Conifers in the Urban Forest

Potential Benefits and Functional Uses of the Cone Trees

By J. Casey Clapp

Special Thanks to:

Bit about me

- Associate Consultant with Tree Solutions, Inc. based in Portland and Seattle
- Master of Science from University of Massachusetts, Amherst
- Bachelor of Science from Oregon State University
- ISA Certified Arborist
- ISA Qualified Tree Risk Assessor

Western redcedar (*Thuja plicata*) in Olympic National Park, Washington

Green Infrastructure

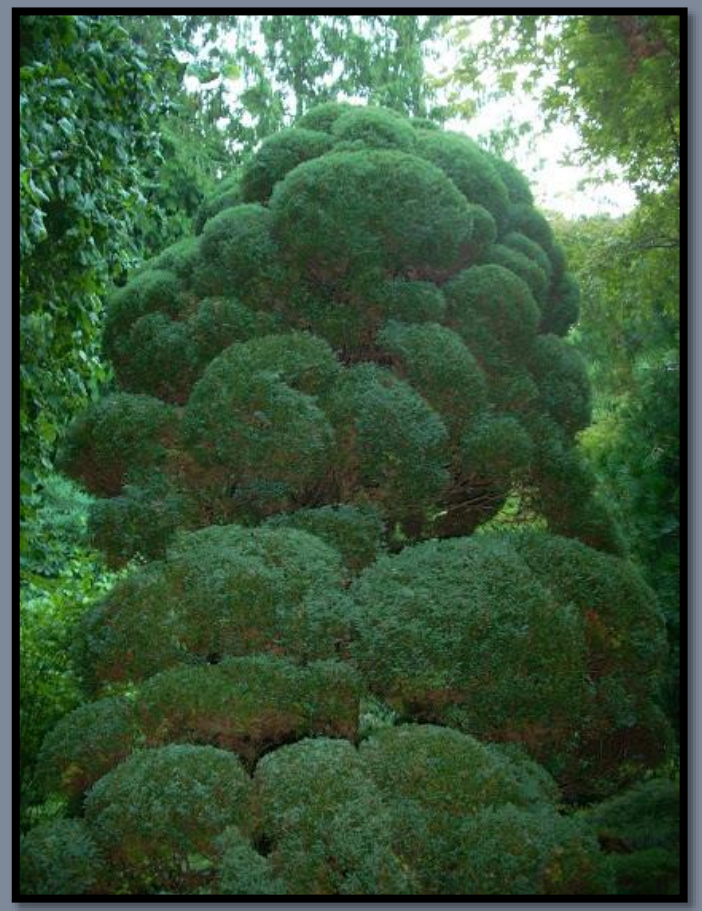


Photo: J. Casey Clapp

Why is green infrastructure important?

- Urban Ecosystem Benefits
  - Storm water management
  - Pollution mitigation
  - Urban heat island mitigation
  - Wildlife habitat
  - Sound/visual buffers
  - Aesthetics
  - Positive mental health effects

Green Infrastructure

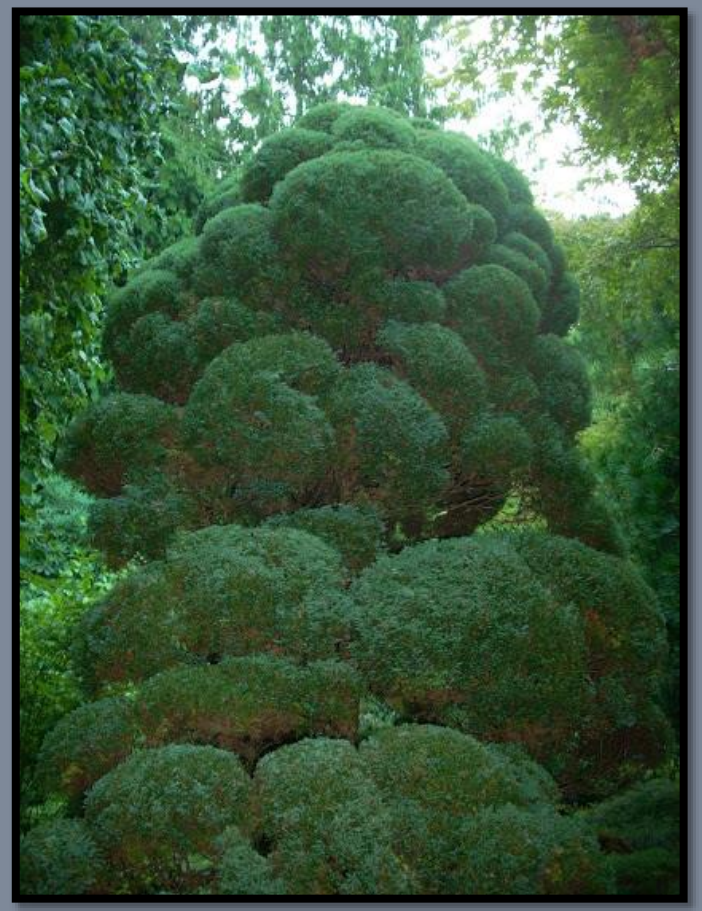


Photo: J. Casey Clapp

Why is green infrastructure important?

- Urban Ecosystem Benefits
  - Can be translated to cost saving (cost avoidance)
  - Spend less on water treatments, pollution abatement, healthcare, cooling, heating,
  - Intangibles?
    - Happiness, lower stress, satisfaction, safety, value of habitat for animals?

Conifers!

