LANDFIRE Biophysical Setting Model

Biophysical Setting 7216290 **Western North American Boreal Tussock Tundra**

☐ *This BPS is lumped with:*
☐ *This BPS is split into multiple models:*

General Information

Contributors (also see the Comments field **Date** 4/4/2008

Modeler 1	Jennifer Allen	Jennifer_Allen@nps.gov	**Reviewer**	Lisa Saperstein	Lisa_Saperstein@fws.gov
Modeler 2			**Reviewer**	Stuart Chapin	fffsc@uaf.edu
Modeler 3			**Reviewer**		

Vegetation Type
Upland Grassland/Herbaceous

Map Zone
72

Model Zone
☑ Alaska
☐ California
☐ Great Basin
☐ Great Lakes
☐ Northeast
☐ Northern Plains
☐ N-Cent.Rockies
☐ Pacific Northwest
☐ South Central
☐ Southeast
☐ S. Appalachians
☐ Southwest

Dominant Species*

ERVA4	BENA
CABI5	LEPAD
VAOX	SPHAG2
CHCA2	PLSC70

General Model Sources
☑ Literature
☑ Local Data
☑ Expert Estimate

Geographic Range

This BpS occurs in the boreal and the northern section of Sub-boreal region of AK. It is found on lowland to subalpine sites.

Biophysical Site Description

The following information was taken from the draft Boreal Ecological Systems description (NatureServe 2008):
Permafrost is usually present at depths of 30-50 cm. Soils are generally poorly drained, gleyed, and often with a poorly decomposed organic horizon at the surface, which may constitute most of the active layer. Frost scars are common. Tussock bog communities occur on lowlands of boreal and boreal transition AK, on filled-in sloughs on flood plains and on cold, poorly drained slopes and terraces. These sites are underlain by wet, silty mineral soils with a surface peat layer 10 to 40 cm thick surrounding the tussocks (Viereck et al 1992).

Vegetation Description

The following information was taken from the draft Boreal Ecological Systems description (NatureServe 2008):
Boreal Tussock Tundra is dominated by sedges in a tussock growth form. Eriophorum vaginatum is the primary tussock-former in most stands and Carex bigelowii is also common. On wetter sites, Oxycoccus spp. (Vaccinium oxycoccos) and Chamaedaphne calyculata may be present. Total shrub cover is less than 25%, although shrubs such as Betula nana (including B. glandulosa), Ledum decumbens (Ledum palustre L. ssp. Decumbens), Vaccinium spp. may be present. Mosses (Sphagnum spp., Pleurozium schreberi, Hylocomium splendens) may form a nearly continuous mat between tussocks. Lichens may be a

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

significant component on some sites.

Disturbance Description

The fuel layer in sedge-shrub tussock tundra is dense and continuous and leads to large, fast spreading fires (Duchesne and Hawkes 2000, Racine et al 1987). Racine (1979) found much variation in burn intensity on a landscape scale on the Seward Peninsula, from completely unburned to intensely burned. These patterns are related to variations in topography and the composition, moisture content and soil organic accumulations of the plant communities. Fires in Eriophorum tussock tundra types tend to be light because of the wet soil profile (Wein 1971). Burns in this type usually consume all aerial woody and herbaceous plant material and litter; regeneration is vigorous via rhizomes and root sprouts. Racine (1979) found that burning was generally less severe in the tussock-shrub and sedge-shrub tundras than in the birch and ericaceous shrub tundra of the Seward Peninsula. He found that tundra burns were patchy, with unburned communities and unburned patches within burned communities.

More fires occur near the forest-tundra ecotone and spread further if trees are present (Heinselman 1981). Wein (1976) reports that July and August are the most common months for lightning fires in tundra ecosystems, while Racine et al (1983; 1985) found that distinct fire seasons occur in both June and July in the Noatak River watershed. Subsidence and thermal erosion following fire is usually minimal in tundra ecosystems (Walker 1996).

