gov/documents/alaska/docs/awfcg_2018_FuelModelGuideAlaskaVegetation.pdf

Barnes, J.L. and J.S. McMillan. 2012. Fire and fuels circular plot monitoring protocol. Alaska NPS Fire Management Program, Fire Ecology Program, Fairbanks, AK.

Brown J.K. 1974. Handbook for inventorying downed material. General Technical Report INT-16. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, Utah.

Lutes, D.C., R.E. Keane, J.F. Caratti, C.H. Key, N.C. Benson, S. Sutherland, and L.J. Gangi. 2006. FIREMON: Fire effects monitoring and inventory system. Gen. Tech. Rep. RMRS-GTR-164. Fort Colllins, CO. USDA Forest Service.

Mitchell, J.M. and J.L. Barnes. 2011. FFI (FEAT-FIREMON Integrated) Data Entry Instructions: NPS Alaska Regional Fire Ecology Program. Unpublished Report. Fairbanks, Alaska.

Olson, D., R. Ottmar, and R. Vihnanek. 2003. The 2002 Mystery Creek burn. Preliminary forest floor consumption and fuel moisture report to the U.S. Fish and Wildlife Service. USDA Forest Service Pacific Northwest Research Station Seattle Forestry Sciences Laboratory. Seattle, Washington.

Scott, J.H. and R.E. Burgn. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: USDA, Forest Service, Rocky Mountain Research Station.

Seaton, C.T. 2002. Winter foraging ecology of moose in the Tanana Flats and Alaska Range foothills. Master's Thesis, University of Alaska Fairbanks

USDA Forest Service. 2019. Kenai Peninsula existing vegetation mapping project. Unpublished report.

USDA Natural Resources Conservation Service. 2011. The PLANTS Database (http://plants.usda.gov 22 May 2011). National Plant Data Center, Baton Rouge, Louisiana.

USDI National Park Service. 2003. Fire monitoring handbook. Boise (ID): Fire Management Program Center, National Interagency Fire Center. http://www.nps.gov/fire/ecology/science/FMH.htm

Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick. 1992. The Alaska vegetation classification. General Technical Report 286. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Table 1. Monitoring plot locations within the East Fork prescribed burn unit, NAD83 datum

Plot	Latitude	Longitude
Peatland Plots		
P1	60.63129	-150.419
P2	60.62318	-150.426
P3	60.62841	-150.333
P4	60.64165	-150.38
P5	60.63447	-150.365
P6	60.61495	-150.351
P7	60.62514	-150.431
P8	60.61627	-150.359
P9	60.65168	-150.397
P10	60.62884	-150.427
P11	60.6458	-150.4
P12	60.61586	-150.421
Mixed Forest Plots		
M1	60.60161	-150.459
M2	60.59308	-150.506
M3	60.5978	-150.4
M4	60.61585	-150.395
M5	60.59565	-150.442
M6	60.59313	-150.454
M7	60.6244	-150.409
M8	60.59877	-150.457
M9	60.59175	-150.497
M10	60.6053	-150.399
Spruce Forest Plots		
S1	60.61026	-150.415
S2	60.6013	-150.422
S3	60.62529	-150.368
S4	60.60946	-150.386
S5	60.6137	-150.396
S6	60.57937	-150.469
S7	60.60121	-150.424
S8	60.61658	-150.413
S9	60.61426	-150.359
S10	60.63095	-150.405
S11	60.59792	-150.447
S12	60.61595	-150.377
S13	60.59661	-150.427
S14	60.58288	-150.46
S15	60.58237	-150.498
S16	60.63839	-150.398
S17	60.60575	-150.45

Plot	Latitude	Longitude
Spruce Forest Plots, Continued		
S18	60.58231	-150.51
S19	60.61747	-150.401
S20	60.63913	-150.389
S21	60.5791	-150.483
S22	60.60965	-150.42
S23	60.62239	-150.355
S24	60.63341	-150.387
S25	60.57772	-150.471
S26	60.63453	-150.378
S27	60.62537	-150.34
S28	60.6194	-150.368
S29	60.63712	-150.402
S30	60.57762	-150.483
Alternate Plots		
AP1	60.64728306	-150.3872197
AP2	60.62918243	-150.4195727
AP3	60.63953462	-150.3753554
AP4	60.64914312	-150.401853
AP5	60.63476359	-150.4137256
AM1	60.60689335	-150.3950448
AM2	60.62545682	-150.40887
AM3	60.59220621	-150.5043554
AM4	60.5695689	-150.5024038
AM5	60.60198967	-150.4606815
AS1	60.60097319	-150.4424219
AS2	60.59328916	-150.4456256
AS3	60.59233563	-150.4516123
AS4	60.58090838	-150.4798216
AS5	60.63030128	-150.4029031

Table 2. Crown class descriptions for recording canopy heights on *Site Description* data sheet.

Crown Class	**Description**
Open Grown	Trees with crowns which have received light from above and all sides throughout most of their lives. Their forms or crown shapes have not been and are not likely to be influenced by other trees.
Dominant	Trees with crowns extending above the general level of the crown canopy and receiving full light from above and partly to the side; larger than average trees in the stand, with crowns dense, comparatively wide and long, but possibly crowded on the sides.
Codominant	Trees with crowns forming the general level of the crown canopy and receiving full light from above but comparatively little from the sides; usually with medium-size crowns more or less crowded on the sides.
Overtopped	Trees with crowns entirely below the general level of the crown canopy, receiving no direct light from above or from the sides. Use this code for small trees and regeneration under forest canopy. Note-Only use this class if there is clearly a younger cohort of trees coming up under the taller trees.

Table 3. Down and dead woody debris (Brown's Transects): Woody fuel types, diameter size classes, and distance segment in which each fuel type is tallied along 16-m transect

Diameter size	**Fuel Type**	**Distance to tally along transect**
0 to 0.25 inch	1-hour fuels	From 0 to 1.82 m (6 ft)
0.25 to 1 inch	10-hour fuels	From 0 to 1.82 m (6 ft)
1 to 3 inches	100-hour fuels	From 0 to 3.66 m (12 ft)
> 3 inches	1000-hour fuels Record species, diameter and solid/rotten	From 0 to 16 m (52.49 ft)

Table 4. Shrub and tree species commonly foraged on by moose.
These species will be recorded in the following height classes: 0 -0.5, 0.51 - 1.5, and 1.51 – 3.0 meters. Willows and Highbush Cranberry are considered both moose browse and Tall Shrub species, so will also be recorded in a >3m height class. For all other shrub species, record only if >1.5 m tall.

Common Name	*Scientific Name*	*Comments*
Willow	*Salix spp.*	*Record to species if possible*
Paper birch	*Betula neoalaskana, B. paprifera var. kenaica*	*No need to split out species*
Quaking aspen	*Populus tremuloides*	*May produce many suckers post-fire*
Balsam poplar/black cottonwood	*Populus balsamifera*	*No need to split out species*
Highbush Cranberry	*Viburnum edule*	
Dwarf Birch	*Betula glandulosa*	*May not be common*

Table 5. Codes for point burn severity

SEVERITY CODES	Forest and ShrubTypes	
	Substrate (S)	Vegetation (V)
5 Unburned	Not burned	Not burned
4 Scorched	Litter partially blackened; duff nearly unchanged; wood/leaf structures unchanged	Foliage scorched and attached to supporting twigs (red needles may have dropped and be found at base of trunks)
3 Lightly Burned	Litter charred to partially consumed; upper duff layer may be partially consumed but not altered over the entire depth; surface appears black; small woody debris is partially burned.	Foliage and smaller twigs partially to completely consumed; branches mostly intact; less than 40% of the shrub canopy is commonly consumed
2 Moderately Burned	Litter mostly to entirely consumed, leaving coarse, light colored ash; duff deeply charred to lower duff or upper/lower duff interface, but underlying mineral soil is not exposed; small woody debris is mostly consumed.	Foliage, twigs, and small stems consumed; some branches (>.5-2.5 cm in diameter) (0.25-1.0 in) still present; 40- 80% of the shrub canopy is commonly consumed.
1 Heavily Burned	Litter and duff completely consumed, or within 1 cm of mineral soil, sometimes leaving fine white ash; mineral soil may be visibly altered, sometimes reddish. *Marchantia* and fire mosses may be present.	All plant parts less than 2.5 cm (1 in) in diameter are consumed, only leaving deeply charred major stems or trunks.
0 or N/A Not applicable	Inorganic preburn (i.e. rock or soil unchanged by fire)	None present preburn

