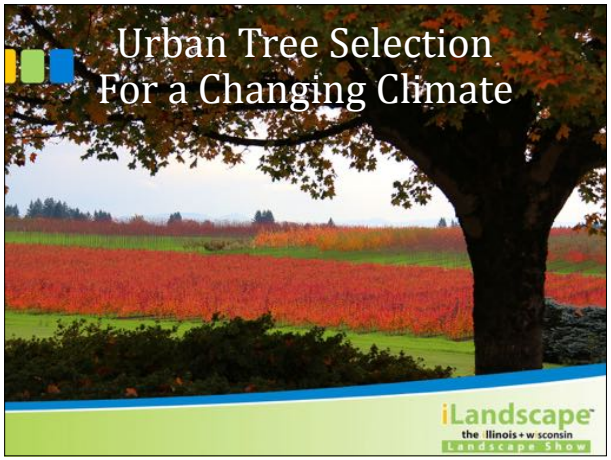

Urban Tree Selection
For a Changing Climate
iLandscape
the Illinois + Wisconsin
Landscape Show

1


Urban Tree Selection
For A Changing Climate
iLandscape
the Illinois + Wisconsin
Landscape Show

2


Greetings from Michigan
Dr. Bert Cregg, PhD, Michigan State University,
Dept. of Horticulture and Dept. of Forestry

3

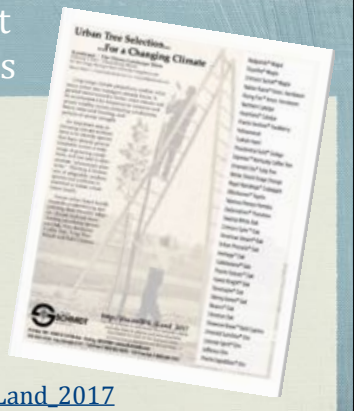
Greetings from Oregon

Nancy Buley, Communications Director

4

Information at your fingertips

List of featured Trees: Link to fact sheets and photos



http://jfss.co/JFS_iLand_2017

5

Download the handout at this link to access a clickable list of climate-resilient trees and links to climate information resources.

Information at your fingertips

Climate change resources and tree selection information

http://jfss.co/JFS_iLand_2017

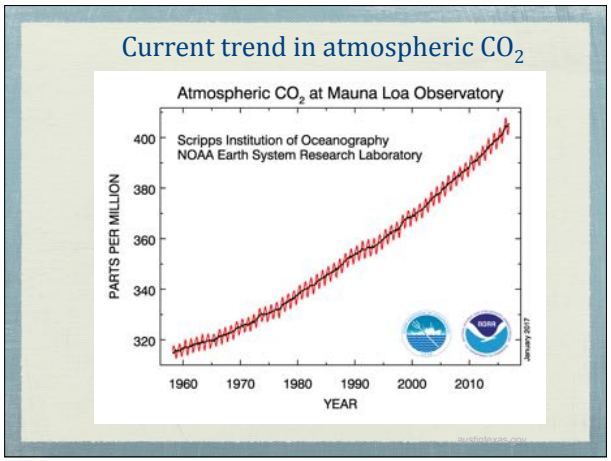
6

Download the handout at this link to access a clickable list of climate-resilient trees and links to climate information resources

7

Climate change is in the news these days – the mainstream press as well as horticultural and urban forestry magazines. The Michigan Landscape™ Magazine and Arborist News, Volume 26, Number 5, October 2016 (www.isa-arbor.com)

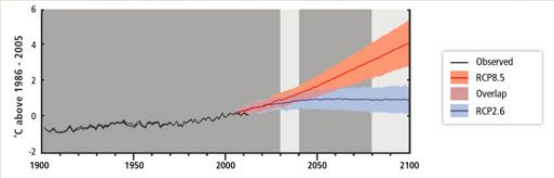
8



9

Regardless of politics, one fact is undeniable. Global CO2 is increasing dramatically in response to burning of fossil fuels.