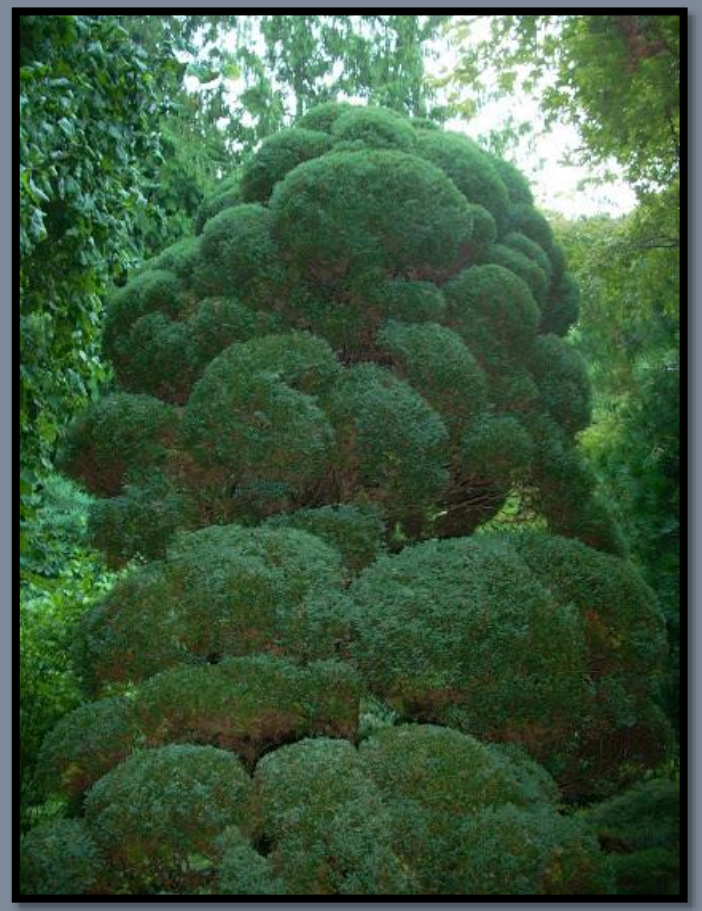


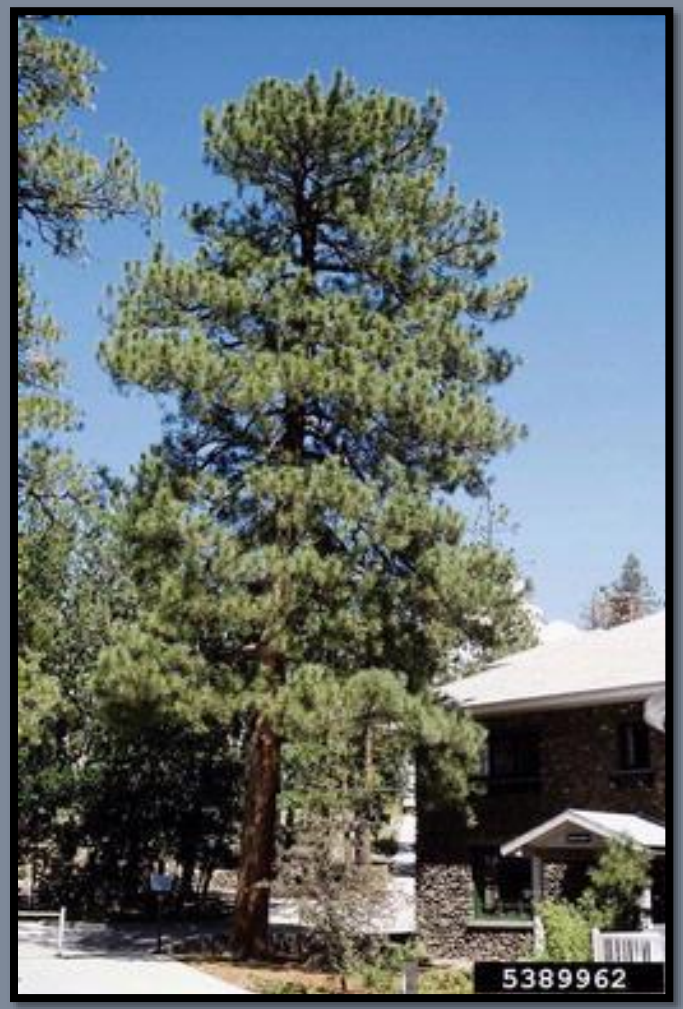
Photo: J. Casey Clapp

How do conifers fit in our green infrastructure system?

- Another tool in the tool box
  - Right tree, right place…..
  - Right objective

Urban Forest as Infrastructure

Output

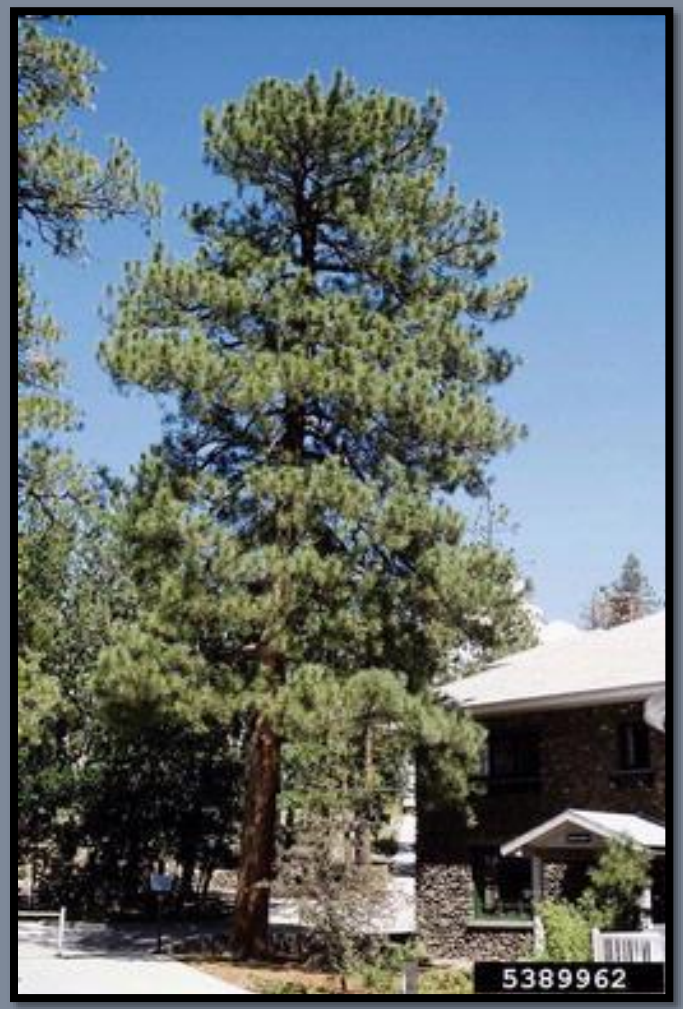


Ponderosa pine (*Pinus ponderosa*)
Photo: Tom DeGomez, bugwood.org

- Site objectives
- Available tools
- Efficiency
- Cost vs. return
- Conflicts

Urban Forest as Investment

Output



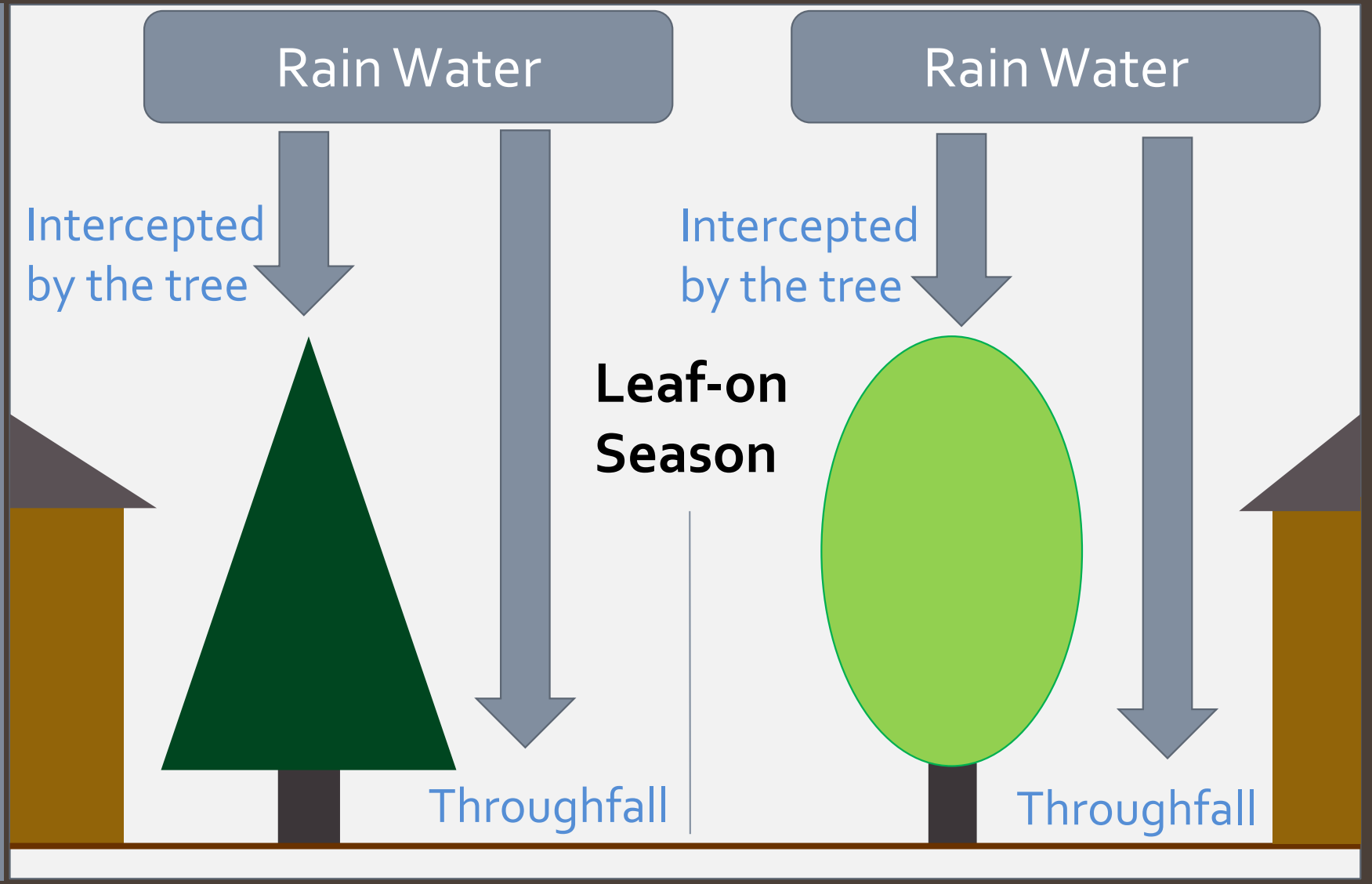
Ponderosa pine (*Pinus ponderosa*)
Photo: Tom DeGomez, bugwood.org

- Site objectives
- Available tools
- Efficiency
- Cost vs. return
- Conflicts

- Stability
  - Throughout disturbance
  - Throughout changing climactic conditions
- Efficiency
  - High return on investment
    - Encourage more investment

Canopy Dependent services

- Many ecosystem services are dependent on the tree canopy
- No canopy, no service
  - Rainwater interception
  - Pollution absorption
  - Physical barrier
  - Buffering
  - Wildlife cover



