16442

Alaskan Pacific Sitka Spruce Forest and Beach Ridge - Periglacial Woodland and Shrubland

BpS Model/Description Version: Nov. 2024

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| --- | --- | --- | --- |
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Vegetation Type

Forest and Woodland

Map Zones

77, 78

Geographic Range

This Biophysical Setting (BpS) is found from Kodiak Island south through southeast AK.

Biophysical Site Description

This BpS occurs on young terrains exposed through deglaciation since the end of the Little Ice Age, as well as those sites uplifted by isostatic rebound and/or regional tectonics. This includes landscapes less than 500yrs old throughout Southeast and Southcentral Alaska. Specific systems have been described from Sitka (Flagstad and Boucher 2013), Klondike Gold Rush National Park (Flagstad and Boucher 2015), Yakutat (Shephard 1993, 1995), Glacier Bay (Boggs et al. 2008a), Wrangel St. Elias National Park (Jorgenson et al. 2008), Kenai Fjords (Boggs et al. 2008b, Flagstad 2007), and Kodiak Island (Fleming and Spencer 2004). Periglacial systems (those underlain by ice) are described by Boggs and others (2019). Soils are shallow, stony, and well-drained to excessively well-drained. Substrates include glacial till, residuum, and colluvium. Soil profile development is lacking or minimal.

Vegetation Description

Common early successional or pioneer communities are initially dominated by non-vascular plants (e.g. mosses: *Racomitrium canescens, Polytrichum juniperinum*; lichens: *Stereocaulon tomentosum, Cladonia crispata, Cladina portentosa*) and later early-seral herbaceous or shrubs species can capture the site. Common herbaceous species may include *Calamagrostis canadensis, Chamerion angustifolium, C. latifolium, Heracleum maximum, Lupinus nootkatensis, Equisetum arvense, Athyrium filix-femina, Dryopteris expansa, Phegopteris connectilis, Streptopus amplexifolius, Pyrola* spp., *Carex mertensii* and *Chamerion* spp.

In the mid-successional stage, the Sitka spruce (*Picea sitchensis*) overstory underlain by a dense shrub understory is co-dominated by Sitka alder (*Alnus viridis* ssp. *sinuata*), salmonberry (*Rubus spectabilis*), and Devil’s club (*Oplopanax horridum*) in younger stands, with the contribution of early blueberry (*Vaccinium ovalifolium*) and rusty menziesia (*Menziesia ferruginea*), increasing in older stands. *Salix alaxensis, S. barclayi*, or *S. sitchensis* may also be abundant. Ferns such as lady fern (*Athyrium filix-femina*) and spreading woodfern (*Dryopteris expansa*), five-leafed bramble (*Rubus pedatus*), foamflower (*Tiarella trifoliata*), and the feathermoss *Rhytidiadelphus loreus* is common in the understory.

Later-seral transitional forest communities support either *Populus balsamifera* ssp. *trichocarp*a or a mix of *Populus balsamifera* ssp*. trichocarpa* and *Picea sitchensis*. Subalpine fir occurs in limited areas usually near mainland corridors to interior ecosystems (e.g. Skagway area, Taku River valley, and possibly the Stikine River). *Picea sitchensis* often forms a dense layer below the overstory of *Populus balsamifera* ssp. *trichocarpa*. Where *Populus balsamifera* ssp. *trichocarpa* co-dominates with *Picea sitchensis*, the shrub understory is more likely to include willow species, a greater diversity of forbs such as twisted stalk (*Streptopus amplexifolius*) and the northern oak fern (*Gymnocarpium dryopteris*), and the feathermosses *Hylocomium splendens* and *Pleurozium schreberi.* Transitional forest communities are generally found on older landscapes at low elevations near the maximum glacial extent.

