Wildlife Research Report ADF&G/DWC/WRR–2024–02

Evaluation of vegetation within the Funny River Fire footprint, Game Management Unit 15B

Doug Beattie, Mary Jo Hill, Dan Thompson, and Sue Rodman

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Doug Beattie
Program Coordinator
Alaska Department of Fish and Game
1801 S Margaret Way
Palmer, AK 99645
Doug.Beattie@alaska.gov
(907) 861-2101

Dan Thompson
Wildlife Research Biologist
Alaska Department of Fish and Game
34961 Kalifornsky Beach Road
Soldotna, AK 99669-8276-6736
Dan.Thompson2@alaska.gov
(907) 269-9368

Mary Jo Hill
Wildlife Biologist
Alaska Department of Fish and Game
34961 Kalifornsky Beach Road
Soldotna, AK 99669-8276-6736
Dan.Thompson2@alaska.gov
(907) 269-9368

Sue Rodman
Fish and Game Coordinator
Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, AK 99581-1599
Sue.Rodman@alaska.gov
(907) 267-2274

Alaska Department of Fish and Game
Division of Wildlife Conservation
PO Box 115526
Juneau, AK 99811-5526

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Cover Photo: ADF&G staff documenting percent vegetation cover within the 2014 Funny River Fire footprint. ©2020 ADF&G. Photo by Daniel P. Thompson.

Conversions and abbreviations

The following conversions and abbreviations are used without definition in this Division of Wildlife Conservation report. All others, including deviations from definitions listed below, are noted in the text at first mention, in the titles or footnotes of tables, and in figures or figure captions.

- 1 gram (g) = 0.035 ounce (oz)
- 1 millimeter (ml) = 0.039 inch (in)
- 1 centimeter (cm) = 0.394 inch (in)
- 1 meter (m) = 3.281 feet (ft)
- 1 kilometer (km) = 0.621 miles (mi)
- 1 hectare (ha) = 2.471 acres (ac)
- 1 kilojoule (kJ) = 0.239 kilocalorie (kcal)
- 1 megajoule (MJ) = 239.0 kilocalorie (kcal)

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Abstract

In 2014, the Funny River Fire impacted 196,600 acres on Alaska's Kenai Peninsula. In 2017, the U.S. Forest Service (USFS) undertook an effort to classify and map the dominant vegetation types on the Kenai Peninsula. USFS classified much of the area impacted by the Funny River Fire as Mesic Herbaceous dominance type (45%). Based on the characteristics of the Mesic Herbaceous dominance type, these areas should provide good summer habitat with high foraging opportunities for moose (*Alces alces*), but poor winter habitat with no woody browse available. Ongoing research by the Alaska Department of Fish and Game (ADF&G) found that during 2015–2019, ~43% of GPS-collared moose locations within the Funny River Fire footprint occurred within the Mesic Herbaceous dominance types, including during winter. In 2020, ADF&G surveyed vegetation within the Funny River Fire footprint to assess if those areas classified as Mesic Herbaceous dominance type by USFS in 2017 were still accurate or if these areas are beginning to transition into a different dominance type. We found that only 29% of areas classified as Mesic Herbaceous dominance type in the USFS 2017 survey had plant communities that matched the classification in the ADF&G 2020 survey, while the remainder of the dominance types were characterized by plant communities that included shrubs and trees. Our findings suggested that within 3 years after the 2017 vegetation classification within the Funny River Fire footprint, the composition of the vegetation had changed, and we recommend that the area be resurveyed in the near future to track such changes in seral states. Tracking vegetation seral state trajectories over time will provide a better understanding of which portions of the Funny River Fire footprint will provide good browsing opportunities for moose as the forest regenerates after a landscape-scale wildfire.

Project Background

After the 2014 Funny River Fire, the Alaska Department of Fish and Game (ADF&G) initiated research to assess how moose respond to a large-scale fire in Game Management Unit 15B on Alaska's Kenai Peninsula. Population dynamics and forage availability, after mature forests are returned to early seral states after fire, have indicated a positive response from moose (Schwartz and Franzmann 1989); the 196,600-acre Funny River Fire presented an opportunity to provide empirical data that confirms these trends and relationships that we have assumed for decades. The Funny River Fire burned ~32% of the entire vegetated area of Unit 15B; this burn was almost entirely within the Kenai National Wildlife Refuge and mostly within the area designated as wilderness. A 3-year, fine-scale moose research project was initiated to assess habitat and thermal cover preferences in the fire-disturbed portion of Unit 15B as compared to the adjacent Unit 15A, which is dominated by a mature, late seral stage boreal cover type. Adult female moose were captured and fitted with a GPS collar that collected locations at 30-minute intervals. Building on this research, ADF&G then began a long-term, coarse-scale moose location study in 2016, using locations collected every 4 hours over a 5-year period. Additionally, moose body condition was assessed during repeated captures. Body condition metrics and habitat selection will be correlated for each moose by GPS collar locations and vegetation mapping. The vegetation map is an integral component needed to correlate the moose locations and patterns tracked after the fire to assess preferences in habitat and thermal cover related to vegetation composition and structure. Research methods and results associated with the moose movement studies will be published separately; however, population response of moose to this fire is expected to impact management decisions and provide evidence for future regulatory changes. Results from this study on moose response after fire are intended to inform land management decisions to improve habitat either by supporting anthropogenic disturbance of late seral boreal forests through prescribed fire and mechanical treatments or through wildland fire use where appropriate. These disturbance methods are highlighted as they can enhance forage quality and quantity for moose and therefore provide positive benefit to moose hunting and recreational viewing opportunities. As part of the larger research effort, this document reviews the recent vegetation mapping efforts on the Kenai Peninsula and the associated changes in vegetation cover after the 2014 Funny River fire specific to Unit 15B.

Prior to the 2014 Funny River Fire, a comprehensive assessment of vegetation on the Kenai Peninsula using remote sensing with ground truthing to develop a large-scale yet accurate picture of dominant vegetation types was published by O'Brien in 2006, hereafter referred to as the O'Brien 2006 survey. While that mapping effort no longer reflects the current status of dominant vegetation within the area impacted by the Funny River Fire, it serves as a valuable historical record of the vegetation prior to 2014. Moreover, it provides a useful contrast to the post-fire vegetation communities, and it may be possible to examine trends to predict post-fire vegetation compositions from pre-fire states.

The most recent vegetation map for the Kenai Peninsula used data collected in 2017, hereafter referred to as the U.S. Forest Service (USFS) 2017 survey. This effort was coordinated through USFS and partner agencies (Bellante et al. 2020) and used the Kenai Vegetation Dominance Classification system (KVDC). The USFS 2017 vegetation survey methods used within the Funny River Fire footprint were primarily helicopter-based assessments with photo interpretation (35 sites) and limited ground assessments (7 sites). While this coarse-scale approach used for the

USFS 2017 survey vegetation dominance map was appropriate for classifying vegetation types across the landscape, it did not provide the fine-scale vegetation data required to better understand how moose use the vegetation resources available to them (White et al. 2014, Welch et al. 2015, Denryter et al. 2017). For example, the USFS 2017 survey data show that within the Funny River Fire footprint, 45% of the area was classified as a Mesic Herbaceous dominance type. These are plant communities with <10% cover by tree species >3 m in height, <25% shrub cover, and contain indicator species of a mesic moisture regime such as fireweed (*Chamerion angustifolium*) or bluejoint grass (*Calamagrostis canadensis*; Bellante et al. 2020). This definition offers a useful overview of a plant community's structure but gives little indication of plant species that moose are using in this area or what other species were present but not observed (e.g., sapling shrubs and trees).

Due to the coarse scale of the USFS 2017 survey map in the Funny River Fire footprint, ADF&G resurveyed the vegetation in 2020 to provide the data necessary to remap the area to meet the goals of the moose research project in Unit 15B. The updated vegetation mapping also served to evaluate the USFS 2017 survey vegetation dominance map through ground surveys to serve as training sites for future mapping and remote sensing efforts in this region. As much of the area within the Funny River Fire was classified as Mesic Herbaceous dominance type in the USFS 2017 survey, this vegetation type was the focus of the new survey effort. Moreover, moose collar data collected during the period of 2015–2019 indicated that a majority (~43%) of recorded moose locations in the Funny River Fire footprint were within the Mesic Herbaceous dominance type (D. Thompson, Alaska Department of Fish and Game unpublished data). Consequently, focusing on the area classified as Mesic Herbaceous dominance type in the USFS 2017 survey will help researchers develop a better understanding of how and why moose use these areas. Additionally, 3 other vegetation dominance types from the USFS 2017 survey were highlighted as being potentially important to moose: Low Shrub Willow – Dwarf Birch, Quaking Aspen, and White/Lutz Spruce – Birch. These 3 dominance types were examined because >5% of moose collar locations occurred within them, respectively. When combined with the area classified as Mesic Herbaceous dominance type, the total area within these 4 dominance types accounted for 64% of the Funny River Fire footprint and 69% of total moose collar locations (D. Thompson, Alaska Department of Fish and Game unpublished data).

While knowing the vegetation in areas used by moose is beneficial, knowing how moose are using the vegetation is important to aid management decisions regarding moose populations and habitat enhancement projects. Deciduous trees and shrubs provide valuable forage for a range of ungulates, including moose (Risenhoover 1989, Denryter et al. 2017, Parker et al. 1999). When ungulates browse on these deciduous trees and shrubs, they remove the leaves from accessible stems and damage the buds and cambium at the browse site on the plant (Mopper et al. 1991). The damage caused to terminal buds changes the architecture of these plants, which can then be identified in the field (Mopper et al. 1991). Such architectural changes have been used in the past to measure the intensity of use by ungulates (Seaton et al. 2011); this reliable indicator of moose use can be used to record where moose are foraging and on which species.