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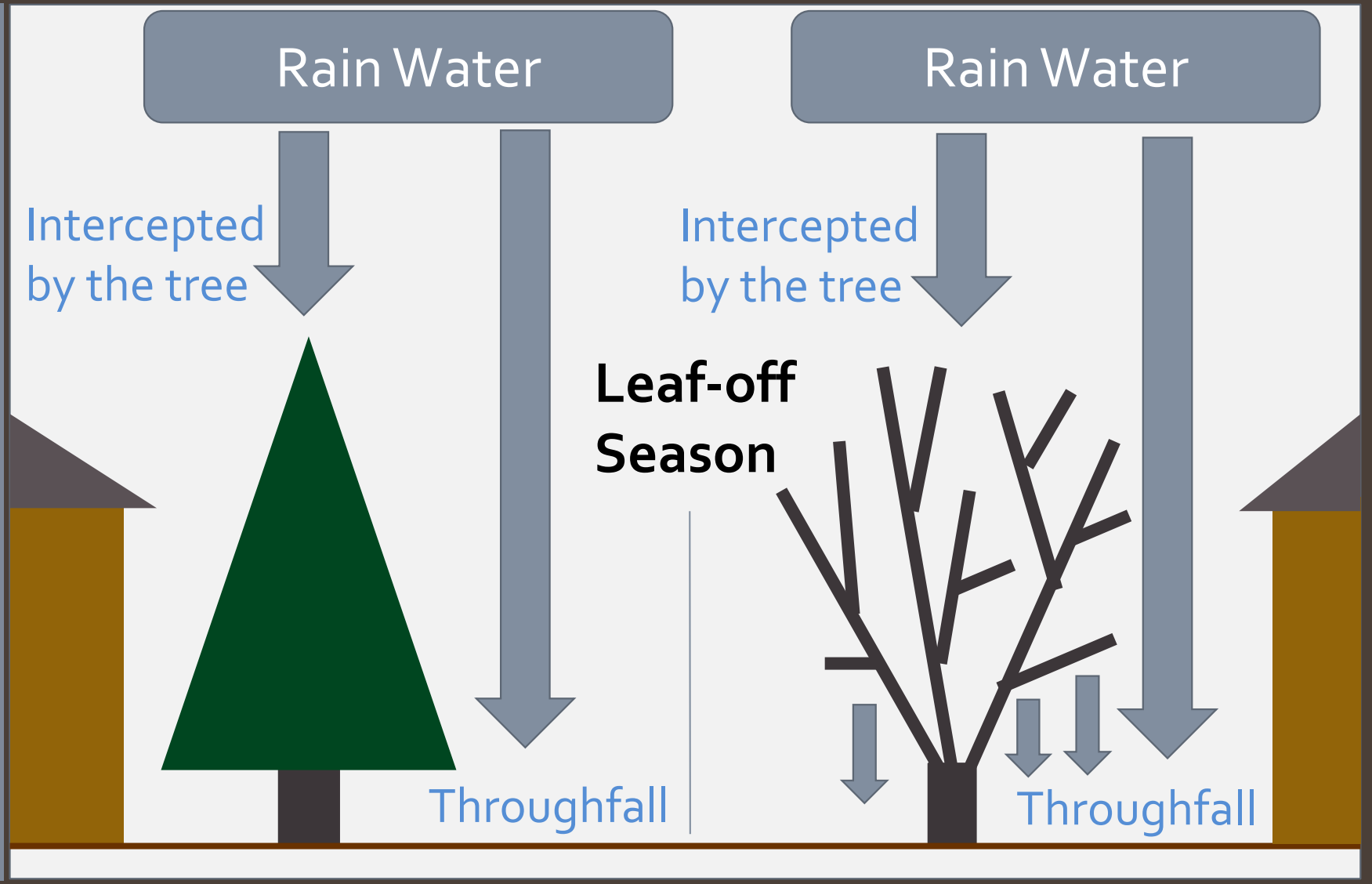


Evergreens

Douglas-fir (*Pseudotsuga menziesii*)
Photo: Richard Webb, Bugwood.org

Leaf Area Index (LAI)

- Measure of tree canopy density
- Evergreen species maintain high LAI year-round
  - Individually offered services
  - Collectively raise the leaf-off season LAI of the whole urban forest

Xiao and McPherson (2002); Zinke (1967); Xiao *et al*. (2000); Xiao *et al*. (1998); Asadian and Weiler (2009)

Flow Control

Deodar cedar (*Cedrus deodara*)
Photo: John Ruter, Bugwood.org

Storm Water Management

- Evergreen species maintain high LAI year-round
  - Singular evergreen intercepted 27% gross annual rainfall, as compared with 15% for deciduous
  - Evergreen coniferous forest intercepts 20-40% gross annual rainfall as compared to 10-20% for deciduous broadleaf forest
  - Average canopy interception for Douglas-fir was 49.1% and 60.9% for western redcedar

Xiao and McPherson (2002); Zinke (1967); Xiao *et al*. (2000); Xiao *et al*. (1998); Asadian and Weiler (2009)

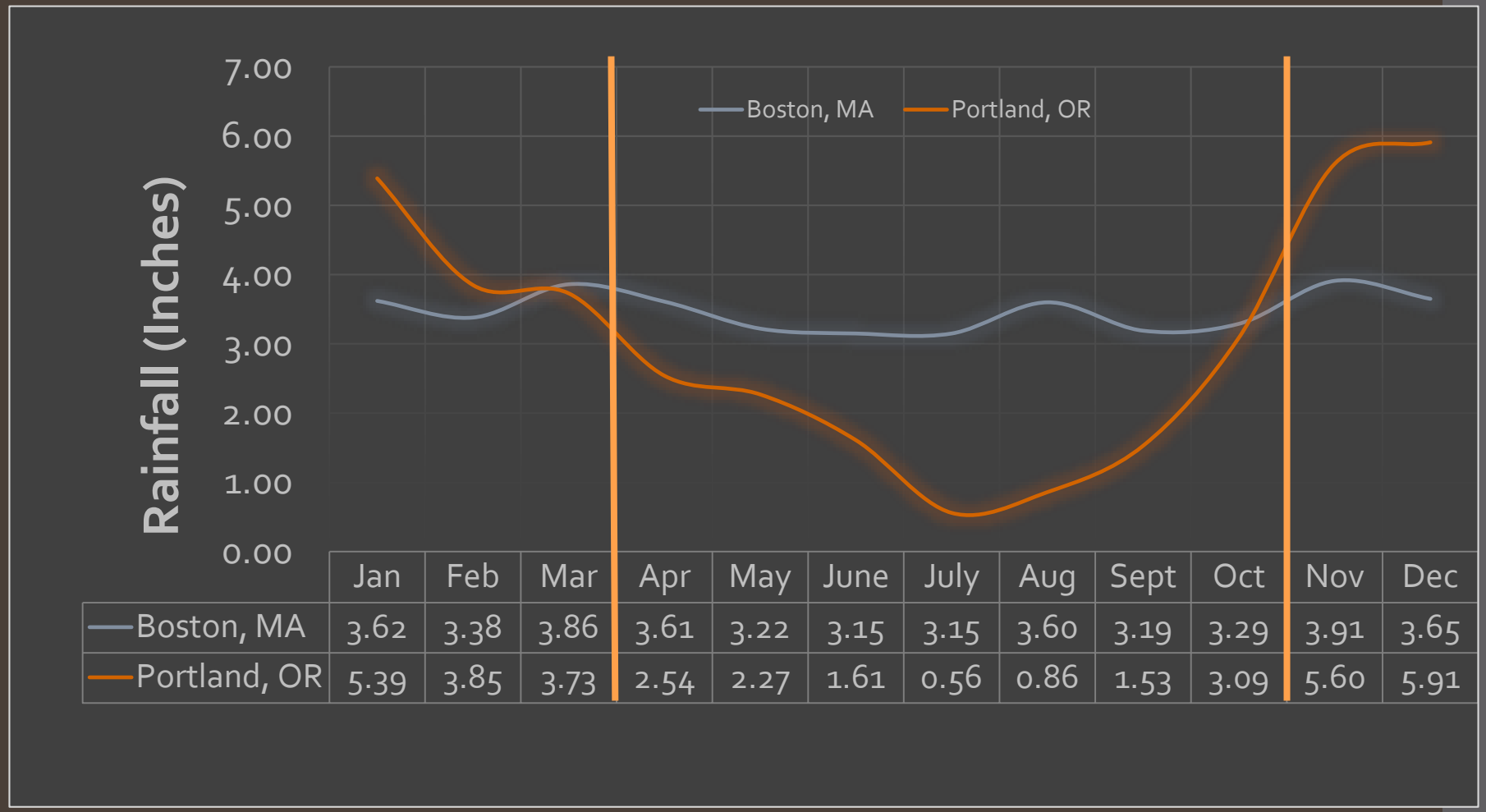
Flow Control

	Annual Total
Portland	36.94
Boston	41.63

	Leaf-On (Apr-Oct)
Portland	12.46
Boston	23.21

	Leaf-Off (Nov- Mar)
Portland	24.48
Boston	18.42

	Avg. Missed	Avg. Int.
Portland	66.27%	33.73%
Boston	44.25%	55.75%



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Boston, MA	3.62	3.38	3.86	3.61	3.22	3.15	3.15	3.60	3.19	3.29	3.91	3.65
Portland, OR	5.39	3.85	3.73	2.54	2.27	1.61	0.56	0.86	1.53	3.09	5.60	5.91

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So what can conifers offer?

