

The Future of Pacific Madrone

Research Conference April 19-20, 2016

Washington State University
Research and Extension Center
Puyallup, WA 98371



Tour Handbook

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WSU Puyallup and Plant Pathology Program

Welcome to the WSU Puyallup Research and Extension Center (the Center), which was established in 1894. Today it consists of a 160-acre main campus and the 152-acre Goss research farm in the Puyallup Valley. Its 100 faculty, staff and graduate students from 7 academic departments address complex biological, ecological and social issues facing urban communities and growers throughout the state and beyond.

The Ornamental/Forestry Plant Pathology Program is one of the larger research and extension programs at the Center. The scope of this program includes work on the management of disease on Christmas trees, ornamental and conifer nursery stock, ornamental bulb crops and cut flowers, and madrone. In addition, extensive work relating to postharvest needle and moisture retention of cut Christmas trees is also conducted at WSU Puyallup. These programs are supported by a variety of federal, state, and industry grants.

Keys to the success of this program include dedicated WSU staff, graduate students and volunteers, the support of industry organizations, and the large number of cooperators who are assisting us with various projects. In addition, there are indispensable growers who provide plant material and space for field trials. It is the combination of all of the above and external grants that makes this program possible.

Although many of the WSU Puyallup Ornamental/Forestry Plant Pathology research projects are conducted at grower sites, there are currently about 16 acres of plant pathology research plots at the Center. These plots are used for a variety of disease, insect, genetic and keepability studies. Today you will have the opportunity to see a portion of the madrone research that is being conducted at the Center. We hope that the tour will be educational and that you enjoy your visit.

Plant Pathology Program Personnel



Project leaders and Staff

Dr. Gary Chastagner, Professor of Plant Pathology (chastag@wsu.edu)
Dr. Marianne Elliott, Research Associate and Sudden Oak Death Education Coordinator
Katie Coats, Research Associate
Andree DeBauw, Ag. Res. Tech. III
David McLoughlin, Plant Technician II
Part time staff: Lucy Rollins, Travis Bonnette, Jenne Ford, Kathy Riley, Don Sherry,
Carly Thompson, Mike Fernandez, and Shan Medford

Graduate Students

Andrea Garfinkel, Plant Pathology Ph.D. Degree
Katie McKeever, Plant Pathology Ph.D. Degree

Overview of Pacific Madrone Common Garden Studies

<http://www.puyallup.wsu.edu/ppo/madrone/>

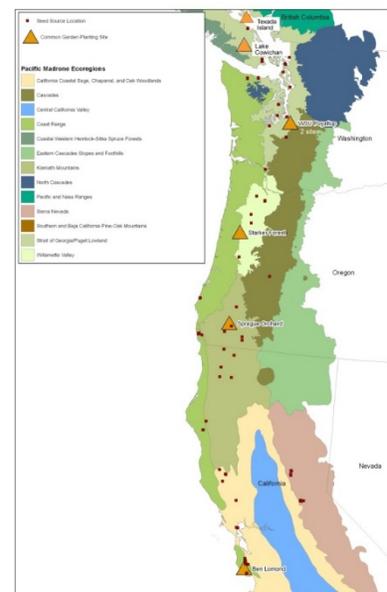
Pacific madrone (*Arbutus menziesii* Pursh) is the largest member of the family Ericaceae and is native to western North America. It is an important ecological species providing habitat and food for numerous wildlife species, especially cavity-nesting birds.

In urban environments it provides excellent erosion control and slope stabilization and is highly prized as an ornamental species for its crooked beauty, colorful bark, showy flowers, and brightly colored fruits. Native American tribes have also used various portions of this tree for food, utensils and medicinal purposes.

The overall health of Pacific madrone has been declining since the last half of the 20th century. Several diseases affect the health of Pacific madrone, including endemic canker diseases caused by species of *Fusicoccum*, numerous foliar pathogens, and introduced diseases such as *P. cinnamomi*. Climate change has the potential to drastically alter the health of our native forests and urban landscapes.



