

Family: *Pinaceae*

Taxon: *Picea engelmannii*

Synonym: *Abies engelmannii* Parry

Common Name: Engelmann spruce
Mountain spruce

Questionnaire :	current 20090513	Assessor:	Chuck Chimera	Designation: L
Status:	Assessor Approved	Data Entry Person:	Chuck Chimera	WRA Score -0.5
101	Is the species highly domesticated?		y=-3, n=0	n
102	Has the species become naturalized where grown?		y=1, n=-1	
103	Does the species have weedy races?		y=1, n=-1	
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"		(0-low; 1-intermediate; 2-high) (See Appendix 2)	Low
202	Quality of climate match data		(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)		y=1, n=0	n
204	Native or naturalized in regions with tropical or subtropical climates		y=1, n=0	n
205	Does the species have a history of repeated introductions outside its natural range?		y=-2, ?=-1, n=0	y
301	Naturalized beyond native range		y = 1*multiplier (see Appendix 2), n= question 205	n
302	Garden/amenity/disturbance weed		n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed		n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed		n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed		n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs		y=1, n=0	n
402	Allelopathic		y=1, n=0	
403	Parasitic		y=1, n=0	n
404	Unpalatable to grazing animals		y=1, n=-1	n
405	Toxic to animals		y=1, n=0	n
406	Host for recognized pests and pathogens		y=1, n=0	
407	Causes allergies or is otherwise toxic to humans		y=1, n=0	n
408	Creates a fire hazard in natural ecosystems		y=1, n=0	y
409	Is a shade tolerant plant at some stage of its life cycle		y=1, n=0	y
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)		y=1, n=0	n
411	Climbing or smothering growth habit		y=1, n=0	n

412	Forms dense thickets	y=1, n=0	y
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	>3
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	n
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	n
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	n
706	Propagules bird dispersed	y=1, n=-1	
707	Propagules dispersed by other animals (externally)	y=1, n=-1	
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m2)	y=1, n=-1	n
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	
803	Well controlled by herbicides	y=-1, n=1	
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	n
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	
Designation: L		WRA Score -0.5	

Supporting Data:

101	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is the species highly domesticated? No] "There are no recognized races or geographical varieties of <i>P. engelmannii</i> . There is abundant evidence that natural introgressive hybridization between <i>P. engelmannii</i> and <i>P. glauca</i> occurs in sympatric areas (Hosie, 1969; Daubenmire, 1974)."
102	2012. WRA Specialist. Personal Communication.	NA
103	2012. WRA Specialist. Personal Communication.	NA
201	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Species suited to tropical or subtropical climate(s) 2-High] "Engelmann spruce grows in a humid climate with long, cold winters and short, cool summers. It occupies one of the highest and coldest forest environments in the western United States, characterized by heavy snowfall and temperature extremes of more than -45.6° C (-50° F) to above 32.2° C (90° F)."
201	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Species suited to tropical or subtropical climate(s) 2-High] "P. engelmannii is a western North American species which is distributed predominantly in the Subalpine or Cordilleran forest region (Klinka et al., 1999a). Its range extends in Canada from northern British Columbia and Alberta south through all western states of the USA to New Mexico and Arizona (Hosie, 1969; Little, 1979; Alexander and Shepperd, 1984; Alexander, 1987). It is a major component of the high-elevation Cordilleran forest"
202	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Quality of climate match data 2-High]
203	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Broad climate suitability (environmental versatility)? No] "The range of mean annual temperatures is narrow considering the wide distribution of the species. Average annual temperatures are near freezing, and frost can occur any month of the year. Average precipitation exceeds 61 cm (24 in) annually, with only moderate or no seasonal deficiency." ... "Engelmann spruce is restricted to cold, humid habitats because of its low tolerance to high temperature and drought (25,45). However, solar radiation at high elevations heats soil surfaces [up to 66° C (150° F or more)] and increases water losses from both seedlings and soil by transpiration and evaporation (9,73,80)."
203	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Broad climate suitability (environmental versatility)? No] "P. engelmannii has a relatively narrow amplitude confined to a humid, continental subalpine boreal climate, with long, cold winters and short, warm summers: temperature extremes of more than -46°C to above 32°C (Krajina, 1969; Klinka et al., 1999a). Average annual temperatures are near freezing, and frost can occur any month of the year. Average precipitation exceeds 610 mm annually, with only moderate or no seasonal deficiency. Summer is the driest season in the Cascades and Rocky Mountains west of the Continental Divide south to southwestern Colorado. The mountains east of the divide, in southwestern Colorado, and in New Mexico and Arizona, receive considerable summer rainfall, while winter snowfall can be light (Baker, 1944)."
204	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Native or naturalized in regions with tropical or subtropical climates? No] "P. engelmannii is a western North American species which is distributed predominantly in the Subalpine or Cordilleran forest region (Klinka et al., 1999a). Its range extends in Canada from northern British Columbia and Alberta south through all western states of the USA to New Mexico and Arizona (Hosie, 1969; Little, 1979; Alexander and Shepperd, 1984; Alexander, 1987). It is a major component of the high-elevation Cordilleran forest"
205	1980. Skolmen, R.G.. Plantings on the forest reserves of Hawaii: 1910–1960. Institute of Pacific Islands Forestry, Pacific Southwest Forest & Range Experiment Station, US Forest Service, Honolulu, HI	[Does the species have a history of repeated introductions outside its natural range? Yes] 94 planted in Honouaule, Mauna Kea and Pohakuloa in 1932-1933
205	1991. Uchytel, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Does the species have a history of repeated introductions outside its natural range? Yes] "Engelmann spruce is widely distributed throughout the mountains of the western United States and Canada. It occurs from central British Columbia and Alberta as far south as New Mexico and Arizona [6]. It is cultivated in Hawaii [101]."