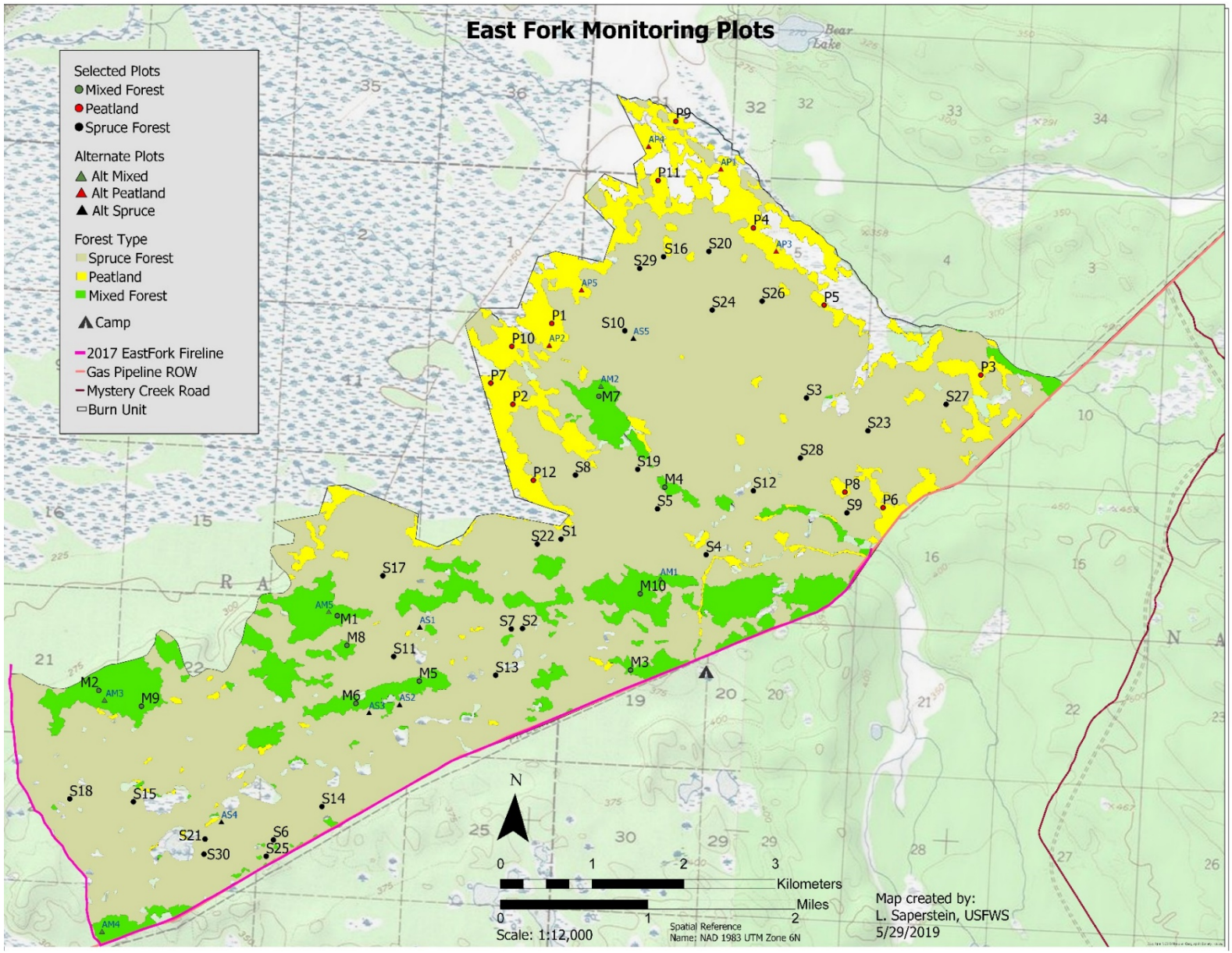
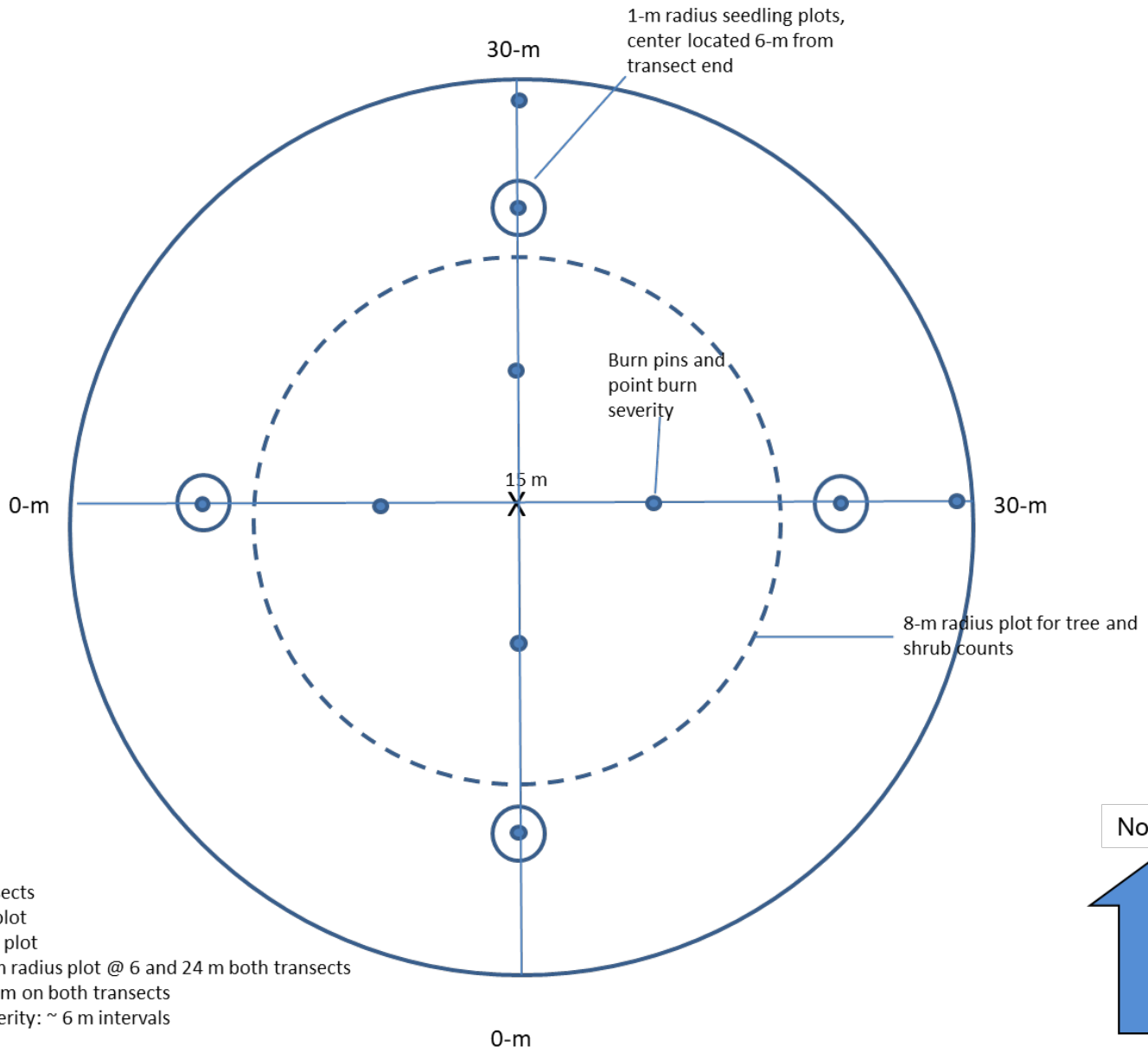


Figure 1. East Fork prescribed burn unit and study plots



CBI: Full plot
Point-intersect: Full transects
Tree counts: 8-m radius plot
Shrub counts: 8-m radius plot
Tree seedling counts: 1-m radius plot @ 6 and 24 m both transects
Browns transects: 0 – 15 m on both transects
Burn pins/Point burn severity: ~ 6 m intervals
(6, 12, 18, 24, and 29 m)

Figure 2 Layout of plot. Diagram is not to scale

Figure 3. Best way to secure the 16-m end of the tape measure.

4a. Shows inclusion of center and southern flag. Azimuth should read CP – S (center point to south), rather than just "S."

4b. Good labeling on whiteboard and person holding board does not intrude on photo. However, the center flag is not included as a reference

4c. Properly taken photo.