- Dense foliage with high LAI can capture more rainwater
- Evergreen foliage captures more rainwater on average each year
  - Especially important if most storm events occur during the leaf of season

Urban Forest Efficiency!

Indirect and Direct Effects

Limber pine (*Pinus flexillis*)
Photo: Tom DeGomez, Bugwood.org

Pollution Mitigation Efficiency --Direct Effects

- LAI is an important factor for pollution mitigation
  - Absorb more pollutants, such as CO_2, NO_2, and ozone
  - Intercept more particulate matter
- Conifers absorbed ozone during the winter time
- Conifers absorbed ozone during drought conditions

Nowak et al. (2000); Nowak et al. (2006); Taha et al. (1996); Fausto et al. (2012); Geiger, 2005; Heisler, 1986[1]; Akbari, 2002

Indirect and Direct Effects

Limber pine (*Pinus flexillis*)
Photo: Tom DeGomez, Bugwood.org

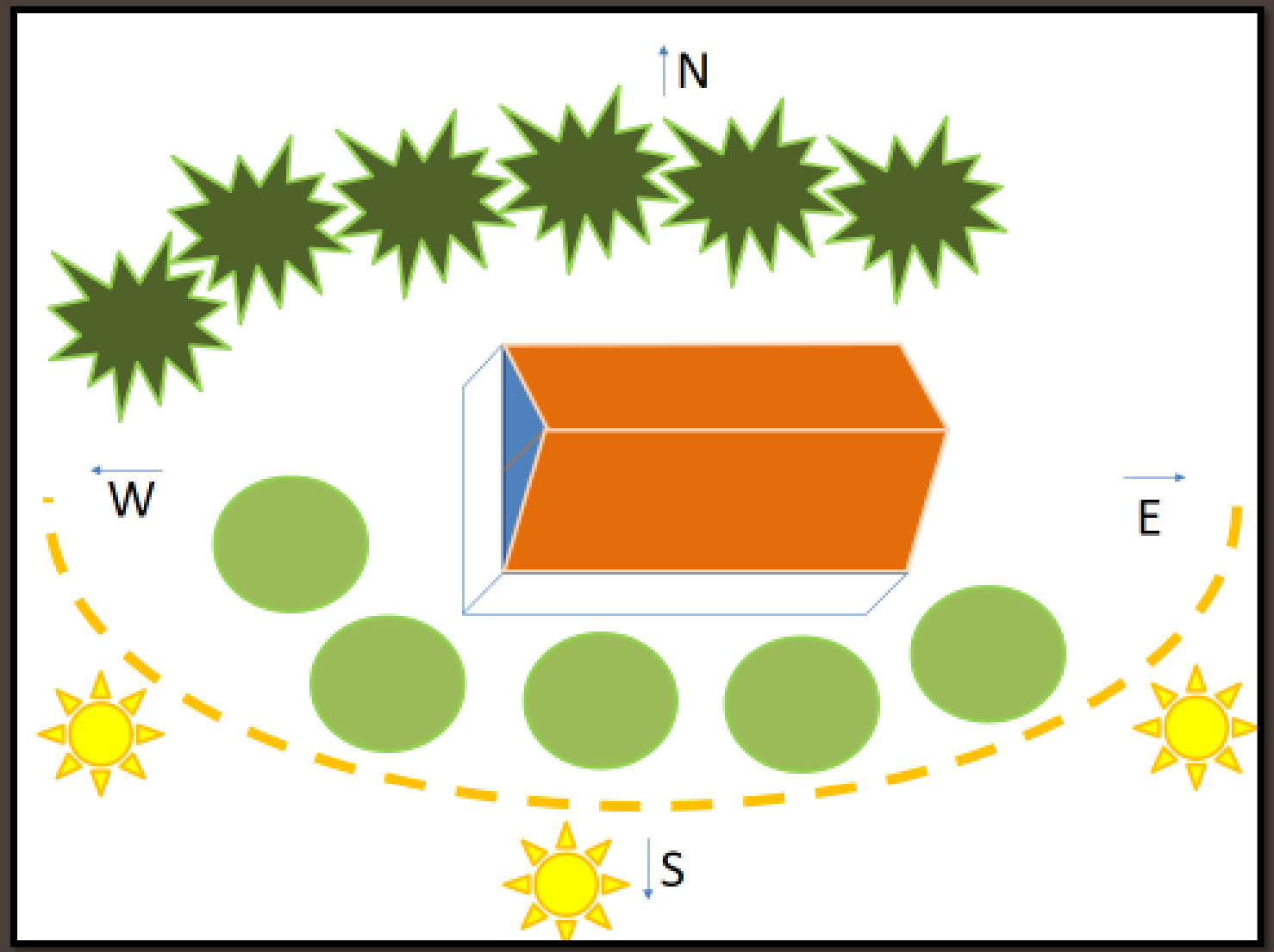
Pollution Mitigation Efficiency --Indirect Effects

- Microclimate and Urban Heat Island Effect
  - Sites with high LAI had lower soil and ambient air temperatures
- Wind buffer planting
  - Further away can lead to 25% reduction in winter heating costs
  - Up close can limit cold air infiltration and heat loss through conduction

Nikolopoulou *et al*. (2001); Neimeira (2009); Geiger, 2005; Heisler, 1986[1]; Akbari, 2002

Indirect and Direct Effects

- Evergreen conifers slow cold winds from the north
- Broadleaf deciduous trees shade building in the summer
- Leafless trees allow in maximum solar radiation during the winter



Key Component

Port Orford-Cedar
(*Chamaecyparis lawsoniana*)
Photo: John Ruter, Bugwood.org

Urban Forest Diversity

- Conifers add diversity in terms of species composition…
  - tree functional type, physiology, and physical structure
- Conifers add to ecological diversity at several hierarchical levels

Diversity Leads to Stability!

Justus (2008); McKinney (2002;) Clatter and Harper (2009)

Living Asset

Blue spruce (*Picea pungens)*
Photo: USDA Forest Service, Bugwood.org

Urban Forest as Ecosystem

- Stability in terms of ecosystem services
  - Resistance—withstanding disturbance
  - Resilience—how quickly the system returns to an original level of ecosystem service

Maintain the highest level of ecosystem services throughout a disturbance, and return to the original level as quickly as possible

Multi-Dimensional

Whitebark pine (*Pinus albicaulis*)
Photo: Dave Powell, USDA Forest Service; Bugwood.org

Hierarchical Diversity Levels

- Insect and disease outbreak
  - *Diversity in species*
- Wind storms
  - *Diversity in structure*
- Ice and snow storms
  - *Diversity in structure*
- Drought
  - *Diversity in physiology and functional type*

Justus (2008); McKinney (2002;) Clatter and Harper (2009)

Multi-Dimensional

Whitebark pine (*Pinus albicaulis*)
Photo: Dave Powell, USDA Forest Service; Bugwood.org

Hierarchical Diversity Levels

- Wildlife value
  - *Diversity in species, functional type, and structure*
- Wintertime pollution absorption
  - *Diversity in functional type*
- Landscaping interest
  - *Diversity in species, structure, and functional type*

Justus (2008); McKinney (2002;) Clatter and Harper (2009)

Multi-Dimensional

Whitebark pine (*Pinus albicaulis*)
Photo: Dave Powell, USDA Forest Service; Bugwood.org

Aesthetic Values

- Evergreen structure during winter time
- Unique varieties and cultivars
- Interesting species characteristics
- Cones!