In most areas of tussock-shrub tundra on the Seward Peninsula, less than one half of accumulated organic soil layer was removed by fire (Racine 1979). Thaw depths increased to reach into the mineral soils, but were not greatly increased except where organics were removed. Frost features were made more conspicuous, and soil nutrient concentrations (K and P) increased locally.

Mean fire return interval estimates for tussock tundra ecosystems include:
-50-300yrs (personal communication FRCC experts' workshop March 2004)
-260yr (s.d. 170) fire return interval for past 1500yrs for Noatak National Preserve (preliminary data from Higuera et al. 2008)
-180-1,460yrs in forest shrubzone and 9,320yrs in shrub subzone in northern Quebec; shorter cycle west of Hudson's Bay/in interior zone (Payette et al 1989)
-612yrs for Noatak River watershed (all vegetation types) (Racine et al 1983)
-611yr fire rotation for Noatak River watershed (all vegetation below 600m which is predominantly tundra) (Racine et al 1985)
-Fire interval yet to be determined (Racine et al 1987)
-Rapid recovery following fire makes fire frequency difficult to determine (Wein 1971)
-The fire regime of tundra systems are likely quite variable from one region to another making generalizations difficult (Viereck and Schandelmeier 1980)

On interior and southcentral Alaska Tussock Tundra sites the thaw pond cycle (disturbance leads to thawing of permafrost and ponding) and paludification (Sphagnum layer buildup and saturation) are important disturbances. On the Seward Peninsula and western AK, frost action creates polygonal ground and other periglacial features and is a widespread, small-scale and continuous disturbance.

Change in the arctic and subarctic climate is another source of disturbance that is currently affecting tundra ecosystems.

Adjacency or Identification Concerns

Native Uncharacteristic Conditions

Scale Description

Vegetation found in large patches.

Wien (1976) reports many tundra fires in the 1 to 100 ha size range and few large (thousands of ha) fires. Racine (1979) reports that in 1977, lightning-caused fires burned 35,480 ha on the Seward Peninsula, with one fire burning 9,440 ha. Jandt and Meyers (2000) report that large fires (>200,000 ha) occur about every 10yrs in the Buckland Valley and surrounding highlands of the Seward Peninsula. Racine et al (1983) found that 40 fires burned 100,000 ha (1000 km2) in the 30,000 km2 watershed of the Noatak River between 1956 and 1981. Racine et al (1985) found a minimum fire size of .4 ha, a maximum fire size of 45,800 ha and a mean fire size of 1310 ha from 1956-1983 in the Noatak River watershed, an area dominated by tundra vegetation. Of the 79 fires in analyzed by Racine et al (1985), nearly half were between 1 and 10 ha in size. Forty-three percent of wildland fires occurring in interior Alaska occur in treeless areas, primarily tundra bogs and fens (Viereck 1975).

Issues/Problems

Experts at the Fairbanks meeting indicated the need for a late seral sphagnum tussock bog stage that would develop as a result of paludification in class B. The VDDT model does not include that stage because it would be hard to distinguish for mapping using LANDFIRE methods.

This model is based in part on data from the Seward Peninsula, which is not part of the Boreal region. In particular, much of the data on fire regimes comes from the Seward and Noatak areas, both of which are part of the Arctic region.

Comments

This model was created for the AK boreal region and did not receive review for the arctic region.

This model was based on input from the experts who attended the LANDFIRE Fairbanks (Nov. 07) modeling meeting and refined by Jennifer Allen. Much of the text in the Disturbance Description, Scale Description and Succession Class Descriptions in this report were taken from the Tussock Tundra 1 PNVG model description (Murphy and Witten 2006).

This model was origioanlly developed with two herbaceous classes: a Mesic Graminoid Tussock and a Wet Graminoid Tussock class. When it was determined that the LANDFIRE project would not be able to distinguish these classes based on a Viereck et al. (1992) basedd existing vegetation map these two classes were lumped into what is now class A.

