16901

North American Arctic Dwarf-Shrub Lichen Tundra - Frequent Fire

BpS Model/Description Version: Nov. 2024

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| --- | --- | --- | --- |
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| None | None | None | None |

Reviewer: Robin Innes

Vegetation Type

Shrubland

Map Zones

68

Model Splits or Lumps

This Biophysical Setting (BpS) was split into frequent and infrequent fire variants so regional differences in fire frequency could be represented. The frequent fire variant applies to map zone 68 within level 2 ecoregions (Nowacki et al. 2001): Intermontane Boreal and Bering Tundra. In all other areas the infrequent fire variant applies.

Geographic Range

This BpS occurs throughout arctic Alaska, from the Bristol Bay lowlands in southwestern Alaska and the south side of the Brooks Range, to the North Slope on the Arctic Ocean. This description applies to areas with more frequent fire including the Seward Peninsula and the Noatak River watershed.

Biophysical Site Description

This is a common system on acidic and non-acidic substrates in the hills and mountains of arctic AK. This system does not occur in arctic lowlands. Common slope positions include valleys, sideslopes (especially north-facing), late-lying snowbeds, summits, and ridges. Sites are typically dry to mesic. Sites with >25% lichen cover tend to be exposed to the wind and accumulate little winter snow (Viereck et al. 1992). Non-acidic sites are more common near floodplains, on carbonate substrates, and loess deposition areas. This system does not occur on flat thaw-lake plains.

Vegetation Description

Dwarf-shrub cover is >25%, dominated by dwarf-shrubs other than *Dryas* spp. and lichen cover may exceed 25% particularly on exposed sites. Herbaceous cover varies from a trace to 75%. Dwarf-shrubs that dominate or co-dominate the system include *Cassiope tetragona, Empetrum nigrum, Vaccinium uliginosum, Salix reticulata, Salix arctica, Salix rotundifolia,* and *Arctostaphylos alpina. Cassiope tetragona* is more common on non-acidic sites, and *Empetrum nigrum* dominates this system in its southern range. Other shrubs include *Betula nana, Dryas octopetala, Dryas integrifolia, Ledum palustre* ssp*. decumbens, Loiseleuria procumbens, Vaccinium vitis-idaea, Salix phlebophylla, Saxifraga oppositifolia, Rhododendron lapponicum,* and *Arctostaphylos rubra*. Common herbaceous species include *Hierochloe alpina, Boykinia richardsonii, Carex microchaeta, Carex scirpoidea, Geum glaciale, Pedicularis lanata, Eriophorum angustifolium* ssp*. triste, Equisetum* spp., *Antennaria alpina,* and *Festuca altaica*. Mosses such as *Rhytidium rugosum, Aulacomnium turgidum, Distichium capillaceum, Racomitrium lanuginosum, Dicranum elongatum,* and *Polytrichum* spp. may be common but contribute little cover (Viereck et al. 1992). On non-acidic sites common lichens include *Flavocetraria cucullata, Flavocetraria* spp., *Stereocaulon* spp., *Alectoria nigricans,* and *Thamnolia vermicularis*, but *Cladonia* and *Cladina* species are uncommon. On acidic sites dominant lichens are *Cladina rangiferina* and/or *Cladina stellaris*.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| CATE11 | *Cassiope tetragona* | White arctic mountain heather |
| EMNI | *Empetrum nigrum* | Black crowberry |
| VAUL | *Vaccinium uliginosum* | Bog blueberry |
| SALIX | *Salix spp.* | Willow |
| ARAL2 | *Arctostaphylos alpina* | Alpine bearberry |
| BENA | *Betula nana* | Dwarf birch |
| CABI5 | *Carex bigelowii* | Bigelow's sedge |
| CAMI4 | *Carex microchaeta* | Smallawned sedge |

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

Disturbance Description

In 2013 an extensive search was done by Fire Effects Information System staff to locate information for a synthesis on fire regimes of Alaskan tundra communities (Innes 2013). This synthesis found that studies providing information on fire frequency in tundra ecosystems generally do not differentiate among plant communities and that for tundra types mean fire-return intervals (MFRIs) from 50 to >1,000 years were reported (Innes 2013). When fires burn, stand-replacing crown fires are common (Innes 2013). Sae-Lim and others (2019) reported MFRIs for four tundra sites in the Noatak Watershed ecoregion with MFRIs from 135 to 309 years.