Justus (2008); McKinney (2002;) Clatter and Harper (2009)

Taxodium

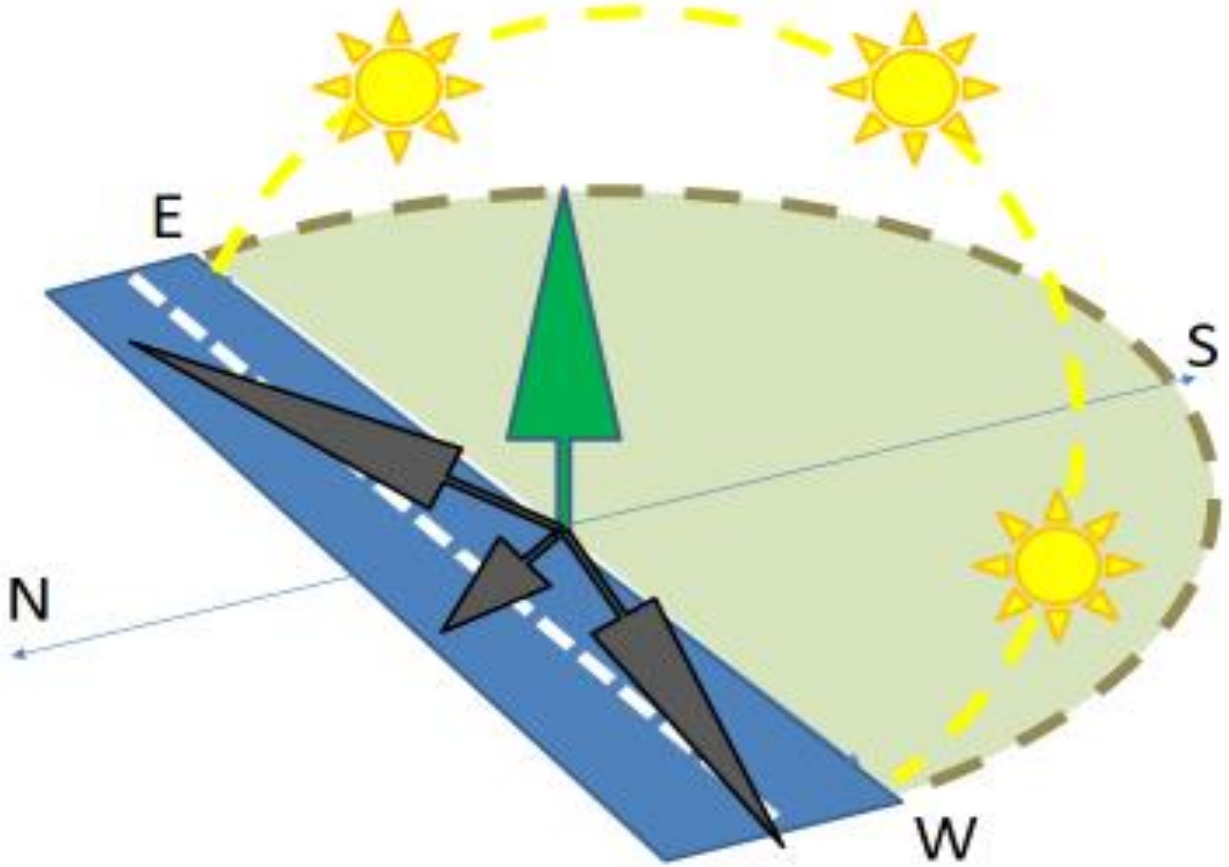
Photo: Robert Videki
Bugwood.org

Just like all situations, there are always trade-offs

- Like all plants, require certain maintenance
- Acidic soils may result
- Form could be issue
- Winter shading
- Like all plants, certain disease and pest issues

Quality Design

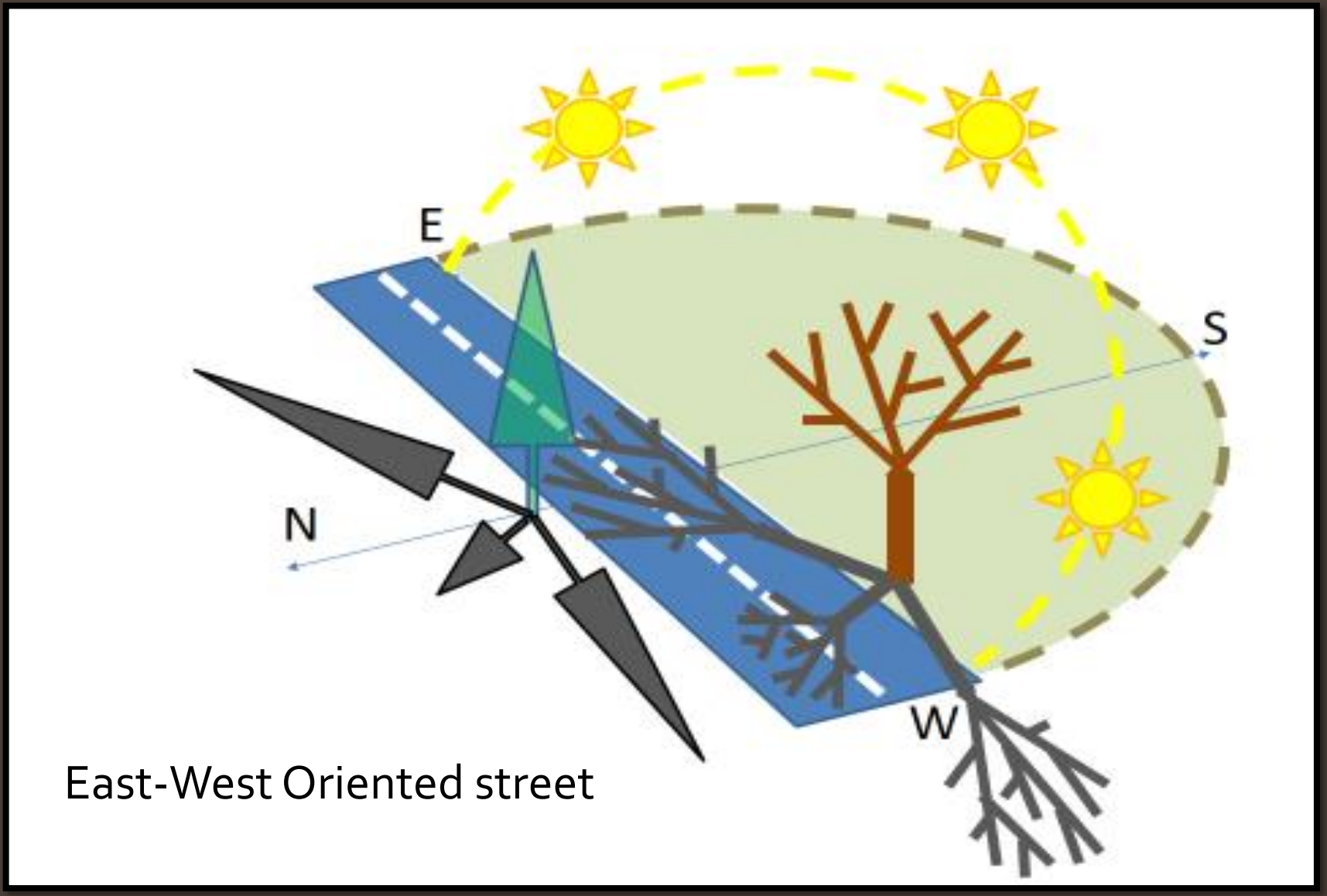
Photo: Casey Clapp



East-West Oriented street

Quality Design

- Deciduous trees on the south side of the street
- Evergreen conifers on the north side of the street
  - Diversity
  - Year round benefit
  - Avoids conflicts
  - Provides evergreen structure during winter



East-West Oriented street

Photo: Casey Clapp

Umbrella pine

Photo: Hugh Conlon, whatgrowsthere.com

Take aways

- Right tool for the right job: base plant choice on objective for planting
  - Right tree for the right place *and* right objective
- Expand your diversity!
- Climate change
  - May need to start looking at different plants that can take changing conditions, so plant pallets may need to expand; conifers can help fill gaps

World-Class Folks

Chinese-fir(*Cunninghamia lanceolata*)
Photo: John Ruter, Bugwood.org

Great Big Thank You!

