16460

Alaskan Pacific Maritime Western Hemlock Forest

BpS Model/Description Version: Nov. 2024

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| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
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Vegetation Type

Forest and Woodland

Map Zones

75, 77, 78

Model Splits or Lumps

North Pacific Mesic Western Hemlock-Yellow-cedar Forest (1040) and North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest (1178) are lumped into the Alaskan Pacific Maritime Western Hemlock Forest for Biophysical Setting (BpS) modeling.

This BpS should be mapped as separate existing vegetation types, but they are lumped for modeling because it is unclear how models would differ quantitatively for the two types. Western Red-cedar tends to occur on slightly wetter sites below 800 ft elevation (Demeo et al. 1992) and Western Red-cedar-Western Hemlock associations will overlap with Western Hemlock series, particularly in lower elevation, more poorly drained sites.

Geographic Range

Western hemlock is found from Prince William Sound (the northwestern limit of Western Hemlock) through southeast AK where it is the dominant forest type on mountain and hillslopes.

Biophysical Site Description

This BpS is commonly found on moderately productive, upland sideslopes and low angle terrain from sea level to about 2000 ft elevation (DeMeo et al. 1992). Soils are somewhat poorly to well drained. Western hemlock stands range from somewhat poorly drained sites with a greater cedar component to well drained sites with a Sitka spruce component. Sites dominated by western hemlock tend to be more stable or less disturbance prone than sites dominated by Sitka spruce.

Vegetation Description

The overstory is typically dominated by *Tsuga heterophylla*, or a mix of *Tsuga heterophylla* and *Picea sitchensis* or *Tsuga heterophylla* and *Thuja plicata*, especially below 800 ft. Higher elevation or cooler microsites with somewhat poorly drained soils include *Callitropsis nootkatensis.* Overstory canopy cover is usually at least 60%. *Tsuga heterophylla* stands are most prevalent on hill and mountain slopes and footslopes, but can also be found in riparian zones and on uplifted beaches (DeMeo et al. 1992). Common shrubs include *Vaccinium ovalifolium* and *Menziesia ferruginea* (NatureServe 2008). *Lysichiton americanus* occurs in poorly drained depressions. Other common forbs include *Rubus pedatus, Streptopus amplexifolius, Cornus* *canadensis, Tiarella trifoliate, Streptopus roseus,* and *Maianthemum dilatatum* (NatureServe 2008; Schoen and Dovichin 2007). Common ferns *include Gymnocarpium dryopteris, Blechnum spicant,* and *Dryopteris expansa*. (DeVelice et al. 1999; Demeo et al. 1992; Martin et al. 1995).

In the northern portion of the region (Yakutat through Prince William Sound) *Tsuga mertensiana* may also be present in the canopy. *Callitropsis nootkatensis* (formerly *Cupressus nootkatensis*) may be present in the canopy in southeast Alaska (e.g., Glacier Bay), and represents somewhat less productive sites, but is rare in this system in Prince William Sound (the NW limit of *Callitropsis nootkatensis*) (Hennon and Trummer 2001). Sites tied to disturbance, such as v-notches, are dominated by *Oplopanax horridus* and *Rubus spectabilis* in the understory.

Western hemlock, Sitka spruce and redcedar forests found on karst topography represent a special subtype within the Western Hemlock BpS. Although most of this subtype has been eliminated due to logging it is important from a conservation perspective and provides extremely valuable wildlife habitat (Schoen and Dovichin 2007). Karst environments support some of the largest trees in the region because the soils have better drainage and roots anchored in the carbonate bedrock tend to be windfirm (Schoen and Dovichin 2007). Alaback (1982) found that the forest understory in karst environments had very low productivity due to the dense overstory canopy and very productive tree growth.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| TSHE | *Tsuga heterophylla* | Western hemlock |
| PISI | *Picea sitchensis* | Sitka spruce |
| THPL | *Thuja plicata* | Western red cedar |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry |
| MEFE | *Menziesia ferruginea* | Rusty menziesia |
| COCA13 | *Cornus canadensis* | Bunchberry dogwood |

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

Disturbance Description

Wind disturbances at both small and large scales play a fundamental role in shaping forest dynamics in Southeast Alaska (Alaback et al. 2017; Harris and Farr 1974; Nowacki and Kramer 1998). Wind disturbance characteristics change over a continuum dependent on landscape features (e.g., exposure, position on the landscape, topography). Distinct wind disturbance regimes grade from exposed landscapes where recurrent, large-scale wind events prevail to wind-protected landscapes where small-scale canopy gaps predominate. Blowdowns in southeast Alaska range in size from 1 to 1,000 acres and disproportionately occur as smaller patches (typically < 50 acres) (Nowacki and Kramer 1998). An area’s susceptibility to windthrow can affect stand structure and forest development. Stands on wind protected sites tend to have an uneven age structure and are more likely to reach late stages of development than stands on wind prone sites (Kramer et al. 2001).