205	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Does the species have a history of repeated introductions outside its natural range? Yes] "P. engelmannii was introduced to Europe in England in 1862 (Hillier, 1991) and in Germany in 1891 when it was included into a network of experimental plantations by the German Forest Research Institute. Currently, it is grown only in arboreta and parks (Hermann, 1987). Provenance and species trials have been established in Norway (Magnesen, 1998, 1999). A trial of 13 spruces, including P. engelmannii, was established at a mountain site in New Zealand in 1964-65; in 1988, the P. engelmannii had reached an average height of 6 m (Miller and Knowles, 1989)."
301	2005. Wagner, W.L./Herbst, D.R./Lorence, D.H.. Flora of the Hawaiian Islands website. Smithsonian Inst., Washington, D.C. http://botany.si.edu/pacificislandbiodiversity/hawaiianflora/index.htm	[Naturalized beyond native range? No evidence from Hawaiian Islands]
301	2010. Carrillo-Gavilan, M.A./Vila, M.. Little evidence of invasion by alien conifers in Europe. Diversity and Distributions. 16: 203–213.	[Naturalized beyond native range? No] "Table 1 General information on alien conifers in Europe found from an analysis of papers listed in the ISI Web of Science (date of access up to March 2009)." [Reported to be introduced, but not naturalized in the Czech Republic and the UK]
301	2010. Stace, C.. New Flora of the British Isles. Cambridge University Press, Cambridge, UK	[Naturalized beyond native range? No evidence from the British Isles] "used in shelter-belts and very small-scale forestry in W Br and Man;"
302	2007. Randall, R.P.. Global Compendium of Weeds - Picea engelmannii [Online Database]. http://www.hear.org/gcw/species/picea_engelmannii/	[Garden/amenity/disturbance weed? No] No evidence
302	2010. Carrillo-Gavilan, M.A./Vila, M.. Little evidence of invasion by alien conifers in Europe. Diversity and Distributions. 16: 203–213.	[Garden/amenity/disturbance weed? No] No evidence
303	2007. Randall, R.P.. Global Compendium of Weeds - Picea engelmannii [Online Database]. http://www.hear.org/gcw/species/picea_engelmannii/	[Agricultural/forestry/horticultural weed? No] No evidence
303	2010. Carrillo-Gavilan, M.A./Vila, M.. Little evidence of invasion by alien conifers in Europe. Diversity and Distributions. 16: 203–213.	[Agricultural/forestry/horticultural weed? No] No evidence
304	2007. Randall, R.P.. Global Compendium of Weeds - Picea engelmannii [Online Database]. http://www.hear.org/gcw/species/picea_engelmannii/	[Environmental weed? No] No evidence
304	2010. Carrillo-Gavilan, M.A./Vila, M.. Little evidence of invasion by alien conifers in Europe. Diversity and Distributions. 16: 203–213.	[Environmental weed? No] No evidence
305	2003. Smith, G.F./Kelly, D.L./Mitchell, F.J.G.. Establishing native woodlands in former upland conifer plantations in Ireland. Pp. 37-46 In J. Humphrey et al. (eds). The Restoration of Wooded Landscapes. Edinburgh Forestry Commission, Edinburgh, UK	[Congeneric weed? Yes. Picea sitchensis] "Because of land use change and the advent of sustainable forest policies, former upland conifer plantations may provide opportunities for native forest restoration at the landscape scale. To investigate the feasibility of restoring Irish oakwoods to such sites, we established, in 1999, 21 pairs of fenced and unfenced permanent plots in clearfelled conifer plantations in the Wicklow Mountains and Killarney National Parks, in the Irish Republic. Browsing damage from deer, sheep and other animals caused significant mortality to planted sessile oak (Quercus petraea) and downy birch (Betula pubescens) seedlings. Mortality at first sampling was 11.3% higher for oaks and 22.4% higher for birch planted in unfenced plots than in fenced plots. Damage from small herbivores, mostly hares, also caused significant mortality in the first year. While mortality of undamaged birch seedlings was 34.7%, mortality of seedlings damaged by small herbivores was 58.8%. A reduced cover of felling brashwas associated with higher birch mortality and higher frequency of small herbivore damage. Brash may thus play an important role in sheltering trees from browsing from certain animals. Natural regeneration of tree species was highly variable across the sites and appeared to be limited mainly by dispersal. The most abundant species were the invasive exotics Sitka spruce (Picea sitchensis) and Rhododendron ponticum. The majority of Sitka spruce reseeding seems to be limited to a window of a few years before developing vegetation reduces recruitment opportunities."

