

CLIMATE CHANGE VULNERABILITY OF URBAN TREES

PUGET SOUND REGION, WASHINGTON



This list was developed to aid Puget Sound Region community forestry practitioners in selecting trees to reduce climate change vulnerability of their urban forests. It is meant to be a complement to other tree selection resources. Other factors may also need to be considered, such as aesthetics, local site conditions, wildlife value, or nursery availability. It is also important to note that some species may have climate benefits but may not be suitable for planting for other reasons, such as having invasive potential or susceptibility to pests or pathogens.

Vulnerability: Trees can be vulnerable to a variety of climate-related stressors such as intense heat, drought, flooding, and changing pest and disease patterns. Climate vulnerability is a function of the impacts of

climate change on a species and its adaptive capacity. Species with projected negative impacts of climate change on their habitat suitability and low adaptive capacity will have high vulnerability. Those with projected positive or neutral climate change impacts on their habitat suitability and high adaptive capacity will have low vulnerability. The following factors were used to determine climate vulnerability:

Urban adaptability: Adaptability scores were generated for each species based on literature describing its tolerance to climate-related disturbances such as drought, flooding, pests, and disease, as well as its growth requirements such as shade tolerance, soil needs, and ease of nursery propagation. Scores were assigned to species using published methods for assessing vulnerability of trees planted in developed sites¹. A positive score indicates that a species is tolerant to a wide range of disturbances and can be planted on a variety of sites. A negative score indicates a species is highly susceptible to disturbances and/or is limited to specific planting sites.

Hardiness and heat zone suitability: Tree species heat and hardiness zone tolerances were recorded from government, university, and arboretum websites. Species tolerance ranges were compared to current and projected heat and hardiness zones for Seattle, Washington using downscaled climate models under low emissions (RCP 4.5) and high emissions (RCP 8.5) scenarios for changes in greenhouse gases². For this particular assessment, we include heat zone suitability alone, as well as heat and hardiness zone suitability. Suitability was determined by the current and projected zones for the Seattle region through the end of the 21st century. For some species, only the hardiness zone ranges were available, and heat zone suitability was not determined (marked N/A). The assessed tree species had the same suitability and vulnerability under both low and high emissions scenarios because all species were suitable under the projected heat zones through the end of the century, and the projected hardiness zone is the same under both low and high emissions scenarios.

Current and projected USDA Hardiness Zones and AHS Heat Zones for Seattle, Washington. Hardiness zone is determined by the average lowest temperature over a 30 year period. Heat zones are determined by the number of days above 86°F.

Time Period	Hardiness Zone Range		Heat Zone Range	
	Low Emissions	High Emissions	Low Emissions	High Emissions
1980–2010	8-9		2	
2010–2039	8-9	9	2	3
2040–2069	9	9	3	4
2070–2099	9	9	3	6

SOURCES: ¹Adaptability scores were assigned using methods developed by Brandt et al. 2021 <https://www.frontiersin.org/articles/10.3389/fevo.2021.721831/full> ²Future heat and hardiness zone information were provided from: <https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=96088b1c086a4b39b3a75d0fd97a4c40>



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www.forestadaptation.org

URBAN ADAPTABILITY:

- + **High:** Species may perform better than modeled
- **Medium**
- **Low:** Species may perform worse than modeled

ZONE SUITABILITY:

- ✓ **Suitable**
- ✗ **Not Suitable**

VULNERABILITY:

- ▼ **Low:** Suitable zone, high adaptability
- **Low-moderate:** Suitable zone, medium adaptability
- ⊖ **Moderate:** Suitable zone, low adaptability or zone not suitable, high adaptability
- **Moderate-high:** Zone not suitable, medium adaptability
- △ **High:** Zone not suitable, low adaptability