Given the large percentage of the fire footprint that is classified as Mesic Herbaceous dominance type, the high frequency of GPS moose collar locations within the fire footprint, and the minimal ground truth locations observed within the fire footprint in 2017, ADF&G decided that additional vegetation surveys at these sites were needed to better understand how moose are using the area.

In 2020, the ADF&G Federal Wildlife Restoration Grant AKW-16 Kenai Moose Habitat Enhancement was amended to add this project.

GOALS AND OBJECTIVES

The goal of this field project, hereafter referred to as the ADF&G 2020 survey, was to evaluate the dominance type classifications from the USFS 2017 survey where a high frequency of moose GPS locations occurred during the summer months within the Funny River Fire footprint. The evaluation of the dominance types was to verify or correct the type classifications.

Objectives for 2020 field data collection

1. Evaluate the USFS 2017 survey vegetation dominance types assigned to the Funny River Fire through ground-based vegetation plots in four dominance types: Mesic Herbaceous, Low Shrub Willow – Dwarf Birch, Quaking Aspen, and White/Lutz Spruce – Birch.
2. Apply the ADF&G 2020 survey data collected in the Mesic Herbaceous dominance type to reclass the USFS 2017 survey Mesic Herbaceous dominance type into new classifications based on prior forest types classified in the O'Brien 2006 survey.

Methods

SAMPLE SIZE AND SELECTION

We sampled 60 plot locations (Fig. 1) within the Funny River Fire footprint. The number of plots was determined by the proportion of area occupied by 4 vegetation dominance types from the USFS 2017 survey within the fire footprint: Mesic Herbaceous, Low Shrub Willow – Dwarf Birch, Quaking Aspen, and White/Lutz Spruce – Birch (Table 1). Within the Mesic Herbaceous dominance type, plot locations were further stratified based on the O'Brien 2006 survey vegetation classifications for Black Spruce, White/Lutz/Sitka Spruce, and Mixed Forest (Table 1). This secondary stratification was designed to allow us to determine if there was variation in post-fire vegetation response that correlated to the pre-fire vegetation composition.

Table 1. The stratification of the 60 plots surveyed in the ADF&G 2020 survey by the 2006 O'Brien and U.S. Forest Service 2017 survey vegetation classifications.

USFS 2017 survey dominance type	O'Brien 2006 survey classification	Number of plots
Mesic Herbaceous	Black Spruce	14
Mesic Herbaceous	White/Lutz/Sitka Spruce	14
Mesic Herbaceous	Mixed Forest	10
Low Shrub Willow – Dwarf Birch	–	10
Quaking Aspen	–	6
White/Lutz Spruce – Birch	–	6

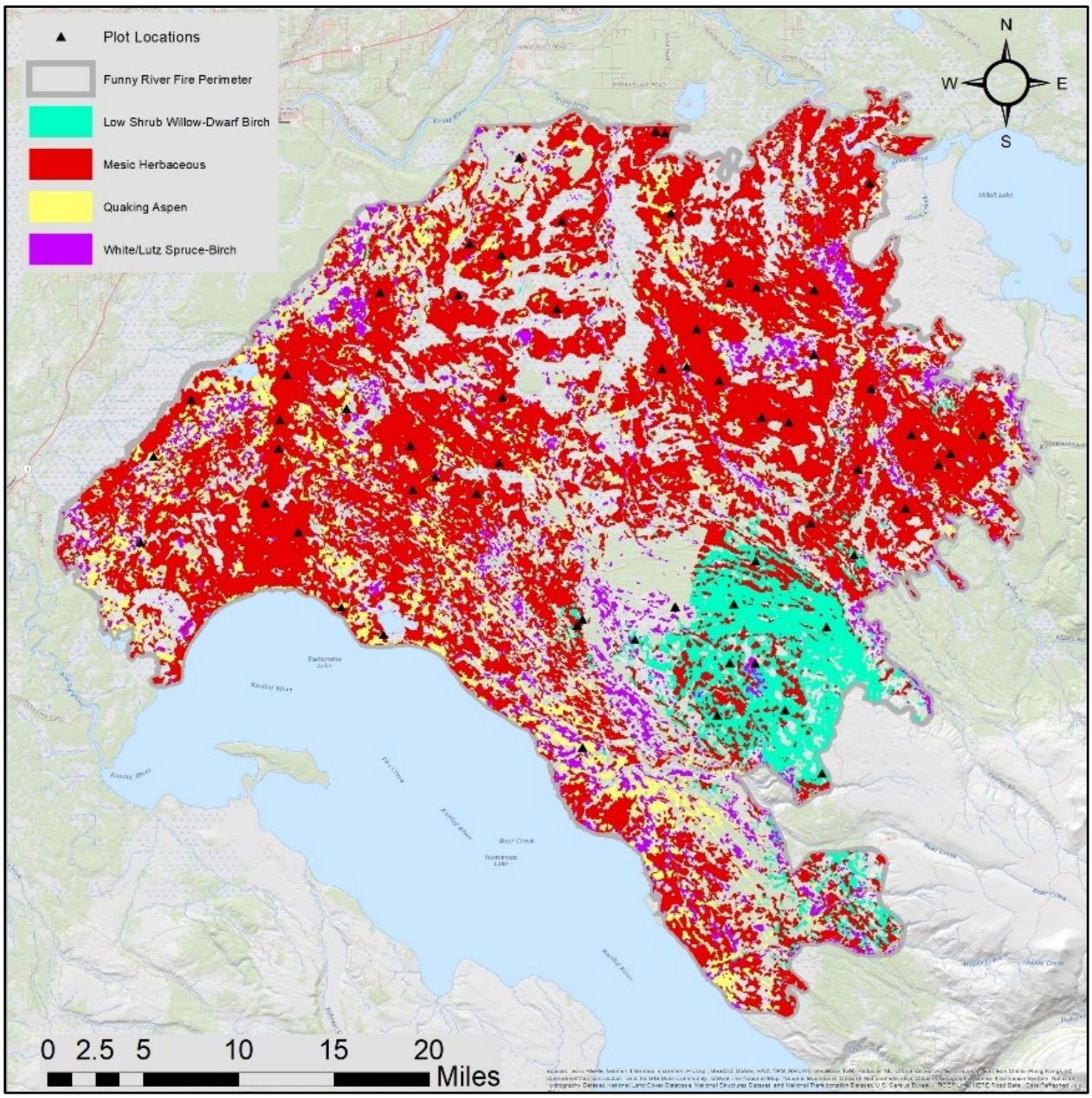

Figure 1. Plot locations and U.S. Forest Service 2017 survey vegetation dominance types of interest within the 2014 Funny River Fire footprint.

FIELD METHODS

We used methods adapted from the Fire and Fuels Circular Plot Monitoring Protocol (Barnes and McMillan 2012). These sampling methods have been adopted by ADF&G to facilitate statewide collaboration and use of compatible fire effects monitoring methods. We measured the following vegetation attributes for each species encountered: ground cover, tree density, documented browse species, browse species height, and browse architecture. Data was collected using the ESRI Survey123 application on iPads. Below is a brief description of these methods, which are

provided in detail in the ADF&G Funny River Fire Vegetation Monitoring Plot Methods (July 2020).

A 16 m diameter circle plot (201 m^2) was established with 2 perpendicular 16 m line transects intercepting the plot center. One transect line ran south to north, while the second ran east to west. Vegetation and ground cover were measured using the point-intercept method (Herrick et al. 2005) every 0.5 m along both 16 m transect lines (n = 64 per plot).

If a shrub species considered preferable moose browse (Appendix B) was recorded along the point-intercept transect, the height and browse architecture of the shrub was documented. Browse architecture classifications were identified as *broomed*, *browsed*, and *unbrowsed* and were based on evidence of prior moose browsing (Seaton 2002). Broomed indicated a high level of browsing that was potentially impacting the plant's growth. Browsed indicated that the plant had been browsed upon, but the browsing did not significantly impact growth. Unbrowsed plants did not have visible evidence that a moose had browsed the plant.

Tree density, counted for any tree species >1.37 m tall, was sampled within the full 16 m diameter plot, with researchers tallying each tree by species and diameter at breast height (DBH) size class. Kenai birch (*Betula papyrifera* var. *kenaica*) and Alaska birch (*Betula neoalaskana)* were not distinguished from each other but were recorded as *Betula neoalaskana*. Likewise, balsam popular (*Populus balsamifera*) and black cottonwood (*Populus balsamifera* ssp. *Trichocarpa*) were not separated for this project.

In Units 15A and 15B, young Alaska birch, aspen (*Populus tremuloides*), and Scouler's willow (*Salix scouleriana*) were preferred moose forage tree species that regenerate readily after a disturbance; hence, availability of these species is key in post-fire moose habitat evaluation.

When a young tree is greater than browsing height (3 m), that tree may still be available to moose. Staff at the ADF&G Kenai Moose Research Center have observed moose regularly bending or breaking trees within DBH ≤5 cm to reach the growth that is above 3 m. Therefore, in addition to DBH class, moose browse tree species <5 cm DBH were separated by height, 1.37–3 m and >3 m.

Lastly, through ocular estimation, the number of browse tree species under 3 m in each browse architecture class was assigned into categories: 0%, 1–25%, 26–50%, 51–75%, and 76–100% of plants.

Seedling density counts were sampled within three 1 m radius subplots. Seedlings were defined as any tree species, including Scouler's willow, that were <1.37 m tall.

Five images were taken from the centerpoint, one toward each cardinal direction and one of ground cover (Appendix C).