Vegetation Classes

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

Class A 85 %

Early Development 1 All Structures

Upper Layer Lifeform

- [x] Herbaceous
- [ ] Shrub
- [ ] Tree

Indicator Species* and Canopy Position

ERVA4	Upper
CABI5	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	Herbaceous	Herbaceous
Height	Herbaceous	Herbaceous
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

Zero plus years

Mesic graminoid tussocks dominates for the first 10yrs or longer. First year following fire Eriophorum (cottongrass) and Carex spp. (sedges) regrow via rhizomes, most vascular species begin to recover, shrubs sprout from rootstock. Sedges often capture site 6-10yrs post fire. Grasses (Calamagrostis and Arctagrostis) are locally important following fire. A high severity fire can lead to increased shrub development (class C), whereas a low to moderate severity fire typically leads to the development of a wet graminoid tussock stage.

Wet graminoid tussock can dominate some sites developing about 10yrs post fire. It is the most common stage after a low to moderate severity fire. Over time paludification results in the development of a sphagnum tussock bog (the model does not include the sphagnum tussock bog stage because it would be hard to distinguish for mapping using LANDFIRE methods).

This class persists in the absence of disturbance or will follow an alternate successional pathway to class B (probability = 0.001). Replacement MFRI = 175yrs.

Class B 15 %

Late Development 1 All Structures

Upper Layer Lifeform

- [ ] Herbaceous
- [x] Shrub
- [ ] Tree

Indicator Species* and Canopy Position

CHCA2	Upper
VAOX	Upper
ERVA4	Upper
CABI5	Upper

Structure Data (for upper layer lifeform)

	Min	Max
Cover	Open Shrub (25-74% shrub cover)	Closed Shrub (> 75% shrub cover)
Height	Dwarf Shrub (< 20 cm)	Dwarf Shrub (< 20 cm)
Tree Size Class	None	

- [ ] Upper layer lifeform differs from dominant lifeform.

Description

10yrs+

Dwarf shrub, tussock. Most common stage after a high severity fire. Tussocks dominated by Eriophorum (cottongrass), Carex spp. (sedges). Common shrubs include Oxycoccus spp. (Vaccinium oxycoccus), Chamaedaphne calyculata, Betula nana, Ledum decumbens and Vaccinium. Lichens begin to re-establish but do not reach former abundance until 50-120yrs following fire. Fire is difficult to detect even in the early stages of this class, however the proportions of species differs from the pre-burn community, with very few lichens, fewer shrubs and more sedges, grasses and cottongrass. Former abundances of all species are typically reached 50-120yrs post fire.

This class persists in the absence of disturbance. Replacement MFRI = 175yrs.

---

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement sev

Class C **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover		
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class D **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover		
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Class E **0 %**

[Not Used] [Not Used]

Upper Layer Lifeform

☐ Herbaceous
☐ Shrub
☐ Tree

Indicator Species* and Canopy Position

Structure Data (for upper layer lifeform)

	Min	Max
Cover		
Height		
Tree Size Class		

☐ Upper layer lifeform differs from dominant lifeform.

Description

Disturbances

Fire Regime Group:** IV

Historical Fire Size (acres)

Avg 0
Min 0
Max 0

Sources of Fire Regime Data

☑ Literature
☑ Local Data
☑ Expert Estimate

Fire Intervals	Avg FI	Min FI	Max FI	Probability	Percent of All Fires
Replacement	175			0.00571	100
Mixed					
Surface					
All Fires	175			0.00573	

Fire Intervals (FI):

Fire interval is expressed in years for each fire severity class and for all types of fir combined (All Fires). Average FI is central tendency modeled. Minimum and maximum show the relative range of fire intervals, if known. Probability is the inver of fire interval in years and is used in reference condition modeling. Percent of all fires is the percent of all fires in that severity class.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100- year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement sev

Additional Disturbances Modeled

☐ Insects/Disease ☐ Native Grazing ☐ Other (optional 1)
☐ Wind/Weather/Stress ☐ Competition ☐ Other (optional 2)

References

Duchesne L. C. and B.C. Hawkes. 2000. Fire in northern ecosystems. In: Brown, J.K. and J.K. Smith (eds.) Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 p.

