16790

Alaska Sub-boreal White-Lutz Spruce-Hardwood Forest and Woodland

BpS Model/Description Version: Nov. 2024

Reviewer: Ilana Abrahamson, Lindsey Flagstad, Hunter Gravley, Beth Schulz, Anjanette Steer

Vegetation Type

Forest and Woodland

Map Zones

73, 74, 75, 76, 77, 78, 80

Geographic Range

This Biophysical Setting (BpS) occurs throughout the boreal transition region of Alaska and is commonly found on the Kenai Peninsula.

Biophysical Site Description

This BpS occurs on well-drained upland terrain. Soils generally develop on surficial deposits including glacial till, colluvium, and loess. Forested sites that are hardwood-dominated are more common at low elevations and at the upper elevational limit of broad-leaved trees. At low elevations this system is found predominantly on gentle lower hillslopes, side slopes, toe slopes, large moraines, and inactive riparian terraces, although floodplain stands of cottonwood are not included in this system. In Katmai National Park and Preserve, the system occurs between 19- and 286-meters elevation mostly on slopes and valley bottoms (Boggs et al. 2003).

Vegetation Description

*Picea glauca* or *Picea x lutzii* (the hybrid produced where the ranges of *Picea sitchensis* and *Picea glauca* overlap) are the dominant conifers. Other tree species include *Betula neoalaskana*, which may be codominant with *Picea glauca, Populus balsamifera* ssp*. trichocarpa, P. balsamifera* ssp*. balsamifera*, and/or *Populus tremuloides*. *Picea mariana* may also be present. *Betula papyrifera* *var.* *kenaica* may replace Alaska birch towards the boreal-temperate transition. Total hardwood tree species cover is >25% on hardwood-dominated sites. Tree height ranges from 6 to 21 meters. *Salix scouleriana* is locally common.

Common understory shrubs include *Alnus viridis* ssp*. sinuata, Viburnum edule, Rosa acicularis, Ribes triste, Vaccinium vitis-idaea, Linnaea borealis, Salix barclayi, Rubus spectabilis*, and *Sambucus racemosa. Menziesia ferruginea, Vaccinium ovalifolium* and *Oplopanax horridus* may also be common, especially in spruce-dominated sites.

Herbaceous species may also dominate the understory. Common herbaceous species include *Athyrium filix-femina, Calamagrostis canadensis, Chamerion angustifolium, Gymnocarpium dryopteris, Heracleum maximum, Cornus canadensis,* and, especially in spruce-dominated sites, *Equisetum* spp. and *Dryopteris expansa*. Common mosses include *Hylocomium splendens* and *Pleurozium schreberi* (DeVelice et al. 1999).

BpS Dominant and Indicator Species

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

The major disturbance processes are fire, insect infestations and diseases, blowdown, landslides, and (in the Kenai Mountains) snow avalanches. Windthrow gap disturbances are important in both spruce and hemlock recruitment in these forests (Potkin 1997).

Although lightning and natural fires have historically been infrequent and rare in the region, wildfire plays an important role in the disturbance regime of this system (Comer et al. 2003). Under the natural fire regime, fires were infrequent, but could be very large (USDA Forest Service 2002). Estimates of the mean fire return interval range from 600-800 years (Berg and Anderson 2006; Berg et al. 2004; Potkin 1997; personal communication FRCC experts’ workshop March 2004). White spruce is typically killed by fire (Abrahamson 2015). Post-fire regeneration of white spruce appears to be more successful when fires occur in mast years (Peters et al. 2005). This interaction between fire, masting, and subsequent tree regeneration could have implications for historical stand structure and successional dynamics over time (Peters et al. 2005).

In 2014, an extensive literature search was done by Fire Effects Information System staff to locate information for a synthesis on fire regimes of Alaskan white spruce communities (Abrahamson 2014). According to this synthesis: “Most historical and paleological evidence suggests that subboreal white spruce communities on the Kenai Peninsula burned infrequently [Berg and Anderson 2006, Boucher 2003, Potkin 1997]. Soil charcoal data from the western Kenai Peninsula suggest that upland white spruce and Lutz spruce forests have not burned for an average of 600 years. Across 22 sites, time-since-fire ranged from 90 to ~1,500 years. Over the last ~2,500 years, the mean fire-return interval was 515 ± 355, with intervals ranging from 105 to 1,642 years [[Berg](http://www.fs.fed.us/database/feis/fire_regimes/AK_white_spruce/all.html#16) and Anderson 2006].” However, research is indicating a shorter fire return interval based on warmer average summer temperatures and lower annual precipitation (Young et al. 2017) indicating a higher wildfire frequency especially in the forest-tundra boundary.