The latest seral stage considered in this modeled is dominated by *Picea sitchensis* and characterized by a rich moss ground layer. *Tsuga heterophylla* (Southeast Alaska) or *Tsuga mertensiana* (Southcentral Alaska) recruit in the understory. Other common understory species in this stage include *Rubus spectabilis*, *Sambucus racemosa*, *Oplopanax horridus*, and *Ribes bracteosum* (Cooper 1923). Herbaceous species may include *Aspidium spinulosum*, *Polystichum braunii*, *Athyrium filix-femina*, *Listera cordata*, *Actaea rubra*, *Orthilia secunda*, and *Moneses uniflora* (Cooper 1923). Mosses include *Hylocomium splendens*, *Rhytidiadelphus triquetrus*, and *R. squarrosus* (Cooper 1923).

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| ALVIS | *Alnus viridis ssp. sinuata* | Sitka alder |
| POBA2 | *Populus balsamifera ssp. trichocarpa* | Black poplar |
| PISI | *Picea sitchensis* | Sitka spruce |
| SASI2 | *Salix sitchensis* | Sitka willow |
| CHLA13 | *Chamerion latifolium* | Dwarf fireweed |
| RUSP | *Rubus spectabilis* | Salmonberry |
| EQVA | *Equisetum variegatum* | Variegated scouringrush |

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

Disturbance Description

The following is one conceptual model for how succession will proceed on recently deglaciated sites:

Primary succession on recently deglaciated terrain (glacial till or bedrock shields) usually begins with colonization of bare rock and soil by lichens and mosses, followed by grasses and forbs, then by shrub species such as alder and willow. The rate and direction of succession is variable and depends on initial site conditions, propagule pressure, and species interactions (Chapin et al. 1995; Fastie 1995; Flagstad 2007). On glacial till substrates, *Alnus viridis* ssp*. sinuata* and/or *Salix* spp. (*S. sitchensis, barclayi*) dominate the site within about 20yrs. On bedrock substrates, mosses and herbaceous species may persist longer due to the lack of microsites for shrub establishment. Disturbance-prone sites may remain dominated by *Alnus viridis* ssp*. sinuata. Alnus viridis* ssp*. sinuata* helps to fix nitrogen in the soil, facilitating the growth of trees. Seed dispersal is also an important factor in the successional dynamics of a recently deglaciated site (Chapin et al. 1995). After about 50yrs a transitional forest system characterized by *Populus balsamifera* ssp*. trichocarpa* (common on well-drained sites) or *Alnus viridis* ssp*. sinuata* and *Picea sitchensis* can emerge through the tall shrub canopy. *Picea sitchensis* eventually gains dominance in the canopy and over long time-scales (not considered in this model) mountain hemlock or possibly sloping peatland systems may develop. This transition to a hemlock-spruce forest is evident at Glacier Bay where bark beetles killed some of the even-age Sitka spruce approximately 140yrs after colonization, yielding a multi-age forest favoring more western hemlock (Paul Hennon, personal communication).

Rates of succession will be highly variable based on substrate, landform, and elevation. Avalanche and rock slides will slow development on high angle slopes. On low angle slopes with finer glacial deposits succession will proceed more rapidly.

Avalanches, rock slides, glacial advance and outwash, and windthrow are the primary disturbances that affect this type. Windthrow is more likely in this BpS than other maritime forests because the trees are shallowly rooted in young soils. Some areas are also prone to periodic glacial outburst floods, also known as jokulhlaups, which may occur annually, but this is not a widespread phenomenon across the range of this BpS.

In 2014, an extensive literature search was done by Fire Effects Information System staff to locate information this and other BpSs with black cottonwood for a synthesis on fire regimes of Alaskan black cottonwood communities, with few results (Innes 2014).

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

Adjacency or Identification Concerns

A variety of vegetation types could be found adjacent to this BpS depending on substrate, landform, and elevation. Most adjacent undisturbed areas on low to mid elevation valley landscapes are western hemlock or spruce-hemlock forest, depending on age and local site factors.

Although the Alaskan Pacific Sitka Spruce Forest and Beach Ridge - Beach Ridge BpS (formerly called Alaskan Pacific Hypermaritime Sitka Spruce Beach Ridge) occurs on recently uplifted sites, it is considered a separate BpS.

Issues or Problems

Periglacial Sitka spruce forests represent a unique biophysical environment with unique successional dynamics. It is difficult to model these dynamics using the LANDFIRE methodology, which assumes that over time an equilibrium condition will be reached and that the percent of the landscape in each seral stage varies within a certain range (i.e. the natural or historic range of variability). These modeling assumptions do not apply to areas where spruce is actively invading recently deglaciated or uplifted sites where plants colonize newly exposed ground and modify the biophysical environment over time.