Figure 4. Photo examples

Figure 5. Laser pointer for point-intercept of ground vegetation


Figure 6. GRS densitometer
Image from Forestry Suppliers, Inc

Figure 7. Examples of broomed architecture caused by heavy browsing by moose
Photos by ADFG

Appendix 1. Checklists

Appendix 1.1. Field Gear List

	Item	Per Plot
Plot Set-Up		
Tech	GPS w/appropriate map coverage and plot locations downloaded	1
Plot	30-meter tape	2
Plot	Chaining pins	5
Plot	Pin flags	6
Plot	Compass	2
Plot	Rebar, wooden lathe, other plot markers	1
Plot	12” heavy nails for marking transect ends	4
Plot	Mallet for stakes	
Plot	Flagging	1 roll
Plot	Laser range finders/hypsometers (TruPulse)	1
Photos		
Plot	White board/dry erase markers	1 (with extra markers)
Tech	Digital Camera, extra battery	1
Point-Intercept		
Plot	Point-intercept pole	1
Plot	Laser pointers	1
Plot	GRS densitometer	1
Plot	Fuel Diameter measure (go-nogo)	1
Plot	Hand lens	1-2
Plot	Extra AA batteries for laser pointer (in case)	4
Tree Data		
Plot	Clinometer/hypsometer (TruPulse)	1
Plot	Diameter calipers	1
Plot	Diameter logger's tape, metric	1
Plot	Diameter tape (small), metric	1
Plot	Folding ruler 2 meter	2
Plot	Paintsticks or tree crayons	1
Brown’s Transects		
Plot	Go-No Go tool (also for point-intersect)	1
Plot	Caliper or DBH tape (also for tree data)	1
Tall Shrub/Moose browse		
Plot	Folding ruler 2 meter (also for tree data)	1
Plot	Hypsometer (TruPulse) (also for tree data)	1
Duff Plugs		
Plot	Compass or similar saw	1
Plot	Clippers	1
Plot	Metal ruler (cm)	1
General Items		
Plot	Clipboards	3
Plot	Field vest (optional)	1/person
Plot	Write in Rain notebook	1/person

Field Gear List, continued

General Items		
Plot	Extra AA and 9V batteries	1 pkg each
Plot	Plant IDs (hard copy or digital)	
Plot	Field 1st aid kit/1 per team	
Plot	Ziplocks	
Plot	Hand Lens	
Logistic	Inreach	
Logistic	Bendix King Radio w/appropriate freqs	1
Logistic	Copies of original datasheets if revisit	1 set for each year
Logistic	Blank data sheets, field notebooks	
Logistic	Maps of plot locations, laminated	
Logistic	Satellite Phone/cell phone	
Logistic	Shotgun w/ammo or bear spray	
Personal	Food, Clothing, water, insect repellant	

Appendix 2. Data Sheets

Site Description Datasheet

General Site Information:

Unit: Kenai NWR **Project:** East Fork RX **Plot ID:** KEN-EFRX-_____ **Date (M/D/Y):** ___/___/____

Field Crew: _____ **Plot Markers:** _____

Transect Azimuth: _____ (0m to 30m) Transect Slope: ____% **Plot Dimensions:** 30 m diameter

Slope: _____% **Aspect:** _____Deg **Declination used:** 15.5 E **Elevation:** _____m

Soil (circle): Wet Moist Dry **Disturbance** (non-treatment; circle): Fire Wind Insect Other: _____

Fire Indicators (circle): Burn Snags Burned Stumps Fire Scars Burned Plants Charcoal

Est. Time Since Fire (circle): 0-9 yrs 10-20 yrs 21-50 yrs 51-100 yrs > 100 yrs UNK

Treatment/Fire Description:

Plot Type (circle): Wildfire Hazard Fuels (RX Fire) Control

Treatment phase (circle): Pre-treatment Post-treatment Maintenance treatment

Treatment Year: _____ **Pre or Post:** _____(yrs) **Type of Treatment:** Prescribed Fire

Latitude/Longitude: GPS Type: _____ GPS Identification: _____ GPS Datum:_____

Description	Waypoint	Latitude (DD.DDDD)	Longitude(DD.DDDD)	GPS Error
Centerpoint		N	W	m/ft

Plot Vegetation Class:

Current Alaska Vegetation Class (Viereck et al)_____

Pre-Disturbance Viereck Class: _____

Adjacent Vegetation Classes_____

Circle if appropriate: No Tall Shrubs in Plot **No Seedlings in Plot**

Canopy Height Class:

Crown Class	Species	Average Height (m)
Open Grown		
Dominant		
Codominant		
Overtopped		

Notes on Back of Page

Plot Layout and General Notes: Provide notes on vegetation, disturbance, whether plot was shifted from target site, burn information, and other plot notes as needed below.

Photo Record Datasheet

Unit: Kenai NWR Project: EFRX Plot ID: KEN-EFRX-_____

Date (M/D/Y): ___/___/____ Recorder:_____ Camera used:_____

Description	Photo #	Photo Time (military)	Comments
Center to North P			
Center to North L			
Center to East P			
Center to East L			
Center to South P			
Center to South L			
Center to West P			
Center to West L			
North to South			
East to West			
South to North			
West to East			
Ground			
Duff Plug 1			
Duff Plug 2			
Duff Plug 3			
Duff Plug 4			
Photo Data Sheet			

Notes:

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Vegetation Point Intercept Datasheet

Unit: Kenai **Project:** **Plot ID:** KEN-EFRX-_____ **Pre or Post** _____ yrs

Field Date: _____ **Field Crew:** _____Transect: _____

Record substrate and species codes of trees, shrubs, forbs and groundcover intercepted at each 50 cm interval, record plants tallest to lowest. **Record status** (superscript): **D** (dead), **C** (charred), **S** (scorched). ***=**collected. Record woody material by size class: 1 hr, 10 hr, 100 hr, 1000 hr.

PNT	Meters	*Tallest* SPP 1	SPP 2	SPP 3	SPP 4	SPP 5	SPP 6	SPP 7
1	0.1							
2	1							
3	2							
4	3							
5	4							
6	5							
7	6							
8	7							
9	8							
10	9							
11	10							
12	11							
13	12							
14	13							
15	14							
16	16							
17	17							
18	18							
19	19							
20	20							
21	21							
22	22							
23	23							
24	24							
25	25							
26	26							
27	27							
28	28							
29	29							
30	29.9							

Common codes

Trees

Code	*Species Name – Common Name*
PIGL	Picea glauca – White spruce
PIMA	Picea mariana – Black spruce
BENE	Betula neoalaskana – Paper birch
POBA	Populus balsamifera – Balsam poplar
POBAT	Populus balsamifera ssp. trichocarpa
POTR	Populus tremuloides – Aspen

Shrubs

Code	*Species Name – Common Name*
BENA	Betula glandulosa- Shrub birch
ALNUS	Alnus spp – Alder
LEGR	Ledum groenlandicum – Bog Labrador tea
LEPAD	Ledum palustre ssp.decumbens – Marsh Labrador Tea
MEFE	Menziesia ferruginea – Rusty menziesia
ROAC	Rosa acicularis – Prickly rose
SALIX	Willow
VAUL	Vaccinium uluginosum – blue berry
VAVI	Vaccinium vitis-idaea – lowbush cranberry

Ground		**Herbaceous and Graminoids**	
Code	*Species Name – Common Name*	*Code*	*Species Name – Common Name*
LICHEN	Lichen	EPAN2	*Epilobium angustifolium* – Tall Fireweed (CHANA9))
FMOSS	Feather moss	POAL	Polygonum alpinum – Wild rhubarb
SPHAG2	Sphagnum spp (moss)	MEPA	Mertensia paniculata - Tall blue bells
MOSS	Moss other than Sphagnum or feathermoss	LIBO3	Linnaea borealis – Twin flower
W	Water	EQUIS	Equisetum spp – Horsetail
DUFF	Organic duff	CACA4	Calamagrostis canadensis – blue joint grass
MIN	Bare Mineral soil	ERVA4	Eriophorum vaginatum – Cotton tussock sedge
1 HR, 10HR… 100 hr 1000 hr	Woody debris 0-0.25” diameter Woody debris 0.25 – 1” Woody debris 1 – 3” 3”+	LTRH LTRNDL LTRL	Herbaceous Litter Conifer Litter Lichen Litter

Tree Density Tally Datasheet

Unit: Kenai **Plot ID: -KEN-EFRX-_____ Field Date: _____ Field Crew: _____ Plot Dimensions: 8m radius**

Tally the number of trees taller than **4.5' (1.37-m)** by diameter size class, species and status within the 8-m circular plot area. Tally trees by live, dead, or if disease or insects are prevalent (record damage code). Dead trees with < 45° angle to ground are not tallied. For small "layering" trees, pull trees upright to determine if height is > 1.37m. Tally seedlings"/saplings (*live* trees less than 1.37m tall) by species and life status in three 1-m radius circular plots at 4-m, 8-m and 12-m on transect. **Resprouts:** new growth from older root stock, **Seedlings:** new plants from seeds < 10cm (3.9") high, **Mature** >10cm.