305	2004. Richardson, D.M./Rejmánek, M.. Conifers as invasive aliens: a global survey and predictive framework. Diversity and Distributions. 10: 321–331.	[Congeneric weed? Yes. <i>Picea sitchensis</i>] "Appendix List of naturalized or invasive (in bold) conifers (Pinopsida), based on hundreds of published and unpublished sources and the unpublished data and personal observation of the authors over more than a decade." ... " <i>P. sitchensis</i> (Great Britain; Ireland; New Zealand)"
401	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Produces spines, thorns or burrs? No] "A large-sized tree (dwarfed. Prostrate or krummholz in subalpine parkland), occasionally over 55 m tall, 200 cm in diameter at breast height (Hosie, 1969), and over 500 years old. The stem is straight and distinct to the top of the tree, with the leading shoot upright. The crown is dense, symmetrical, narrow and spire-like. The lower branches are often sloping downward; secondary branches may hang vertically. The bark is thin, broken into large, loose, coarse, rounded, brownish scales; newly exposed bark is silvery-white and resinuous. The twigs are greyish to light brown and somewhat hairy. The wood is light, straight-grained, soft, moderately strong and resilient; no distinct heartwood, low in resin (Farrar, 1995)."
402	1983. Taylor, R.J./Shaw, D.C.. Allelopathic effects of Engelmann spruce bark stilbenes and tannin–stilbene combinations on seed germination and seedling growth of selected conifers. Canadian Journal of Botany. 61(1): 279-289.	[Allelopathic? Potentially] "The allelopathic effects of Engelmann spruce bark and bark extracts on seed germination and seedling growth of several conifer species were examined. Extracts were hydroxystilbenes (isorhapontin and astringin) and condensed tannins. Experiments included the following: (i) seed germination in petri dishes with various concentrations of stilbenes and tannin–stilbenes; (ii) seed germination in petri dishes containing Engelmann spruce bark fragments; (iii) seedling growth in varying mixtures of peat/Engelmann spruce bark, the latter added either before or after seedling establishment; (iv) seedling growth in samples of Engelmann spruce forest soil horizons. In all experiments and in all species there was an allelopathic response to bark extracts. This response was expressed through inhibition of seed germination (seed-coat rupture and radicle emergence), necrotic discoloration and protoplasmic disruption of root-tip cells, suppression of root hairs, and repressed growth in general. Among the conifers tested <i>Pinus ponderosa</i> and <i>Tsuga mertensiana</i> appeared to be the most tolerant to bark extracts, <i>Pinus contorta</i> the most sensitive. <i>Picea engelmannii</i> was moderately sensitive."
403	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Parasitic? No] Pinaceae
404	1991. Uchytíl, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Unpalatable to grazing animals? No] "Wildlife food: The young growth of Engelmann spruce is occasionally browsed by ungulates, but it is not an important food item and is probably only taken as a last resort [4]. Spruce grouse and blue grouse may feed extensively on buds and needles [56,80]. Squirrels sometimes clip and eat twigs and buds [77]."
404	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Unpalatable to grazing animals? No] "They also provide timber, habitats for a wide range of game and non-game wildlife, forage for livestock, and are used for recreation (Alexander, 1977)."
405	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Toxic to animals? No] "The only significant biotic factor affecting spruce regeneration on a long-term study on the Fraser Experimental Forest was birds. About 15 percent to 20 percent of the total mortality resulted from the clipping of cotyledons on newly germinated seedlings by greyheaded juncos (<i>Junco caniceps</i>) (9,73,75)."
405	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Toxic to animals? No] "They also provide timber, habitats for a wide range of game and non-game wildlife, forage for livestock, and are used for recreation (Alexander, 1977)." [No evidence]
405	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Toxic to animals? No] No evidence
406	1991. Uchytíl, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Host for recognized pests and pathogens? Potentially] "Disease: The most common disease of Engelmann spruce is caused by wood-rotting fungi which results in root or butt decay. Spruce broom rust is also common in spruce-fir forests and causes bole deformation and spike tops, increases susceptibility to wind breakage, and provides entry points for decay fungi in spruce [7]. Dwarf mistletoe (<i>Arceuthobium microcarpum</i>) causes heavy mortality of spruce trees in Arizona and New Mexico [7]. Insects: The spruce beetle is the most serious insect pest of Engelmann spruce. Outbreaks are associated with extensive windthrow because downed trees provide a good food supply, causing a rapid expansion of beetle populations. Unabated logging slash has been responsible for past outbreaks [7]."