Age ranges mentioned in this description and given in the state-and-transition model should be considered approximations. The current model is partially based on age ranges and seral stage descriptions from Reiners et al. 1971 and Cooper 1923. Snow avalanche, rockslide, glacial advance and outwash, and windthrow (only in the forest stages) are believed to be primary disturbances affecting recently deglaciated sites. They are therefore included in the state-and-transition model, but there are no data to support the probabilities assigned to them. The probabilities were assigned in a relative sense, assuming that the probability of non-wind disturbance, especially avalanches and rockslides, was most prevalent but decreased over time as vegetation developed, soil stabilized, and distance from the glacier increased. The class percentages from this model should not be used as a reference condition to calculate fire regime condition class. It is likely that class percentages vary widely over time and from site to site.

This model was largely developed based on studies in Glacier Bay which may not be representative of other periglacial environments. Walker (1995) found that conditions at Glacier Bay favored more rapid growth and succession than at other sites in Alaska.

Native Uncharacteristic Conditions

Innes 2014 and Zouhar 2017 include information about contemporary changes relevant to this BpS.

Comments

08/2022 The description was updated based on reviewer feedback to include more recent literature as well as updated and additional vegetation species information. Based on reviewer feedback, Kori Blankenship added an alternative succession transition to the model to represent the possibility that the Mid1Closed Alder-Willow Thicket state succeeded directly to the Late2Closed Sitka Spruce Forest state, skipping the intervening Late1All Spruce-Cottonwood Transition Forest state. The probability of this successional pathway is not known.

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 was based on input from experts who attended the LANDFIRE Juneau Modeling Meeting (Feb. 08) and refined by Rick Turner. Sclass age ranges and descriptions are partially based on a chronosequence of sites in primary succession at Glacier Bay, AK (Reiners et al. 1971, p. 56). Review comments resulted in minor descriptive edits to the model description and quantitative changes to the state-and-transition model. Model changes included the addition of a Sitka Spruce forest stage (Class D) and the addition of windthrow disturbance in the Spruce-Cottonwood Transitional Forest (Class C) and Sitka Spruce Forest (Class D) stages.

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

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 - Open

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| CACA4 | *Calamagrostis canadensis* | Bluejoint | Upper |
| EQVA | *Equisetum variegatum* | Variegated scouringrush | Upper |
| CHLA13 | *Chamerion latifolium* | Dwarf fireweed | Upper |
| ALVIS | *Alnus viridis* ssp*. sinuata* | Sitka alder | Upper |

Description

Pioneer: Non-Vascular plants, Dryas, Sparse Willows, Poplar and Alder

After ice retreat the first plants to pioneer a site include *Polytrichum juniperinum, Equisetum variegatum, E. arvense, Carex* ssp*.,* and *Chamerion latifolium*. Herbaceous species colonizing the initial pioneer community include *Calamagrostis canadensis, Chamerion angustifolium, Heracleum maximum, Lupinus nootkatensis, Athyrium filix-femina, Dryopteris expansa, Phegopteris connectilis, Streptopus amplexifolius, Pyrola* spp., *Carex mertensii*, and *Chamerion* spp. Scattered *Salix* ssp., *Alnus viridis* ssp. *sinuate*, and *Populus balsamifera* ssp. *trichocarpa* seedlings may be present.

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

Class B 10 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| ALVIS | *Alnus viridis* ssp*. sinuata* | Sitka alder | Upper |
| SAAL | *Salix alaxensis* | Feltleaf willow | Upper |
| SASI2 | *Salix sitchensis* | Sitka willow | Upper |
| SABA3 | *Salix barclayi* | Barclay's willow | Upper |

Description

Alder-Willow Thicket

*Alnus viridis* ssp*. sinuata* often dominates the species composition, although *Salix alaxensis, S. sitchensis,* or *S. barclayi* may also be abundant. The relative abundance of *Salix* species can be quite variable; *S. alaxensis* is typically found on disturbed sites with sandy soils. Scattered pole sized cottonwoods may be present in this stage.