LOGISTICS

All 60 plots were sampled in July 2020. The vast majority of the Funny River fire footprint is remote, and 63% of the fire footprint is within the Kenai Wilderness Area. The 2 plots that were accessible by road were completed on 30 June 2020. The remaining 58 plots were completed 6–

14 July 2020 and accessed with an R-44 helicopter and foot travel. The July field effort included the pilot and 2 crews, each with 2 ADF&G staff each day. Due to weather constraints, the number of plots completed per day varied, with 1 day lost due to weather. The remaining days had a minimum of 3 plots and a maximum of 10 plots completed per day.

Data Management and Analysis

All plot data collected was uploaded into the plot-level monitoring software application FEAT/FIREMON Integrated (FFI; Lutes et al. 2009). Analysis for the vegetation measurement data was done using the functions and tools available within FFI and in STATA version 14.0 (StatCorp LP, College Station, Texas, USA).

Vegetation cover data that was collected by species on the point-intercept transect method was broken into plant functional types for cover calculations and analysis (Appendix 1). Plant functional types included broadleaf tree, needleleaf tree, shrub, dwarf shrub, herbaceous, non-vascular, lichen, and non-vegetated. Plant functional types were done to match, as closely as possible, the vegetation groupings used in the 2017 KVDC.

To further refine the USFS 2017 survey Mesic Herbaceous dominance type, we first evaluated how the ADF&G 2020 survey plot data changed from the USFS 2017 survey within the 3 defined classifications (Black Spruce, White Spruce, and Mixed Forest) based on the classifications from the O'Brien 2006 survey (Table 1). Using mixed model regression, we then evaluated if the percentage of vegetated cover was influenced by the interaction of the categorical variable for plant functional type (Appendix 1) with the continuous variables for elevation or latitude. For these relationships, we only used the vascular plant functional groups broadleaf tree, shrub, dwarf shrub, and herbaceous, excluding needleleaf tree as there was minimal sample size for this category (<1% of data). Variables for latitude and elevation were evaluated to determine if these metrics influenced the percent vegetated cover. These evaluations were completed on account of unsubstantiated observations during moose captures that some vegetation types (e.g., Mesic Herbaceous dominance type and bluejoint grass) had a higher concentration along the southern end of the fire footprint (thermal effect adjacent to Tustemena Lake) and declined as elevation increased up to the Tustumena Bench.

Results

Kenai Vegetation Dominance Types

We compared how the ADF&G 2020 survey plot locations were classified by the USFS 2017 survey with the new classification based on our fieldwork in 2020. There were 37 out of 60 vegetation plots sampled in the ADF&G 2020 survey that changed in vegetation classification from the USFS 2017 survey. The greatest differences between the USFS 2017 survey and the ADF&G 2020 survey vegetation classifications were seen in the areas classified in 2017 as Mesic Herbaceous dominance type and White/Lutz Spruce – Birch dominance type (Fig. 2). We further examined the differences between the area classified as Mesic Herbaceous dominance type or White/Lutz Spruce – Birch dominance type in the USFS 2017 survey and ADF&G 2020 survey classifications. Of the 38 plots sampled in areas classified as Mesic Herbaceous dominance type in the USFS 2017 survey, 27 plots were reclassified as a different vegetation

class in the ADF&G 2020 survey (Fig. 3; Table 2). Additionally, 5 out of 6 White/Lutz Spruce – Birch dominance type plots from the USFS 2017 survey were classified as a different vegetation class in the ADF&G 2020 survey (Fig. 4). Two types classified in 2017 had ≥80% of plots classified the same in 2020: Low Shrub Willow – Dwarf Birch dominance type (8 out of 10 plots) and Quaking Aspen dominance type (5 out of 6 plots; Fig. 2).

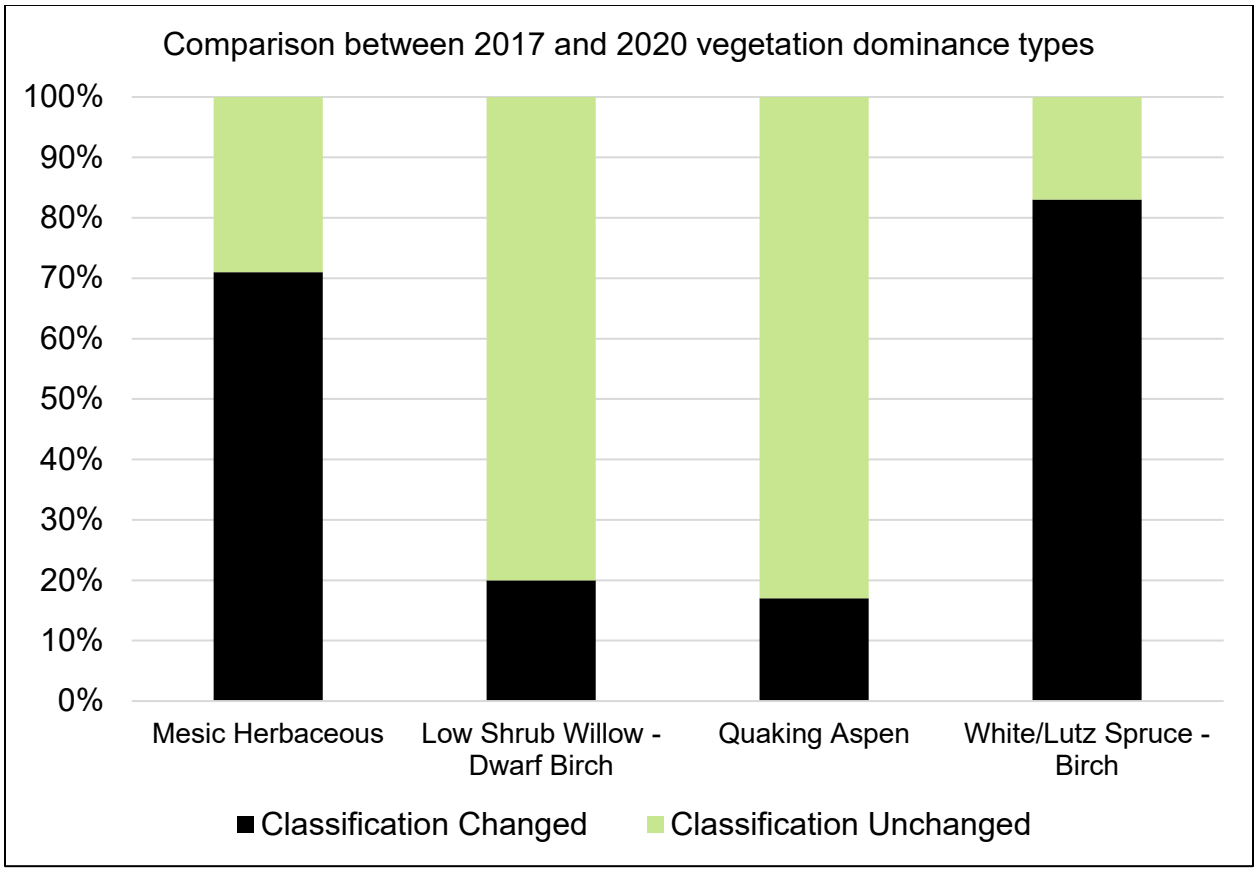

Figure 2. The proportion of plots that were assigned the same vegetation dominance type in both the U.S. Forest Service 2017 survey and the ADF&G 2020 survey.

The ADF&G 2020 survey identified that 29% of the Mesic Herbaceous dominance type classified in the USFS 2017 survey retained this same dominance type in 2020. The remaining 71% of the Mesic Herbaceous dominance type classified in the USFS 2017 survey was reclassified in the ADF&G 2020 survey. The 2 main dominance types reclassified in the ADF&G 2020 survey were Quaking Aspen (24%) and Low Shrub Willow – Dwarf Birch (21%). These dominance types are characterized by the presence of woody vegetation, which is generally absent in the Mesic Herbaceous dominance type. This is a notable change in the vegetation dominance type from the Mesic Herbaceous dominance type classified in the USFS 2017 survey.