Projected global temperatures: Best-case and worst-case scenarios

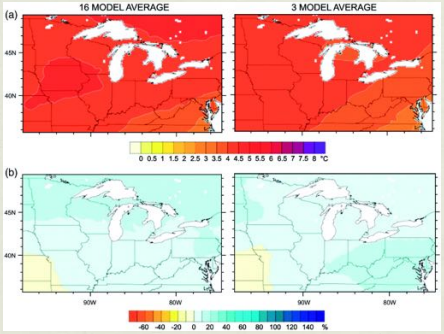


IPCC 2014

10

Increasing global CO2 and other greenhouse gasses are projected to lead to significant changes in global temperatures.

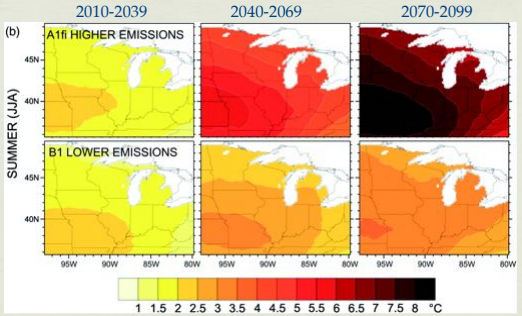
Upper Midwest 2070-2099: Much warmer, slightly wetter



11

Climate models predict warmer, wetter weather.

Upper Midwest 2070-2099: Hot times in the summer . . .



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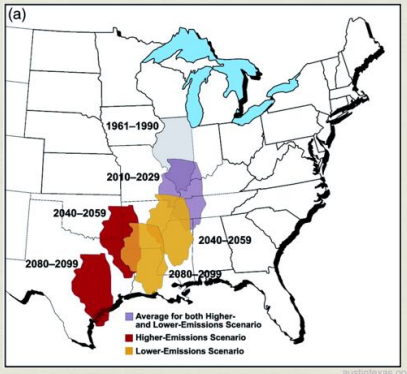
Summers are predicted to be hotter.

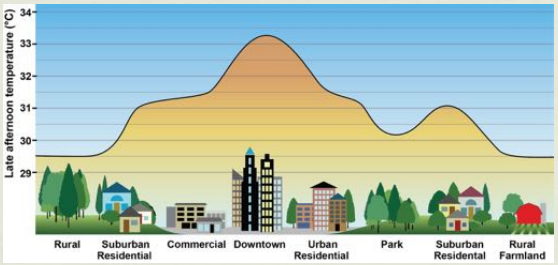
What does climate change mean for Illinois?

13



Urban heat island

14



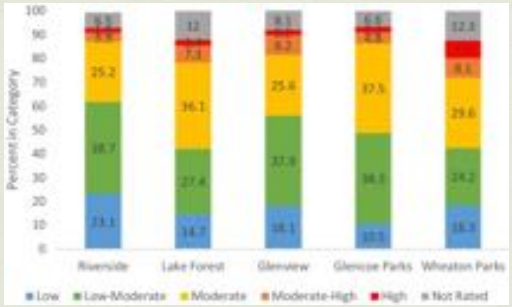
In urban areas, changes in global climate will be superimposed over existing micro-climate effects such as urban heat islands.

Urban trees - Canary in the coal mine?

15

As a result of the combined effects of climate change and urban heat islands, urban trees are 'living on the edge' and may become the canary in the coal mine for climate change.

Climate change risk to tree species in Chicagoland



L. Brandt et al, 2016

16

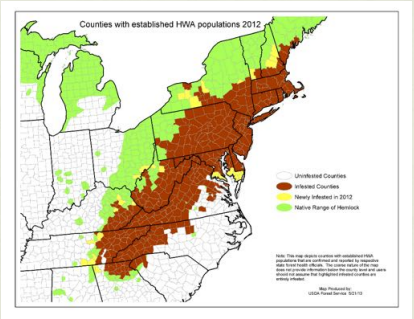
L. Brandt, et al. A Framework for Adapting Urban Forests to Climate Change, Environmental Science & Policy (2016) https://www.fs.fed.us/nrs/pubs/jrnl/2016/nrs_2016_Brandt_001.pdf

Impacts of climate change on trees: Some more obvious than others

- Drought
- Heat
- Flooding
- Pests
- Winter injury(?!)

