16120

Western North American Boreal Dry Grassland

BpS Model/Description Version: Nov. 2024

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Tina Boucher | antvb@uaa.alaska.edu | None | None |
| Colleen Ryan | colleenryan@tnc.org | None | None |
| None | None | None | None |

Reviewer: Lindsey Flagstad, Robin Innes

Vegetation Type

Herbaceous

Map Zones

70, 71, 73, 74

Geographic Range

This Biophysical Setting (BpS) occurs across the boreal and sub-boreal regions of AK. Today, dry grassland communities in AK are relatively uncommon (Edwards and Armbruster 1989; Lloyd et al. 1994), but during the late Pleistocene these were more common (Edwards and Armbruster 1989). Steppe associations are considered analogues of vegetation that was widespread across Beringia during the colder and drier conditions of the late Pleistocene (Kassler 1979; Lipkin and Tande 1991; Murray 1981; Murray et al. 1983; Walker et al. 1991), where dry grasslands represent glacial refugia that may support distinctive flora characterized by a high diversity of Beringian and endemic plant species (Edwards and Armbruster 1989; Murray et al. 1983; Roland 1996).

Biophysical Site Description

Soil conditions in boreal regions are frequently conducive to dry grasslands (Redmann and Schwarz 1986). Soils are well drained to excessively drained, and permafrost is absent. This system typically occurs on dry sideslopes or bluffs. Some slopes may have steep, unstable soil (NatureServe 2008). Dry grasslands typically develop on steep, south-facing slopes where a warm and dry microclimate is thought to exclude trees (Boggs et al. 2019). The topography of steppe bluffs has implications for microclimate in so far that surfaces undergo great daily and annual fluctuations in temperature and moisture (Edwards and Armbruster 1989; Lewis 1998; Roland 1996; Walker et al. 1991). Moisture of steppe soils is strongly limited by exposure to wind, low accumulation and residence of snow, drainage across steep slopes, and high soil evaporation and transpiration caused by the slopes’ direct orientation to the low-angled sun (Bliss et al. 1973; Lewis 1998; Lloyd et al. 1994; Kassler 1979; Roland 1990; Wesser 1991).

Steppe soils are well-drained silty loams to loams with low organic matter content (Roland 1996). Permafrost is typically absent due to warm soil temperatures in the summer and poor insulation in the winter (Boggs and Sturdy 2005). Soil pH ranges from 6.2 to 8.0 with a mean of 7.0 and is often elevated by input of calcium carbonate-rich loess (Kassler 1979; Marsh et al. 2006; Roland 1996; Walker et al. 1991). Bare soil is characteristic of developing steppe (Howenstein et al. 1985; Lewis 1998; Murray et al. 1983; Shacklette 1966). The presence of biological soil crusts has been noted in several mature steppe bluffs (e.g. Dickson 2000; Marsh et al. 2006; Walker et al. 1991; Zazula et al. 2002).

Vegetation Description

These sites are typically dominated by grasses, though forbs and shrubs may be common, but shrub cover is less than 25%. Common graminoids include *Festuca altaica, F. rubra, Calamagrostis purpurescens, Elymus inovatus, Pseudoroegneria spicata, Bromus pumpellianus,* and *Poa glauca*. Shrubs include the low shrubs *Artemisia frigida, A. arctica, Amelanchier alnifolia, Elaeagnus commutata, Shepherdia canadensis,* and *Juniperus communis*, and the dwarf shrub *Arctostaphylos uva-ursi*. Common forbs are *Artemisia arctica, Bupleurum americanum,* and *Saxifraga tricuspidata* (Lipkin and Tande 1991).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| FEAL | *Festuca altaica* | Altai fescue |
| FERU2 | *Festuca rubra* | Red fescue |
| CAPU | *Calamagrostis purpurascens* | Purple reedgrass |
| PSSP6 | *Pseudoroegneria spicata* | Bluebunch wheatgrass |
| BRINA | *Bromus inermis ssp. pumpellianus var. arcticus* | Pumpelly's brome |
| ARFR4 | *Artemisia frigida* | Prairie sagewort |
| ARAL5 | *Artemisia alaskana* | Alaska wormwood |

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

Disturbance Description

Little is known about the successional dynamics of this community, but it is assumed to be relatively stable over time (Viereck et al. 1992). Large scale disturbances affecting dry grasslands include fire and mass wasting for systems developing on slopes (Lewis 1998); smaller scale disturbances include burrowing and/or grazing by rodents and ungulates (Vetter 2000). Fire is thought to favor grassland development by removing more competitive forest taxa (Lewis 1998; Roland 1990). Similarly, landslides are thought to favor grassland development by removing forest taxa, exposing mineral soil for colonization by seedlings, and altering the competitive balance in favor of faster growing, more readily dispersed plants (Roland 1990; Roland 1996).