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

Class C 21 Late Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| POBA2 | *Populus balsamifera* ssp*. trichocarpa* | Balsam poplar | Upper |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| ALVIS | *Alnus viridis* ssp*. sinuata* | Sitka alder | Lower |
| SALIX | *Salix* spp. | Willow | Lower |

Description

Spruce-Cottonwood Transition Forest

This stage is typically found on older deglaciated landscapes at lower elevations near the maximum glacial extent; elsewhere it is absent, and succession proceeds directly to Sitka spruce forest. *Populus balsamifera* ssp*. trichocarpa* or a mix of *Populus balsamifera* ssp*. trichocarpa* and *Picea sitchensis* dominate. Common understory shrubs include *Rubus spectabilis, Alnus* *viridis* ssp*. sinuata, Salix sitchensis,* and *Oplopanax horridus.*

Rock slides (Option 1) cause a transition to Class A. Snow avalanches (Option 1) cause a transition to class B. Wind throw causes a transition to Class B.

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

Class D 66 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| RUSP | *Rubus spectabilis* | Salmonberry | Lower |
| SARA2 | *Sambucus racemosa* | Red elderberry | Lower |
| OPHO | *Oplopanax horridus* | Devilsclub | Lower |

Description

Sitka Spruce Forest

*Picea sitchensis* eventually gains canopy dominance over the hardwoods. *Tsuga heterophylla* (Southeast Alaska) and *Tsuga mertensiana* (Southcentral Alaska) seedlings and saplings may be present and a rich moss understory develops (Reiners et al. 1971). As the forest matures, *Tsuga heterophylla* will likely gain dominance, but then the Mt. Hemlock Forest BpS model would apply. *Alnus viridis* ssp. *sinuata* and *Salix* spp. are present in more open stands. Common understory species include *Rubus spectabilis, Sambucus racemosa, Oplopanax horridus*, and *Ribes bracteosum* (Cooper 1923). Herbaceous species may include *Aspidium spinulosum, Polystichum braunii, Athyrium filix-femina, Listera cordata, Actaea rubra, Orthilia secunda*, and *Moneses uniflora* (Cooper 1923). The characteristic moss covering the ground is dominated by *Hylocomium splendens, Rhytidiadelphus triquetrus,* and *R. squarrosus* (Cooper 1923).

Rock slides (Option 1) cause a transition to Class A. Snow avalanches (Option 1) cause a transition to Class B. Wind throw causes a transition to Class B.

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

Model Parameters

Deterministic Transitions

|  |  |  |  |
| --- | --- | --- | --- |
| **From Class** | **Begins at (yr)** | **Succeeds to** | **After (years)** |
| Early1:OPN | 0 | Mid1:CLS | 19 |
| Mid1:CLS | 20 | Late1:ALL | 49 |
| Late1:ALL | 50 | Late2:CLS | 149 |
| Late2:CLS | 150 | 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** |
| Optional 2 | Early1:OPN | Early1:OPN | 0.01 | 100 | Yes | 0 |
| Optional 1 | Early1:OPN | Early1:OPN | 0.01 | 100 | Yes | 0 |
| Alternative Succession | Mid1:CLS | Late2:CLS | 0.01 | 100 | Yes | 0 |
| Optional 1 | Mid1:CLS | Early1:OPN | 0.005 | 200 | Yes | 0 |
| Wind or Weather or Stress | Late1:ALL | Mid1:CLS | 0.002 | 500 | Yes | 0 |
| Optional 1 | Late1:ALL | Mid1:CLS | 0.001 | 1000 | Yes | 0 |
| Optional 1 | Late1:ALL | Early1:OPN | 0.001 | 1000 | Yes | 0 |
| Wind or Weather or Stress | Late2:CLS | Mid1:CLS | 0.002 | 500 | Yes | 0 |
| Optional 1 | Late2:CLS | Mid1:CLS | 0.001 | 1000 | Yes | 0 |
| Optional 1 | Late2:CLS | Early1:OPN | 0.001 | 1000 | Yes | 0 |

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