17

Impacts of climate change on trees: Expansion of pest ranges



USDA Forest Service 5/21/13

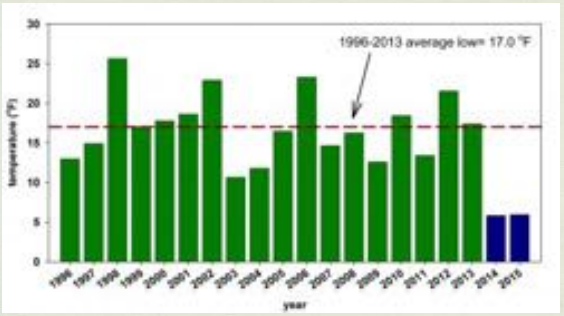
18

Impacts of climate change on trees: Periodic extreme cold may still occur

19

String of mild winters before 2014

20



Source: MSU Enviro-Weather

Number of nights with low temperatures at or below hardiness zone in East Lansing, MI

21

Years	Nights @ Zone 5b (10 and -15 F)	Nights below Zone 5b < -15 F
1996-2013	10	0
2014	7	2
2015	3	5

Source: MSU Enviro-Weather

22

Trees respond to extremes – not averages

Fifteen-year-old
Cedrus deodora 'Polar Winter'
killed during winter 2014

23

Strategies for dealing with climate change

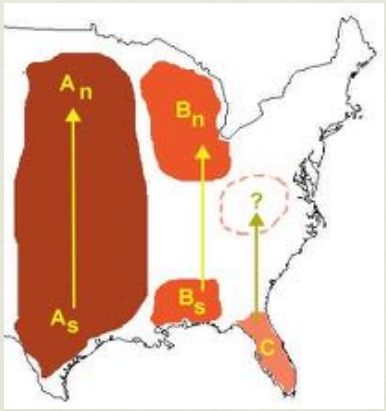
24

Organisms have three principal means of responding to changes in their environment.

Adaptation
Migration
Acclimation

A bit of review: Ecologists tell us that organisms have three possible responses to a change in their environment; adaptation, migration, and acclimation. Adaptation is an evolutionary process – but climates are projected to change faster than trees can evolve so this is not going to help.

Assisted colonization



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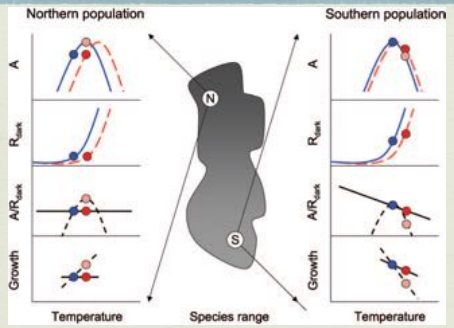
BC Forest Service Migration Adaptation Trial

26

In British Columbia, foresters that manage trees on 100 year rotations have initiated trials to understand the potential impacts of assisted migration on forest trees.

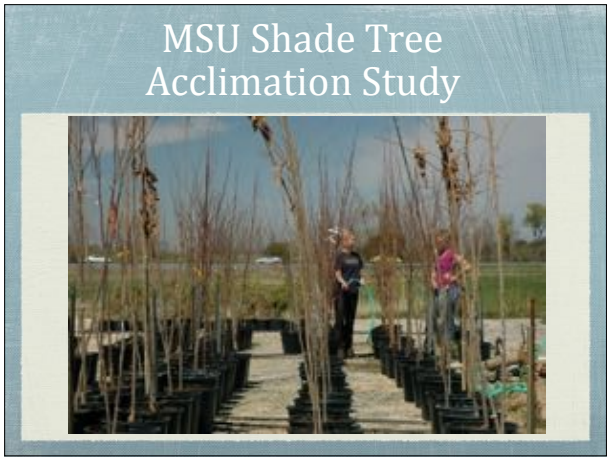
Physiological acclimation



Ghannoum and Way, 2011

27

Another possible tree response to rising temperatures is acclimation. From physiological studies we know that certain plants are better able to adjust their metabolism (photosynthetic rates, respiration rate) and morphology (leaf thickness, stomatal density) in response to changing environment.