		Tree Counts by DBH (cm)					Seedling <1.37 6m S-N	Seedling <1.37 24 M S-N	Seedling <1.37 6 M W-E	Seedling <1.37 24 M W-E
Tree Species	**Status**	**< 5cm (< 2 inches)**	**5.1-10 cm (2 – 3.9 inches)**	**10.1-15 cm (4 – 5.9 inches)**	**15.1-23 cm (6 – 9 inches)**	**>23 cm (>9 inches)**				
Black Spruce *Picea mariana*	LIVE						R	R	R	R
	Dmg___						S	S	S	S
	DEAD									
	Dmg___						M	M	M	M
Avg Live Ladder (m)										
Avg. Dead Ladder (m)										
White spruce *Picea glauca*	LIVE						R	R	R	
	Dmg___						S	S	S	
	DEAD									
	Dmg___						M	M	M	
Avg Live Ladder (m)										
Avg. Dead Ladder (m)										
Aspen *Populus tremuloides*	LIVE						R	R	R	
	Dmg___						S	S	S	
	DEAD									
	Dmg___						M	M	M	

Paper birch *Betula neo-alaskana*	LIVE						R S M	R S M	R S M	
	Dmg___ _									
	DEAD									
	Dmg___ _									
Balsam poplar *Populus balsamifera*	LIVE						R S M	R S M	R S M	
	Dmg___ _									
	DEAD									
	Dmg___									

HOW TO MEASURE DBH (FIREMON 2006)

The diameter of a tree or shrub is conventionally measured at exactly 4.5 ft (1.37 m) above the ground surface, measured on the uphill side of the tree if it is on a slope. Wrap a diameter tape around the bole or stem of the plant, without twists or bends, and without dead or live branches caught between the tape and the stem. When making the diameter measurement, the diameter tape should always be positioned so that it is perpendicular to the tree stem at the point of measurement. If the tree splits above breast height, record as one tree with the diameter measurement made at a representative area below the swell caused by the separation. If the tree splits below breast height then record two trees with diameter measured as close as possible to breast height while still getting a representative measure. If there is a stem deformity at breast height, measure the diameter at the closest location above or below that will allow the most representative diameter measurement (fig. HT-31). There may be times when it is necessary to remove problem branches to thread the DBH tape around the tree bole. If so, carefully remove just enough of the unwanted branches so you do not threaten the survival of the tree.

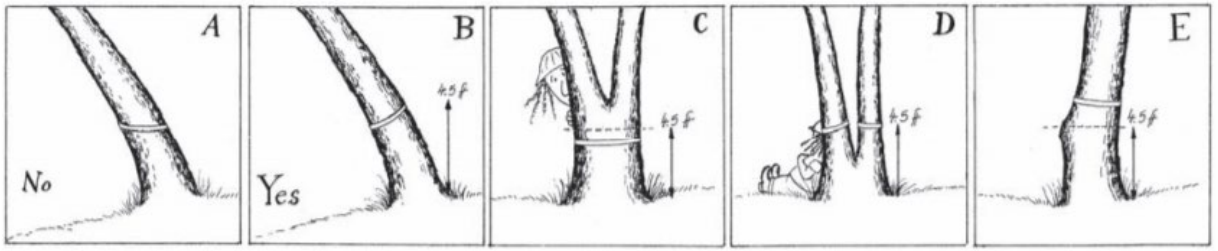

Figure HT-31—DBH measurements. A) Diameter tape is not perpendicular to the tree stem. B) Correct way to measure tree diameter is with tape perpendicular to tree stem. C) If the tree splits above breast height measure tree diameter below any swell cause by the separation. D) If the tree splits below breast height measure as two trees. E) Measure the most representative diameter above or below any deformity.

Down Woody Debris Datasheet

Unit: Kenai **Plot ID:** **KEN-EFRX -_____** **Pre or Post _____ yrs**

Field Date: _____ Field Crew: _____ Transect Length: 15 m

Record the number of intercepts of woody fuels by diameter size class along the transect. Record 1hr (0 - 1/4") and 10 hr (1/4"- 1") from 0 - 1.82-m (6 ft) along transect, 100 hr (1" - 3") from 0 - 3.66 m (12 ft) along transect, and 1000hr (> 3") from 0 – 16 m (52.49 ft). For masticated wood with irregular shape, base size class according to side of chip facing you; may or may not be widest portion of the chip. **Record the species and diameter by condition (solid or rotten) for 1000 hr fuels(>3"). For masticated material, record diameter at widest point on chip and record length.** Optional: Record litter and duff layer thickness at each end of the transect in location off-set by at least 1-m from transect.

	# of intercepts			**>3" Diam: Record Diameter (in) and Species** (0-16 m)	
Transect	**0 – 0.25" 1 hr** (0-1.82 m)	**0.25 - 1" 10 hr** (0-1.82 m)	**1 - 3" 100 hr** (0-3.66 m)	**3"+ solid 1000 hr S**	**3"+ rotten 1000 hr R**
Dir. ____				Species: Diam. Lngth:	Species: Diam. Lngth:
Slope ___				Species: Diam. Lngth:	Species: Diam. Lngth:
				Species: Diam. Lngth:	Species: Diam. Lngth:
				Species: Diam. Lngth:	Species: Diam. Lngth:
				Species: Diam. Lngth:	Species: Diam. Lngth:
				Species: Diam. Lngth:	Species: Diam. Lngth:
				Species: Diam. Lngth:	Species: Diam. Lngth:
	Total:	Total:	Total:		

Definitions & Tally Rules

>Downed woody material is dead twigs, branches, stems and boles of trees and shrubs that lie on or above the ground.
>Measure woody material first to avoid disturbing it and biasing your estimates.
>Do not count dead woody stems and branches still attached to standing shrubs and trees (see below)
>If more than 45 degrees and dead, but still attached at the bole it is still counted
>Do not tally any particle having a central axi that coincides perfectly with the sampling plane.
>If the sampling plane intersects a curved piece more than once tally each intersection
>For rotten logs that have fallen apart try to estimate its original diameter
>Tally uprooted stumps and roots not encased in dirt. Do not tally undisturbed stumps.
>For masticated chips, measure where it crosses the tape in the same orientation as it lies on the ground

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Tall Shrub and Moose Browse Density/Architecture Datasheet

Unit: Kenai **Project:** East Fork Rx **Plot ID:** KEN-EFRX-_____ **Field Date:** _____ **Field Crew:** _____ **Plot Dimensions:** 8m radius

DENSITY COUNTS: Tally all stems for each moose browse or tall shrub species within the 8-m radius circular plot by height class & life status. A stem is defined originating at the ground surface level with no visible connection to a neighboring stem.
Status: **R** – Resprout, live stem resprouted from a fire or other disturbance top-killed plant. **L –** Live, non-resprout **D -** Dead
PLANT ARCHITECHURE: For each species, estimate percentage of plants in plot below 3m that fall within each architecture classification based on moose browse evidence. For shrub species, a plant is defined as a stem or group of stems that are rooted greater than 10 cm apart.
Architecture classes are defined as:
Broomed (Brmd) - 1) *sapling type plants*: the main apical stem has been broken by moose. Look back through the history of the plant, this may have happened 2–10 years before you measured it; 2) *bushy type plants*: more than half of the CAG stems arise from lateral stems that were produced as a result of browsing.
Browsed (Brwd) - Has been browsed some in the past, but browsing has not significantly affected its growth. Less than half of CAG twigs between 0.0 and 3.0 m arise from lateral stems that were produced from browsing.
Unbrowsed (Unbrw) - There is no visible evidence that moose have ever browsed this plant.