A leaf blight, consisting of brown, desiccated leaves occurring mainly in the lower canopy has been observed on Pacific madrone throughout its range and symptoms are generally most severe during late winter and early spring. In May 2009 and 2011 severe damage occurred on trees in some areas of western Washington and Oregon. A previously unreported pathogen (*Phaciidiopycnis washingtonensis*), which has been reported to cause rots of stored apple and persimmon fruit and cankers and twig dieback of apple and crabapple trees, was shown to cause leaf blight on madrone leaves that had been predisposed to cold injury. The increased disease severity on madrone observed in the springs of 2011 and 2014 in Washington and Oregon may have been due to predisposition of foliage by extreme cold temperatures in the winters of 2010 - 2011 and 2013 - 2014.



Establishment of common garden plots

Seed from 105 parent trees representing 13 ecoregions within the range of Pacific madrone was selected from the WSU madrone seed collection. Seedlings were grown and planted in 7

common garden sites from California to British Columbia. We are looking for genetic variation in growth, cold tolerance, and disease resistance in order to learn how this species reacts to climate change.

Provenances of Pacific madrone used in field trials

Ecoregion/sub region	families	latitude (N)	longitude (W)	elevation (m)
St. of Georgia-Puget Sound/North (PS/n)	13	48.10-49.19	124.00-122.35	24-114
Coast Range/Wash. (CR/w)	2	48.06-48.07	123.80-123.80	177-179
St. of Georgia-Puget Sound/South (PS/s)	11	46.06-47.98	123.45-122.36	6-109
Cascades/Wash. (CA/w)	4	46.84-46.84	122.31-122.31	267-428
Willamette Valley (WV)	14	44.04-45.44	123.37-122.76	64-223
Cascades/Or. (CA/o)	5	43.68-44.70	122.35-121.99	742-924
Coast Range/Or. (CR/o)	3	43.01-43.02	124.42-124.41	37-38
Klamath Mtns/West (K/w)	5	42.20-42.23	124.33-124.22	226-816
Klamath Mtns/East (K/e)	15	40.29-42.92	123.76-122.98	140-1270
Coast Range/Calif-N (CR/cn)	3	40.09-40.09	123.81-123.81	129-247
Sierra Nevada (SN)	8	38.74-39.40	121.10-120.65	432-993
Calif-Sage,Chapp,Oak (CS)	14	38.01-39.25	123.19-122.48	4-426
Coast Range/Calif-S (CR/cs)	8	37.02-37.34	122.18-122.07	351-873

Locations of Pacific madrone common garden plot established between 2011-2013.

ID	Site	Elevation (m)	# Families	Spacing (m)
PV	WSU Puyallup (valley site) - WA	10	105	2 x 2.25
PH	WSU Puyallup (hill site) - WA	32	105	1 x 2
SF	Starker Forests - OR	235	105	2.5 x 2.5
SO	BLM Sprague Seed Orchard - OR	325	105	2.5 x 3
BL	Cal Fire Ben Lomond Conservation Camp - CA	800	105	2 x 2.2
TI	Texada Island - BC	93	86	2x2
CLRS	Cowichan Lake Research Station - BC	181	95	2x2

Due to high mortality at BL and CLRS from drought, these sites will be replanted in 2016

Rain Garden Plant Research at WSU-Puyallup Dr. Rita L. Hummel,
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Low Impact Development (LID) is an emerging concept for treating urban storm water with a goal of restoring the natural hydrologic function to urban landscapes. One important tool in the integrated LID approach is bioretention, which utilizes the biological, physical, and chemical properties of plants, soil media, and microorganisms to infiltrate water and filter pollutants. Rain gardens or bioretention cells are shallow depressions in the



landscape filled with soil media and plants. Plants are a critical component of rain gardens; they transpire water and help maintain favorable soil infiltration and microbiological activity. The moisture status of plants within a rain garden can vary with season and location. Plants must tolerate the wet winters of the Pacific Northwest as well as the dry summers, preferably without supplemental irrigation. During wet seasons, rain gardens will have different hydrologic zones, varying from temporarily saturated, oxygen-deprived conditions in low areas to dry conditions in the upper area that merges with the existing landscape. For long-term success, identifying plants that will be healthy and viable under these widely varying conditions is crucial.

