16441

Alaskan Pacific Sitka Spruce Forest and Beach Ridge - Sitka Spruce Forest

BpS Model/Description Version: Nov. 2024 9/11/15

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Vegetation Type

Forest and Woodland

Map Zones

73, 75, 76, 77, 78, 80

Geographic Range

This Biophysical Setting (BpS) is found along the Gulf Coast of Alaska and the North Pacific, in the perhumid and subpolar rainforest zones. It is present in a narrow coastal band (likely 1 to several km wide) on the west side of Cook Inlet including portions of Katmai and Lake Clark National Parks. The northern extent of Sitka spruce is near the Johnson River.

Biophysical Site Description

This productive ecological system occurs on well-drained sideslopes, footslopes, and floodplains along the Gulf Coast of Alaska and the North Pacific where the boreal and maritime regions of Alaska overlap in the perhumid and subpolar rainforest zones. Spruce occurs on rolling bedrock hills and valleys where there is a strong maritime influence and warm, wet coastal storms occur. Sites dominated by *Picea sitchensis* are usually tied to disturbance such as slope instability, water movement (either downhill through the soil or in open streams), exposure to salt spray, or windthrow. Soils tend to be well-drained to excessively well-drained, shallow to deep, stony, and well-developed (except in areas where spruce is invading meadows and shrublands).

In the northern portion of the temperate rainforest (Kodiak Island, Kenai Fjords, and Prince William Sound), *Picea sitchensis* is frequently the dominant canopy tree from sea level to treeline on productive sites, and it is the only conifer that occurs on Afognak and Kodiak islands, where its range is actively expanding. In the southern portion of the Alaskan rainforest, *Picea sitchensis* is linked more closely with disturbance (e.g., very steep sites, recently deglaciated landscapes, outer coast headlands, alluvial fans, landslides) and karst substrates. It also occurs commonly at upper elevations just below the mountain hemlock zone. Mature forests usually have very little downed wood or snags. Beach ridges form and become removed from direct contact with saltwater through long-shore sediment transport coupled with isostatic rebound. Coastal beach communities are often dominated by *Leymus mollis* and brackish meadows. *Picea sitchensis* seedlings establish in the brackish meadows, but often do not survive, probably due to excessive salt spray. Further inland, *Picea sitchensis* seedlings establish and survive in these meadows, causing the meadow to transition to forest. *Picea sitchensis* establishes about 130 years after beach ridge formation and may succeed to *Tsuga heterophylla* forest where soil drainage decreases.

The biophysical environment of the Kodiak Archipelago is unique in that vegetation communities on these islands are still responding to the retreat of Pleistocene glaciers and ash deposition from the 1912 Katmai eruption (Fleming and Spencer 2007). Fleming and Spencer (2007, p. 5) note that: “Sitka spruce forest is actively moving south along the island of Kodiak, perhaps as much as a mile/century [the source of this claim is unknown (personal communication, Page Spencer)]. This succession replaces alder, salmon and elderberry and forb meadows with dense spruce forest. Preferred wildlife habitats with grasses, sedges and forbs, and prolific berry crops, are being replaced with dense conifers.”

Vegetation Description

*Picea sitchensis* is the dominant tree species, although *Tsuga mertensiana* or *Tsuga heterophylla* may be minor canopy associates and can be codominant especially on older sites. In southeastern Alaska, *Alnus rubra* may be an associated understory tree species, especially in riparian floodplain systems and on alluvial fans. *Oplopanax horridus* and mosses are common in the understory of open stands (Fleming and Spencer 2007). Closed stands tend to have a very sparse understory that may include *Oplopanax horridus*, *Vaccinium ovalifolium*, *Sambucus racemosa*, *Viburnum edule*, *Alnus viridis* ssp. *sinuata*, *Rubus spectabilis*, and feather mosses (e.g., *Hylocomium splendens* and *Rhytidiadelphus loreus*) (Fleming and Spencer 2007). *Calamagrostis canadensis* and *Menyanthes trifoliata* are also present in some forest openings. In Lake Clark National Park near the northern extent of this BpS, a broader range of species is present including *Picea glauca* which may hybridize with *Picea sitchensis*. In this area, the characteristic moss understory found in the Kodiak Archipelago is absent. *Calamagrostis nutkaensis* may be common on exposed sites near the coast.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| PISI | *Picea sitchensis* | Sitka spruce |
| OPHO | *Oplopanax horridus* | Devilsclub |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry |
| SARA2 | *Sambucus racemosa* | Red elderberry |
| ALVIS | *Alnus viridis ssp. sinuata* | Sitka alder |
| RUSP | *Rubus spectabilis* | Salmonberry |
| HYSP70 | *Hylocomium splendens* | Splendid feather moss |
| RHLO70 | *Rhytidiadelphus loreus* | Loreus goose neck moss |