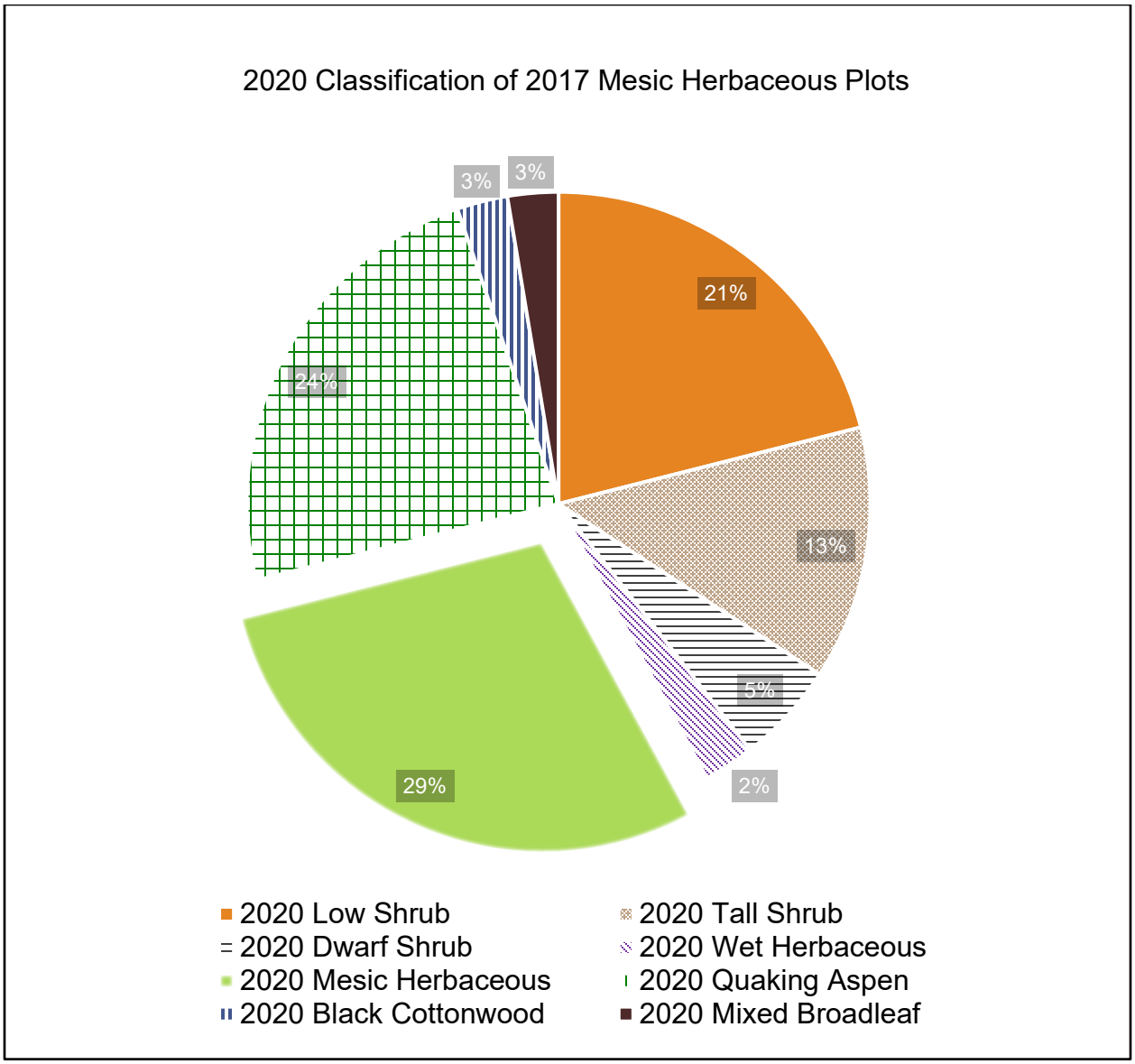

Figure 3. Proportion of vegetation dominance types from the ADF&G 2020 survey within the Funny River Fire footprint that were initially mapped as Mesic Herbaceous dominance type in the U.S. Forest Service 2017 survey.

Table 2. A comparison of plot classification over time for those plots classified as Mesic Herbaceous dominance type in the U.S. Forest Service 2017 survey.

USFS 2017 survey dominance type	O'Brien 2006 survey	ADF&G 2020 survey dominance type	*n*
Mesic Herbaceous *n* = 38	Black Spruce *n* = 14	Quaking Aspen	1
		Tall Shrub Willow	1
		Low Shrub Willow – Dwarf Birch	6
		Ericaceous Dwarf Shrub	2
		Mesic Herbaceous	3
		Wet Herbaceous	1
	White Spruce *n* = 14	Quaking Aspen	2
		Tall Shrub Willow	3
		Low Shrub Willow – Dwarf Birch	1
		Other Low Shrub (rusty menziesia/rose)	1
		Mesic Herbaceous	7
	Mixed Forest *n* = 10	Quaking Aspen	6
		Black Cottonwood (and balsam poplar)	1
		Mixed Broadleaf	1
		Tall Shrub Willow	1
		Mesic Herbaceous	1

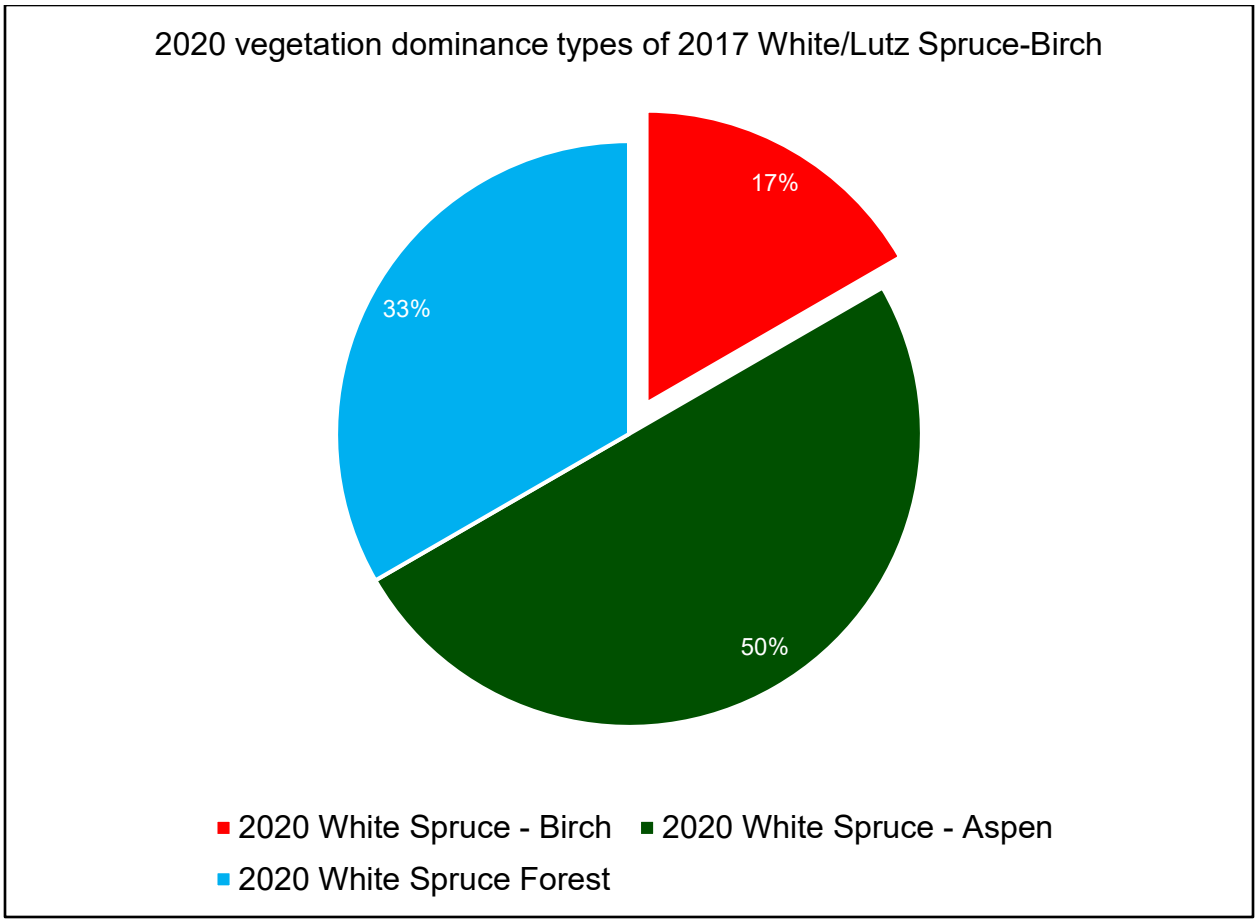

Figure 4. Proportion of vegetation dominance types from the ADF&G 2020 survey within the Funny River Fire footprint that were initially mapped as White/Lutz Spruce – Birch dominance type in the U.S. Forest Service 2017 survey.

Of the plots observed in the USFS 2017 survey White/Lutz Spruce – Birch dominance type, only 17% were classified as the same dominance type in the ADF&G 2020 survey (Fig. 4). Two other vegetation dominance types accounted for the remaining 83% of plots surveyed in the ADF&G 2020 survey: White/Lutz Spruce (33%) and White/Lutz Spruce – Aspen (50%; Fig. 4). To be classified as White/Lutz Spruce – Birch dominance type, Alaska birch must account for >25% of the total tree cover. Moreover, in the White Spruce – Aspen dominance type, aspen accounted for >25% of total tree cover.

O'Brien 2006 survey vs. ADF&G 2020 survey Classifications

We also compared how the ADF&G 2020 survey data compared to the O'Brien 2006 survey classifications, but only for areas classified as Mesic Herbaceous dominance type in the USFS 2017 survey. The 3 O'Brien 2006 survey classifications we compared to the ADF&G 2020 survey were Black Spruce, White Spruce, and Mixed Forest.

Areas that were classified as Mixed Forest in the O'Brien 2006 survey, and reclassified as Mesic Herbaceous dominance type in the USFS 2017 survey, were dominated by broadleaf forest

dominance types (74%) as observed in the ADF&G 2020 survey (Fig. 5; Fig. 6; Table 2). Most of this area was classified in the ADF&G 2020 survey as Quaking Aspen dominance type (60%), followed by Black Cottonwood dominance type (7%) and Mixed Broadleaf dominance type (7%).