Tall Shrub and Moose Browse Density Counts by Height Class						Plant Architecture	
Species	**Status**	**0-0.5 m**	**0.5-1.5m**	**1.51-3 m**	**>3 m**	**Class**	**% Browse Category (Circle)**
Aspen *(Populus tremuloides)*	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Paper birch *(Betula papyrifera)*	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Balsam poplar *(Populus balsamifera)*	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Dwarf Birch *(Betula glandulosa)*	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**

Tall Shrub and Moose Browse Density Counts by Height Class						Plant Architecture	
Species	**Status**	**0-0.5 m**	**0.5-1.5m**	**1.51-3 m**	**>3 m**	**Class**	**% BrowseCategory (Circle)**
Willow ***(Salix Spp.)***	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Highbush Cranberry ***(Viburnum edule)***	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Alder sp. ***(Alnus sp)***	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Rusty Menziesia ***(Menziesia ferruginea)***	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
	D					Unbrw	**0 1-25 26-50 51-75 76-100**
Other Tall Shrub _____	R					Brmd	**0 1-25 26-50 51-75 76-100**
	L					Brwd	**0 1-25 26-50 51-75 76-100**
_____	D					Unbrw	**0 1-25 26-50 51-75 76-100**

Comments (bark stripping, broken stems, other evidence of moose use; Willow species identified on plot):_____

Duff Measurement Datasheet: Measure at least 2 duff plugs per plot

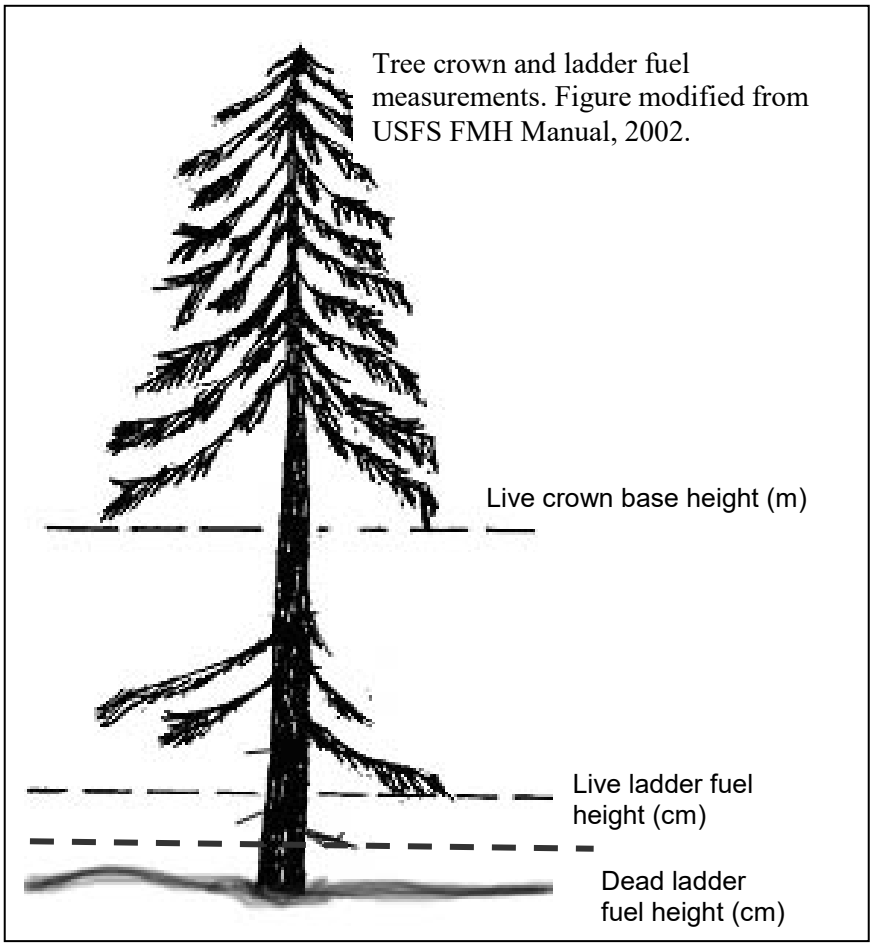
Unit: Kenai Project :East Fork Rx Plot ID: KEN-EFRX- Field Date: Observer:

Sample Site 1			Sample Site 2		
Gen. Location and site characteristics:			Gen. Location and site characteristics:		
	Thickness (cm)	**Comments**		**Thickness (cm)**	**Comments**
Litter			Litter		
Lichen			Lichen		
Live Moss*			Live Moss*		
Dead Moss			Dead Moss		
Upper Duff			Upper Duff		
Lower Duff			Lower Duff		
Sample Site 3			**Sample Site 4**		
Gen. Location and site characteristics:			Gen. Location and site characteristics:		
	Thickness (cm)	**Comments**		**Thickness (cm)**	**Comments**
Litter			Litter		
Lichen			Lichen		
Live Moss*			Live Moss*		
Dead Moss			Dead Moss		
Upper Duff			Upper Duff		
Lower Duff			Lower Duff		

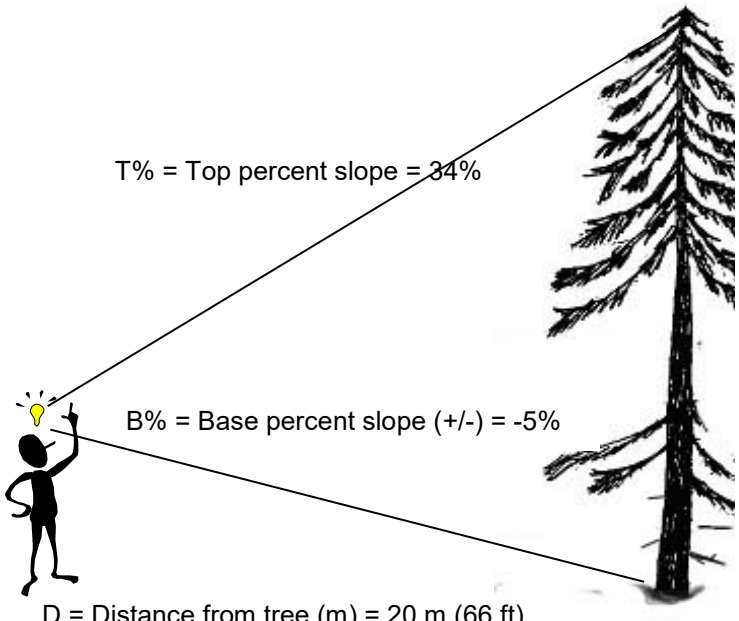
*Record species of moss, if known

Appendix 2.1. Cheat Sheets

Tree Crown Measurements- Cheatsheet



Tree Height Measurements (if hypsometer is not available)



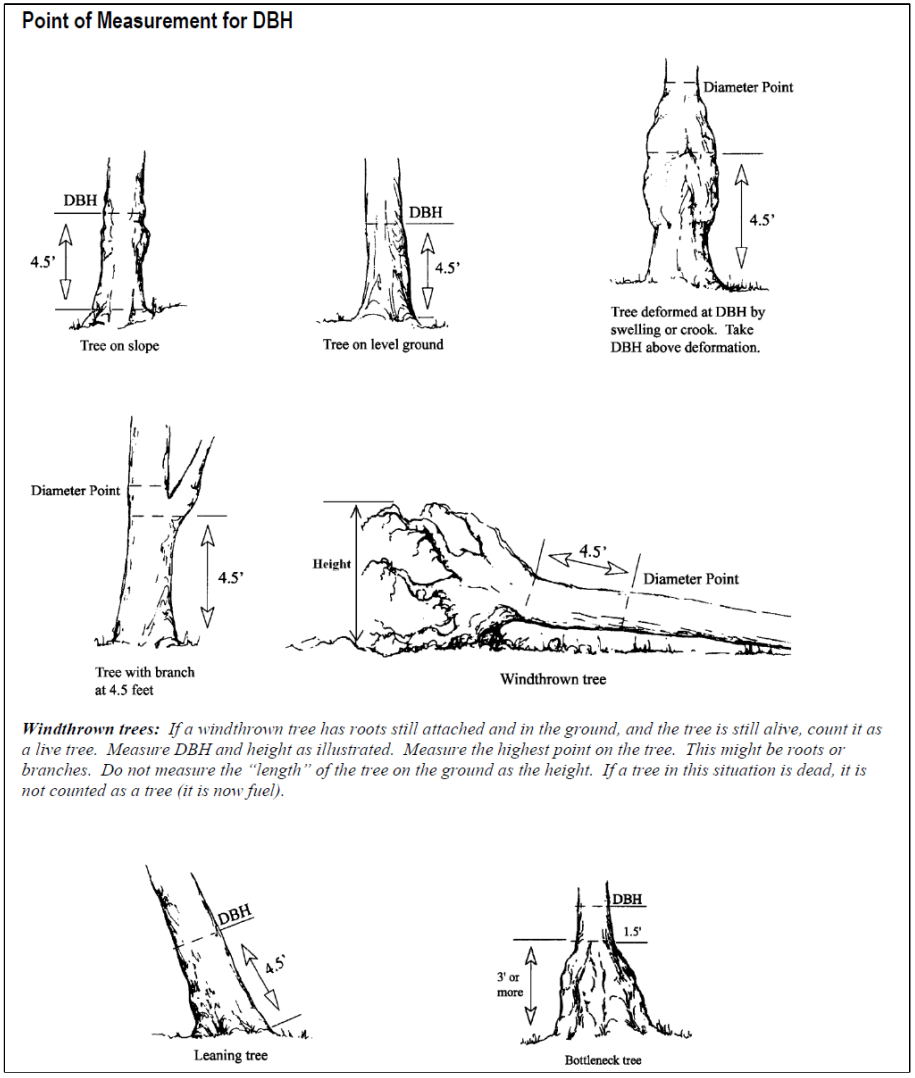
Tree height equals:
Height (m) = D x (T% - B%). If the base percent is negative (reading eye-level to tree or on slope above tree DBH), then add B%, if base percent is positive (on slope below tree DBH) then subtract B%. Height = 20 m x (0.34 + 0.05) = 7.8 m