Spruce bark beetle (*Dendroctonus rufipennis*) infestations are a major natural disturbance of sub-boreal spruce and spruce-hardwood forests. Spruce beetles typically attack larger, slow-growing spruce, but infestations periodically escalate to epidemic levels when forest and climatic conditions are favorable for beetle expansion (NatureServe 2008). During epidemic-level infestations, beetles are less selective and may attack and kill a wider range of spruce trees. Beetle outbreaks that thin stands and produce a growth release in surviving trees occur on average every 50yrs in white and Lutz spruce forests on the Kenai Peninsula (Berg et al 2006). Spruce bark beetle outbreaks that produce a more substantial thinning occur at longer intervals, with the last two severe infestations occurring in the 1870s-1880s and 1987–present (Berg et al 2006). The bark beetle outbreak that began in 1987 on the Kenai Peninsula has killed over 1.3 million acres of spruce (USDA Forest Service 2002). Berg (2004) found no association between spruce bark beetle mortality and fire in the past. In south-central and southwest Alaska, Sheriff and others (2011) reported a 10-to-165-year interval between outbreaks and an average of 48 years based on a 250-year record.

When the canopy of these forests is thinned by heavy spruce bark beetle-mortality, bluejoint grass (*Calamagrostis canadensis*) and fireweed (*Epilobium angustifolium*) tend to increase rapidly and dominate the site for at least 10 years (Holsten et al. 1995). *Calamagrostis* may proliferate rapidly from its pre-disturbance low level network of rhizomatous roots and may develop into a thick, seedling-excluding sod within a few years (Berg et al 2006). Boucher (2003) found that rapid spread of *Calamagrostis* occurs primarily on sites with deep, loamy soils. Thinning of the spruce canopy by beetle attacks also helps to maintain hardwoods in the canopy over time.

Fire Frequency

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

Matrix, small or large patch

Adjacency or Identification Concerns

Issues or Problems

There is little scientific literature about fire regimes in Alaskan white spruce communities (Abrahamson 2014). However, Roland et al. (2019) includes a comparison of two coniferous systems in Interior Alaska that may be helpful for white spruce communities (not Lutz spruce).

Native Uncharacteristic Conditions

The present landscape of the western Kenai Peninsula reflects human-caused fires that occurred over the last 100 years, creating areas of early successional plant communities, which include large stands of broadleaved forests (Potkin 1997). Over 99% of the fires occurring on the Kenai Peninsula portion of the Chugach National Forest between 1914 and 1997 were ignited by human actions (Potkin 1997). These human-caused fires have generally increased the richness and patchiness of the vegetation at the landscape scale (USDA Forest Service 2002). The large number of acres burned on the Kenai Peninsula during settlement caused conversion of some mature spruce stands to grass, brush, and broadleaf tree vegetation types. Prior to the settlement period of the late 1800s, the majority of the age structures of the coniferous forest surveyed by Potkin (1997) were likely in the late successional stages (Langille 1904 in Potkin 1997) and conifers were likely dominant.

Following spruce bark beetle outbreaks on the Kenai Peninsula grass and other fine vegetation increased (Holsten et al 1995). Fire spreads rapidly through this type of vegetation; indeed, the majority of fires (most of which were human caused) on the Kenai Peninsula portion of the Chugach National Forest between 1914 and 1997 occurred in grassy vegetation (Potkin 1997). Standing and downed beetle killed trees increase the amount of both fine, flashy fuels and heavy fuels. Spruce bark beetle outbreaks may be increasing in frequency and severity in southcentral Alaska due to the warming climate. Berg et al. (2006) found that recent outbreaks on the Kenai peninsula were positively associated with average summer temperature in the preceding years. If this is true, current patterns of beetle attack and current fire regimes are likely atypical of reference conditions for this type.

Comments

Reviewers noted that information on spruce bark beetle should be updated in the Disturbance Section and that the Region 10 - Forest & Grassland Health report is a good resource for more current information than is currently in this description.

10/2021 This description was updated by NatureServe staff and Kori Blankenship based on the updated Ecological Systems classification for Alaska. Edits focused on adjusting the Geographic Range, Biophysical Site Descriptions, and Vegetation Description sections.

For LANDFIRE National this model did not receive review specifically for z76. This model was based on the FRCC Guidebook Potential Natural Vegetation Group model for Coastal Boreal Transition Forest (CBTF) (Murphy and Witten 2006). Disturbances with a probability of .0001 (i.e. 10,000 year return interval) were removed from the model because their effect is insignificant in a 1000 year simulation. Class ages were adjusted slightly to make them line up along the main successional pathway, and the relative age function was not used in any class except Class A to comply with LANDFIRE modeling rules. These changes did not change the fire return intervals or the percent of the landscape in each class. Because only minor changes were made to the CBTF VDDT model, its original authors are included as contributors to this model, and Kori Blankenship's name was added. Much of the text in the General Information section of this description was taken from the draft Boreal Ecological Systems legend (NatureServe 2008).