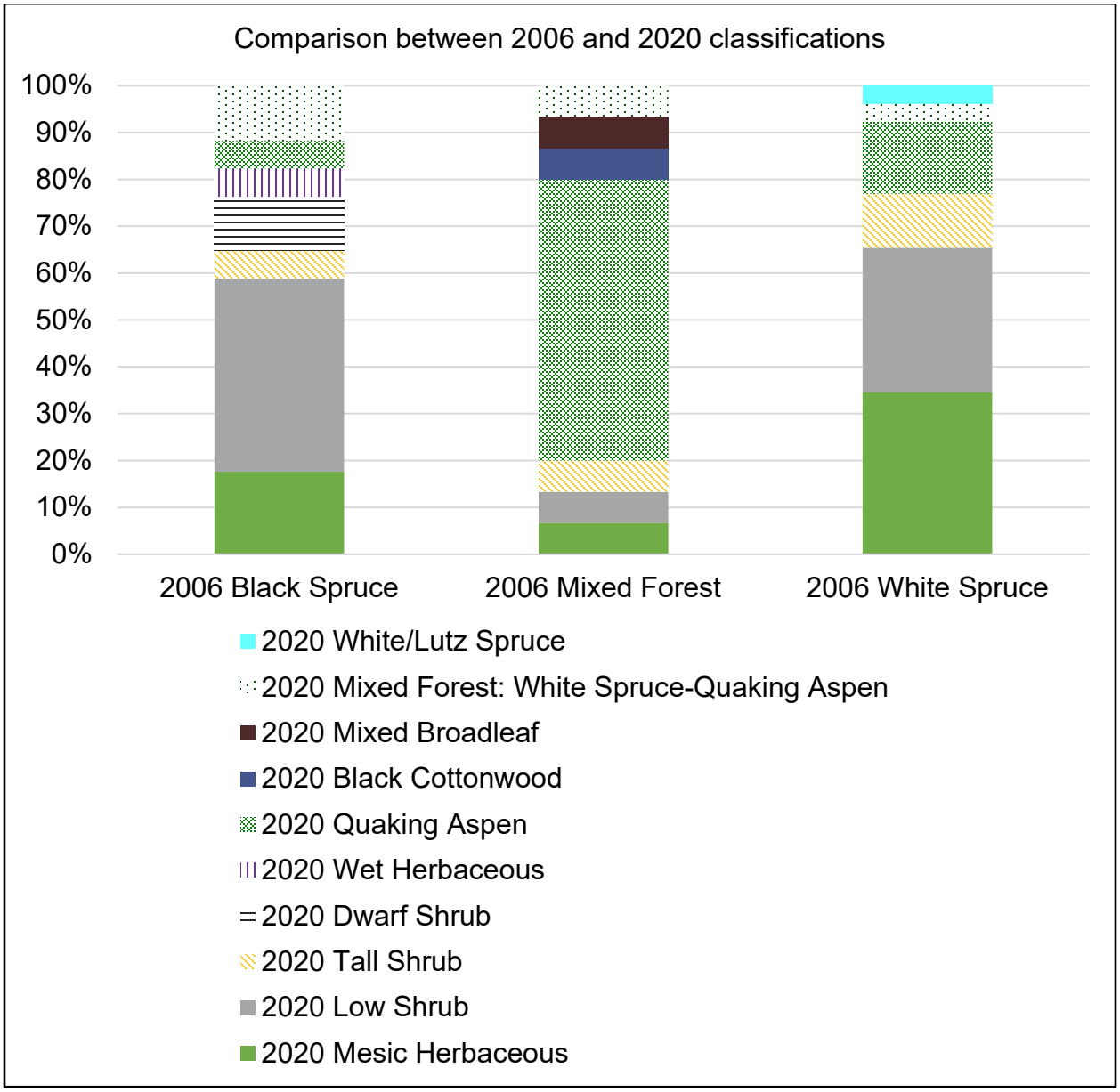

Figure 5. Proportion of vegetation dominance types from the ADF&G 2020 survey within the Funny River Fire footprint that were initially mapped as Mesic Herbaceous dominance type in the U.S. Forest Service 2017 survey, stratified by the O'Brien 2006 survey classifications (Black Spruce, White Spruce, and Mixed Forest).

Areas that were classified as Black Spruce in the O'Brien 2006 survey and reclassified as Mesic Herbaceous dominance type in the USFS 2017 survey were largely characterized by shrub dominance types as observed in the ADF&G 2020 survey (59%; Fig. 5; Table 2). This shrub

dominance was predominantly in the Low Shrub Willow – Dwarf Birch dominance type (41%). Shrub birch (*Betula glandulosa*) accounted for 6% percent vegetation cover in the shrub functional group, while lowbush cranberry (*Vaccinium vitis-idaea*) accounted for 12% percent cover in the dwarf shrub functional group (Fig. 6).

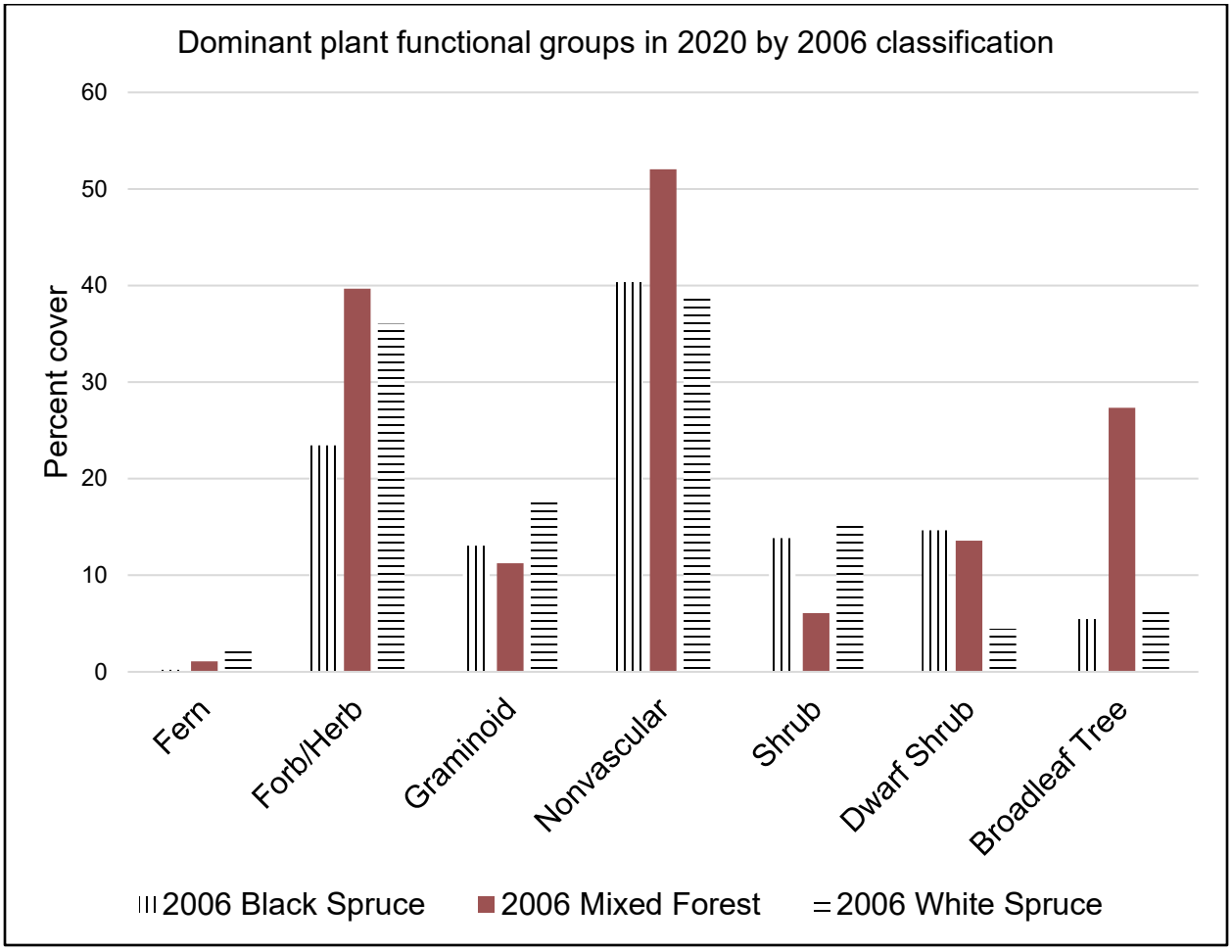

Figure 6. Proportion of plant functional types from ADF&G 2020 survey within the Funny River Fire footprint that were mapped as Mesic Herbaceous dominance type in the U.S. Forest Service 2017 survey and stratified by the O'Brien 2006 survey classifications (Black Spruce, White Spruce, Mixed Forest).

Areas classified as White Spruce in the O'Brien 2006 survey and reclassified as Mesic Herbaceous dominance type in the USFS 2017 survey did not have any vegetation dominance types that accounted for >50% of the area as observed in the ADF&G 2020 survey (Fig. 5; Table 2). In the ADF&G 2020 survey, Mesic Herbaceous dominance type accounted for 35% of the area classified in the O'Brien 2006 survey as White Spruce and was the most prevalent dominance type in this classification; however, shrub dominance types were found in 5 out of the remaining 7 plots in the ADF&G 2020 survey (Fig. 5; Table 2), with a large proportion of the shrub functional type consisting of Sitka willow (*Salix sitchensis*) accounting for 3% percent vegetation cover. Overall, areas that were classified as either Black Spruce or White Spruce in the O'Brien 2006 survey and Mesic Herbaceous dominance type in the USFS 2017 survey had

more shrubs in the ADF&G 2020 survey than areas classified as Mixed Forest in the O'Brien 2006 survey.

In the ADF&G 2020 survey, percent cover decreased with elevation for the dwarf shrub functional group (Fig. 7; $z = -2.62$; $P = 0.009$), while elevation did not influence percent cover in the remaining function groups (Fig. 7A; $z > 0.08$; $P > 0.075$). Percent cover of the herbaceous functional group decreased with higher latitude (Fig. 7; $z > -2.72$; $P = 0.006$), while the dwarf shrub functional group marginally increased with higher latitude (Fig. 7; $z > 1.99$; $P > 0.047$). Latitude did not influence percent cover for broadleaf or shrub functional groups (Fig. 7; $z > -1.09$; $P > 0.278$).