Replicated rain garden cells were installed at the Puyallup Research and Extension Center. Each cell has approximately 256 ft² surface area, and a bioretention soil mix depth of 18 inches. The mix is a 60% sand: 40% compost blend. Funding for the construction of this infrastructure was obtained through a Department of Ecology Grant (<http://www.wastormwatercenter.org/rain-garden-research-facility/>).

Rain garden experiments include three different plant treatments and an unplanted control treatment. The three plant treatments are: 1) a trees and shrubs planting; 2) a mixed landscape planting with trees, shrubs, ornamental grasses, sedges and rushes; and 3) a managed grassland planting of four grass species. Each design is replicated four times. Plants were selected based on aesthetic characteristics and their considered potential for survival in the different rain garden hydrologic zones. The table below lists the plants and the hydrologic zones in which they are being tested.

Sources of plants: Beargrass, Pacific madrone, colonial bentgrass, tufted hairgrass, and the fescues were grown from seed at WSU Puyallup. The other plants were obtained from Briggs Nursery, Fourth Corner Nurseries, J. Frank Schmidt & Son Co., Vasey Nursery, Woodbrook Nursery and The Landscape Plant Development Center. Seed Research of Oregon supplied the grass seed. We would like to thank them all for their assistance and support of this project.

For more information check out the following:

Low Impact Development Technical Guidance Manual for Puget Sound. December 2012.

Available at http://www.psp.wa.gov/downloads/LID/20121221_LIDmanual_FINAL_secure.pdf

Rain Garden Handbook for Western Washington: A Guide for Design, Installation, and Maintenance. June 2013.

Planting Trees and Shrubs in the Landscape. WSU Extension Fact Sheet, FS047E. 2011.

Available at <http://cru.cahe.wsu.edu/CEPublications/FS047E/FS047E.pdf>

Plants Under Evaluation* in the WSU Puyallup LID Research Rain Gardens		
Scientific Name	Common Name	Rain Garden Hydrologic Zone
TREES		
<i>Acer truncatum</i> x <i>A. platanoides</i> 'Warrenred'	Pacific Sunset® maple	**Transition Zone
<i>Amelanchier</i> x <i>grandiflora</i> 'Autumn Brilliance'	Serviceberry	Dry and Wet Zones
<i>Arbutus menziesii</i>	Pacific madrone	Dry Zone
<i>Arbutus</i> 'Marina'	Strawberry tree	Dry Zone
<i>Betula nigra</i> 'Summer Cascade'	Summer Cascade birch	Transition and Wet Zones
<i>Magnolia virginiana</i> 'Henry Hicks'	Sweetbay magnolia	Dry and Wet Zones
<i>Nyssa sylvatica</i>	Tupelo	Transition Zone
<i>Taxodium distichum</i>	Bald cypress	Wet Zone
<i>Taxodium distichum</i> 'Cascade Falls'	Cascade Falls Bald cypress	Transition Zone
SHRUBS AND GROUND COVERS		
<i>Cistus</i> x <i>purpureus</i>	Purple rockrose	Dry and Transition Zones
<i>Clethra alnifolia</i> 'Hummingbird'	Summer sweet	Transition and Wet Zones
<i>Cornus sericea</i>	Redosier dogwood	Transition and Wet Zones
<i>Cornus sericea</i> 'Kelseyi'	Dwarf redosier dogwood	Dry and Transition Zones
<i>Diervilla lonicera</i>	Dwarf bush-honeysuckle	Transition Zone
<i>Diervilla sessifolia</i> 'Cool Splash'	Cool Splash bush-honeysuckle	Transition Zone
<i>Fragaria chiloensis</i>	Beach Strawberry	Dry and Transition Zones
<i>Gaultheria shallon</i>	Salal	Dry Zone
<i>Helianthemum nummularium</i> 'Sudbury Gem'	Sudbury Gem sunrose	Dry and Transition Zones
<i>Ilex vomitoria</i> 'Nana'	Dwarf yaupon holly	Transition Zone
<i>Leucothoe axillaris</i>	Coast leucothoe	Transition Zone
<i>Mahonia aquifolium</i>	Oregon grape	Transition zone
<i>Mahonia nervosa</i>	Longleaf mahonia	Dry Zone
<i>Mahonia repens</i>	Creeping mahonia	Dry Zone
<i>Myrica californica</i>	Pacific wax myrtle	Transition and Wet Zones
<i>Philadelphus lewisii</i> 'Blizzard'	Blizzard Mockorange	Transition Zone
<i>Physocarpus capitatus</i>	Pacific Ninebark	Wet Zone
<i>Physocarpus opulifolius</i> 'Center Glow'	Center Glow ninebark	Dry, Transition and Wet Zones
<i>Potentilla fruticosa</i>	Shrubby cinquefoil	Dry and Transition
<i>Salix integra</i> 'Hakuro-nishiki'	Dappled willow	Wet Zone
<i>Spiraea douglasii</i>	Douglas spiraea	Wet Zone