406	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Host for recognized pests and pathogens? Potentially] "The spruce beetle (<i>Dendroctonus rufipennis</i>) is the most serious insect pest of <i>P. engelmannii</i> (Schmid and Frye, 1977). It is restricted largely to mature and overmature spruce, and epidemics have occurred throughout recorded history. The western spruce budworm (<i>Choristoneura occidentalis</i>) is another potentially dangerous insect attacking <i>P. engelmannii</i> and <i>Abies lasiocarpa</i> (Furniss and Carolin, 1977). A summary of the ecology, past insecticidal treatments, and silvicultural practices associated with western spruce budworm in northern Rocky Mountain forests is given by Carlson et al. (1983). The most common diseases of <i>P. engelmannii</i> are caused by wood-rotting fungi that result in loss of volume and predispose trees to windthrow and windbreak (Hinds and Hawksworth, 1966). These include <i>Phellinus nigrolimitatus</i> , <i>Flammula alnicola</i> , <i>Polyporus tomentosus</i> , <i>Gloeocystidiellum radiosum</i> and <i>Coniophora puteana</i> . Trunk rots, which caused 88% of the decay, were associated with <i>Phellinus pini</i> , <i>Haematostereum sanguinolentum</i> , <i>Echinodontium sulcatum</i> , and <i>Amylostereum chailletii</i> . Spruce broom rust (<i>Chrysomyxa arctostaphyli</i>) is also common in spruce-fir forests. It causes bole deformation, loss of volume, spiketops, and increases susceptibility to windbreak and infection by decay fungi."
407	2008. Wagstaff, D.J.. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	[Causes allergies or is otherwise toxic to humans? No] No evidence of toxicity
407	2012. Pollen Library. Engelmann's Spruce (<i>Picea engelmannii</i>). IMS Health Incorporated, http://www.pollenlibrary.com/Specie/Picea+engelmannii/	[Causes allergies or is otherwise toxic to humans? No] "Allergenicity: No allergy has been reported for Engelmann's Spruce (<i>Picea engelmannii</i>) species."
408	1991. Uchytel, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/ng/all.html	[Creates a fire hazard in natural ecosystems? Yes] "Fuels and fire behavior: The fuel structure in stands dominated by Engelmann spruce and subalpine fir promotes highly destructive stand-destroying fires. Fuel loads are higher than in lower elevation montane stands, and the fuel beds tend to be irregular and have large amounts of needle litter accumulating under the narrow crowned trees [31,91]. The needles are small and fine, and form a compact fuel bed in which fire spreads slowly [28]. These concentrated, slow-burning fuels commonly produce flames high enough to reach Engelmann spruce's low-growing, lichen-draped branches and start crown fires [20,91]."
409	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Is a shade tolerant plant at some stage of its life cycle? Yes] "Reaction to Competition- Engelmann spruce is rated tolerant in its ability to endure shade (24). It is definitely more shade-enduring than interior Douglas-fir, western white pine, lodgepole pine, aspen, western larch, or ponderosa pine but less so than subalpine fir (the most common associate throughout much of its range), grand fir, white fir, and mountain hemlock."
409	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Is a shade tolerant plant at some stage of its life cycle? Yes] "A moderately shade-tolerant and snowpack tolerant tree species."
410	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Tolerates a wide range of soil conditions? No] "Regardless of the parent materials, spruce grows best on moderately deep, well drained, loamy sands and silts, and silt and clay loam soils developed from a variety of volcanic and sedimentary rock. Good growth also is made on glacial and alluvial soils developed from a wide range of parent materials, where an accessible water table is more important than physical properties of the soil. It does not grow well on rocky glacial till, heavy clay surface soils, saturated soils, or on shallow, dry coarse-textured sands and gravels developed primarily from granitic and schistic rock or coarse sandstones and conglomerates (13,23)."
410	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Tolerates a wide range of soil conditions? No] "In summary, <i>P. engelmannii</i> tolerates a minor water deficit as well as water surplus; its growth increases with increasing available soil nutrients, and decreases with increasing elevation (Krajina, 1969; Klinka et al., 1999a). Best growth is often achieved along watercourses in mid-altitudes, on deep, rich, moist, loamy soils (Hosie, 1969)."
411	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Climbing or smothering growth habit? No] "A large-sized tree (dwarfed. Prostrate or krummholz in subalpine parkland), occasionally over 55 m tall, 200 cm in diameter at breast height (Hosie, 1969), and over 500 years old. The stem is straight and distinct to the top of the tree, with the leading shoot upright. The crown is dense, symmetrical, narrow and spire-like. "
412	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Forms dense thickets? Yes] "Engelmann spruce and subalpine fir occur as either codominants or in nearly pure stands of one or the other."