Heinselman, M.L. 1981. Fire and succession in the conifer forests of northern North America. In: West, D.C., H.H. Shugart, and D.B. Botkin. Forest succession: concepts and application. Springer-Verlag, New York. Chapter 23.

Higuera, P.E., M. Chipman, J. Allen, S. Rupp and F.S. Hu. 2008. Preliminary data provided by Jenifer Allen from a study of tundra fire regimes in the Noatak National Preserve since 6000 years before present.

Jandt, R.J. and R.C. Meyers. 2000. Recovery of lichen in tussock tundra following fire in Northwestern Alaska. USDOI BLM-Alaska Open File Report 82.

Murphy, K.A. and E. Witten. 2006. Tussock Tundra 1. In Fire Regime Condition Class (FRCC) Interagency Guidebook Reference Conditions. Available at www.frcc.gov.

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

Payette, S., C. Morneau, L. Sirois, M. Desponts. 1989. Recent fire history of the northern Quebec biomes. Ecology. 70:656-673.

Personal communication experts' workshop, March 2-4 2004. Fire Regime Condition Class (FRCC) interagency experts' workshop to develop and review Potential Natural Vegetation (PNV) groups for Alaska. Anchorage, Alaska.

Racine, C.H., L.A. Johnson, L.A. Viereck. 1987. Patterns of vegetation recovery after tundra fires in northwestern Alaska, USA. Arctic and Alpine Research. 19:461-469.

Racine. 1979. Climate of the Chucki-Imuruk area. Pages 32-37 in H. R. Melchior, ed., Biological Survey of the Bering Land Bridge National Monument. Alaska Cooperative Park Studies Unit, University of Alaska Fairbanks, Fairbanks, AK.

Racine, C. H., W. A. Patterson III, and J. G. Dennis. 1983. Permafrost thaw associated with tundra fires in northwest Alaska. Pages 1024-1029 in Proceedings, Permafrost, Fourth International Conference. National Academy Press, Washington, D.C.

Racine, C.H.; J.G. Dennis and W.A. Patterson III. 1985. Tundra fire regimes in the Noatak River Watershed, Alaska: 1956-83. Arctic 38:194-200.

Racine, C; J.L. Allen and J.G. Dennis. 2006. Long-term monitoring of vegetation change following tundra fires in Noatak National Preserve, Alaska. Arctic Network of Parks inventory and monitoring program,

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve

National Park Service, Alaksa Region. Report no. NPS/AKRARCN/NRTR-2006/02.

Viereck, L.A. 1975. Forest ecology of the Alaska Taiga. In: Proceedings of the circumpolar conference on northern ecology; 1975 September; Ottawa, ON. National Research Council of Canada: I-1 to I-22.

Viereck et al. 1992. The Alaska vegetation classification. Pacific Northwest Research Station, USDA Forest Service, Portland, OR. Gen. Tech. Rep. PNW-GTR286. 278 p.

Viereck, L.A.; Schandelmeier, L.A. 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

Walker, D.A. 1996. Disturbance and Recovery of Arctic Alaskan Vegetation. In: JF Reynolds and JD Tenhunen eds, Landscape function and disturbance in arctic tundra. Ecological studies vol. 120, Springer Verlag Berlin Heidleberg

Wein, R.W. 1976. Frequency and characteristics of arctic tundra fires. Arctic, 29,213-222.

Wein, R.W. 1971. Panel discussion: In: Slaughter, C.W., Barney, Richard J., and Hansen, G.M. (editors). 1971. Fire in the Northern Environment – A Symposium. Sponsors: Alaska Forest Fire Counc il and Society of American Foresters. Held at: The University of Alaska, Fairbanks. April 13-14, 1971. Published by: Pacific.

*Dominant Species are from the NRCS PLANTS database. To check a species code, please visit http://plants.usda.gov.
**Fire Regime Groups are: I: 0-35 year frequency, surface severity; II: 0-35 year frequency, replacement severity; III: 35-100+ year frequency, mixed severity; IV: 35-100+ year frequency, replacement severity; V: 200+ year frequency, replacement seve