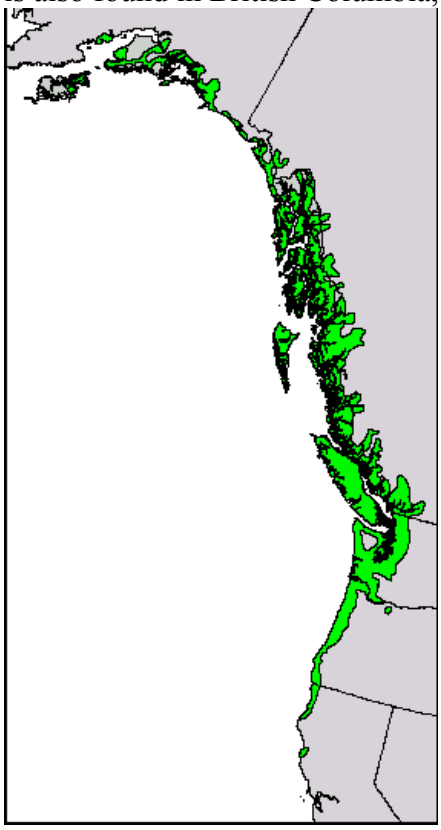
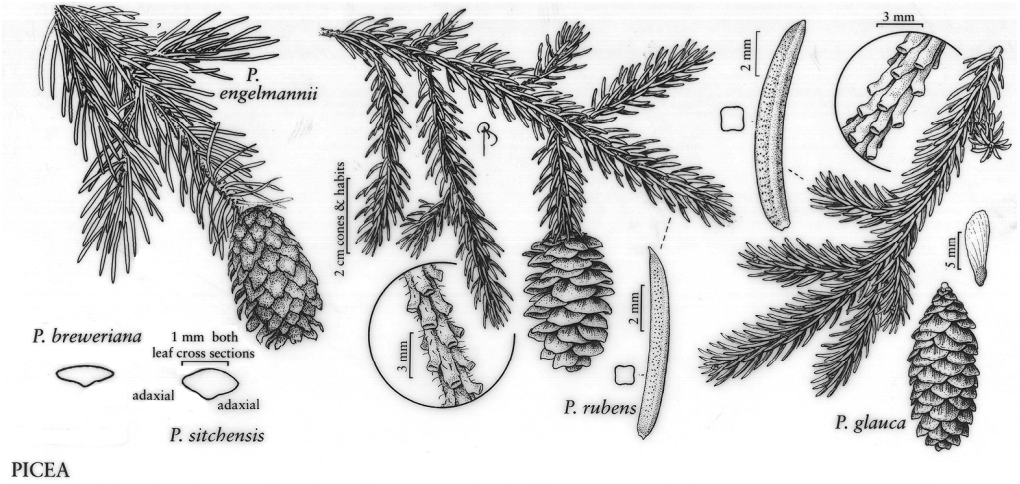
Plant Propagation Protocol for *Picea sitchensis* (Sitka Spruce)
ESRM 412 – Native Plant Production

Photo from USDA (2)

TAXONOMY	
Family Names	
Family Scientific Name:	Pinaceae (1, 2)
Family Common Name:	Pine family (1, 2)
Scientific Names	
Genus:	*Picea* (1, 2)
Species:	*sitchensis* (1, 2)
Species Authority:	Bongard (1832); Carriere (1855) (3)
Variety:	
Sub-species:	
Cultivar:	
Authority for Variety/Sub-species:	
Common Synonym(s) (include full scientific names (e.g., *Elymus*	*Pinus sitchensis* Bongard 1832 *Abies falcata* Rafinesque *A. menziesii* (Douglas ex D. Don) Lindley 1835, not Mirbel 1825 *Picea falcata* (Rafinesque) Suringar *P. menziesii* (Douglas ex D. Don) Carrière