412	1991. Uchytil, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Forms dense thickets? Yes] "Climax stands consisting entirely of Engelmann spruce are somewhat scattered and often restricted to wet or cold habitats [4,88]. The Engelmann spruce series is generally recognized by the absence or scant representation of subalpine fir. This is because many ecologists, especially those working in the northern Rocky Mountains, believe that only in the absence of subalpine fir does Engelmann spruce dominate at climax [22,67,98]."
501	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Aquatic? No] Terrestrial
502	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Grass? No] Pinaceae
503	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Nitrogen fixing woody plant? No] Pinaceae
504	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "A large-sized tree (dwarfed. Prostrate or krummholz in subalpine parkland), occasionally over 55 m tall, 200 cm in diameter at breast height (Hosie, 1969), and over 500 years old. The stem is straight and distinct to the top of the tree, with the leading shoot upright. "
601	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.</i>	[Evidence of substantial reproductive failure in native habitat? No] "Viable seeds of spruce that survive over winter normally germinate following snowmelt when seedbeds are moist and air temperature is at least 7° C (45° F). Field germination of spruce over long periods in Colorado have ranged from 0 to 28 percent of the sound seeds dispersed, depending upon the seedbed and environmental factors (9,73)."
602	1991. Uchytil, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Produces viable seed? Yes] "Viability and germination: The viability of Engelmann spruce seed is rated as good [7]. Germination averages 69 percent, which is much higher than that of associated species [7,77]. Under natural conditions, seeds overwinter under snow and germinate 2 to 3 weeks following snowmelt [6,83]. Occasionally germination may occur after summer rains or be delayed until the second year [4]."
602	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Produces viable seed? Yes] "Reproduction capacity is intermediate; a moderate seed producer; cone production begins at an age of 15-40 years. Seed dissemination capacity is intermediate; seed dispersal up to 250 m from the parent tree." ... "Propagation by seed is the only contemporary method for regenerating <i>P. engelmannii</i> . Techniques for collection, processing, testing, and storage of seed are given in Schopmeyer (1974). Natural regeneration (where applicable) and/or planting, using a containerized stock, is used for establishment. "
603	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.</i>	[Hybridizes naturally? Yes] "There is abundant evidence that natural introgressive hybridization between Engelmann and white spruce occurs in sympatric areas, especially around Glacier Park in Montana (32). It has been suggested that Engelmann and Sitka spruces cross in British Columbia, but it seems more likely that the crosses are between Sitka and white spruce. Engelmann spruce has been artificially crossed with several other spruces, but with only limited success (38)."
603	1991. Uchytil, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Hybridizes naturally? Yes] "Natural hybridization between species of <i>Picea</i> is common. Engelmann spruce x white spruce (<i>Picea glauca</i>) hybrids are common where the ranges of these species overlap. Natural crosses between these species occur from central British Columbia as far south as eastern Washington and Yellowstone National Park [23]. Within this area, trees at low elevations closely resemble pure white spruce. Pure Engelmann spruce tends to dominate at higher elevations [23]. Engelmann spruce x white spruce hybrids are common throughout low elevations in British Columbia [32]."
603	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Hybridizes naturally? Yes] "There are no recognized races or geographical varieties of <i>P. engelmannii</i> . There is abundant evidence that natural introgressive hybridization between <i>P. engelmannii</i> and <i>P. glauca</i> occurs in sympatric areas (Hosie, 1969; Daubenmire, 1974)."
604	1990. Burns, R.M./Honkala, B.H.. <i>Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.</i>	[Self-compatible or apomictic? Yes] "Flowering and Fruiting- Engelmann spruce is monoecious; male and female strobili are formed in the axils of needles of the previous year's shoots after dormancy is broken, usually in late April to early May- Ovulate strobili (new conelets) are usually borne near ends of the shoots in the upper crown and staminate strobili on branchlets in the lower crown (38,102). Separation of male and female strobili within the crown reduces self-fertilization." [Mechanisms exist to reduce self-fertilization, but self-fertilization is possible]