Succession Classes

**Mapping Rules**

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

**Description**

Class A 3 Early Development 1 - All Structures

Indicator Species

Description

Post disturbance regeneration: herbaceous to tall shrub-sapling. Following a moderate severity burn, vegetative reproduction of shrubs and birch and aspen from shoots and suckers. Light-seeded herbs establish where mineral soil is exposed. White and Lutz spruce seedlings are rare, but may be present if mineral soil was exposed, seed trees remained after fire, and they produced a good seed crop (Foote 1983). Following severe fire on loamy soil, *Calamagrostis* may spread rapidly from rhizomes and capture a large percentage of the site (Boucher 2003). Mosses and lichens exist but are not an important component. If *Calamagrostis* captures the site, it may persist throughout this class but may become less dominant within 20yrs (Schulz 2000).

Common shrubs include *Menziesia ferruginea, Alnus viridis* ssp*. sinuata, Vaccinium ovalifolium, Oplopanax horridus, Vaccinium vitis-idaea* and *Linnaea borealis*. Common herbaceous species include *Calamagrostis canadensis, Equisetum arvense, Dryopteris expansa* and *Gymnocarpium dryopteris.*

More open sites are represented by an alternate succession pathway.

*Maximum Tree Size Class*  
Seedling/Sapling <5"

Class B 12 Mid Development 1 - Closed

Indicator Species

Description

Closed conifer, hardwood, or mixed. Tree saplings gain canopy dominance over shrubs. Tree species may include spruce, hardwoods, or both. *Rosa acicularis, Equisetum* spp., and *Linnaea borealis* are commonly in the understory. Mosses and lichens become established.

*Maximum Tree Size Class*  
Pole 5–9" (swd)/5–11" (hwd)

Class C 14 Mid Development 1 - Open

Indicator Species

Description

Open conifer, hardwood, or mixed. Young trees become dominant in the overstory. *Calamagrostis*, if dominant in Class A, diminishes in importance. *Rosa acicularis, Equisetum* spp*.,* and *Linnea borealis* are commonly in the understory. Lichens and mosses become established.

*Maximum Tree Size Class*  
Pole 5–9" (swd)/5–11" (hwd)

Class D 64 Late Development 1 - Open

Indicator Species

Description

Open conifer, open spruce, hardwood, or mixed stands with tree density < 60%. Hardwoods, if present and mixed with spruce, lose dominance in overstory during this phase. Occasional hardwoods may remain. The understory may include various combinations of tall shrubs, low shrubs, herbs, mosses, and lichens.

*Maximum Tree Size Class*  
Large 20" – 40"

Class E 7 Late Development 1 - Closed

Indicator Species

Description

Closed conifer, hardwood, or mixed. Site is dominated by mature conifers with > 60% canopy closure. Hardwoods, if present and mixed with spruce, lose dominance in overstory during this phase. The understory may include various combinations of tall shrubs, low shrubs, herbs, mosses, and lichens.

*Maximum Tree Size Class*  
Large 20" – 40"

Model Parameters

Deterministic Transitions

Probabilistic Transitions

References

Abrahamson, Ilana L. 2014. Fire regimes of Alaskan white spruce communities. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/fire\_regimes/AK\_white\_spruce/all.html [2016, October 20].

Abrahamson, Ilana. 2015. Picea glauca, white spruce. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/plants/tree/picgla/all.html [2016, October 20].

Bellante, G.; Boucher, T.; Charnon, B.; Goetz, W.; Homan, K.; Pan, C.; Pugh, N.; Megown, K; Schrader, B.; Schulz, B.; Wittwer, D. 2020. Kenai Peninsula Existing Vegetation Map Project. GTAC-10209-RPT1. Salt Lake City, UT: U.S. Department of Agriculture, Forest Service, Geospatial Technology and Applications Center. 39 p.

Berg, E. 2004. White spruce fire history on the Kenai Peninsula, Alaska, based on radiocarbon-dated soil charcoal. Unpublished manuscript. Kenai National Wildlife Refuge, Alaska.

Berg, E.E., J.D. Henry, C.L. Fastie, A.D. De Volder and S.M. Matsuoka. 2006. Spruce beetle outbreaks on the Kenai Peninsula, Alaska, and Kluane National Park and Reserve, Yukon Territory: Relationship to summer temperatures and regional differences in disturbance regimes. For. Ecol. Man. 227(3):219-232.

Berg, E. and R.S. Anderson. 2006. Fire history of white and Lutz spruce forests on the Kenai Peninsula, Alaska, over the last two millennia as determined from soil charcoal. For. Ecol. Man 227: 275-283. doi:10.1016/j.foreco.2006.02.042

Boggs, K., S. C. Klein, J. Grunblatt and B. Koltun. 2003. Landcover classes, ecoregions and plant associations of Katmai National Park and Preserve. Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, AK 99501. 274 p.