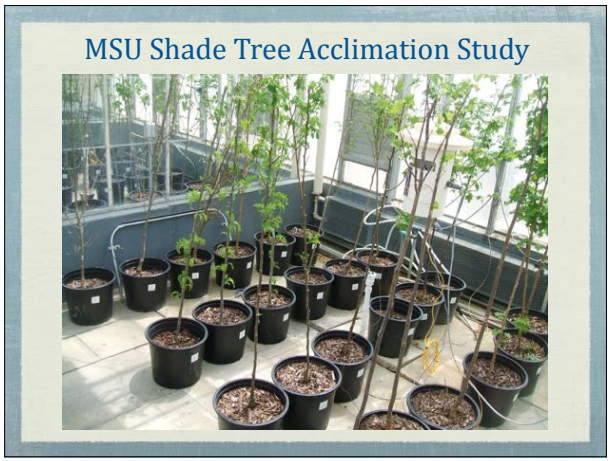


28

In order to better understand the ability of urban trees to acclimate to increased temperatures we have initiated a program of research to investigate the physiological and morphological responses of street tree cultivars under warming conditions. We started the project by planting 5-6’ bare root 5-6’ whips in #10 containers.

29

Trees included an array of trees commonly used for street trees



30

In order to better understand the ability of urban trees to acclimate to increased temperatures we have initiated a program of research to investigate the physiological and morphological responses of street tree cultivars under warming conditions.

Temperature acclimation

31

Each section of the greenhouse was set to one of three temperatures.

Temperature acclimation

- Three temperature regimes
  - Ambient (based on average day/night temps for local area)
  - Ambient + 5°C
  - Ambient +10°C
- June - October
- Natural photoperiod

32

Each section of the greenhouse was set to one of three temperatures.

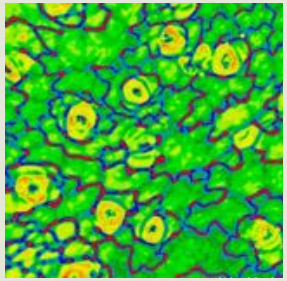
Temperature effects on leaf morphology & physiology

33

Physiological/morphological acclimation

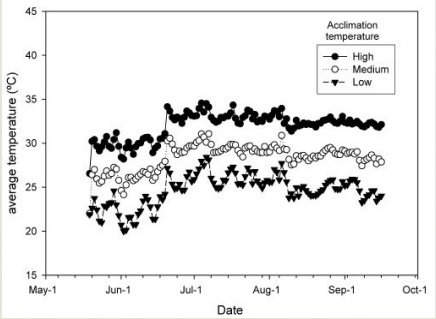
34

- Net photosynthesis
- Dark respiration
- Leaf thickness
- Stomatal density
- Guard cell size



MSU Shade Tree Acclimation Study

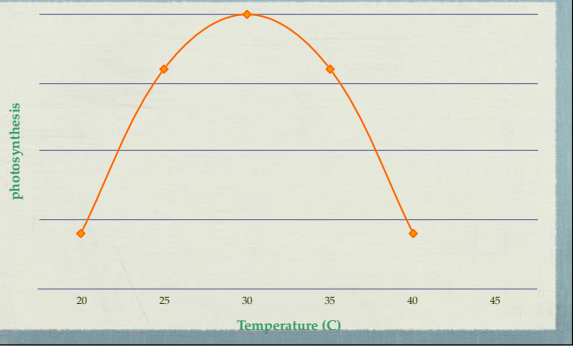
35



Photosynthetic temperature response

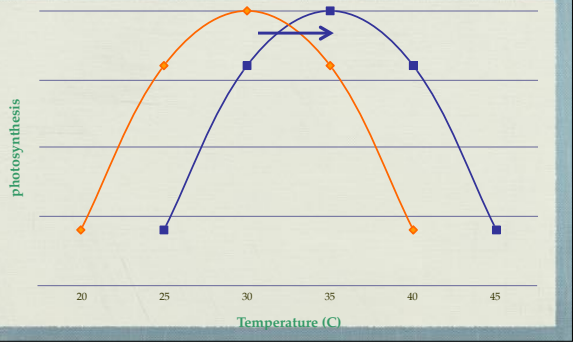
36

Photosynthetic temperature acclimation



37

Photosynthetic temperature acclimation



38

Acclimation responses to increased temperature

- *Quercus bicolor*
  - Increased optimum temperature for photosynthesis
- *Acer rubrum* and *Gleditsia triacanthos*
  - Increased stomatal density
- *Pyrus calleryana* and *Quercus bicolor*
  - Decreased leaf thickness

39

Each species responded to the varied temperatures in different ways.