*Invasive species

COMMON NAME	HEAT ONLY			HEAT & HARDINESS	
	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Aleppo pine	•	✓	●	✓	●
Alleghany serviceberry	+	✓	▼	✓	▼
American basswood	•	✓	●	✗	○
American beech	•	✓	●	✓	●
American elm	•	✓	●	✓	●
American hornbeam	+	✓	▼	✓	▼
American smoke tree	•	✓	●	✗	○
American sycamore	•	✓	●	✓	●
American witch-hazel	•	✓	●	✗	○
Amur maackia*	+	✓	▼	✗	⊖
Apricot	•	✓	●	✗	○
Arizona cypress	•	✓	●	✓	●
Austrian pine	•	✓	●	✗	○
Bald cypress	+	✓	▼	✓	▼
Big leaf maple	•	✓	●	✓	●
Birch bark cherry	•	✓	●	✗	○
Black cherry	-	✓	⊖	✓	⊖
Black locust*	•	✓	●	✗	○
Black maple	•	✓	●	✗	○
Black poplar	•	N/A	N/A	✓	●
Black walnut	-	✓	⊖	✓	⊖
Boxelder	•	✓	●	✓	●
Callery pear*	•	✓	●	✓	●
Cherry plum	•	✓	●	✓	●
Chinese chestnut	•	✓	●	✗	○
Chinese elm	+	✓	▼	✓	▼
Chinese fringetree	+	✓	▼	✓	▼
Chinese juniper	+	✓	▼	✓	▼
Chinese pistachio	+	✓	▼	✓	▼
Chinese tree lilac	+	✓	▼	✗	⊖
Coast live oak	•	✓	●	✓	●
Coast redwood	-	✓	⊖	✓	⊖
Cockspur hawthorn	•	✓	●	✗	○
Colorado spruce	•	✓	●	✗	○
Common chokecherry	•	✓	●	✗	○
Common fig	-	✓	⊖	✓	⊖
Common hackberry	+	✓	▼	✓	▼
Common hawthorn*	•	✓	●	✗	○
Common hazel/European filbert	•	✓	●	✗	○
Common hibiscus	+	✓	▼	✗	⊖
Common holly*	•	✓	●	✓	●
Common laburnum	•	✓	⊖	✗	△
Common lilac	•	✓	●	✗	○
Common pear	•	✓	●	✓	●
Common plum	•	✓	●	✓	●

COMMON NAME	HEAT ONLY			HEAT & HARDINESS	
	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Corkscrew willow	•	N/A	N/A	✓	●
Cornelian cherry	•	✓	●	✗	○
Crabapple	•	✓	●	✗	○
Crepe myrtle	+	✓	▼	✓	▼
Dawn redwood	•	✓	●	✗	○
Douglas fir	•	✓	⊖	✗	△
Downy serviceberry	+	✓	▼	✓	▼
Eastern hemlock	-	✓	⊖	✗	△
Eastern red cedar	+	✓	▼	✓	▼
Eastern redbud	•	✓	●	✗	○
Eastern white pine	-	✓	⊖	✗	△
Edible apple	•	✓	●	✗	○
Emerald sushine elm	+	N/A	N/A	✗	⊖
Empress tree*	+	✓	▼	✓	▼
English elm	•	✓	●	✗	○
English laurel*	•	✓	●	✓	●
English oak	•	✓	●	✗	○
English walnut	•	✓	●	✗	○
European ash	•	✓	●	✗	○
European hornbeam	•	✓	●	✓	●
European larch	•	✓	●	✗	○
European olive	•	✓	●	✓	●
Flowering dogwood	•	✓	●	✓	●
Foothill pine	-	N/A	N/A	✓	⊖
Freeman maple	+	✓	▼	✗	⊖
Giant sequoia	•	✓	⊖	✗	△
Ginkgo	+	✓	▼	✗	⊖
Glossy privet	+	✓	▼	✓	▼
Golden raintree*	+	✓	▼	✓	▼
Grand fir	•	✓	●	✗	○
Gray birch	-	✓	⊖	✗	△
Green ash	•	✓	●	✓	●
Green beech	•	✓	●	✗	○
Hardy rubber tree	+	✓	▼	✗	⊖
Higan cherry	•	✓	●	✗	○
Hinoki cypress	-	✓	⊖	✗	△
Honey locust*	•	✓	●	✗	○
Horse chestnut*	•	✓	●	✗	○
Ironwood	+	✓	▼	✓	▼
Italian stone pine	•	✓	●	✓	●
Jack pine	-	✓	⊖	✗	△
Japanese cherry	•	✓	●	✗	○
Japanese maple	•	✓	●	✗	○
Japanese snowbell	•	✓	●	✗	○
Japanese stewartia	-	✓	⊖	✗	△