glaucus Buckley), including variety or subspecies information)	*Pinus menziesii* Douglas ex D. Don (3, 4).
Common Name(s):	Common names for Sitka spruce include tideland spruce, coast spruce, Menzies spruce, épinette de Sitka, and yellow spruce (4, 5).
Species Code (as per USDA Plants database):	PISI (2)
GENERAL INFORMATION	
Geographical range (distribution maps for North America and Washington state)	Sitka spruce is found in Alaska, Washington, Oregon, and California, USA; it is also found in British Columbia, Canada (2).  Map is from source 3.
Ecological distribution (ecosystems it occurs in, etc):	Sitka spruce occurs in pure or mixed stands; it grows well in moist, well-drained soils, which include alluvial floodplains, marine terraces, headlands, recent glacial outwash, and avalanche tracks (6). It also grows where there are old logs or where there are mounds of boggy areas (6).
Climate and elevation range	Sitka spruce prefers a wet, temperate (often cool) climate and grows at low to middle elevations, but it reaches the timberline on the Queen Charlotte Islands and most of the maritime areas of southeast Alaska (6). It usually grows at elevations of 1,000 to 3,000 feet (7).
Local habitat and abundance; may include commonly	In Alaska, Sitka spruce grows only in the mountains and along a piedmont glacier (7). In British Columbia, the range in the south only includes a narrow strip in the mainland and offshore islands; it grows more abundantly on the

associated species	northern tip and in the western portion of Vancouver Island (7). In Washington, Sitka spruce thrives along the Strait of Georgia, around the Puget Sound, in valleys on the eastern side of the state, and in the Olympic Peninsula forests (7). The area where Sitka spruce grows narrows as it gets closer to Oregon but then goes inland along several major rivers in Oregon (7). In northern California, Sitka spruce is less abundant and more spread out (7).
Plant strategy type / successional stage (stress-tolerator, competitor, weedy/colonizer, seral, late successional)	Sitka spruce is an early pioneer species that grows on immature soils formed by glacial retreat (7). Sitka spruce needs high amounts of calcium, magnesium, and phosphorus and grows well when soils are formed from rocks with these elements (7). Sitka spruce also requires deep, moist, well-aerated soils that are acidic (pH values of 3.9 to 5.7) (2).
Plant characteristics (life form (shrub, grass, forb), longevity, key characteristics, etc)	Sitka spruce is of the tree variety. It can live up to 700 to 800 years and grows to be about 200 feet tall (80 m) (7, 8). They often grow in forests associated with western hemlock *(Tsuga heterophylla)* where the stands are dense (7). Its trunk is usually 2 m, but can grow larger (2). Characteristics of its needles are shown in the picture below (9); needles are usually 5/8 to 1 inch long (10).  PICEA Sitka spruce's sapwood is creamy white or a light yellow, and the heartwood is pinkish yellow to brown (10). Sapwood in mature Sitka spruce trees usually ranges from three to six inches (10).
PROPAGATION DETAILS	
Ecotype (this is meant primarily for experimentally derived protocols, and is a description of where the seed that was tested	Possibly ecotypes include the aforementioned regions, elevations, and climates where Sitka spruce is known to propagate and grow.