- Dr. Dennis Ryan, Rick Harper, Dr. Dave Bloniarz
- University of Massachusetts, Amherst
- Tree Solutions, Inc.
- The Department of Environmental Conservation
- Friends and Colleagues

X, Y, Z

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End of Show. Everything after this is just in case it comes up in questions

Giant Arborvitae

Photo: Linda Chalker-Scott (Blogs.extension.org)

Western redcedar

Thuja plicata

- Large-growing, evergreen conifer; ~100 ft.
- Drooping branches with upsweeping tips
- Dense, dark green foliage; semi-shade tolerant
- Takes moist soil conditions, prefers nutrient rich soils
- Zones 5-8

Hemlock

Photo: Rick Harper

Hemlock

Tsuga sp.

- Large-growing, evergreen conifer; ~80 ft.
- Dark green, medium density foliage; soft
- Attractive form similar to eastern hemlock; shade tolerant
- Takes moist to semi-dry soil conditions
- Not susceptible to hemlock woolly adelgid
- Zone 6

Incense cedar

Photo: John Ruter, Bugwood.org

Incense cedar

Calocedrus decurrens

- Medium-growing, evergreen conifer; ~50 ft.
- Dense, light green, aromatic foliage
- Prefers moist, well drained soils; full sun
- Narrowly conical, upright growth
- Notably rot resistant
- Zones 5-8

Japanese cedar

Photo: Richard Webb, Bugwood.org

Japanese cryptomeria

Cryptomeria japonica

- Medium-growing, evergreen conifer; ~60 ft.
- Dense, light green foliage
- Takes a wide range of soil types
- Full sun to very light shade
- Zones 5-9

Metasequoia

Photo: Gary Kling
Bugwood.org

Dawn redwood

Metasequoia glyptostroboides

- Large-growing, *deciduous* conifer; ~100 ft.
- Light green foliage; conical habit
- Takes medium to moist soils; full sun
- Tolerant of wet soils and air pollution
- Zone 4-8
- Lovely form year-round

Norway spruce

Photo: Richard Webb
Bugwood.org

Norway spruce

Picea abies

- Large-growing, evergreen conifer; ~60 ft.
- Drooping branchlets with upsweeping tips
- Dense, dark green foliage; conical habit
- Takes a wide range of soils, but prefers well-drained
- Zones 2-7

Redcedar (Eastern)

Photo: Richard Webb
Bugwood.org

Eastern Redcedar

Juniperus virginiana

- Medium growing, evergreen conifer; ~65 ft.
- Dark green foliage; compacts conical habit
- Tolerant of wide range of soils; full sun
- Drought tolerant; takes pollution well; tolerant of saline conditions
- Zone 2-9

Sequoia

Photo: Tom DeGomez
Bugwood.org

Giant sequoia

Sequoiadendron giganteum

- LARGE growing, evergreen conifer; ~180 ft.
- Dark green foliage; spreading conical habit
- Very dense crown
- Tolerant of dry soils, prefers moist, well-drained; full sun
- Zone 6-8

Taxodium

Photo: Robert Videki
Bugwood.org

Bald cypress

Taxodium distichum

- Large growing, *deciduous* conifer; ~70 ft.
- Light green foliage; conical habit; becomes rounded with age
- Tolerant of wet soils, low soil oxygen, and upland soils
- Varieties available without 'knees'
- Zone 4-9

Umbrella Pine

Photo: Hugh Conlon, whatgrowsthere.com

Umbrella pine

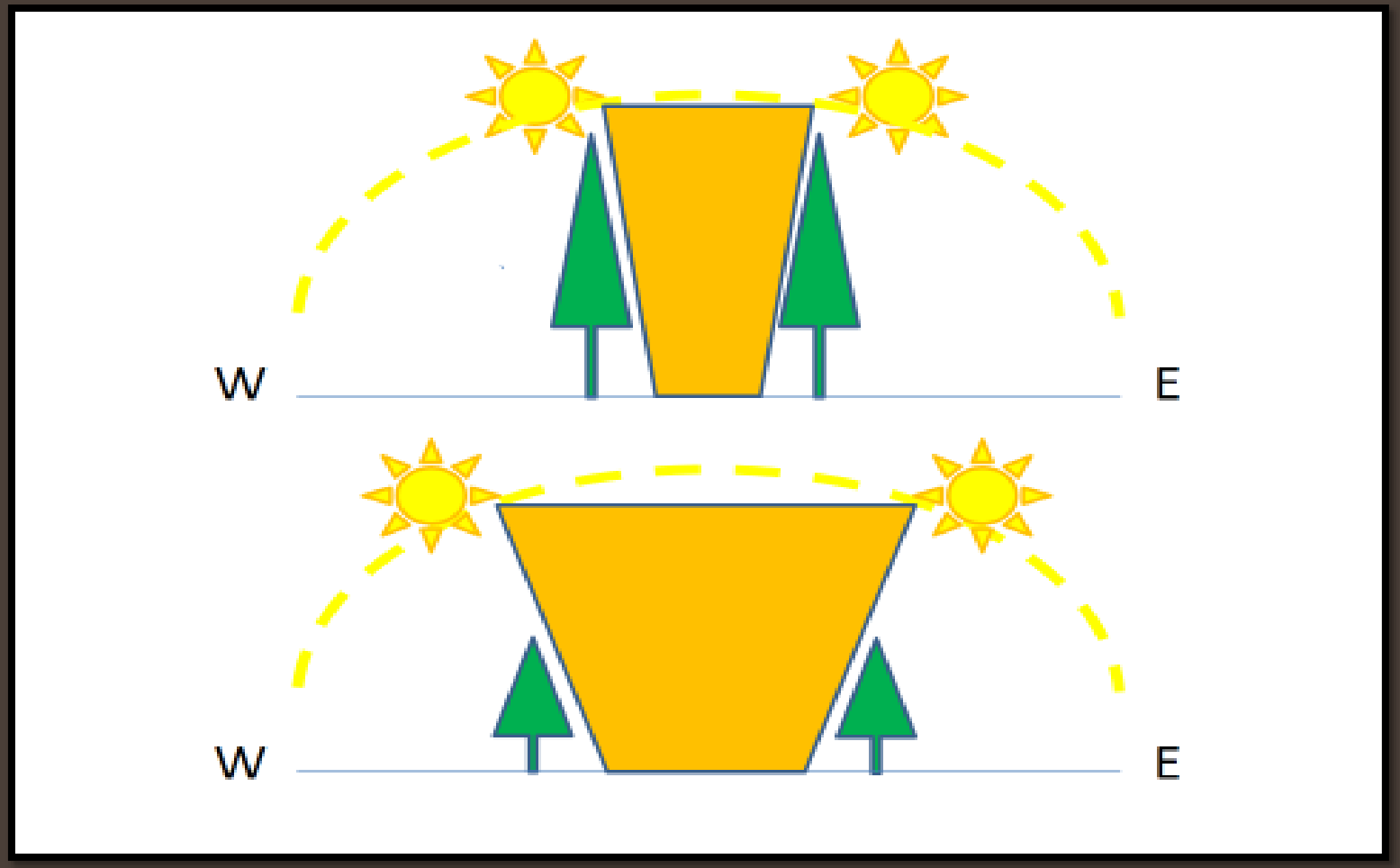
Sciadopitys verticillata

- Medium growing, evergreen conifer; ~30 ft.
- Light green foliage; rounded, upright habit
- Lights fair soils, well-drained.
- Full sun to slight shade
- Zone 5-8

Planning

- Evergreen trees shade during the winter time
- May increase the acidity of the soil
- Generally have upright, excurrent habits
- Come in many shapes and sizes

Functional Design



Quality Design

- Trees will shade either in the morning or evening
- Sun will strike road surface in the middle of the day
- Too much of a conflict?