Pre- and post-fire monitoring data in a dwarf shrubland on Seward Peninsula offers one possible successional trajectory for this community (Racine et al. 2004). On a site burned in 1977, plot data indicated that during the first three years after fire, bryophytes (*Ceratodon purpureus* and *Marchantia polymorpha*) dominated the site. *Carex bigelowii, Chamerion angustifolium* (= *Epilobium angustifolium*) and *Calamagrostis canadensis* also increased. By 10 years, the site was graminoid dominated. Shrubs, including *Ledum palustre, Vaccinium vitis-idaea, Empetrum* *nigrum* and *Betula nana*, were slow to recover or had not recovered on the sites within 24 years. Cover of *Salix pulchra* increased after the fire from 1% on the control site to 4-22% on various burned plots. It is unclear how well this successional sequence represents a “reference” condition for Arctic Dwarf-Shrubland. The authors note that the 1977 fire on their study site “accelerated the predicted effects of climate warming on arctic tundra by increasing the percent cover of deciduous shrubs (Racine et al. 2004, p. 9).”

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 247 | 100 |  |  |
| Moderate (Mixed) |  |  |  |  |
| Low (Surface) |  |  |  |  |
| All Fires | 247 | 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

Large patch

Adjacency or Identification Concerns

Issues or Problems

Most of the fire regime literature available for tundra ecosystems in Alaska is from the Seward Peninsula and Noatak River Watershed where fire occurs more frequently than other regions of the state (Innes 2013). Little is known about fire history in arctic tundra communities in northern and northwestern Alaska (Innes 2013). Participants in the virtual Tundra Work Session held in the winter 2022 indicated that fire frequencies for tundra vary considerably across its geographic range and that the fire regime may be driven more by the climate than the vegetation or fuel type.

Native Uncharacteristic Conditions

The current conditions should be similar to the reference condition. According to Innes 2013: “Because most of the area occupied by tundra in Alaska is sparsely populated and has little road access, fire regimes in tundra may not differ much from historical regimes [Chapin et al. 2000, DeWilde and Chapin 2006, Heinselman 1981]. As of 2006, about 66% of interior Alaska was considered to have an essentially "natural" fire regime, with few human ignitions, negligible suppression activity, and many large, lightning-caused fires.” Innes 2013 provides information about climate change and Alaska tundra communities.

Comments

4/2022 Kori Blankenship changed the geographic range and map zones to which this BpS model and description apply based on feedback from reviewer Robin Innes and participants in the virtual Tundra Work Session held in the winter 2022. Reviewer feedback is needed to refine the geographic range of the frequent and infrequent fire model variants.

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.

In 2021 the name of this BpS was changed from Alaska Arctic Dwarf-Shrubland - Frequent Fire to North American Arctic Dwarf-Shrub Lichen Tundra – Frequent Fire in response to changes to the Ecological Systems classification.

During LANDFIRE National, this system was created for the AK Arctic region and did not receive review for other regions in the state. This model was created by Kori Blankenship and Keith Boggs based on the draft Arctic Ecological Systems description (Boggs et al. 2008) and a successional sequence documented by Racine et al. (2004).

The modelers estimated that the fire return interval for this type was similar to that of the Alaska Arctic Tussock Tundra - frequent fire model.