Boucher, T.V. 2003. Vegetation response to prescribed fire in the Kenai Mountains, Alaska. Res. Pap. PNW-RP-554. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 59 p.

Comer, P., D. Faber-Langendoen, R. Evans, S. Gawler, C. Josse, G. Kittel, S. Menard, C. Nordman, M. Pyne, M. Reid, M. Russo, K. Schulz, K. Snow, J. Teague, and R. White. 2003-present. Ecological systems of the United States: A working classification of U.S. terrestrial systems. NatureServe, Arlington, VA.

DeVelice, R.L., Hubbard, C.J., Boggs, K. et al. 1999. Plant community types of the Chugach National Forest. Tech. Publ. R10-TP-76. Juneau, AK: USDA Forest Service, Alaska Region. 375 p.

Foote, J. M. 1983. Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. Res. Pap. PNW-307. Portland, OR. USDA Forest Service. Pacific Northwest Research Station. 108 p.

Holsten, E.H., R.A. Werner and R.L. DeVelice. 1995. Effects of spruce beetle (Coleoptera: Scolytidae) outbreak and fire on Lutz spruce in Alaska. Environmental Entomology 24(6): 1539-1547.

Murphy, K.A. and E. Witten. 2006. Coastal Boreal Transition Forest. In Fire Regime Condition Class (FRCC) Interagency Guidebook Reference Conditions. Available at www.frcc.gov.

Peters, V.S., S.E. Macdonald and M.R.T. Dale. 2005. The interaction between masting and fire is key to white spruce regeneration. Ecology 86(7): 1744-1750.

Potkin, M. 1997. Fire history disturbance study of the Kenai Peninsula mountainous portion of the Chugach National Forest. Draft. USDA Forest Service, Chugach National Forest. December 5, 1997. Anchorage, Alaska

Ritter, D. F. 1986. Process geomorphology. Wm. C. Brown Publishers, Dubuque, Iowa. 579 p.

Roland, C. A., J. H. Schmidt, S. G. Winder, S. E. Stehn, and E. F. Nicklen. 2019. Regional variation in interior Alaskan boreal forests is driven by fire disturbance, topography, and climate. Ecological Monographs 89(3):e01369. 10.1002/ecm.1369

Rowe, J.S. 1972. Forest Regions of Canada. Canadian Forest Service, Department of Environment. Ottawa. Inform. Can. Catalogue #FO 47-1300.

Rude, M. Kenai Peninsula Spruce Bark Beetle Mitigation Program, unpublished data

Schulz, B. 2000. Resurrection Creek Permanent Plots Revisited. USDA Forest Service, Forest Health Protection, Alaska Region, Anchorage, AK. Technical report R10-TP-89. 14 p.

Sherriff, R. L.; Berg, E. E.; Miller, A. E. 2011. Climate variability and spruce beetle (Dendroctonus rufipennis) outbreaks in south-central and southwest Alaska. Ecology. 92(7): 1459-1470.

USDA Forest Service. 2004. Forest insect and disease conditions in Alaska in 2003. U.S. For. Ser., For. Pest Manage. Tech. Rep. R10-TP-123, Anchorage, Alaska.

USDA Forest Service. 2002. Final Environmental Impact Statement, Chugach National Forest

Land Management Plan Revision. Available at: http://www.fs.fed.us/r10/chugach/forest\_plan/feis\_docs.html.

Van Hees, W.W.S. and F.R. Larson. 1991. Timberland resources of the Kenai Peninsula, Alaska, 1987. U.S. For. Ser. Resour. Bull. PNW-RB-180. Portland, Oregon. 56 p.

Viereck, L.A., C.T. Dyrness, A.R. Batten and K.J. Wenzlick. 1992. The Alaska vegetation classification. Pacific Northwest Research Station, USDA Forest Service, Portland, OR. Gen. Tech. Rep. PNW-GTR286. 278 p.

Werner, R.A., E.H. Holsten, S.M. Matsuoka and R.E. Burnside. 2006. Spruce beetles and forest ecosystems in south-central Alaska: A review of 30 years of research. Forest Ecology and Management. 227(3):195-206.

Yarie J. 1983. Forest community classification of the Porcupine River drainage, interior Alaska, and its application to forest management. USDA Forest Service GTR PNW-154.

Yarie J. 1981. Forest fire cycles and life tables – a case study from interior Alaska. Can. J Forest Res. 11:554-562.

Young, A.M, Higuera, P., Duffy, P.A. and Feng Sheng Hu. 2017. Climatic thresholds shape northern high-latitude fire regimes and imply vulnerability to future climate change. Ecography. 40 (5): 666-617.  https://doi.org/10.1111/ecog.02205.