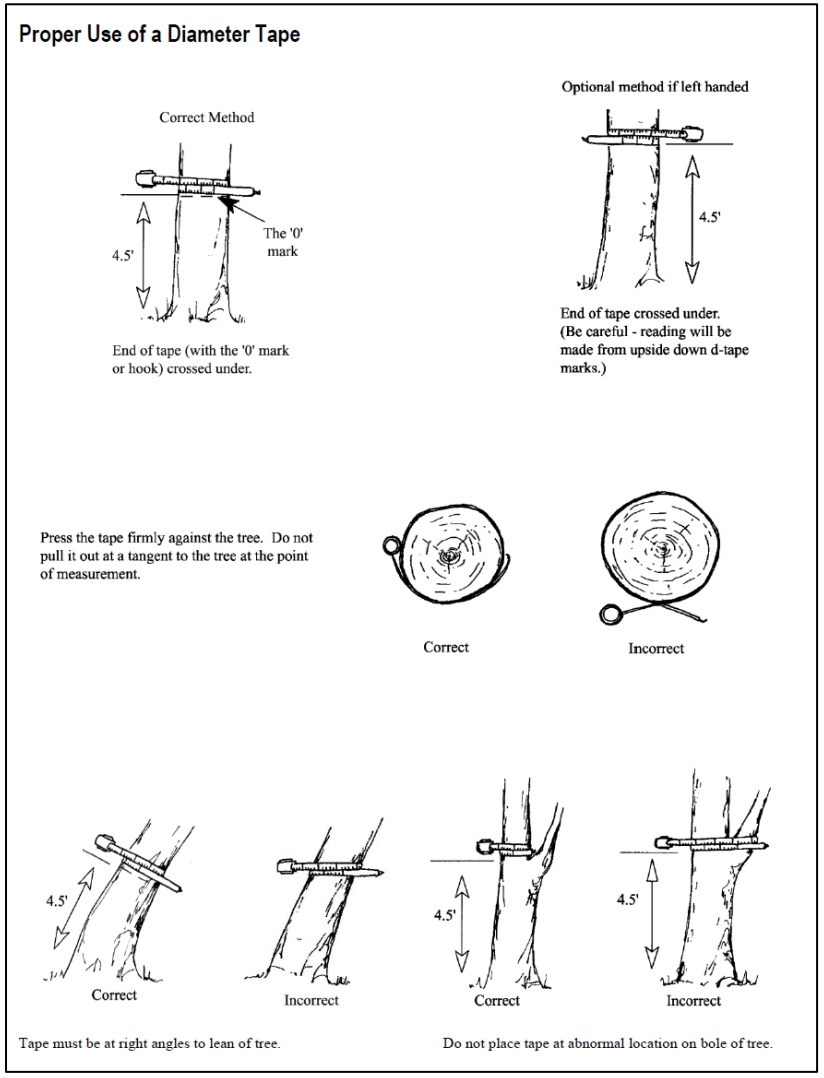
Remember to use percent side of clinometer (right side scale or look for percentage sign at top or bottom of scale) and to move the clinometer up and down, not your head if possible. *Hint:* 10-m (33 ft) and 20-m distances makes easier math, but you must go back far enough to accommodate tree heights.

Damage Codes for Trees

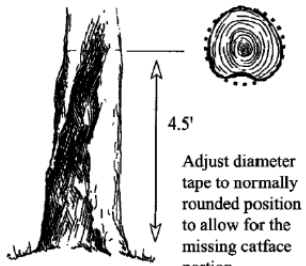
Damage Type	Damage Code	Brief Description
Physical	FORK	Forked top of a tree, multiple primary leaders in a tree crown.
	BROK	Broken tree top.
	DTOP	Upper portion of tree is dead
	BURL	A hard, woody and often rounded outgrowth on a tree.
	DAMG	Mechanical damage to tree
	FIRE	Evidence of fire damage or death.
	LEAN	Tree is leaning.
	MAMM	Damage caused by mammals, such as bear claw marks, porcupine, rabbit or beaver chewing.
	REDB	Red belt, winter desiccation. Foliage and buds killed or faded. May be worse on windward side of tree. New growth is green & normal. Pg. **202** AK I &D
Other	RUST	Spruce needle rust. Current year spruce needles are infected leaving the trees with a distinct orange tinge when the rust is fruiting on the needles. Pg.**129**AK I & D
	BRM	Spruce broom rust. Branches or twig swelling, large burls on main bole or witches' broom (branch proliferation in tree crown). Rust tints needles in the broom yellow/orange. Pg.**146** AK I & D
	GALL	Spruce gall aphids, cause the tree to form conspicuous cone shaped galls on spruce twigs. Dark purple to green initially and then turning brown. Pg. **58** AK I&D
Rots	HRT	Heart rots. *Phellinus pini* conks are hard and woody, upper surface dark brown, hairy (when young), with concentric ridges and a narrow velvety, light brown margin. Lower surfaces dark brown with pores. Coring shows discoloration of the heartwood, light purplish to gray and later changing to reddish brown. Decay pockets may be empty or filled with a mass of white fibers. Other heart rots would be brown cubicle rots, cores will show brown, yellow crumbly rot. Rots described Pg. **162-193** AK I & D.
	ROOTRT	Tomentosa root rot (*Inontus tomentosus*) and Armillaria. Both may have chloritic thin crown, reduced growth, distressed cone crop, resin flow or saturation near root collar. Wind thrown trees lacking major roots. Lose needles oldest to youngest. In Tomentosa roots honeycombed and filled with white mycelium, pink staining. Armillaria has white mycelium and black stringy rhizomorphs under the bark. Rhizomorphs may also be on roots or in soil. Decay in root produces yellow stringy rot w/ fine black lines. Pg. **160** AK I & D
	ROT	Unknown cause of rot, try to record if brown or white rot (Br or W).
Beetles and Bore	BB	Unknown bark beetles, not identifiable as either spruce bark beetle or *Ips* spp. Describe galleries or collect insects.
	IPS	*Ips* spp., engraving beetle. Easily confused with spruce bark beetle. They are smaller (1/8 to 1/4 in) with concave wing covers with projections at the rear. Y, H or star shape galleries. Differences from spruce bark beetle; forked egg galleries, lighter (yellow brown to red orange), and finer boring dust, little boring dust in galleries. Pg. **79** AK I & D
	SPB	Spruce bark beetle damage. Spruce trees. Pg. **71-77** AK I & D.
	BORE	Other boring insect damage – e.g.Carpenter ants, Long-horn beetles, wood wasps, ambrosia beetles
	BRNZ	Bronze birch bore damage. Stem swelling on birch or aspen due to larval galleries are winding – 6mm wide filled with boring dust. Adult may feed on foliage. Pg. **94** in AK I &D.
Defoliators	ASLM	Aspen leaf miner. Larvae feeds on leaves of aspen, leaving galleries in the leaves. Pg. **43** in AK I&D.
	BUDW	Spruce bud worm, brown head, with a lighter body and ivory spots. Web new foliage together and feed in web. Pg. **24** AK I & D
	TUSS	Rusty Tussock Moth. Caterpillars (four yellow tussocks of hair on back) consume leaves of trees and shrubs. Large areas of defoliation can occur. Hosts: Willow, birch, spruce and blue berry Pg. **41**
	UNKN	Tree is damaged or dead, but cannot determine cause.