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 | A | A | A | A | A | A | A |
| Herb | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Herb | >1.0 | A | A | A | A | A | A | A | A | A | A |
| 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 7 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CABI5 | *Carex bigelowii* | Bigelow's sedge | Upper |
| CAMI4 | *Carex microchaeta* | Smallawned sedge | Upper |
| CHANA2 | *Chamerion angustifolium* ssp*. angustifolium* | Fireweed | Upper |
| CACA4 | *Calamagrostis canadensis* | Bluejoint | Upper |

Description

Immediately post-fire bryophytes (e.g., *Polytrichum* spp., *Ceratodon purpureus* and *Marchantia polymorpha*) and sedges dominate the site (Racine et al. 2004).

*Maximum Tree Size Class*  
None

Class B 93 Late Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CATE11 | *Cassiope tetragona* | White arctic mountain heather | Upper |
| EMNI | *Empetrum nigrum* | Black crowberry | Upper |
| VAUL | *Vaccinium uliginosum* | Bog blueberry | Upper |
| SALIX | *Salix* spp. | Willow | Upper |

Description

Dwarf shrubs recapture the site within 24 years (Racine et al. 2004). Low shrubs can occur but with < 25% cover. *Vaccinium, Salix, Arctostaphylos* and *Ledum* spp. tend to recover more quickly than *Empetrum nigrum* which has shallow rhizomes that are more susceptible to moderate and high severity fire.

*Maximum Tree Size Class*  
None

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Late1:ALL | 19 |
| Late1:ALL | 20 | 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:ALL | Early1:ALL | 0.004 | 250 | Yes | 0 |
| Replacement Fire | Late1:ALL | Early1:ALL | 0.004 | 250 | Yes | 0 |

References

Boggs et al. 2008. International Ecological Classification Standard: Terrestrial Ecological Classifications. Draft Ecological Systems Description for the Alaska Arctic Region.

Chapin, F. S., III; McGuire, A. D.; Randerson, J.; Pielke, R., Sr.; Baldocchi, D.; Hobbie, S. E.; Roulet, N.; Eugster, W.; Kasischke, E.; Rastetter, E. B.; Zimov, S. A.; Running, S. W. 2000. Arctic and boreal ecosystems of western North America as components of the climate system. Global Change Biology. 6(Supplement 1): 211-223.

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.

DeWilde, La'ona; Chapin, F. Stuart, III. 2006. Human impacts on the fire regime of interior Alaska: interactions among fuels, ignition sources, and fire suppression. Ecosystems. 9(8): 1342-1353.

Heinselman, Miron L. 1981. Fire intensity and frequency as factors in the distribution and structure of northern ecosystems. In: Mooney, H. A.; Bonnicksen, T. M.; Christensen, N. L.; Lotan, J. E.; Reiners, W. A., technical coordinators. Fire regimes and ecosystem properties: Proceedings of the conference; 1978 December 11-15; Honolulu, HI. Gen. Tech. Rep. WO-26. Washington, DC: U.S. Department of Agriculture, Forest Service: 7-57.

Innes, Robin J. 2013. Fire regimes of Alaskan tundra 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\_tundra/all.html [2016, June 28].

Racine, C., R. Jandt, C. Meyers and J. Dennis. 2004. Tundra fire and vegetation change along a hillslope on the Seward Peninsula, Alaska, U.S.A. Arctic, Antarctic, and Alpine Research. 36(1): 1-10.

Sae-Lim, J., Russell, J. M., Vachula, R. S., Holmes, R. M., Mann, P. J., Schade, J. D., and Natali, S. M. 2019. Temperature-controlled tundra fire severity and frequency during the last millennium in the Yukon-Kuskokwim Delta, Alaska. The Holocene. 29(7): 1223-1233.

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

Viereck, L.A., and L.A. Schandelmeier. 1980. Effects of fire in Alaska and adjacent Canada--a literature review. BLM-Aalska Tech. Rep. No. 6. Anchorage, Alaska: U.S. Department of the Interior, Bureau of Land Management. 124 p.