GRASSES		
<i>Deschampsia cespitosa</i> 'Northern Lights'	Tufted hairgrass	Dry, Transition and Wet Zones
<i>Festuca glauca</i> 'Boulder Blue'	Blue fescue	Dry and Transition Zones
<i>Miscanthus sinensis</i> 'Little Kitten'	Japanese silvergrass	Dry, Transition and Wet Zones
<i>Molinia caerulea</i> 'Skyracer'	Moor grass	Dry, Transition and Wet Zones
<i>Agrostis capillaris</i>	Colonial bentgrass	Dry, Transition and Wet Zones
<i>Deschampsia cespitosa</i>	Tufted hairgrass	Dry, Transition and Wet Zones
<i>Festuca arundinacea</i>	Tall fescue	Dry, Transition and Wet Zones
<i>Festuca rubra</i>	Slender creeping red fescue	Dry, Transition and Wet Zones
<i>Festuca rubra</i> var. <i>commutata</i>	Chewings fescue	Dry, Transition and Wet Zones
SEDGES AND RUSHES		
<i>Carex obnupta</i>	Slough sedge	Transition and Wet Zones
<i>Juncus. ensifolius</i>	Dagger-leaf rush	Transition and Wet Zones
<i>Juncus tenuis</i>	Slender rush	Wet Zone
HERBACEOUS PERENNIALS		
<i>Solidago missouriensis</i>	Goldenrod	Dry Zone
<i>Xerophyllum tenax</i>	Beargrass	Dry Zone
<p>*Disclaimer: This is a list of plants being tested for their potential adaptability to rain garden hydrozones, not a list of recommended plants. Although some of the plants are tried and true rain garden species, some were included for experimental purposes. The plants were placed in different hydrozones in the rain garden based on their potential adaptation. For example, the Pacific madrone and beargrass were only planted in the upper or dry zone while the tufted hairgrass was planted in all three zones (wet, transition and dry). Survival, growth and quality of all plants will be evaluated over time.</p> <p>**Plants in the transition zone may be placed higher (drier) or lower (wetter) depending on the plant species.</p>		

Puyallup “Hill” common garden planting

Stop 1

- Overview of the WSU Puyallup Research and Extension Center



- Overview of “Hill” Plot

Puyallup Hill Plot

Planting date	Fall 2011
Elevation (m)	32
No. of Families	105
Spacing (m)	1 x 2
No. Reps	4
No. trees/family/rep	5
Area (ha)	0.46

- Phytophthora root rot and flowering



Stop 2

- Variation on foliage color



- Winter damage



Stop 4

- Variation in bud break and foliage characteristics of trees.