Out-planting during the spring of 2013

40

Our non-profit tree planting partners

Data Collection 2014-16

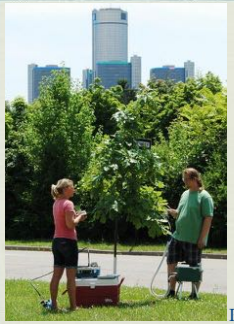
41

Survival and growth

Environmental

Data Collection 2014-16

42



Leaf water potential

Photosynthesis and SPAD

Callery pear and swamp white oak consistently had highest levels of photosynthesis

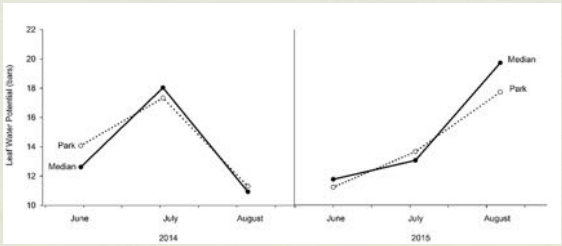
43

Mean net photosynthesis of seven shade tree selections growing near downtown Detroit, 2015.

Species	Net photosynthesis*	Leaf conductance
Callery pear	11.65a	0.23a
Swamp white oak	10.44a	0.20a
Pacific Sunset® maple	8.17b	0.13b
Red maple	7.51b	0.11b
Tulip poplar	6.87b	0.11b
Emerald Sunshine® elm	6.82b	0.12b
Sugar maple	6.26b	0.09b

Water stress was similar between sites until severe drought in 2015

44



Tying it all together

45

Tree responses to temperature are complex and must be considered at many scales

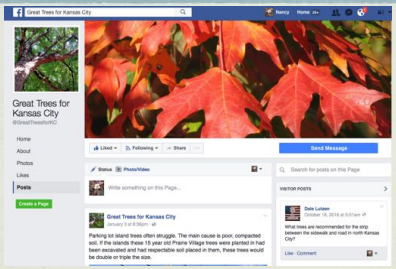
Tying it all together

46

Trees in urban and community forests will be subject to combined effects of climate change and urban heat islands.

Do we look South to the future?

47



Are Great Trees for Kansas City
great trees for Chicagoland's future forest?

A Kansas-based Facebook page shares information about urban tree performance in the Kansas City area. Will top performers there prove to be good performers for the future urban forest of the Chicago region?

It's not that simple!

48

Selecting trees simply on projected warming may leave urban forests at risk to extreme events.

Weather events such as ice storms, and temperature extremes both hot and cold, will accompany a general warming trend and challenge urban tree managers and growers.

Tying it all together

Identifying broadly adaptable genotypes will be key to increasing the resilience of urban forests.

49

Allée of hybrid elms at Chicago Botanic Garden

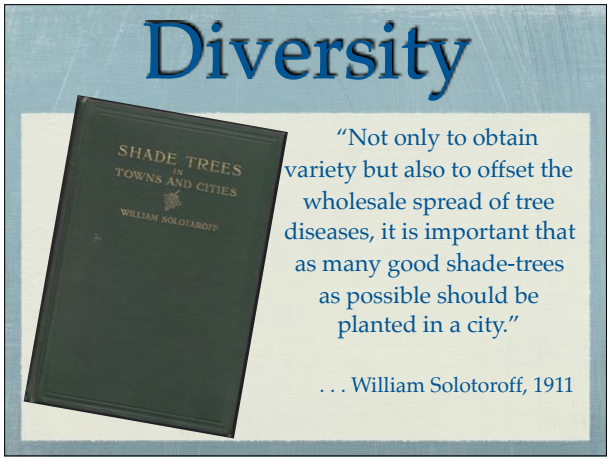
Tying it all together

Species diversity remains the most viable risk management tool.