Dry grasslands are thought to be seral to *Populus tremuloides* (quaking aspen) woodlands with dry understory species such as *Arctostaphylos uva-ursi,* *Rosa acicularis* and *Sheperdia canadensis* (Vetter 2000; Boggs and Sturdy 2005). Where there is sufficient moisture, *Betula neoalaskana* and *Picea glauca* are able to colonize the *Populus tremuloides* woodland; a xeric *Picea glauca* forest may eventually establish (Chapin 2006; Lewis 1998). Following fire, *Populus tremuloides* woodlands may revert to grassland (Lewis 1998).

LANDFIRE National modelers assumed that the fire regime for this system would be similar to that of the adjacent BpS. Starfield and Chapin (1996) estimated a 40-year fire return interval for dry grasslands assuming that Alaskan boreal dry grasslands burn more frequently than other ecosystem types in the region.

Because this system is often found on loose, dry mineral soils on unstable slopes, shifting slopes are an ongoing disturbance. Grazing is probably an important factor in shaping this system, as this is important Dall sheep habitat. Grazing and erosion were not included as disturbances in the model because these are long-term, ongoing phenomena.

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 100 | 100 |  |  |
| Moderate (Mixed) |  |  |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 100 | 100 |  |  |

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

Small to large patch

Adjacency or Identification Concerns

Adjacent systems may include Western North American Boreal Dry Aspen-Steppe Bluff - Higher Elevations or Western North American Boreal Dry Aspen-Steppe Bluff - Lower Elevations. This system does not encompass the coastal Leymus-forb meadows that occur in Aleutians, SW, SC and SE Alaska (NatureServe 2008).

Issues or Problems

Native Uncharacteristic Conditions

Research suggests that dry grasslands are likely to increase as a result of climate change (Rupp et al. 2000a and 2000b).

Comments

More information on this and similar vegetation types can be found in the Fire Effects Information System Synthesis: [Fire regimes of Alaskan dry grassland communities](http://www.fs.fed.us/database/feis/fire_regimes/AK_dry_grassland/all.html). (Innes 2014).

For LANDFIRE National, the fire intervals in this model were adapted from the Boreal Subalpine Steppe Bluff model, also by Boucher and Ryan. During the 2021 review, Kori Blankenship revised the model to include an early herbaceous state (as originally modeled) and a later state where shrubs may be present. Blankenship also eliminated mixed fire (because the dominant species in this BpS are top killed by fire) and changed the replacement fire frequency to 100 years. The more frequent fire interval was based on Starfield and Chapin (1996) but retains the relationship between the adjacent BpS. Lacking data, Blankenship assumed that fire frequency did not vary between states.

Suggested reviewers for this system include Carl Roland and Dalia Vargis-Kretzinger for information on grazing.

Succession Classes

**Mapping Rules**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Upper Layer Lifeform** | **Height (m)** | **Canopy Cover (%)** | | | | | | | | | |
| **0-10** | **11-20** | **21-30** | **31-40** | **41 - 50** | **51-60** | **61-70** | **71-80** | **81-90** | **91-100** |
| Herb | 0-0.5 | A | A | A | B | B | B | B | B | B | B |
| Herb | 0.5-1.0 | A | A | A | B | B | B | B | B | B | B |
| Herb | >1.0 | A | A | A | B | B | B | B | B | B | B |
| Shrub | 0-0.5 | B | B | B | B | B | B | B | B | B | B |
| Shrub | 0.5-1.0 | B | B | B | B | B | B | B | B | B | B |
| Shrub | 1.0-3.0 | B | B | B | B | B | B | B | B | B | B |
| Shrub | >3.0 | B | B | B | B | B | B | B | B | B | B |
| Tree | 0-5 | B | B | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | 5-10 | B | B | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | 10-25 | B | B | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | 25-50 | B | B | UN | UN | UN | UN | UN | UN | UN | UN |
| Tree | >50 | B | B | UN | UN | UN | UN | UN | UN | UN | UN |