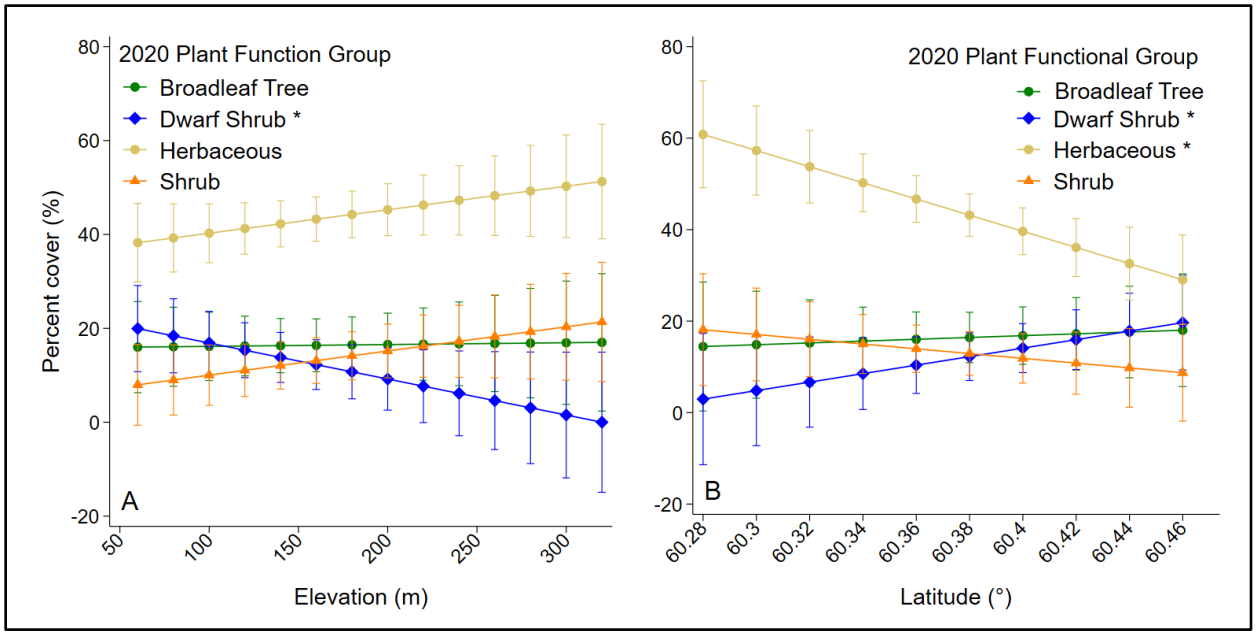

Figure 7. Percent cover by (A) plot elevation and (B) plot latitude of survey plots in the ADF&G 2020 survey by plant functional type located in the U.S. Forest Service 2017 survey Mesic Herbaceous dominance type, stratified by the O'Brien 2006 survey classification. Predicted values with 95% confidence intervals from mixed-effect model regression.

Note: 1 meter (m) = 3.281 feet (ft).

Note: The * symbol denotes significant ($P < 0.05$) relationship between percent cover and associated predictor variable

Use of Browse Species

The highest evidence of browsing was on preferred winter food for moose, including all *Salix* species, shrub and dwarf birch (*Betula nana*), highbush cranberry (*Viburnum edule*), and Western mountain ash (*Sorbus sitchensis*; Fig. 8). Barclay's willow (*Salix barclayi*) and Bebb willow (*Salix bebbiana*) are the only 2 species to show evidence of broomed architecture. Although red elderberry (*Sambucus racemosa*) was browsed, this was from only 1 plant. Very little to no browsing pressure was evident on rust menziesia (*Menziesia ferruginea*), currents (*Ribes* spp.), alders (*Alnus* spp.), and spirea (*Spiraea stevenii*; Fig. 8).

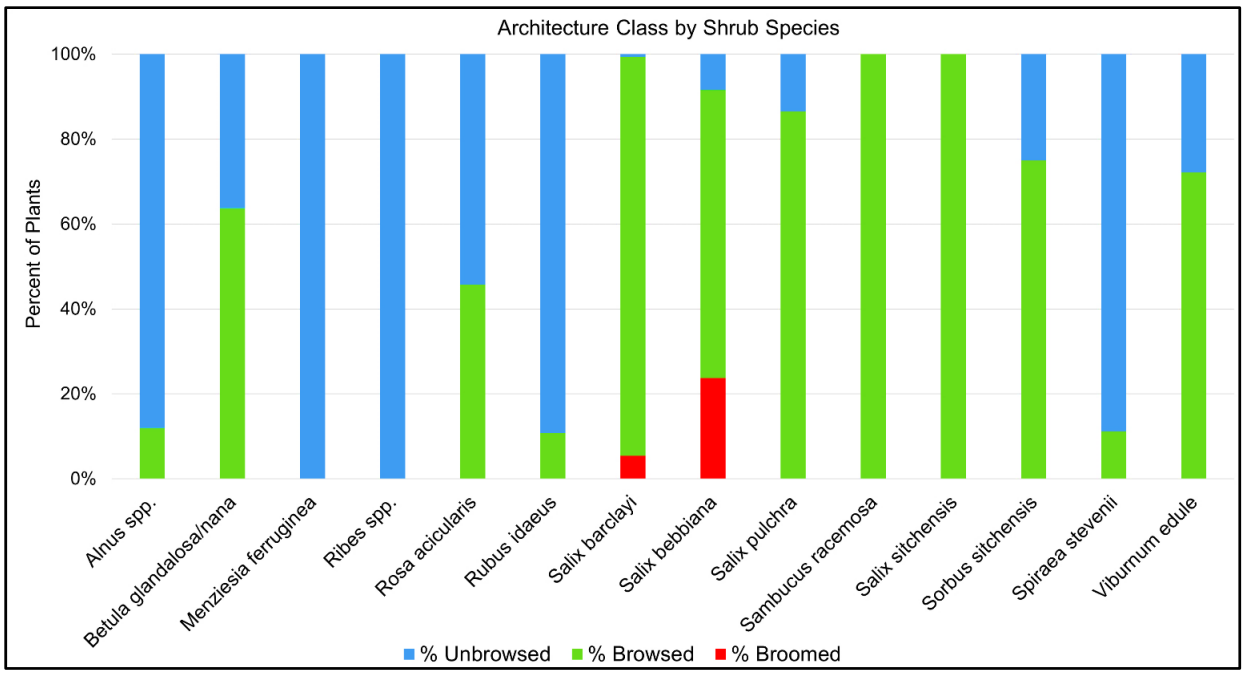

Figure 8. Percent of shrub species browsed by species in the ADF&G 2020 survey within the Funny River Fire footprint in all 4 of the U.S. Forest Service 2017 survey dominance types.

While not all shrub species were browsed equally by moose, as seen in Figure 8, not all of the shrubs were equally available across the 4 vegetation dominance types surveyed. Figure 9 shows the prevalence of shrubs in each vegetation dominance type in a weighted analysis to negate the impact of having a different number of plots in each type sampled. Only 3 species were observed in a single vegetation type: currents occurred only in the Quaking Aspen dominance type, while red elderberry and Sitka willow occurred only in the Mesic Herbaceous dominance type (Fig. 9). Conversely, highbush cranberry, shrub, and dwarf birch were observed in all 4 vegetation dominance types (Fig. 9). All other shrub species appeared to occur in 2 or 3 of the vegetation dominance types surveyed.

The data presented in Figure 10 gives an indication of where browsing occurred within the Funny River Fire Area based on the 4 vegetation dominance types in the USFS 2017 survey. The Low Shrub Willow – Dwarf Birch dominance type had the highest percent of browsed plants (Fig. 10), which also had a large proportion of Barclay's willow and diamond-leaf willow (Salix pulchra; Fig. 9), both of which were highly browsed species (Fig. 8). This is notable as our data indicated that the 70% of the plots within the 2017 Low Shrub Willow – Dwarf Birch dominance type were classified the same in the ADF&G 2020 survey.

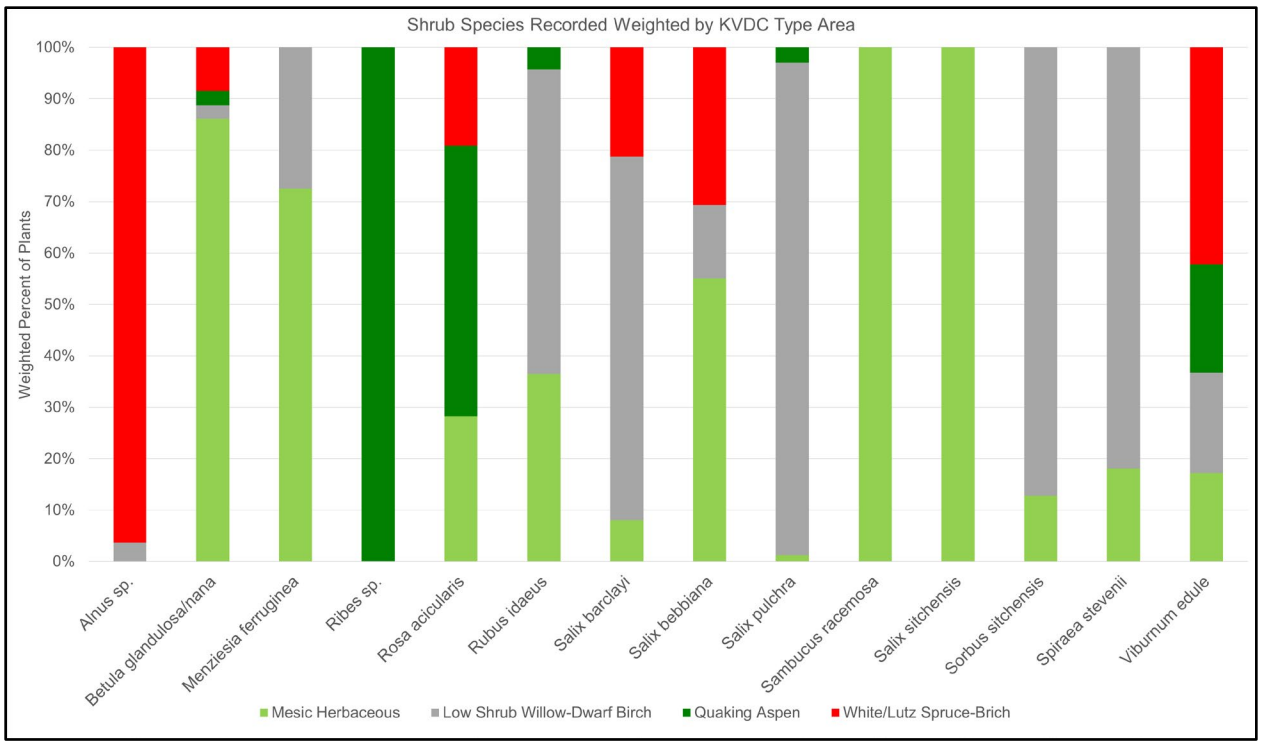

Figure 9. Percent of shrub species browsed, weighted to normalize the data for each vegetation dominance type in the ADF&G 2020 survey within the Funny River Fire footprint.