<table>
<tr><td>came from):</td><td></td></tr>
<tr><td>Propagation Goal (Options: Plants, Cuttings, Seeds, Bulbs, Somatic Embryos, and/or Other Propagules):</td><td>Sitka spruce grows from a seed; it can also grow from a stem cutting (2). It grows into a plant/tree (7, 10).</td></tr>
<tr><td>Propagation Method (Options: Seed or Vegetative):</td><td>Seed (7)</td></tr>
<tr><td>Product Type (options: Container (plug), Bareroot (field grown), Plug + (container-field grown hybrids, and/or Propagules (seeds, cuttings, poles, etc.))</td><td>Sitka spruce can be propagated by bare root, container, cuttings, and seed (2).</td></tr>
<tr><td>Stock Type:</td><td>There are eight stock types of Sitka spruce; they are shown in the chart below and are characterized by growth limiting factors (11).
<table>
<tr><th colspan="6">Ss stock type suitability.</th></tr>
<tr><th colspan="2">Ss</th><th colspan="4">Limiting factors</th></tr>
<tr><th></th><th>Season</th><th>Vegetation competition</th><th>Snow-press</th><th>Animal damage</th><th>Shallow soils</th></tr>
<tr><th colspan="6">Recommended stock types:</th></tr>
<tr><td>PSB 313B 1+0</td><td>Sp</td><td>Poor</td><td>Poor</td><td>Fair</td><td>Good</td></tr>
<tr><td>PSB 410 1+0</td><td>Sp, Su</td><td>Fair</td><td>Poor</td><td>Fair</td><td>Good</td></tr>
<tr><td>PSB 415B 1+0</td><td>Sp, Su</td><td>Fair</td><td>Poor</td><td>Fair</td><td>Poor</td></tr>
<tr><td>PSB 412A 1+0</td><td>Sp, Su</td><td>Fair</td><td>Fair</td><td>Fair</td><td>Good</td></tr>
<tr><td>PSB 415D 1+0</td><td>Sp, Su</td><td>Good</td><td>Good</td><td>Good</td><td>Poor</td></tr>
<tr><td>PSB 512A 1+0</td><td>Sp, Su</td><td>Good</td><td>Good</td><td>Good</td><td>Good</td></tr>
<tr><td>PSB 515A 1+0</td><td>Sp, Su</td><td>Good</td><td>Good</td><td>Good</td><td>Poor</td></tr>
<tr><td>PSB 615A 1+0</td><td>Sp, Su</td><td>Good</td><td>Good</td><td>Good</td><td>Poor</td></tr>
</table></td></tr>
<tr><td>Time to Grow (from seeding until plants are ready to be outplanted):</td><td>It takes about one to two years for the seedling to be ready to move from a pot to a more permanent plot in the ground (2). Individual trees have been known to be mature enough to bear cones before 20 years of age, but it usually takes 20 to 40 years before Sitka spruce bears cones (10). Sitka spruce is not thinned in commercial forests until 15 to 22 years of age, and the final felling occurs at age 35 to 45 (12).</td></tr>
<tr><td>Target Specifications (size or characteristics of target plants to be</td><td>Sitka spruce’s target specifications include the following:
slow initial growth for first few years;
around 27 m in height after 50 years and 48 m after 100 years;
trunk diameter around 2 m at maturation; and</td></tr>
</table>

produced):	• long, lateral roots (2, 7).
Propagule Collection (how, when, etc):	Seed collection begins and ends in the fall (2). Seeds can be collected from good cone crops in 3 to 5 year intervals in most of its range; however, good cone crops occur in 5 to 8 year intervals in Alaska (10). Cones usually start forming when the tree is 20 to 40 years old (10).
Propagule Processing/Propagule Characteristics (including seed density (# per pound), seed longevity, etc):	There are 209,600 Sitka spruce seeds per pound (2). Seeds spread at a slow rate; seedling growth has a low vigor; and the first few years of seedling growth and vegetative spread is fairly slow (2, 10).
Pre-Planting Propagule Treatments (cleaning, dormancy treatments, etc):	The United States Department of Agriculture (USDA) recommends the following: "*Picea sitchensis* seed requires no pretreatment if the seed is sown fresh, however a period of cold unifies and hastens germination (Dirr & Heuser 1987). Sow stored seeds as early in the year as possible. Preferably sow the seeds in a position in light shade. Seeds should be stored in a cool place and should not be allowed to dry out. Put seedlings into individual pots when they are large enough to handle and grow them in the greenhouse for the first winter. They can be planted into their permanent positions in early summer of the following year" (2).
Growing Area Preparation / Annual Practices for Perennial Crops (growing media, type and size of containers, etc):	As enumerated above, seeds should be sown in light shade and stored in a cool place so they do not dry out (2). Individual pots should be used for seedlings that grow too large to be part of a group of emerging seedlings (2). Sitka spruce needs high amounts of calcium, magnesium, and phosphorus and grows well when soils are formed from rocks with these elements (7). Sitka spruce also requires deep, moist, well-aerated soils that are acidic (pH values of 3.9 to 5.7) (2).
Establishment Phase (from seeding to germination):	Sitka spruce seeds germinate in most seedbeds, but survival may be low if certain conditions are not met (7). A soil that is a mixture of mineral and organic soil is usually the best seedbed for germination (7). Light shade and high drainage is also preferred (7). Fine-textured soil is usually preferred for germination, but frost heaving may hinder germination, while coarse-textured mineral soil in light-intensive areas will dry out the soil and prevent germination (7).
Length of Establishment Phase:	Seeds usually germinate with about one month (13), but they will take up to two years to be fully established and ready to be transported from a temporary pot to the earth (2).
Active Growth Phase (from germination until plants are no longer actively growing):	The active growth period of Sitka Spruce takes place in spring and summer of each year (2).
Length of Active Growth Phase:	The length of active growth phase each year occurs within about six months (spring and summer) (2).