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 2 Early Development 1 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| FEAL | *Festuca altaica* | Altai fescue | Upper |
| FERU2 | *Festuca rubra* | Red fescue | Upper |
| CAPU | *Calamagrostis purpurascens* | Purple reedgrass | Upper |
| BRINA | *Bromus inermis* ssp*. pumpellianus var. arcticus* | Pumpelly's brome | Upper |

Description

This class represents the post-fire grass community. Grasses, sedges and/or forbs dominate the site.

*Maximum Tree Size Class*  
None

Class B 98 Late Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| FEAL | *Festuca altaica* | Altai fescue | Upper |
| CAPU | *Calamagrostis purpurascens* | Purple reedgrass | Upper |
| VAVI | *Vaccinium vitis-idaea* | Lingonberry | Upper |
| ARFR4 | *Artemisia frigida* | Prairie sagewort | Upper |
| ARUV | *Arctostaphylos uva-ursi* | Kinnikinnick | Upper |

Description

Grass cover reaches pre-fire levels within two to three years following fire (Tirmenstein, 2000). Shrub cover up to 25% is possible (Viereck et al. 1992).

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:OPN | 0 | Late1:ALL | 2 |
| Late1:ALL | 3 | Late1:ALL | 999 |

Probabilistic Transitions

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Disturbance Type** | **Disturbance occurs In** | **Moves vegetation to** | **Disturbance Probability** | **Return Interval (yrs)** | **Reset Age to New Class Start Age After Disturbance?** | **Years Since Last Disturbance** |
| Replacement Fire | Early1:OPN | Early1:OPN | 0.01 | 100 | Yes | 0 |
| Replacement Fire | Late1:ALL | Early1:OPN | 0.01 | 100 | Yes | 0 |

References

Bliss, L.C., Courtin, G.M., Pattie, D.L., Riewe, R.R., Whitfield, D.W.A. and Widden, P., 1973. Arctic tundra ecosystems. Annual Review of Ecology and Systematics, pp.359-399.

Boggs, K., and M. Sturdy. 2005. Plant associations and post-fire vegetation succession in

Yukon-Charley Rivers National Preserve. Natural Resource Technical Report

NPS/YUCH/NRTR—2005/001. National Park Service, Fort Collins, Colorado.

Boggs, K., L. Flagstad, T. Boucher, M. Carlson, A. Steer, B. Bernard, M. Aisu, P. Lema, B. Heitz, and T. Kuo. 2019. Alaska Ecosystems of Conservation Concern: Biophysical Settings and Plant Associations. Report prepared by the Alaska Center for Conservation Science, University of Alaska, Anchorage for the Alaska Department of Fish and Game. 300 pp.

Chapin, F. Stuart. 2006. Alaska's changing boreal forest / edited by F. Stuart Chapin III ... [et al.] ; illustration editor, Melissa C. Chapin. Oxford; New York : Oxford University Press, 2006.  xiv, 354 p.: ill., maps ; 24 cm.

Dickson, L.G. 2000. Constraints to nitrogen fixation by cyanobacterial crusts in a polar desert ecosystem. Arctic, Antarctic and Alpine Research 32:40-45.

Edwards, M. E., and W.S. Armbruster. 1989. A tundra-steppe transition on Kathul Mountain, Alaska, U.S.A. Arctic and Alpine Research. 21(3): 296-304.

Howenstein, R.E., D.F. Murray, and W.S. Armbruster. 1985. Vegetation ecology of south-facing bluffs in subarctic interior Alaska. Proceedings of the 1985 Arctic Science Conference. Sept 27-29, 1985. University of Alaska-Fairbanks.

Innes, Robin J. 2014. Fire regimes of Alaskan dry grassland communities. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Missoula Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/fire\_regimes/AK\_dry\_grassland/all.html [ 2016, June 28].