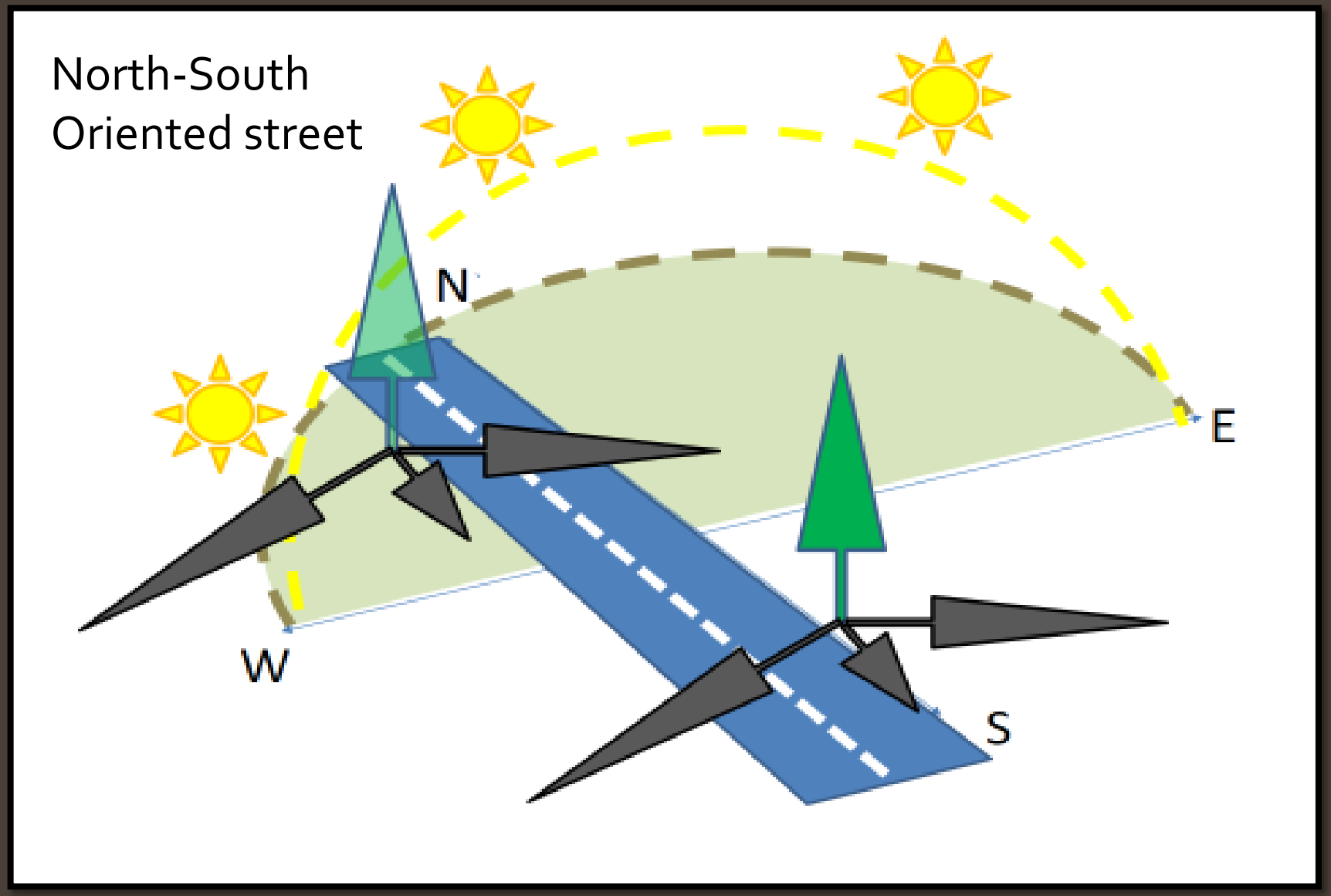


Photo: Casey Clapp

Quality Design

- Trees will shade either in the morning or evening
- Sun will strike road surface in the middle of the day
- Too much of a conflict?
  - Shorter trees
  - Wider spacing

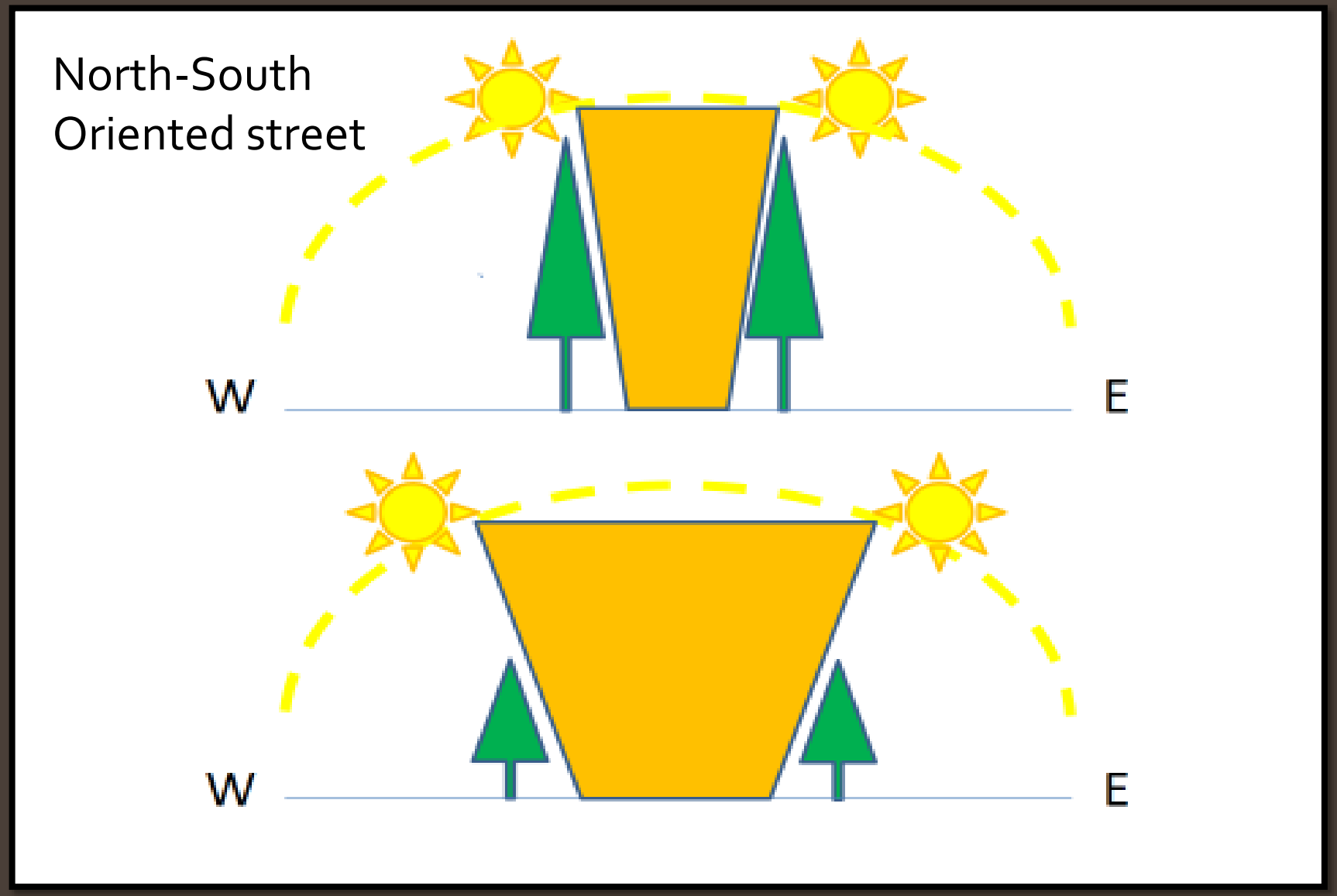


Photo: Casey Clapp

Quality Design

- Trees will shade either in the morning or evening
- Sun will strike road surface in the middle of the day
- Too much of a conflict?
  - Is the road already shaded?