Hardening Phase (from end of active growth phase to end of growing season; primarily related to the development of cold-hardiness and preparation for winter):	The hardening phase takes place in November or December, just before the first frost and after lateral shoot elongation has desisted (14).
Length of Hardening Phase:	The hardening phase takes place within about four weeks (14).
Harvesting, Storage and Shipping (of seedlings):	Seedlings may be harvested after they have been in the greenhouse for their first winter, but they should be planted in the early summer (2).
Length of Storage (of seedlings, between nursery and outplanting):	Seedlings should be stored in the nursery/greenhouse for about 18 months (2). The seeds should be germinated early in the year, allowed to grow until seedlings are large enough for individual pots, and then left in the greenhouse for their first winter (2).
Guidelines for Outplanting / Performance on Typical Sites (eg, percent survival, height or diameter growth, elapsed time before flowering):	Sitka spruce should be planted in the early summer (2). Survival rates may be low if the right seedbed is not provided; see "Establishment Phase" (7). Sitka spruce usually grows to be around 27 m in height after 50 years and 48 m after 100 years; trunk diameter is around 2 m at maturation (7, 6). It usually takes 20 to 40 years for Sitka spruce to start bearing cones, albeit some bear cones before 20 years of age (10).
Other Comments (including collection restrictions or guidelines, if available):	
INFORMATION SOURCES	
References (full citations):	1. "Sitka Spruce – Plant Information." Garden Guides on-line. http://www.gardenguides.com/plants/plant.asp?symbol=PISI#. April 12, 2009. 2. "Plant Profile: Sitka Spruce." USDA: Natural Resources Conservation Services on-line. http://plants.usda.gov/java/nameSearch. April 12, 2009. 3. "Picea sitchensis." The Gymnosperm Database on-line. http://www.conifers.org/pi/pic/sitchensis.htm. April 12, 2009.

4. Taylor, Ronald J. 1993. Sections on Picea and Tsuga. Flora of North America Editorial Committee (eds.): Flora of North America North of Mexico, Vol. 2. Oxford University Press.

5. "*Picea sitchensis*." Integrated Taxonomic Information System on-line. http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=183309. April 12, 2009.

6. Pojar, Jim and Andy MacKinnon. *Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia & Alaska*. Vancouver: Lone Line, 1994.

7. Harris, A.S. 1990. Picea sitchensis. Eds. Burns, R.M. and B.H. Honkala. Silvics of North America, Vol. 1, Conifers. Washington DC: U.S.D.A. Forest Service Agriculture Handbook 654. http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm. Accessed April 12, 2009.

8. "*Picea Sitchensis*." Flora of North America on-line. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500914. April 12, 2009.

9. "Picea sitchensis." Wikipedia on-line. http://en.wikipedia.org/wiki/Sitka_Spruce. April 12, 2009.

10. United States Department of Agriculture: US Forest Service. "Sitka Spruce: An American Wood." Forest Service on-line. http://www.fpl.fs.fed.us/documnts/usda/amwood/265sitka.pdf. April 12, 2009.

11. "Sitka Spruce (Ss and Sxs)." [Canadian] Ministry of Forest and Range on-line. http://www.for.gov.bc.ca/hfp/publications/00078/sispruce.htm. April 12, 2009.

12. "Sitka Spruce." Ireland Department of Agriculture on-line. http://www.agriculture.gov.ie/media/migration/forestry/publications/SitkaSpruce_low.pdf. April 12, 2009.

13. Jones SK, Gosling PG, and Ellis R. Reimposition of conditional dormancy during air-dry storage of prechilled Sitka spruce seeds. *Seed Science Research* (1998) 8,113-122 113.