Kassler, K.C. 1979. Relicts of the late Pleistocene arctic-steppe: investigations of certain south-facing slopes in interior Alaska.

Lewis, N.K. 1998. Landslide-driven distribution of aspen and steppe on Kathul Mountain, Alaska. Journal of arid environments 38(3), pp.421-435.

Lipkin, R., and J. Tande. 1991. Field report: Botanical survey of the Salmon Fork of the Black River. Alaska Natural Heritage Program, University of Alaska Anchorage, Anchorage, Alaska.

Lloyd, Andrea H., W. Ambruster, E. Scott, E. Mary. 1994. Ecology of a steppe-tundra gradient in interior Alaska. Journal of Vegetation Science. 5(6): 897-912.

Murray, D.F. 1981. The role of arctic refugia in the evolution of the arctic vascular flora – a Beringian perspective. Evolution Today, Proceedings of the second International Congress of Systematic and Evolutionary Biology, pp. 11-20.

Murray, D.F., B.M. Murray, B.A. Yurtsev, and R. Howenstein. 1983. Biogeographic significance of steppe vegetation in subarctic Alaska. Proceedings Permafrost Fourth International Conference. July 17-22, 1983.

NatureServe. 2008. International Ecological Classification Standard: Terrestrial Ecological Classifications. Draft Ecological Systems Description for Alaska Boreal and Sub-boreal Regions.

Redmann, R.E., and A. G. Schwarz. 1986. Dry grassland plant communities in Wood Buffalo National Park, Alberta. The Canadian Field-Naturalist. 100(4): 526-532.

Roland. C. 1996. The floristics and community ecology of extrazonal steppe in the Yukon and Kolyma River drainages. M.S. Thesis. University of Alaska Fairbanks.

Roland, C. 1990. Arctic steppe survey Yukon River sites. Research and Resource Management Report Series 90-04. National Park Service. Yukon-Charley Rivers National Preserve.

Rupp, T.S.; F.S. Chapin III, and A.M. Starfield. 2000a. Response of subarctic vegetation to transient climatic change on the Seward Peninsula in north-west Alaska. Global Change Biology. 6(5): 541-555.

Rupp, T.S., A.M. Starfield, and S.F. Chapin III. 2000b. A frame-based spatially explicit model of subarctic vegetation response to climate change: a comparison with a point model. Landscape Ecology. 15(4): 383-400.

Shacklette, H.T.1966. Phytoecology of a greenstone habitat at Eagle, Alaska. Geological Survey Bulletin 1198-F.

Starfield, A.M., and S.F. Chapin III. 1996. Model of transient changes in arctic and boreal vegetation in response to climate and land use change. Ecological Applications. 6(3): 842-864.

Tirmenstein, D. 2000. Festuca altaica, F. campestris, F. hallii. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: https://www.fs.fed.us/database/feis/plants/graminoid/fesspp/all.html [2021, April 22].

Vetter, MA. 2000.  Grasslands of the Marsh J., S. Nouvet, P. Sanborn, and D. Coxson. 2006. Composition and function of biological crust communities along topographic gradients in grasslands of central interior British Columbia (Chilcotin) and southwestern Yukon (Kluane). Canadian Journal of Botany 84:713–731.e Aishihik-Sekulmun Lakes Area, Yukon Territory, Canada. Arctic [Arctic]. Vol. 53, no. 2, pp. 165-173. Jun 2000.

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 pp.

Walker, M.D., Walker, D.A., Everett, K.R. and Short, S.K., 1991. Steppe vegetation on south-facing slopes of pingos, central Arctic Coastal Plain, Alaska, USA. Arctic and Alpine Research 23(2), pp.170-188.

Wesser, S.D., 1991. The effects of light and moisture on two species from contiguous communities of south-facing bluffs in interior Alaska, USA. Arctic and Alpine Research 23(1), pp.99-103.

Zazula, G. D., D. G. Froese, A. M. Telka, R. W. Mathewes, and J. A. Westgate. 2002. Plants, bugs, and a giant mammoth tusk: Paleoecology of Last Chance Creek, Yukon Territory. In Yukon Exploration and Geology. D. S. Edmond, and L.L. Lewis (eds.). Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Whitehorse, Y.T., Canada.