Some research suggests that frequent, small-scale wind events have a larger impact on these forests than the relatively less frequent, large-scale blowdowns (Harcombe 1986). More recent research suggests that catastrophic wind-throw events are a more important driver of forest dynamics in the region than previously recognized (Kramer et al. 2001). Stem-snap and resultant canopy gaps are more likely to occur in old growth forests and mean gap size tends to be larger in old growth forests than in mature forests (Nowacki and Kramer 1998). The direction of gap-maker tree falls is significantly aligned with the direction of prevailing winds.

Catastrophic winds commonly cause large-scale blowdown throughout southeast Alaska (Deal et al 1991). Depending on intensity, wind can create single-generation stands with uniform canopies or multi-generation stands with diverse canopy and size structures. Intervals between complete blowdowns tend to be long with forests cycling through stand initiation, stem exclusion, and understory reinitiation stages, eventually reaching the old growth stage at about 350yrs.

Tree regeneration may be inhibited following windthrow due to the large amount of downed woody debris (Alaback 1984; Harris and Farr 1974). This can lead to the development of a patchy, open canopy structure (Alaback 1984). However, both spruce and hemlock readily germinate on decaying, downed logs, referred to as “nurse logs.” As trees develop on nurse logs their roots spread around the log to reach the soil. When the nurse log decays completely, a line of trees with buttressed roots is left behind.

Fire occurrence is rare and not well documented in the forests of southeaset AK and therefore not included in this model. Fire plays some role in inland areas near Haines, Skagway and generally north of Lynn Canal where the climate is more continental and dryer (personal communication, Roy Josephson). Yakutat, Icy Bay and over to Cordova is not influenced by fire (personal communication, Roy Josephson). Most fires are anthropogenic and recently observed lightning caused fires were quite small (personal communication, Roy Josephson).

Other important disturbances affecting this type can include avalanches, landslides, and tectonic movement. Insect and disease attacks are rare although black-headed budworm and hemlock sawfly outbreaks occasionally cause widespread defoliation (Harris and Farr 1974). Dwarf mistletoe and heart rot fungi perpetuate the hemlock-dominated old-growth condition (Hennon and McClellan 2003).

Fire Frequency

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

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. Frequent small scale windthrow drives patch size.

Adjacency or Identification Concerns

This type occurs below the mountain hemlock zone and above the Sitka spruce riparian zone.

Issues or Problems

Native Uncharacteristic Conditions

Timber harvest, predominantly clearcut harvest, throughout southeast Alaska has created large areas of early successional (particularly the stem exclusion stage) forest.

With global warming, the intensity and duration of wind events may increase as a result of stronger land-water thermal gradients (Alaback and McClellan 1993). A warming climate also appears to be enabling redcedar to grow further north and may be responsible for the decline of yellow cedar (Schoen and Dovichin 2007).

Comments

This model was developed by Sheila Spores but much of the disturbance description was taken from the Coastal Forest PNVG description (Murphy and Witten 2006) and Roy Josephson provided input on fire for the Lynn Canal area. Reviewer Paul Alaback noted that the successional model is a good representation of the Western Hemlock type on the most productive sites. These sites, sometimes referred to as “large tree old-growth (see Caouette and DeGayner 2008),” can support trees with >40 inches DBH and occupy a relatively small percentage of the Western Hemlock zone. While small tree old-growth (see Caouette and DeGayner 2008) can be considered part of the Poorly Drained Conifer BpS, a separate model for medium tree old-growth may be needed (but has not been created yet). Although small and medium tree old-growth (see Caouette and DeGayner 2008), Western Hemlock are more common than the large tree old-growth and much less is known about it. Review comments resulted in minor descriptive changes as well as the addition of the discussion on karst environments and several references. Other review comments resulted in minor edits to the description and slight adjustments to the s-class age ranges.