605	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Requires specialist pollinators? No] "Male flowers ripen and pollen is wind disseminated in late May and early June at low elevations, and from mid-June to early July at high elevations."
606	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Reproduction by vegetative fragmentation? Unlikely] "Vegetative Reproduction-Engelmann spruce can reproduce by layering (47). It most often layers near timberline, where the species assumes a dwarfed or prostrate form. Layering can also occur when only a few trees survive fires or other catastrophes. Once these survivors have increased to the point where their numbers alter the microenvironment enough to improve germination and establishment, layering diminishes. In general, this form of reproduction is insignificant in the establishment and maintenance of closed forest stands (21,76)."
606	1991. Uchytil, R.J.. Picea engelmannii. In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Reproduction by vegetative fragmentation? Yes] "Vegetative reproduction: Near timberline, where the species assumes a dwarf or prostrate form, Engelmann spruce frequently reproduces by layering. Layering also occurs when only a few trees survive fire or other disturbances, but once numbers have increased enough to improve germination and establishment, layering decreases. In closed forest stands layering is negligible [7]."
607	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Minimum generative time (years)? 15+] "Although open-grown Engelmann spruces begin bearing cones when they are 1.2 to 1.5 m (4 to 5 ft) tall and 15 to 40 years old, seed production does not become significant until trees are larger and older. The most abundant crops in natural stands are produced on healthy, vigorous, dominant trees 3.8 dm (15 in) or more in diameter at breast height and 150 to 250 years old. Engelmann spruce is a moderate to good seed producer (11,19,21). Good to bumper seed crops, based on the following criteria, are generally borne every 2 to 5 years, with some seed produced almost every year (19):"
607	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Minimum generative time (years)? 15+] "Reproduction capacity is intermediate; a moderate seed producer; cone production begins at an age of 15-40 years."
701	1991. Uchytil, R.J.. Picea engelmannii. In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)? No] "Engelmann spruce seeds are about 0.12 inch (3 mm) long and have a single, well-developed wing about twice as long as the seed [21,77]." [Possible, but not likely, as seeds lack a means of external attachment]
702	1991. Uchytil, R.J.. Picea engelmannii. In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Propagules dispersed intentionally by people? Yes] "Engelmann spruce is sometimes used as an ornamental landscape plant. It has been used for screenings, windbreaks, and as a specimen tree [90]."
703	1991. Uchytil, R.J.. Picea engelmannii. In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Propagules likely to disperse as a produce contaminant? No] "Dispersal: Engelmann spruce seed is generally shed by the end of October, but some may continue to fall throughout the winter. The winged seeds are wind dispersed. " [No evidence that seeds have contaminated produce]
703	2012. WRA Specialist. Personal Communication.	[Propagules likely to disperse as a produce contaminant? No] No evidence found
704	1991. Uchytil, R.J.. Picea engelmannii. In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Propagules adapted to wind dispersal? No] "Dispersal: Engelmann spruce seed is generally shed by the end of October, but some may continue to fall throughout the winter. The winged seeds are wind dispersed. Seeds travel primarily with the prevailing winds, but upslope drafts can influence dispersal at low and middle elevations. Seed is generally dispersed within 300 feet (91 m) of a windward source; when bumper seed crops occur, about 5 to 10 percent of the seed may be dispersed as far as 600 feet (183 m) [6,63]. Seed dispersed during winter can travel great distances by skidding over glazed snow [58]."
704	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules adapted to wind dispersal? Yes] "The small, winged seeds are light, averaging about 297,000 per kg (Schopmeyer, 1974). Nearly all of the seed is disseminated by the wind and dispersed long distances."
705	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Propagules water dispersed? No] "The small, winged seeds are light, averaging about 297,000 per kg (Schopmeyer, 1974). Nearly all of the seed is disseminated by the wind and dispersed long distances."