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

Disturbance Description

Primary succession of the *Picea sitchensis* forest in the Kodiak Archipelago begins with rich forb meadows. Overtime, *Alnus viridis* ssp*. sinuata* invades, fills in and *Sambucus racemosa* and *Rubus spectabilis* are added to the species mix. Eventually *Picea sitchensis* will start to invade. The timing of the transition to *Picea sitchensis* appears to be a function of the timing of the Pleistocene glacial retreat, seed source and seed advancement. As the *Picea sitchensis* trees become denser, the first generation closed *Picea sitchensis* forest develops with *Vaccinium ovalifolium*, *Oplopanax horridus* and feather mosses in the understory. After about 150-300 years the trees start to senesce, small scale blow down occurs and a multi age stand develops. In the forest gaps left after tree death or blowdown a rich shrub layer with *Alnus viridis* ssp. *sinuata*, *Oplopanax horridus* and *Calamagrostis canadensis* competes with the young *Picea sitchensis* trees. With further succession, these forests can become more open. In areas with beaver activity, ponds can form that when drained can again support *Picea sitchensis* trees.

In the Katmai area *Picea sitchensis* advancement appears to be slower than on Kodiak (personal communication, Page Spencer). It is unclear how well the Kodiak successional sequence applies to *Picea sitchensis* forest on the south end of the Kenai Peninsula which appears to be better developed and is the likely seed source for *Picea sitchensis* invading the Kodiak Archipelago.

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). 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). 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 re-initiation stages, eventually reaching the old growth stage (at about 350 years). The direction of gap-maker tree falls is significantly aligned with the direction of prevailing winds. 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). Catastrophic winds commonly cause large-scale blowdown throughout southeast Alaska (Deal et al. 1991). Windthrow is more likely in this system than other maritime forests because the trees are shallow rooted in young soils.

In 2017, a comprehensive literature search for fire history information in Alaskan Pacific maritime ecosystems found a single study. In the Kenai Mountains, Potkin (1997) sampled two stands containing spruce and hemlock trees and reported subsurface charcoal 1270 years +/- 40 BP at one site and no soil charcoal at a second site (Potkin 1997).

Other important disturbances include avalanches, landslides and tectonic movement.

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. Open Sitka spruce forests are often intermixed with alder and forb meadows (Fleming and Spencer 2007).

Issues or Problems

In dense spruce forest where secondary succession characterized by gap dynamics has begun, the disturbance is occurring on a fine scale as individual or small groups of trees die or are windthrown. The small forest openings created by these dynamics are likely not mappable using the LANDFIRE methodology; the state-and-transition model for this BpS attempts to capture broader scale dynamics.

It is unclear how well the dynamics described in the Disturbance Description for the Kodiak Archipelago apply to the Kenai and west Cook Inlet parts of the distribution of this BpS.

Native Uncharacteristic Conditions

Logging on Kodiak Island and on the Kenai Peninsula south of Seldovia has created more early successional forests than would exist otherwise.

Comments

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 Kori Blankenship updated the state-and-transition model for this BpS. During LANDFIRE National it was thought that the states of this type would be difficult to map using LANDIFRE methods. While this may still be the case, Blankenship felt it was important to construct at least a conceptual model to represent the dynamics of the BpS. Blankenship used information from the Fire Regime Condition Class Coastal Forest model by Karen A. Murphy and Evie Witten and the LANDFIRE Alaskan Pacific Maritime Western Hemlock Forest

BpS model by Sheila Spores and reviewed by Paul Alaback, Roy Josephson, and Tom DeMeo. In addition to model changes, Blankenship added to the disturbance regime and succession classes section of the model description which was developed during LANDIFRE National largely based on work in the Kodiak Archipelago (Fleming and Spencer 2007) and conversations with Page Spencer.

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 5 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| OPHO | *Oplopanax horridus* | Devilsclub | Upper |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Upper |
| SARA2 | *Sambucus racemosa* | Red elderberry | 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 20 years. 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).

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

Class B 12 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |

Description

Stem exclusion.

Tree canopy closes and shade intolerant 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 28 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| OPHO | *Oplopanax horridus* | Devilsclub | Lower |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Lower |
| SARA2 | *Sambucus racemosa* | Red elderberry | 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.

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.

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

Class D 55 Late Development 2 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| PISI | *Picea sitchensis* | Sitka spruce | Upper |
| OPHO | *Oplopanax horridus* | Devilsclub | Lower |
| VAOV | *Vaccinium ovalifolium* | Oval-leaf blueberry | Lower |
| SARA2 | *Sambucus racemosa* | Red elderberry | Lower |
| RUPE | *Rubus pedatus* | Trailing raspberry | Lower |
| COCA13 | *Cornus canadensis* | Bunchberry | Lower |

Description

Old growth.

It takes about 350 years from stand initiation to reach the old growth stage (Nowacki and Kramer, 1998). 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.

*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 | 349 |
| Late2:CLS | 350 | 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 |

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