Tips for measuring DBH from the 2016 Chippewa National Forest Common Stand Exam Field Guide (https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd501261.pdf



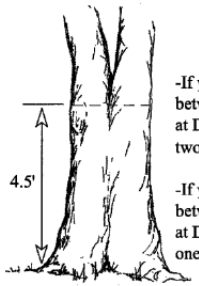


Point of Measurement for DBH (cont.)



Adjust diameter tape to normally rounded position to allow for the missing catface portion

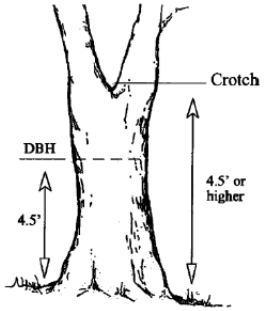
Tree with a catface



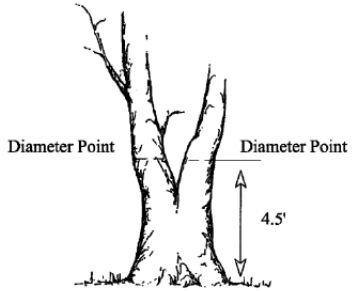
-If you can see light between the two stems, at DBH, measure as two separate trees.

-If you cannot see light between the two stems, at DBH, measure as one tree.

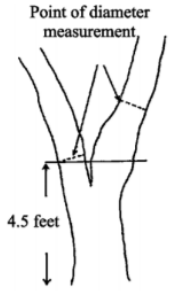
Catface: *Use this same technique on snags where part of the bole is missing at DBH.*



Tree forked at 4.5 feet or higher. Record as one tree and consider only the main fork. Take DBH below the swell of the fork.

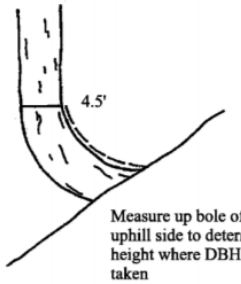


Tree forked below 4.5 feet. Record each fork that is "in" as a separate tree. Measure diameter at 4.5 feet.



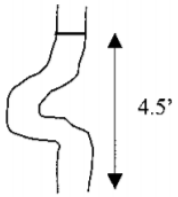
Measuring abnormal diameters on forked trees

Diameter on abnormal fork

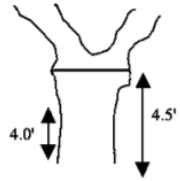


Measure up bole of tree on uphill side to determine height where DBH should be taken

Diameter on pistol butt tree



DBH measurement for a pistol butt shaped tree



Tree forked at DBH. Unable to get a DBH tape through crotch. Take DBH below the swell of the fork.

Metric – English Cheat Sheet

Metric	English	Protocol
2.54 cm	1 inch	General
1 cm	0.39 inches	General
10 cm	4 inches	Shrubs
1 m	39.4 inches / 3.3 feet	General
1.37 m	4.5 feet	General: DBH height
4 m	13 feet	General, Shrubs, Trees
8 m	26 feet	General: Transect radius
16 m	52 feet	General: Transect diameter
20 m	66 ft / 1 chain	General
0 – 0.6 cm	0 – 0.25 inch	Dead and Down Woody Debris
0.6 - 2.5 cm	0.25 – 1 inch	Dead and Down Woody Debris
2.5 – 7.6 cm	1 – 3 inches	Dead and Down Woody Debris
> 7.6 cm	> 3 inches	Dead and Down Woody Debris

Appendix 3. Viereck et al (1992) vegetation classes – cheat sheet. For more detailed descriptions, refer to the original publication.

Woodland: 10 – 25% tree canopy cover
Open Forest: 25 – 60% tree canopy cover
Closed Forest: ≥60% tree canopy cover

If <10% tree cover, it goes into a shrub or herbaceous class.

Common vegetation classes (Level IV; excluding alpine and aquatic)

Code	Description	Comments
IA1j, IA1k	Closed white spruce, black spruce	At least 3 m tall, 60-100% cover; spruce at least 75% of tree canopy
IA1l	Closed mixed black/white spruce	
IA2e, IA2f	Open white spruce, black spruce	At least 3 m tall, 25 – 60% tree cover; at least 75% of tree cover is spruce
IA2g	Open mixed black/white spruce	
IA3c, IA3d	Woodland white spruce, black spruce	At least 3 m tall, 10-25% tree cover; at least 75% of tree cover is spruce
IA3e	Woodland Mixed black/white spruce	
IB1d	Closed paper birch	At least 3 m tall, 60-100% tree cover; at least 75% of tree cover is birch
IB2a	Open paper birch	At least 3 m tall, 25 – 60% tree cover; at least 75% of tree cover is birch
IB1e	Closed quaking aspen	At least 3 m tall, 60-100% tree cover; at least 75% of tree cover is aspen
1B2e	Open quaking aspen	At least 3 m tall, 25 – 60% tree cover; at least 75% of tree cover is aspen
1C1a	Closed mixed spruce/paper birch	At least 3 m tall, 60-100% tree cover; co-dominants
1C1c	Closed spruces-paper birch-quaking aspen	At least 3 m tall, 60-100% tree cover; co-dominants
1C1d	Closed quaking aspen-spruce	At least 3 m tall, 60-100% tree cover; co-dominants
IC2a	Open mixed spruce/paper birch/quaking aspen	At least 3 m tall, 25-60% tree cover; co-dominants
1C2b	Open quaking aspen- spruce	At least 3 m tall, 25-60% tree cover; co-dominants
IC3a	Woodland mixed spruce/paper birch	At least 3 m tall, 10-25% tree cover; co-dominants
IIA2a	Open dwarf black spruce scrub	Trees <3 m tall at maturity=25-60% cover; trees >3 m have less than 10% cover;
IIA3a	Woodland dwarf black spruce scrub	Trees <3 m tall at maturity=10-25% cover; trees >3 m have less than 10% cover
IIB1a, IIB1b	Closed tall scrub-willow, alder	75 – 100% cover of shrubs at least 1.5 m tall; trees <10% cover
IIB1c	Closed tall scrub- shrub birch	
IIB1d	Closed tall scrub alder-willow	
IIB2a	Open tall scrub willow	25-75% cover of shrubs at least 1.5 m tall; trees <10% cover
IIB2b	Open tall scrub alder	
IIB2c	Open tall scrub shrub birch	
IIC1a	Closed low shrub birch	Shrubs 0.2 – 1.5 m tall, at least 75% cover. Trees <10%, tall scrub<25% cover
IIC1b	Closed low willow	
IIC1c	Closed low shrub birch-willow	
IIC2a	Open low mixed shrub-sedge tussock tundra	Shrubs 0.2 – 1.5 m tall, at least 25-75% cover. Trees <10%, tall scrub<25% cover
IIC2b	Open low mixed shrub-sedge tussock bog	Similar to above, but subarctic
IIC2c	Open low mesic shrub birch-ericaceous shrub	Similar to bog below, but lack hydrophytic sedges and Sphagnum
IIC2d	Open low shrub birch ericaceous shrub bog	Similar to above, but on peat with Sphagnum and/or hydrophytic sedges
IIC2e	Open low ericaceious shrub bog	Similar to above, but little to no shrub birch
IIC2f	Open low shrub birch-willow	Poorly drained lowlands; willow co-dominant with birch
IIC2g	Open low willow	25-75% willow cover
IIC2i	Open low willow-graminoid shrub bog	Wet stream bottoms, depressions; understory often CalCan, CarAqu, non-sphag moss
IIC2k	Open low alder-willow scrub	Moist areas, esp. drainageways, understory is SpiBea, Bet, LedDec, VacVit, moss
IIIA2a	Bluejoint meadow	Trees <10%, Shrubs <25% cover
IIIA2d	Tussock tundra	Trees <10%, Shrubs <25% cover
IIIA2h	Sedge-willow tundra	Conspicuous willow component, but shrubs <25%
IIIA2i	Sedge-birch tundra	Conspicuous BetNan or BetGla, but shrubs <25%
IIIA3c	Wet sedge-herb meadow tundra	CarAqu/MenTri, CarAqu/PotPal Shrubs<25%, Sphagnum absent
IIIA3f	Subarctic lowland sedge wet meadow	Mosses (incl. Sphag.) present but sub-dominant to sedge. Lake margin, sloughs,
IIIA3j	Subarctic lowland sedge bog	"quaking" sedge mat; filled in sloughs, boggy pond margins
IIIB2b	Mesic forb- fireweed	Other plants may be present, but are inconspicuous
IIIB3a	Fresh herb marsh, wet	Emergent herbs in water at least 15 cm deep. EquFlu; no woody plants
IIIB3c	Subarctic lowland herb bog	Broad leaf herbs; MenTri, PotPal, CalPal…sphagnum substrate, often floating
IIIC2b	Foliose and fruticose lichen	

Appendix 4. Instructions for measuring duff plugs. Modified from instructions for collecting duff moisture samples in Alaska; information regarding moisture sampling has been removed.