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 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 0.5-1.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | 1.0-3.0 | A | A | A | A | A | A | A | A | A | A |
| Shrub | >3.0 | A | A | A | A | A | A | A | A | A | A |
| Tree | 0-5 | A | A | A | A | A | A | A | A | A | A |
| Tree | 5-10 | B | B | B | B | B | B | B | B | B | B |
| Tree | 10-25 | C | C | C | C | C | C | C | C | C | C |
| Tree | 25-50 | D | D | D | D | D | D | D | D | D | D |
| Tree | >50 | D | D | D | D | D | D | D | D | D | D |

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 4 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| TSHE | *Tsuga heterophylla* | Western hemlock | Upper |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Mid-Upper |
| MEFE | *Menziesia ferruginea* | Rusty menziesia | Mid-Upper |

Description

Post disturbance stand initiation

Herbs, shrubs and tree seedlings grow from seeds, sprouts and advance regeneration. Within five years following disturbance, a vigorous shrub layer develops and will often persist past age 20yrs. Thirty years is used as the estimate of the end of this stage (Alaback 1984; DeMeo et al. 1992). By age 50, shrub cover is reduced past the pre-disturbance level (DeMeo et al. 1992). Post disturbance conifer regeneration will depend on the pre disturbance stand composition and the type of disturbance. Hemlock is more likely to regenerate following windthrow whereas spruce is more likely to regenerate if mineral soil is exposed (e.g. after a landslide).

A reviewer noted that the length of this seral stage will vary somewhat with site quality. The main notable difference is karst vs. non-karst. On karst sites, the trees are patchier initially and it takes longer for a closed canopy to develop. Hemlock sites with devil’s club—an indicator of aerated soils with frequent forest gap creation—will also show this lag. The lag is about 10yrs; i.e., canopies on these sites can be expected to be closed by age 40 (DeMeo et al. 1992).

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

Class B 13 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| TSHE | *Tsuga heterophylla* | Western hemlock | Upper |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |

Description

Stem exclusion

Tree canopy closes and shade in-tolerant species in the understory are lost. Forest structure becomes stratified, with slower-growing, shade tolerant conifer species forming lower canopy strata. Some trees are thinned from the stand due to lack of resources (e.g., light, growing space, nutrients, etc.). Spruce and hemlock dominate. Understory can be completely void of vegetation, therefore no understory species are listed as indicators for this class.

*Maximum Tree Size Class*  
Med. 9–20" (swd)/11–20" (hwd)

Class C 18 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| TSHE | *Tsuga heterophylla* | Western hemlock | Upper |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Lower |
| MEFE | *Menziesia ferruginea* | Rusty menziesia | Lower |

Description

Understory re-initiation

As the overstory ages, new species of shade-tolerant forbs and shrubs appear on the forest floor. Eventually larger tree-fall gaps, which are not subject to closure by lateral extension, begin to appear in the overstory, thus allowing for conifer regeneration and the beginning of gap-phase replacement. A two-aged, two-layered stand forms. Pure hemlock or hemlock-spruce dominate.

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

Class D 65 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| TSHE | *Tsuga heterophylla* | Western hemlock | Upper |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Lower |
| MEFE | *Menziesia ferruginea* | Rusty menziesia | Lower |

Description

Old growth

Multi-aged, multi-layered stand with continuing gap-phase replacement. Tree mortality is generally balanced with growth from newly established seedlings. Large, decadent trees, standing snags, coarse woody debris, overhead gaps and regeneration patches are all present. Heart rot, mistletoe and fluting tend to make these stands valuable for wildlife habitat (Schoen and Dovichin 2007). Pure hemlock or hemlock-spruce dominate.

*Maximum Tree Size Class*  
Very Large 40.0"+

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:ALL | 0 | Mid1:CLS | 29 |
| Mid1:CLS | 30 | Late1:CLS | 119 |
| Late1:CLS | 120 | Late2:CLS | 249 |
| Late2:CLS | 250 | Late2:CLS | 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** |
| Wind or Weather or Stress | Early1:ALL | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Mid1:CLS | Mid1:CLS | 0.001 | 1000 | No | 0 |
| Wind or Weather or Stress | Late1:CLS | Early1:ALL | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late2:CLS | Late2:CLS | 0.01 | 100 | No | 0 |
| Wind or Weather or Stress | Late2:CLS | Early1:ALL | 0.002 | 500 | Yes | 0 |

References

Alaback, P.B. 1993. Biodiversity pattern in relation to climate and genetic base of the rainforests of the west coast of North America. In: Lawford, R., Alaback, P., and Fuentes E.R. (eds): High latitude rain forests of the west coast of the Americas: Climate, hydrology, ecology, and conservation. Springer-Verlag: New York.