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Japanese tree lilac	+	✓	▼	✗	⊖
Japanese white pine	•	✓	●	✓	●
Japanese zelkova	+	✓	▼	✗	⊖
Katsura tree	-	✓	⊖	✗	△
Kentucky coffeetree	+	✓	▼	✗	⊖
Kobus magnolia	•	N/A	N/A	✗	○
Korean mountain ash	•	✓	●	✗	○
Kousa dogwood	+	✓	▼	✗	⊖
Large leaf linden	•	✓	●	✗	○
Lawson's cypress	•	✓	●	✗	○
Littleleaf linden	+	✓	▼	✗	⊖
Live oak	+	✓	▼	✓	▼
Mediterranean cypress	+	✓	▼	✓	▼
Midland hawthorn	•	✓	●	✗	○
Miyabe's maple	+	✓	▼	✗	⊖
Mountain hemlock	•	N/A	N/A	✗	○
Narrow-leaved ash	•	✓	●	✗	○
Noble fir	•	✓	●	✗	○
Nootka cypress	-	✓	⊖	✗	△
Northern catalpa	•	✓	●	✗	○
Northern white cedar	+	✓	▼	✗	⊖
Norway maple*	+	✓	▼	✗	⊖
Norway spruce	•	✓	●	✗	○
Oregon ash	•	✓	●	✗	○
Oregon oak	•	✓	●	✓	●
Pacific dogwood	•	✓	●	✗	○
Pacific madrone	•	✓	●	✓	●
Paper birch	•	✓	●	✗	○
Paperbark maple	-	✓	⊖	✗	△
Peach	•	✓	●	✓	●
Persian parrotia	+	✓	▼	✗	⊖
Persian silk tree	-	✓	⊖	✓	⊖
Pin oak	•	✓	●	✗	○
Ponderosa pine	-	✓	⊖	✗	△
Quaking aspen	•	✓	●	✗	○
Red alder	-	✓	⊖	✗	△
Red maple	+	✓	▼	✓	▼
Red oak	•	✓	●	✗	○
River birch	•	✓	●	✓	●
Rowan	•	✓	●	✗	○
Russian olive*	+	✓	▼	✗	⊖
Sargent cherry	•	✓	●	✗	○
Sawara cypress	•	✓	●	✗	○
Sawtooth oak*	+	✓	▼	✓	▼
Scarlet oak	•	✓	●	✓	●

COMMON NAME	HEAT ONLY			HEAT & HARDINESS	
	ADAPT	ZONE SUIT	VULN	ZONE SUIT	VULN
Scots pine	•	✓	●	✗	○
Serbian spruce	•	✓	●	✗	○
Shantung maple	+	✓	▼	✗	⊖
Shingle oak	+	✓	▼	✗	⊖
Shumard oak	•	✓	●	✓	●
Siberian elm*	•	✓	●	✓	●
Silver birch	-	✓	⊖	✗	△
Silver linden	•	✓	●	✗	○
Silver maple	•	✓	●	✓	●
Smoke tree	+	✓	▼	✗	⊖
Sour cherry	•	✓	●	✗	○
Sourwood	+	✓	▼	✓	▼
Southern catalpa	•	✓	●	✓	●
Southern magnolia	•	✓	●	✓	●
Strawberry tree	+	✓	▼	✓	▼
Sugar maple	•	✓	●	✗	○
Swamp birch	+	✓	▼	✗	⊖
Swamp white oak	+	✓	▼	✗	⊖
Sweet cherry	•	✓	●	✗	○
Sweet chestnut	-	✓	⊖	✗	△
Sweet mountain pine	•	✓	●	✗	○
Sweetgum	-	✓	▼	✓	⊖
Sycamore maple*	•	✓	●	✗	○
Tatarian maple	•	✓	●	✗	○
Tree of heaven*	+	✓	▼	✗	⊖
Trident maple	•	✓	●	✓	●
Tulip tree	-	✓	⊖	✗	△
Tupelo	+	✓	▼	✓	▼
Turkish filbert	•	✓	●	✗	○
Vine maple	+	✓	●	✓	●
Washington hawthorn	•	✓	●	✗	○
Wax-leaf privet	•	✓	●	✓	●
Weeping higan cherry	•	✓	●	✗	○
Western hemlock	-	✓	●	✗	○
Western red cedar	+	✓	▼	✗	⊖
White ash	-	✓	⊖	✓	⊖
White fir	•	✓	●	✗	○
White mulberry*	•	✓	●	✗	○
White oak	-	✓	⊖	✓	⊖
White poplar	•	✓	●	✓	●
White spruce	•	✓	●	✗	○
Willow oak	+	✓	▼	✓	▼
Windmill palm	+	✓	▼	✓	▼
Yellow buckeye	•	✓	●	✗	○
Yellowwood	•	✓	●	✗	○