706	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Propagules bird dispersed? Potentially] "Nearly all of the seed is disseminated by the wind; squirrels, other mammals, and birds are not important in seed dispersal."
707	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Propagules dispersed by other animals (externally)? Potentially] "Nearly all of the seed is disseminated by the wind; squirrels, other mammals, and birds are not important in seed dispersal."
708	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Propagules survive passage through the gut? No] "After seed is shed, small mammals such as deer mice (<i>Peromyscus maniculatus</i>), red backed mice (<i>Clethrionomys gapperi</i>), mountain voles (<i>Microtus montanus</i>), and chipmunks (<i>Eutamias minimus</i>) are the principal source of seed loss. Undoubtedly, mammals consume much seed, but the amount is not known and results of studies on protecting seed are conflicting. For example, in western Montana, spruce seedling success was little better on protected than unprotected seed spots (90), but in British Columbia, protection of spruce seed from rodents was essential to spruce regeneration success (94)." [Consumed seeds are depredated by seed predators, not dispersed internally]
708	1991. Uchytel, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Propagules survive passage through the gut? No] "Engelmann spruce seeds are eaten by several species of small mammals and birds. Red squirrels, chickarees, and chipmunks eat seeds from cached cones [6,98]. Engelmann spruce seeds are also eaten off the ground or snow by chipmunks, mice, and voles [4]. Numerous species of birds, including chickadees, nuthatches, crossbills, and the pine siskin, remove and eat seeds from spruce cones [36,56]. Small birds may make considerable use of spruce seeds, but their foraging is scattered and sporadic throughout subalpine forests [36]."
801	1990. Burns, R.M./Honkala, B.H.. Silvics of North America. Volume 1: Conifers. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.	[Prolific seed production (>1000/m2)? No] "There is great variation in seed production from year to year and from area to area. In one study on the Fraser Experimental Forest in Colorado, annual seed production averaged only 32,100 sound seeds per acre during the period 1956-65 (4). Only one good and two moderate crops were recorded. In more recent studies, spruce seed production has been greater, possibly because the studies were better designed to sample seed production. One such study of seed production on five National Forests, covering 42 area-seed crop years from 1962 to 1971, rated seed crops as 5 bumper, 1 heavy, 6 good, and the remaining 30 fair to failure (74). In the one year, 1967, that a bumper seed crop was produced on all areas, seed production was the highest ever recorded in Colorado (84). In another study on the Fraser Experimental Forest covering 15 years (1970-84) and 13 locations, seed production was rated 2 bumper, 3 heavy, 2 good and 8 fair to failure (21)." [>1,235,000 seeds/hectare produced during a bumper year, which equals 123.5 seeds/square meter.]
801	2005. CAB International. Forestry Compendium. CAB International, Wallingford, UK	[Prolific seed production (>1000/m2)? No] " <i>P. engelmannii</i> is a moderate to good seed producer, but seed production becomes significant when trees are larger and older (150 to 250 years old). Good to bumper seed crops are generally borne every 2 to 5 years, with some seed produced almost every year (Alexander, 1986)."
802	1991. Uchytel, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Evidence that a persistent propagule bank is formed (>1 yr)? Potentially] "Occasionally germination may occur after summer rains or be delayed until the second year [4]."