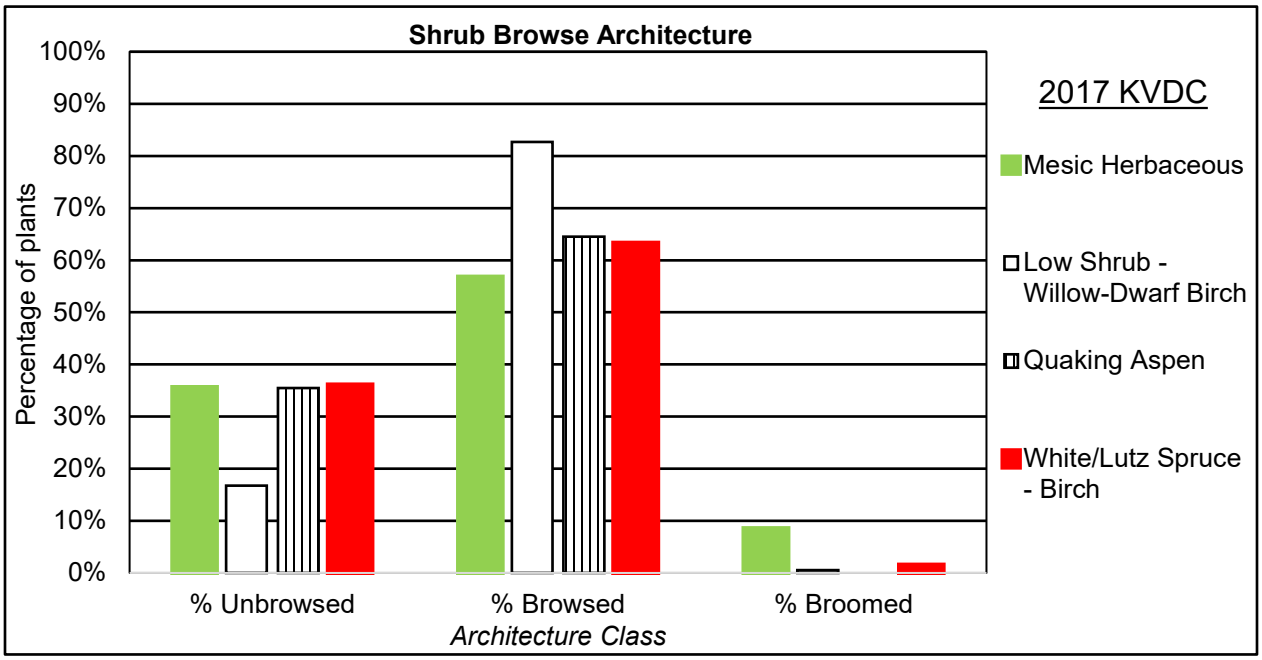

Figure 10. Percent of shrub species by browse architecture, for each vegetation dominance type in the ADF&G 2020 survey within the Funny River Fire footprint.
Note: KVDC refers to the Kenai vegetation dominance classification system.

Discussion and Recommendations

KENAI VEGETATION DOMINANCE TYPES

Our first objective for this project was to evaluate the 4 vegetation dominance types that dominated the Funny River fire footprint in the USFS 2017 survey. The ADF&G 2020 survey provided the foundation for an updated spatial representation of the Mesic Herbaceous and White/Lutz Spruce – Birch dominance types in the USFS 2017 survey Kenai Peninsula Existing Vegetation Map Project. The ADF&G 2020 survey data indicate that the area classified as Mesic Herbaceous dominance type in the USFS 2017 survey is far more heterogeneous, with a mosaic of numerous vegetation types. Indeed, the ADF&G 2020 survey identified 8 different vegetation dominance types within the USFS 2017 survey Mesic Herbaceous dominance type. The ADF&G 2020 survey of the Mesic Herbaceous dominance type provides insight into why moose are using these areas.

The discrepancy between the USFS 2017 survey Kenai Peninsula Existing Vegetation Map Project and the ADF&G 2020 survey may be due to a change in vegetation composition in the 3 years between studies or an initial misclassification in 2017 due to the limitations of the methods used. As we used ground-based sampling methods, we eliminated the predictive element of data interpretation required from the aerial survey and remote sensing methods used in the 2017 study. However, rapid changes in vegetation composition are possible in the years following a fire as plants colonize the disturbed area. Consequently, our data represents a snapshot in time; successional trajectories are shifting with changes in climate. These pathways that were reliable to cite in the past no longer consistently indicate how plant communities are currently evolving. Therefore, we recommend duplicating this vegetation survey within 5–10 years. Unlike the USFS 2017 survey Kenai Peninsula Existing Vegetation Map Project, we did not set out to map the extent of vegetation classifications on the landscape. Consequently, we recommend substantial change in the composition of the USFS 2017 survey Kenai Peninsula Existing Vegetation Map for the Mesic Herbaceous dominance type that we surveyed. Reclassifications of dominance types used in the ADF&G 2020 survey are intended to be used in correlating moose movement to vegetation classes in a later publication.

The ADF&G 2020 survey data indicate that approximately 66% of the plots examined within the USFS 2017 survey Mesic Herbaceous dominance type are actually other vegetation dominance types that comprise of plants palatable to moose. These vegetation dominance types include Quaking Aspen (24%), Black Cottonwood (3%), Mixed Broadleaf Forest (3%), Tall Shrub Willow (13%), and Low Shrub Willow – Dwarf Birch (21%). The remaining area in the ADF&G 2020 survey was classified as either Mesic Herbaceous dominance type (29%) or Ericaceous Dwarf Shrub dominance type (5%). Consequently, 95% of the area is likely to provide some level of browse for moose, as only the Ericaceous Dwarf Shrub type is unlikely to be a good source of browse. However, while 95% of the area mapped in the USFS 2017 survey as Mesic Herbaceous dominance type may have suitable moose browse throughout, each of the reclassified vegetation types from the ADF&G 2020 survey within this area will have differing species abundances and availability. Furthermore, while most of these vegetation species may be suitable moose browse, the nutritional value of species may differ substantially, thereby resulting in a wide range of browse quality throughout the USFS 2017 survey Mesic Herbaceous

dominance type. Further work is required to examine the nutritional value of plants within the ADF&G 2020 survey Mesic Herbaceous dominance type to better understand the nutritional landscape for moose within the Funny River Fire footprint.

COMPARISONS WITH 2006 VEGETATION CLASSIFICATION

While it is not possible to conduct a true statistical analysis from most of the ADF&G 2020 survey data, broad predictions about post-fire vegetation composition can be made from the dominant vegetation prior to the 2014 Funny River fire. Stands that were dominated by Black Spruce in the O'Brien 2006 survey were a range of shrub dominance types after fire in 2020. Similarly in 2020, White Spruce stands in the O'Brien 2006 survey prior to the Funny River Fire are now Mesic Herbaceous dominance types, while areas that were previously Mixed Woodland are now broadleaf forest dominance types. These differences in vegetation response based on the prior vegetation indicate that there may be other factors influencing the seral trajectory of these locations, including elevation, latitude, soil characteristics, and fire severity. Fire severity implicates the extent to which species return after fire. Fire severity plots completed by the U.S. Fish and Wildlife Service within the Funny River Fire area (Saperstein 2015) could further corroborate these data in linking the pre-burn vegetation composition and the mosaic of plant communities observed in the ADF&G 2020 survey. Furthermore, the 2020 ADF&G survey documented that willows and dwarf birch growing in areas that burned were often sprouting from a root crown. This suggests that the majority of willow and dwarf birch seen during our field work were present prior to the fire. While this does not preclude the possibility of ingress of willows and birch species following a fire, it may point to the importance of the presence of these species prior to fire when predicting post-disturbance community composition within this area of the Kenai Peninsula. Willow and birch observed were all <3 m tall and therefore within the height available for moose to browse upon. This is important as it indicates that plants in systems similar to the study area will be available to moose as browse for at least 6 years following a disturbance or treatment.