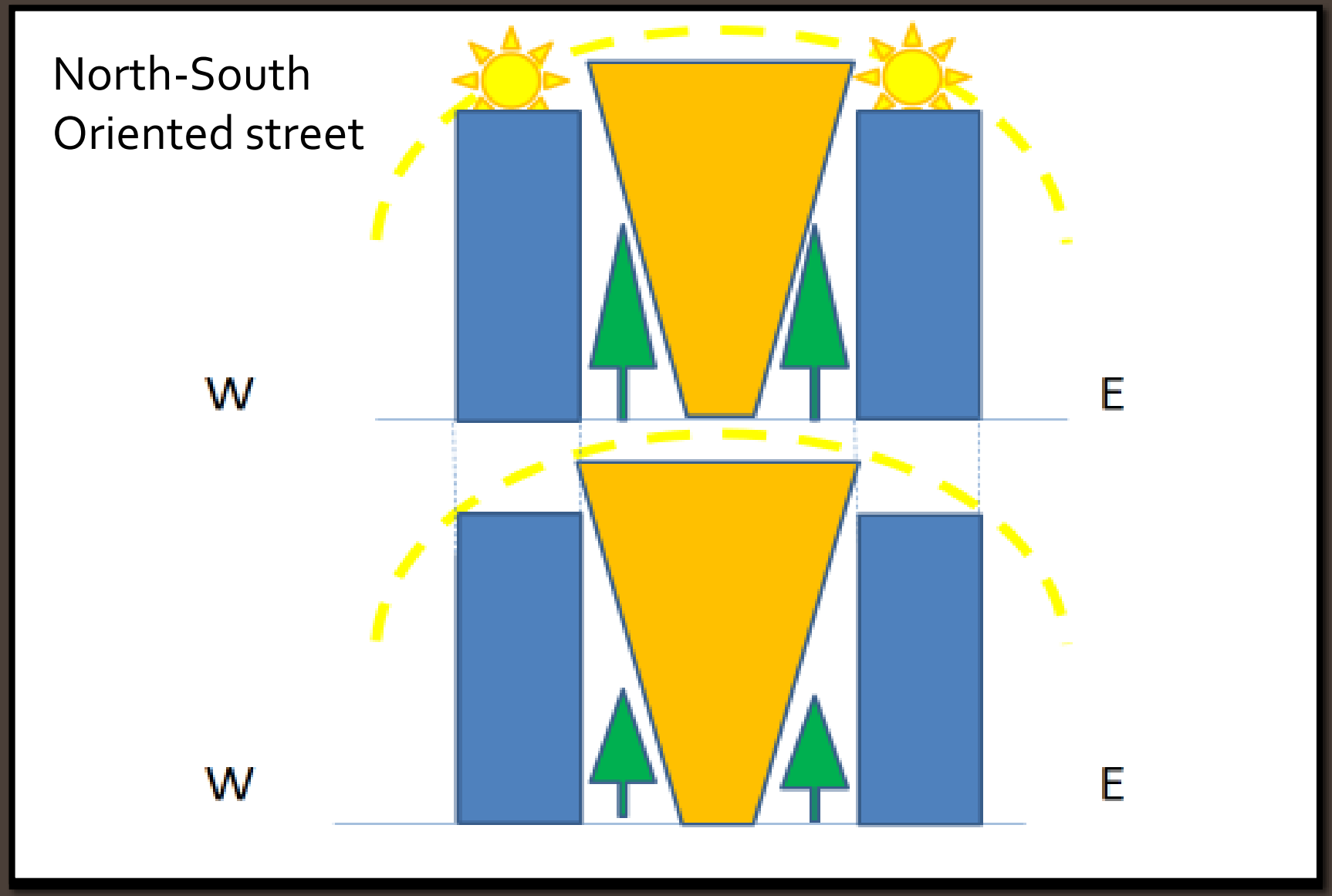


Photo: Casey Clapp

Quality Design

- Barrier plantings
  - Physical
  - Noise
  - Sight
  - Vehicle Spray

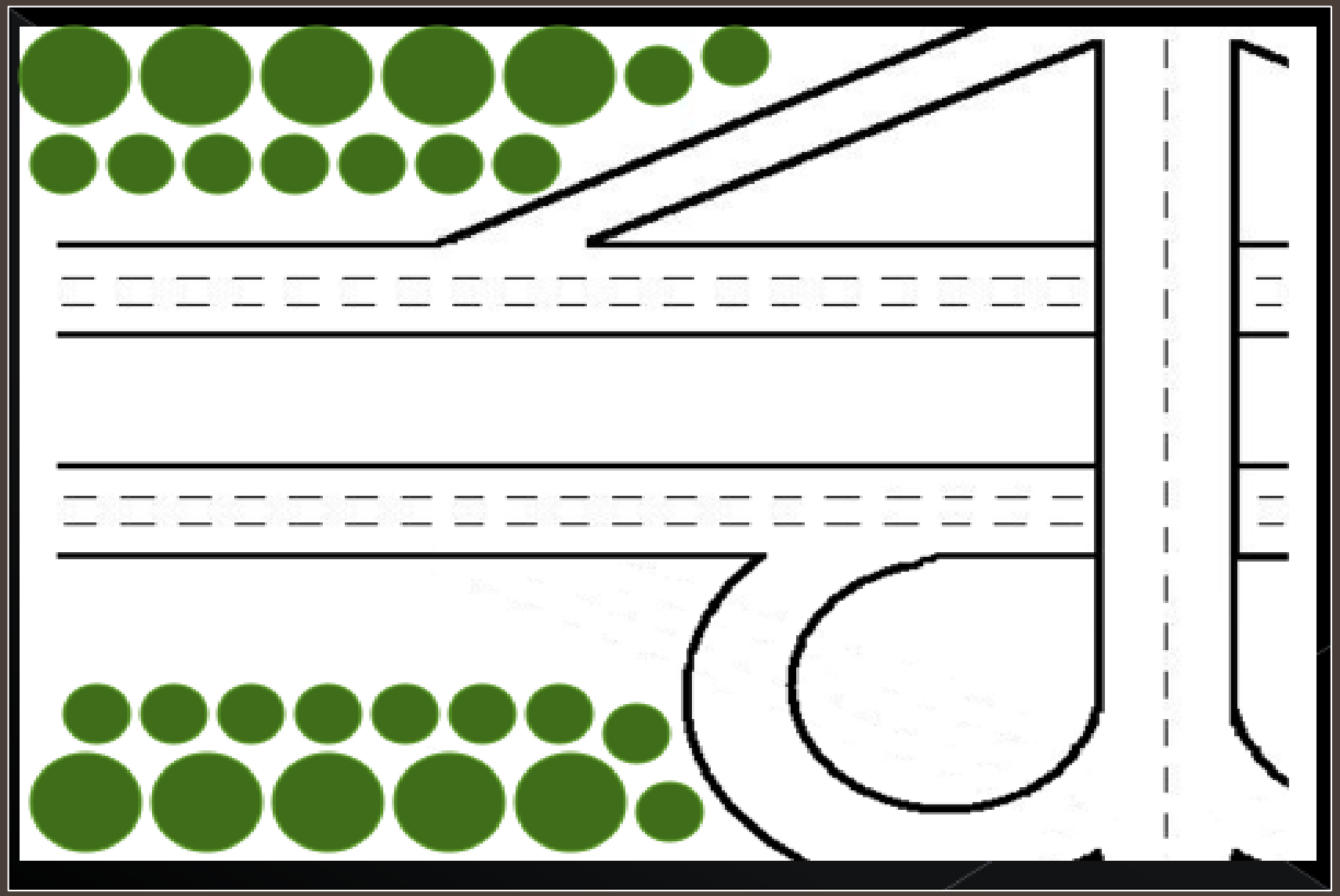


Photo: Casey Clapp

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Quality Design

- Barrier plantings
  - Physical
  - Noise
  - Sight
  - Vehicle Spray
- Buffer Plantings
  - Salt spray

Wyman, 1965	**Miyamoto et al., 2004**	**Appleton et al., 2009**
Trees	**Trees**	**Trees**
Cryptomeria japonica	*Pinus halepensis*	*Cryptomeria japonica*
Cupressus macrocarpa	*Pinus strobus*	*Juniperus virginiana*
Araucaria spp.	*Cupressus arizonica*	*Picea pungens*
Juniperus excelsa stricta	*Pinus eldarica*	*Pinus nigra*
Juniperus lucayana	*Pinus edulis*	*Pinus palustris*
Juniperus virginiana	*Cupressus sempervirens*	*Pinus thunbergii*
Picea asperata	*Pinus pinea*	**Shrubs**
Picea pungens glauca	*Pinus thunbergii*	*Chamaecyparis pisifera*
Pinus halepensis	*Juniperus chinensis*	*Juniperus chinensis*
Pinus nigra	*Juniperus scopulorum*	*Juniperus communis*
Pinus pinaster	*Juniperus deppeana pachyphlaea*	*Juniperus conferta*
Pinus radiata		*Juniperus horizontalis*
Pinus rigida		*Pinus mugo*
Pinus sylvestris		*Taxus baccata*
Pinus thunbergii		
Thuja occidentalis		
Thuja orientalis		

Photo: Casey Clapp

Redcedar (Eastern)

Photo: Richard Webb
Bugwood.org

Eastern Redcedar

Juniperus virginiana

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Valuable Contribution

Chinese-fir(*Cunninghamia lanceolata*)
Photo: John Ruter, Bugwood.org

In Summary…

- Conifers may offer important additions to the urban forest ecosystem
  - Year-round, canopy-dependent urban ecosystem services
  - Increased stability through increased diversity
  - Incorporated into the urban area as functional, efficient infrastructure through smart design

World-Class Folks

Chinese-fir(*Cunninghamia lanceolata*)
Photo: John Ruter, Bugwood.org

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