Stop 5

Variation in growth and health of trees



Container Seedling Production

Seedlings for each of the 105 families that were included in the five common garden trials in Washington, Oregon and California were grown at WSU Puyallup during 2011. It was noted that the color of the foliage for different families varied from a dark green to a reddish-green color. Colorimeter data were collected at the end of the growing season and two clustering methods (Wards, Kmeans) were used to group seedlings into those families with red or green foliage. Families at opposite ends of the green/red scale are shown below.



Variation on foliage color

Green		Reddish-green	
Family	a*	Family	a*
LA8	-15.0785	BR7	-6.17133
PL7	-14.9939	VI4	-6.17059
SC4	-14.964	WL8	-5.81267
LA5	-14.9093	PA3	-5.681
LA10	-14.8829	PA4	-5.28772
SA7	-14.6267	OL1	-4.38456
SA8	-14.5949	BR3	-3.86515
LA13	-14.5414	PA1	-3.47652
GA1	-14.4879	OR1	-2.63533
SN5	-14.3197	WV6	-2.27976
CC4	-14.1854		
CP24	-14.1529		
SA5	-14.1318		

a* - green to magenta color. More negative values indicate dark green.

Puyallup Valley common garden planting

Stop 1

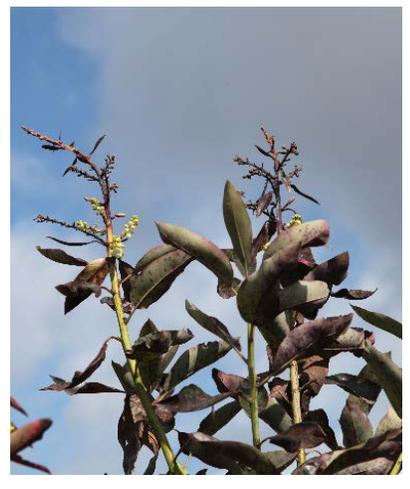