Sampling Technique

Very Important: Do not compress the moss where you are going to sample!

1. Clip any herbs or other stems from the top of the moss.
2. Use a keyhole saw, bread knife, or similar tool with a long serrated edge to cut a square in the moss (Figure 2). Cut down to mineral soil or frozen ground, whichever comes first.
3. Carefully pull away the moss and duff from the sides of the plug. Use your hands to reach down to the bottom and 'pop' the plug out. **Do not compress the sample!** You may need to use the clippers or saw to cut through roots before you can 'pop' the plug.
4. Place the plug on your mat board or other solid surface.

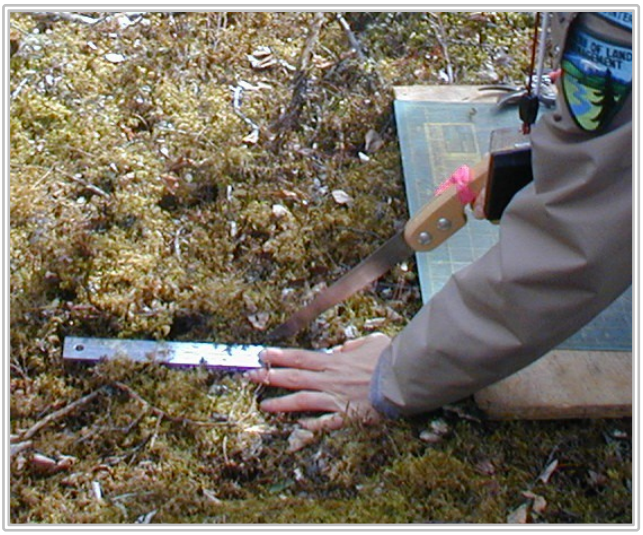


Figure 2. Cutting a duff plug with a keyhole saw. Photo from E. Miller (BLM).

5. Measure the leaf or needle litter layer if it is greater than 1 cm; otherwise record as "T" for trace. Identify the four moss/duff layers: ***Live Moss (LM), Dead Moss (DM), Upper Duff (UD) and Lower Duff (LD)*** (Figure 3). Some layers may be very shallow or not present.

Identifying Duff Layers:

Live Moss (LM): The live moss layer includes the green portion of the moss.

Dead Moss (DM): The dead moss layer is brown and "dead" but not yet starting to decompose. It may include lower sections connected to the green moss. Moss stems and leaves should be fully intact and still mostly oriented vertically.

Upper Duff (UD): Upper duff material has started to decompose and is made up of compacted, fine stems (or pieces of moss). The organic material is randomly oriented rather than upright. Fungal hyphae (white, very fine hair-like strands) are often present in the upper duff layer and are an indicator of decomposition.

Lower Duff (LD) - Optional: The lower duff is very compact and nearly completely decomposed. Moss parts (stems and leaves) are no longer identifiable. This layer is usually thin and very dark in color. **DO NOT** measure mineral soil. Mineral soil is generally lighter in color and when rubbed between your fingers, it smears easily and fills in the lines on your fingertips.

Tips:

- When in doubt, poke the plug. There should be a noticeable difference in density between the dead moss, upper duff, and lower duff layers.
- Don't separate your upper and lower duff layers based on color alone. The upper duff layer can be fairly deep. A darker color towards the bottom of the upper duff layer may just be the moisture gradient. Don't let moisture fool you!

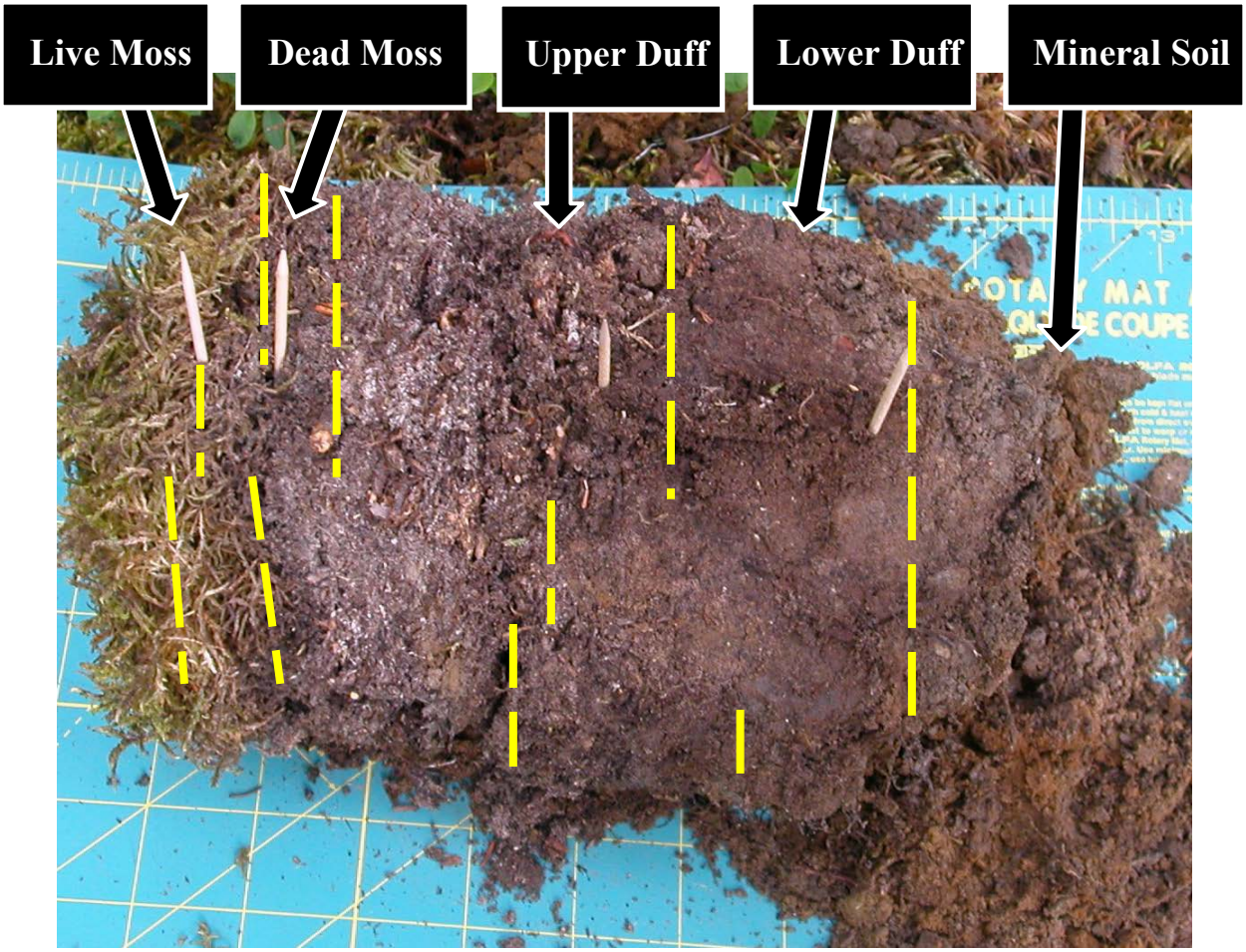


Figure 3. Duff plug sectioned into live moss (LM), dead moss (DM), upper duff (UP), lower duff (LD), and mineral soil layers.

6. Measure the thickness (cm) of each layer and record it on the data sheet along with the corresponding sample number and fuel code (LM, DM, UD, and LD).

References

Wilmore, B. Fuel Moisture Sampling in Boreal Forest Duff.
Unpublished.
http://www.frames.gov/documents/alaska/docs/sampling_manual.pdf