RECOMMENDATIONS

While the USFS 2017 survey Kenai Peninsula Existing Vegetation Map may be accurate in some areas of the Kenai Peninsula, the ADF&G 2020 survey indicates that updates are required for the Funny River Fire footprint. The aerial survey, which was used as the predominant method to confirm remote sensing data within the fire footprint, was insufficient without ground-based plots to train the remote sensing classification used by Bellante et al (2020). With any disturbance to the landscape, plant communities will continue to change with succession in the coming years. Mapping efforts should be refreshed on a regular basis to keep vegetation maps up to date, pending ongoing research by stakeholder agencies. The need to regularly update vegetation maps will likely become more acute under the influence of climate change as successional trajectories of vegetation communities may shift (Baughman et al. 2020) and disturbances may become more extreme (Wilkening et al. 2022, Baughman et al. 2020). This is especially true in areas that experience large scale disturbances, as these can result in dramatic changes to the composition of vegetation communities. An example of such a disturbance was the outbreak of spruce bark beetle (*Dendroctonus rufipennis*) in the southern portion of the Kenai Peninsula, where areas dominated by Lutz spruce (*Picea glauca* x *Picea sitchensis*) were colonized by bluejoint grass following the death of many of the spruce trees (Baughman et al.

2020). In these areas, updated mapping efforts can also serve to better understand how climate change may be impacting successional trajectories, which can inform habitat and species management to improve efforts to mitigate the impacts of climate change.

This report is part of a larger study being conducted by ADF&G to examine how moose respond to large-scale fire in Unit 15B. The ADF&G 2020 survey data will help build a better understanding of how moose use these areas through an improved insight into what vegetation is available to moose within a post-fire landscape. However, our data demonstrate that the USFS 2017 survey Kenai Peninsula Existing Vegetation Map of the Funny River Fire footprint does not accurately reflect the plant communities in the area. An improved vegetation map will allow for more accurate study of how moose use the post-fire landscape. We observed moose browsing throughout the entire study area, which correlates to the initial findings of the larger ADF&G study. Browsing appeared to have occurred within all 4 of the 2017 vegetation dominance types, indicating that moose are able to find suitable forage throughout most of the Funny River Fire footprint.

Using the ADF&G 2020 survey data, we propose to create a new map layer that replaces the USFS 2017 survey Mesic Herbaceous dominance type within the Funny River Fire footprint. The ADF&G 2020 survey results suggest that there are differences within the USFS 2017 survey Mesic Herbaceous dominance type based on prior forest types identified in the O'Brien 2006 survey. We recommend splitting the USFS 2017 survey Mesic Herbaceous dominance type within the Funny River fire footprint into 3 subclasses based on the 3 classifications from the O'Brien 2006 survey using nomenclatures from each survey: Mesic Herbaceous – Black Spruce, Mesic Herbaceous – Mixed Forest, and Mesic Herbaceous – White Spruce. While there is variation within each of these subclasses (Table 2; Fig. 5; Fig. 7), we do not have any finer resolution mapping units available to delineate these different vegetation classes at a smaller scale (e.g., soils map). Furthermore, the methods used for replacing the Mesic Herbaceous dominance type within the 2014 Funny River Fire footprint could be applied to the adjacent 2015 Card Street Fire footprint. Updates to vegetation dominance types for both of these fire footprints will provide a more accurate depiction of the landscape for current ADF&G studies assessing moose movement and nutrition on the northern Kenai Peninsula.

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Appendix A

Plant species and substrates encountered on vegetation point intercept (cover) transects.

Functional Type Group	Scientific Name	Common Name
Broadleaf Tree	*Betula papyrifera var. kenaica and Betula neoalskana*	Kenai birch Alaska birch
	Populus balsamifera	balsam poplar/cottonwood
	Populus tremuloides	quaking aspen
	Salix scouleriana	Scouler's willow
Needleleaf Tree	*Picea glauca*	white spruce
Shrub	*Alnus* sp.	alder
	Amelanchier alnifolia	serviceberry
	Betula glandulosa	shrub birch
	Betula nana	dwarf birch
	Ledum groenlandicum	bog Labrador tea
	Ledum palustre ssp. decumbens	marsh Labrador tea
	Menziesia ferruginea	rusty menziesia
	Ribes sp.	currant/gooseberry
	Rosa acicularis	prickly rose
	Rubus idaeus	American red raspberry
	Salix sp.	Willow, unspecified
	Salix alaxensis	feltleaf willow
	Salix barclayi	Barclay's willow
	Salix bebbiana	Bebb willow
	Salix pulchra	diamond-leaf willow
	Salix sitchensis	Sitka willow
	Sambucus racemosa	red elderberry
	Shepherdia canadensis	soapberry
	Sorbus sitchensis	western mountain ash
	Spiraea stevenii	beauverd spirea
	Vaccinium uliginosum	bog blueberry
	Viburnum edule	highbush cranberry
Dwarf Shrub	*Arctostaphylos uva-ursi*	kinnikinnick
	Empetrum nigrum	black crowberry
	Rubus arcticus	arctic raspberry
	Rubus chamaemorus	cloudberry
	Rubus pedatus	strawberryleaf raspberry
	Vaccinium vitis-idaea	lowbush cranberry

Functional Type Group	Scientific Name	Common Name
Herbaceous	*Achillea borealis*	yarrow
	Anemone narcissiflora	narcissus anemone
	Anemone richardsonii	yellow anemone
	Artemisia arctica	boreal sagebrush
	Athyrium filix-femina	common ladyfern
	Calamagrostis canadensis	bluejoint
	Carex	sedge
	Chamerion angustifolium	fireweed
	Cornus canadensis	bunchberry dogwood
	Dryopteris expansa	spreading woodfern
	Equisetum	horsetail
	Erigeron peregrinus	subalpine fleabane
	Eurybia sibirica	arctic aster
	Festuca altaica	Altai fescue
	Geocaulon lividum	false toadflax
	Geranium eremophilum	wild geranium
	Geum calthifolium	calthaleaf avens
	Gymnocarpium dryopteris	western oakfern
	Linnaea borealis	twinflower
	Lupinus nootkatensis	Nootka lupine
	Pyrola	wintergreen
	Sanguisorba canadensis	Canadian burnet
	Streptopus amplexifolius	claspleaf twistedstalk/watermelon berry
	Trientalis europaea	arctic starflower
	Veratrum viride	green false hellebore
	--	grass, not identified to species
Non-vascular	*Lycopodium* spp.*	clubmoss
	Sphagnum sp.	sphagnum moss
	--	feather moss
	--	moss, other than Sphagnum or feathermoss
Lichen	--	Lichen
Non-vegetated	--	bare mineral soil
	--	Litter
	--	organic duff
	--	Water
	--	woody debris

**Lycopodium spp.* have vascular tissues but were included in the non-vascular plants as they frequently occur in the same layer as non-vascular plants.

Appendix B

Species considered preferable moose browse in Unit 15B.

	Scientific Name	Common Name
Trees	*Betula papyrifera var. kenaica and Betula neoalskana*	paper birch
	Populus balsamifera	balsam poplar/cottonwood
	Populus tremuloides	quaking aspen
	Salix scouleriana	Scouler's willow
Shrubs	*Alnus* sp.	alder
	Betula glandulosa	resin birch
	Betula nana	dwarf birch
	Menziesia ferruginea	rusty menziesia
	Ribes sp.	currant/gooseberry
	Rosa acicularis	prickly rose
	Rubus idaeus	American red raspberry
	Salix alaxensis	feltleaf willow
	Salix arbusculoides	Littletree willow
	Salix barclayi	Barclay's willow
	Salix bebbiana	Bebb willow
	Salix commutata	undergreen willow
	Salix glauca	grayleaf willow
	Salix lasiandra	pacific willow
	Salix monticola	park willow
	Salix myrtillifolia	blueberry willow
	Salix pulchra	diamond-leaf willow
	Salix richardsonii	Richardson’s willow
	Salix sitchensis	Sitka willow
	Sambucus racemosa	red elderberry
	Sorbus sitchensis	western mountain ash
	Spiraea stevenii	beauverd spirea
	Viburnum edule	highbush cranberry

Appendix C

Plot 21 (Left) and 22 (Right), O'Brien 2006 survey Mixed Forest and White Spruce classifications pre-fire, reclassified as Mesic Herbaceous vegetation dominance type in the USFS 2017 survey. In the ADF&G 2020 survey, these plots were reclassified as Quaking Aspen vegetation dominance type with aspen regeneration, mixed herbaceous and moss ground cover. ©2020 ADF&G. Photo by Mary Jo Hill.

Plot 25, facing north (left) and south (right) from plot center. O'Brien 2006 survey White Spruce classification pre-fire and reclassified as Mesic Herbaceous vegetation dominance type in the USFS 2017 survey. In the ADF&G 2020 survey, this plot was reclassified as Mesic Herbaceous vegetation dominance type, with some resprouting Barclay's willow present. ©ADF&G 2020. Photo by Mary Jo Hill.

Plot 01, O'Brien 2006 survey Black Spruce classification pre-fire, reclassified as Mesic Herbaceous vegetation dominance type in the USFS 2017 survey. In the ADF&G 2020 survey, Scouler's and Barclay's willow have resprouted. Ground cover is sparsely vegetated, organic duff layers have remained intact. ©ADF&G 2020. Photo by Mary Jo Hill.

Plot 45, Classified as Low Shrub Willow - Dwarf Birch vegetation dominance type in the USFS 2017 survey. In the ADF&G 2020 survey, Barclay's willow dominates, Bebb and diamond-leaf willow also present. ©ADF&G 2020. Photo by Mary Jo Hill.

Plot 50 (left) and 51 (right). Classified as Quaking Aspen vegetation dominance type in USFS 2017 survey. In the ADF&G 2020 survey, this plot was classified as mature aspen overstory trees that survived fire, with sprouting aspen regenerating in understory. ©ADF&G 2020. Photo by Mary Jo Hill.

Plot 59, classified as White/Lutz Spruce – Birch vegetation dominance type in the USFS 2017 survey. In the ADF&G 2020 survey, this plot was classified as overstory mixed white spruce and quaking aspen. Moss and herbaceous ground cover, open understory. ©ADF&G 2020. Photo by Mary Jo Hill.


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