- Overview of Valley plot

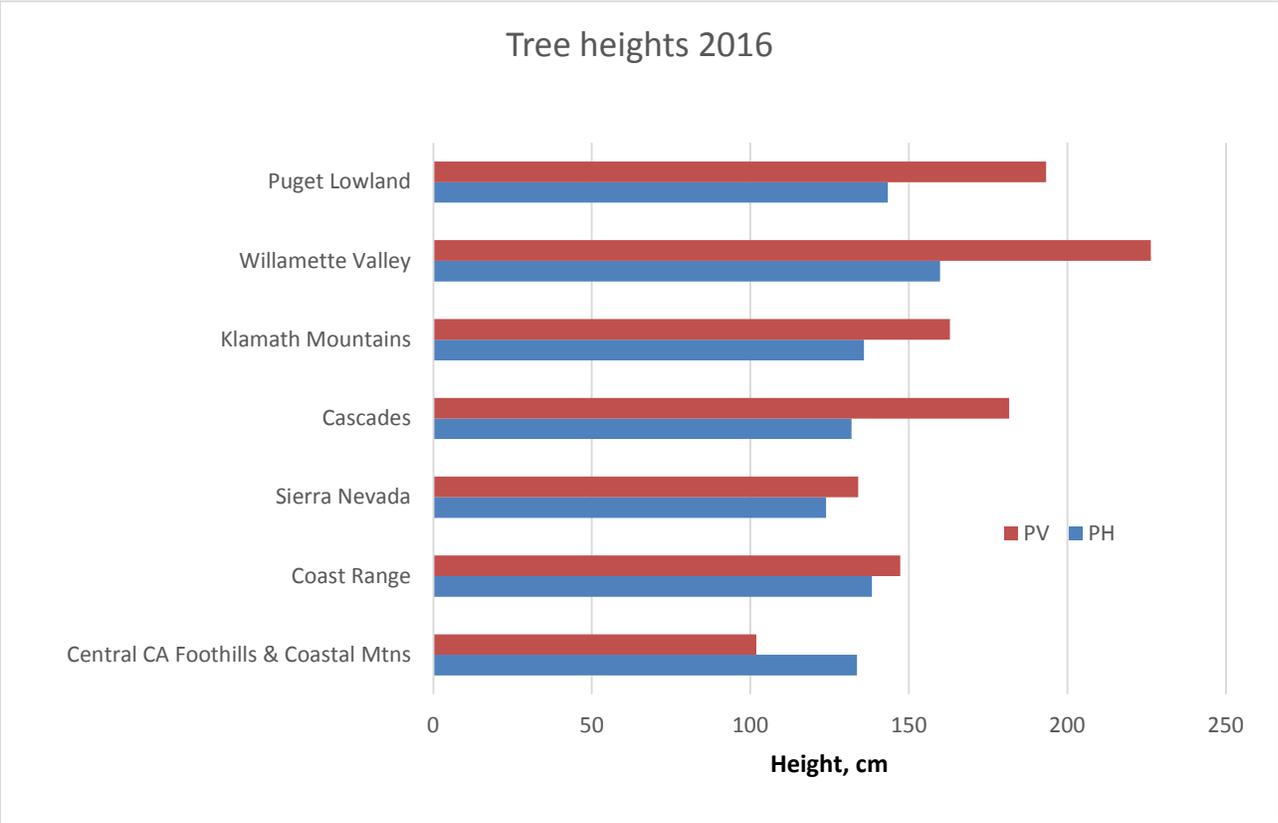
Puyallup Valley Plot

Planting date	Fall 2011
Elevation (m)	10
No. of Families	105
Spacing (m)	2 x 2.5
No. Reps	4
No. trees/family/rep	5
Area (ha)	1.0
Soil type	Briscot Loam (West) and Puy. F. Sandy Loam (East)

Stops 2 and 3

- Winter/Frost damage, dieback, and cankers





Stop 5

Border row: Trees to the left are Cascades, Detroit OR (left) and Klamath Mountains, Klamath NF, CA (right) with interplanted Texas madrone.

National Elm Trial Tour

Adaptability of Dutch Elm-resistant cultivars of elm to Western Washington (<http://www.puyallup.wsu.edu/ppo/elm/>)

Due to the increasing threat that exotic pathogens and insects can have on the health of shade trees, it is to maximize genetic diversity within the nation's urban forests. The graceful American elm that once dominated urban forests across the United States essentially disappeared from urban landscapes after the introduction of Dutch elm disease (DED) into North America. Scientific data on growth, form, and pest resistance for existing DED-resistant elm cultivars are essential in order to promote interest in planting these trees.