802	1996. Johnson, E.A./Fryer, G.I.. Why Englemann spruce does not have a persistent seed bank. Canadian Journal of Forest Research., 26(5): 872-878.	[Evidence that a persistent propagule bank is formed (>1 yr)? Probably No] "Picea engelmannii Parry ex Engelm. Becomes established after fire by dispersing seeds into a burn, not through the maintenance of a persistent soil seed bank. The objective here was to determine causes of spruce seed loss from the bank to understand its lack of a persistent seed bank. One hundred seeds placed in soil cores were enumerated for 2.5 years and divided into three treatments: (i) varying the amount of protection from predators, (ii) keeping litter intact or removing it, and (iii) placing seeds on top of litter or between litter and mineral soil. For all treatments, fewer than 5% of seeds remained at the end of the study. Predation caused the greatest loss to the seed bank, much greater than germination in all treatments. Removal of litter increased germination, but predation occurred at the same rate: therefore, the total rate of loss to the seed bank increased. Seeds placed between litter and mineral soil experienced greater germination and less predation than seeds placed above the litter layer. However, increased germination balanced the reduced predation so there was little difference in the total rate of loss to the seed bank from seeds placed in either location. Further, seeds appeared to lose viability within two seasons. Thus, there is no persistent seed bank because of high predation and a rapid loss of viability."
803	2012. WRA Specialist. Personal Communication.	[Well controlled by herbicides? Unknown] No information found on herbicide efficacy or chemical control of this species
804	1987. Fischer, W.C./Bradley, A.F.. Fire Ecology of Western Montana Forest Habitat Types. General Technical Report INT-223. USDA Forest Service Intermountain Research Station, Ogden, UT	[Tolerates, or benefits from, mutilation, cultivation, or fire? No] "Engelmann spruce, including hybrids with white spruce (<i>Picea glauca</i>) (Habeck and Weaver 1969), is easily killed by fire. The dead, dry, flammable lower limbs, low growing canopy, thin bark, and lichen growth in the branches contribute to the species' vulnerability. The shallow root system is readily subject to injury from fire burning through the duff."
804	1991. Uchytel, R.J.. <i>Picea engelmannii</i> . In: Fire Effects Information System, [Online]. USA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory, http://www.fs.fed.us/database/feis/plants/tree/picea/all.html	[Tolerates, or benefits from, mutilation, cultivation, or fire? No] "Plant adaptations to fire: Engelmann spruce is very fire sensitive and is generally killed even by low-intensity fires. Postfire reestablishment is via wind-dispersed seeds which readily germinate on fire-prepared seedbeds. The occasional mature tree which survives fire, those escaping fire in small, unburned pockets, and trees adjacent to burned areas provide seeds to colonize burned sites. Large trees occasionally survive light fires [31]." ..."Engelmann spruce is easily killed by fire. It is very susceptible to fire because it has (1) thin bark that provides little insulation for the cambium, (2) a moderate amount of resin in the bark which ignites readily, (3) shallow roots which are susceptible to soil heating, (4) low-growing branches, (5) a tendency to grow in dense stands, (6) moderately flammable foliage, and (7) heavy lichen growth [87]."
805	2012. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown] No information found