Alaback, P.B. and Juday, G.P. 1989. Structure and composition of low elevation old growth forest in research natural areas of Southeast Alaska. Natural Areas Journal 9: 27-39.

Alaback, P., and M. McClellan, 1993. Effects of global warming on managed coastal ecosystems of western North America. In Earth system responses to global change; contrasts between North and South America. Academic Press. Pp. 299–327.

Alaback, P.B. 1982. Dynamics of understory biomass in Sitka spruce-western hemlock forests of southeast Alaska. Ecology. 63: 1932-1948.

Alaback, P.B. 1984. Plant succession following logging in the Sitka spruce-western hemlock forests of southeast Alaska: implications for management. General Technical Report PNW-173. USDA Forest Service. Pacific Northwest Forest and Range Experiment Station. Portland, OR. 26 p.

Alaback, P. B., Nowacki, G., & Saunders, S. 2017. Natural disturbance patterns in the temperate rainforests of southeast Alaska and adjacent British Columbia. North Pacific temperate rainforests: ecology and conservation. University of Washington Press, Seattle, Washington, USA, 73-81.

Caouette, J.P. and E.J. DeGayner. 2008. Broad-Scale Classification and Mapping of Tree

Size and Density Attributes in Productive Old-Growth Forests in Southeast Alaska’s

Tongass National Forest. Western Journal of Applied Forestry. 23(2): 106-112.

Deal, R., C. Oliver, and B. Bormann. 1991. Reconstruction of mixed hemlock-spruce stands in coastal Southeast Alaska. Canadian Journal of Forest Research 21:643–654.

DeMeo, T., J. Martin and R.A. West. 1992. Forest plant association management guide, Ketchikan Area, Tongass National Forest. USDA Forest Service, Alaska Region. R10-MB-210. 405p.

Harcombe. P. A. 1986. Stand development in a 130 year old spruce-hemlock forest based on age structure and 50 years of mortality data. For. Ecol. and Manage. 14:41-58.

Harris, A.S. and W. A. Farr. 1974. The forest ecosystem of southeast Alaska. 7: Forest ecology and timber management. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station: PNW-GTR-25. Portland, OR. 109 p.

Hennon, P., and C Shaw. 1997. What’s killing the trees? The enigma of yellow-cedar decline. Journal of Forestry 95(12).

Hennon, P.E. and Trummer, L.M. 2001. Yellow-cedar (Chamaecyparis nootkatensis) at the northwest limits of its range in Prince William Sound, Alaska. Northwest Science. 75: 61-72.

Hennon, P.E. and McClellan, M.H. 2003. Tree mortality and forest structure in temperate rain forests of southeast Alaska. Can. J. For. Res. 33: 1621-1634.

Kramer, M.G., A.J. Hansen, M.L. Taper and E.J. Kissinger. 2001. Abiotic controls on long-term windthrow disturbance and temperate rain forest dynamics in southeast Alaska. Ecology 82(10): 2749-2768.

Lertzman, K.P. and C. J. Krebs. 1991. Gap-phase structure of a subalpine old-growth forest. Can. J. For. Res. 21:1730-1741.

Martin, Jon R., Susan J. Trull, Ward W. Brady, Randolph A. West and Jim M. Downs. 1995. Forest plant association management guide, Chatham Area, Tongass National Forest. USDA Forest Service, Alaska Region. R10-TP-57.

Murphy, K.A. and E. Witten. 2006. Coastal Forest. 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 Maritime Region.

Nowacki, G.J. and M. G. Kramer.1998. The effects of wind disturbance on temperate rain forest structure and dynamics of Southeast Alaska. USDA Forest Service, Pacific Northwest Research Station: PNW-GTR-421.

Oliver, C. 1981. Forest development in North America following major disturbances. Forest Ecology and Management 3:153–158.

Oliver, C., and B. Larson. 1996. Forest stand dynamics. Wiley, New York.

Ott, R. 1997. Natural disturbance at the site and landscape levels in temperate rainforests of Southeast Alaska. Ph.D. dissertation, University of Alaska, Fairbanks.

Ott, R.A., and G.P Juday. 2002. Canopy gap characteristics and their implications for management in the temperate rainforests of southeast Alaska. Forest Ecology and Management. 159(3): 271-291.

Schoen, J.W. and E. Dovichin (editors). 2007. The Coastal Forests and Mountains Ecoregion of Southeastern Alaska and the Tongass National Forest. Published by The Nature Conservancy and the Audobon Society. Available online at http://conserveonline.org/workspaces/akcfm.