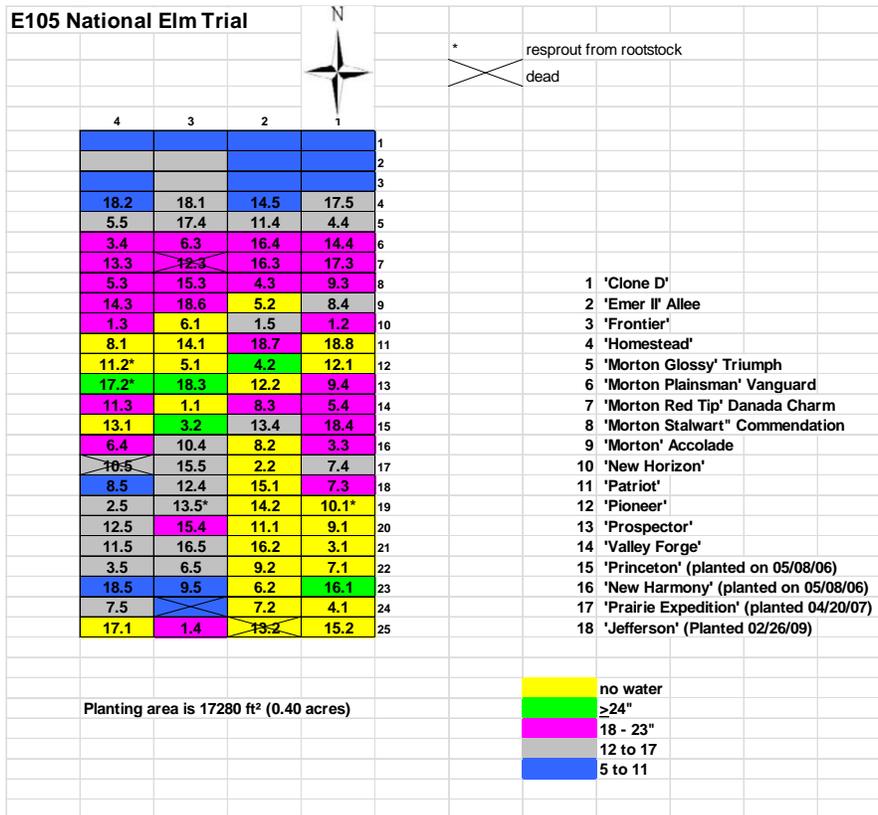
Even though many DED-resistant elm cultivars exist and are available in the nursery trade, much of the public is hesitant to purchase and plant any elm tree. While the DED-resistant elm cultivars could enhance the diversity as well as the beauty of urban forests, they do vary in their response to other biotic and abiotic stresses.

The National Elm Trial (<http://bspm.agsci.colostate.edu/national-elm-trial>) includes 17 DED-resistant commercially available elm cultivars planted at sixteen evaluation sites in fifteen states. These elm cultivars will be evaluated over a wide range of growing conditions and hardiness zones. This trial is a volunteer effort to evaluate and promote the use of Dutch elm disease-resistant American and hybrid elms. The group consists of researchers and extension specialists located at land grant universities.

Study Objectives include: 1) Determine the growth and horticultural performance of commercially available DED-resistant elm cultivars in various climate regimes in the United States, 2) Determine the relative disease, insect, and abiotic stress tolerance of these cultivars, and 3) Promote the propagation and use of elms through local, regional, and national reporting of the trial results to wholesale tree propagators and growers, retail nursery and garden center operators, landscaper designers, arborists, and the general public.

In 2005, fourteen elm cultivars were planted at Puyallup. Two additional cultivars were added to the trial in 2006 and 2007. Each cultivar is represented by one tree in each of five blocks in a randomized complete block. The elm cultivars represent a range of hybrids and species of *Ulmus* commercially available.

Using a standard format, annual assessment of each tree include: height, diameter, crown characteristics, and fall color. At appropriate times during each year, each tree is also evaluated for disease and insect damage, as well as abiotic damage (frost/freeze, wind, winter dieback, sunscald, and moisture stress).



The National Elm Trial planting area at WSU Puyallup

Although very little disease or insect damage has been observed on any of the trees at Puyallup, the ice storm of January 2012 provided a unique opportunity to examine the severity of ice damage to the elm cultivars in this trial. Cultivars that had no damage on any of the trees were 'Frontier' (*U. carpinifolia* x *U. parvifolia*) and 'New Horizon' (*U. pumila* x *U. japonica*). The most heavily damaged was 'Pioneer' (*U. glabra* x *U. carpinifolia*). Based on this information, it is recommended to cultivars such as 'Pioneer' should not be planted in areas prone to ice storms.



Cultivars also differ in fall foliage coloration. The foliage on 'Frontier' develops a dark red coloration compared to the yellow coloration of most of the other cultivars.