14. Lucas PW, Cottam DA, Sheppard LJ, and Francis BJ. "Growth responses and delayed winter hardening in Sitka spruce following summer exposure to ozone." *New Phytol.* (1988), **108,** 495-504.

Other Sources Consulted (but that contained no pertinent information) (full citations):	1. "Picea sitchensis." National Center for Biotechnology Information on-line. http://www.ncbi.nlm.nih.gov/Taxonomy/Browser/wwwtax.cgi?lvl=0&id=3332. April 12, 2009. 2. Jalkanen RE, Redfern DB, and Sheppard LJ. Nutrient deficits increase frost hardiness in Sitka spruce (*Picea sitchensis*) needles. *Forest Ecology and Management* Volume 107, Issues 1-3, 17 August 1998, Pages 191-201.
Protocol Author (First and last name):	Andrew Lurker
Date Protocol Created or Updated (MM/DD/YY):	04/12/09

Appendix: Plant Data Sheet (Zhang 2003)

Plant Data Sheet
Sitka spruce*, Picea sitchensis*

Range
Native range shaped a narrow strip along the north Pacific coast from latitude 61° N. in south-central Alaska to 39° N. in northern California. (1)

Climate, Elevation
Maritime climate has abundant moisture throughout the year, relatively mild winters and cool summers. (1) Grows from sea level to 600m. (2)

Local occurrence (where, how common)
Usually grows in mixed stands, often associated with western hemlock.(1)

Habitat preferences
Deep, moist, well-drained soils and with high in calcium, magnesium and phosphorus. (2)

Plant strategy type/successional stage (stress-tolerator, competitor, weedy/colonizer, seral, late successional)
Woody. And develop epicormic branches along the stem. (1)

Associated species
Western red cedar, red alder, salmonberry, red osier dogwood, red elderberry, lady fern, water parsley, and skunk cabbage. (3)

May be collected as: (seed, layered, divisions, etc.)
Seeds. Stem cuttings. (1)

Collection restrictions or guidelines
Cones ripen from mid-August to mid-September. Collect cones at ripening to avoid seed loss. (2)

Seed germination (needs dormancy breaking?)
Do not require stratification but will germinate more uniformly following a cold, moist stratification period of 30 days. (2)

Seed life (can be stored, short shelf-life, long shelf-life)
Seeds can be stored for several years. (2)

Recommended seed storage conditions
Store 0-2°C in sealed containers. (2) Seed dried to 7-8% moisture content and freezer stored (-17°C to -12°C) will remain viable for many years.(3)

Propagation recommendations (plant seeds, vegetative parts, cuttings, etc.)
Collect cones, separate seeds, plant seeds. And air-layering or rooting of stem cuttings. (1)

Soil or medium requirements (inoculum necessary?)
A thin layer of mulch is recommended. (2)

Installation form (form, potential for successful outcomes, cost)
Seeds, air-layering or rooting of stem cuttings. (1)

Recommended planting density
341,710-881,835 seeds per kilogram. (2)

Care requirements after installed (water weekly, water once, never water, etc.)
Adequate drainage, sufficient nutrients and light shade. (1)

Normal rate of growth or spread; lifespan
Height growth is slow for the first few years but increases rapidly thereafter. Height would be 27m at 50 years, 48m at 100 years. Lifespan up to 700-800 years. (1)

Sources cited

(1) Burns, R. and B. Honkala 1990. Silvics of North America, Volume 2, Hardwoods. Agricultural Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D. C. 877 p.

(2) Rose, R., C. Chachulski and D. Haase. 1996. Propagation of Pacific Northwest Native Plants: A Manual, Volume Two, First Edition. Nursery Technology Cooperative, Oregon State University, Corvallis, Oregon, 73 p.

(3) Stevens, M. and R. Vanbianchi. 1993. Restoring Wetlands in Washington: A Guidebook for Wetland Restoration, Planning and Implementation. Washington State Department of Ecology Publication 93-17, 110 p and Appendices.

Data compiled by: Yongjiang Zhang, April 23, 2003

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