50

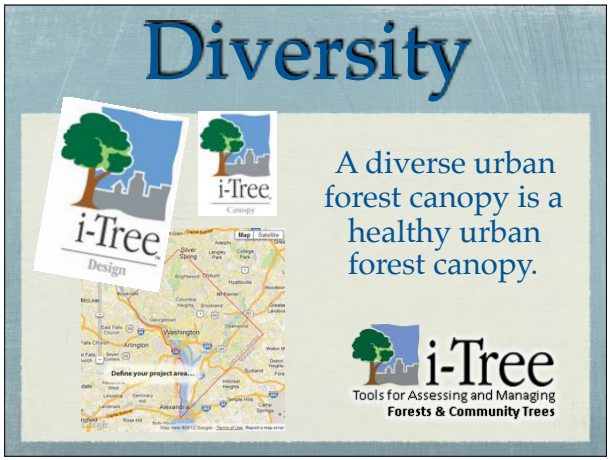
Thanks for your attention

51



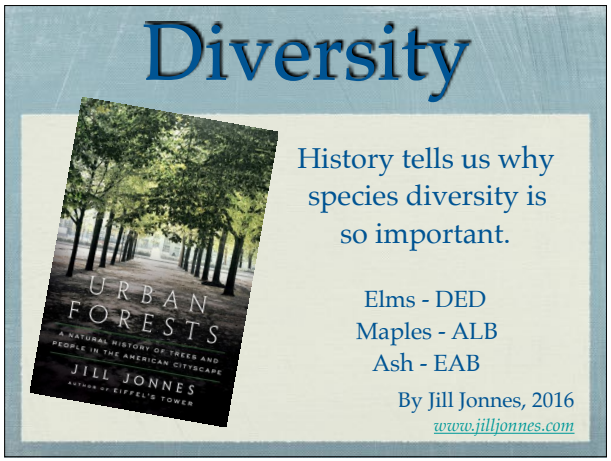
52

Achieving diversity of species in our urban forests has long been recognized as good management practice, but continues to be hard to achieve.



53

Modern tools such as those available for download (free of charge) help us measure the health and diversity of species in our urban forests. http://www.itreetools.org

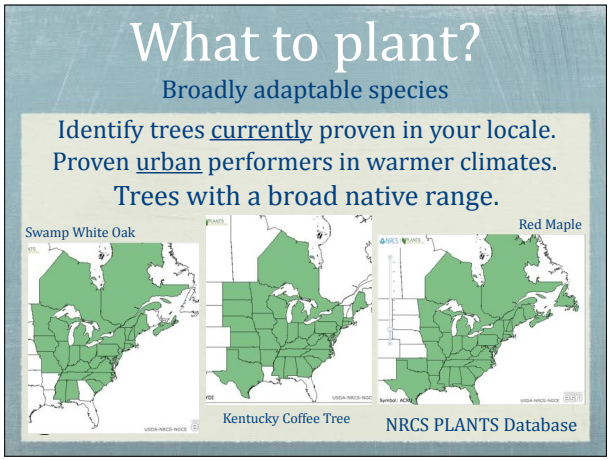


54

Historian and author Jill Jonnes has written a remarkable history of urban forestry - key chapters tell of the devastating losses of some of our grand American species to exotic pathogens and insects. A must-read book for all who care about our urban forests.

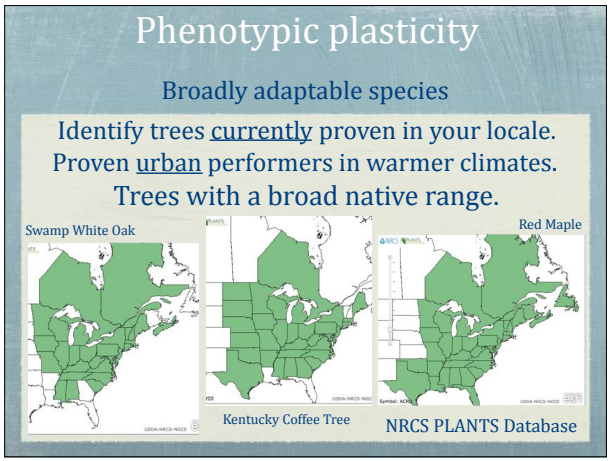
55

There's no crystal ball for predicting which trees will be top performers in the future, but identifying trees that have been proven to perform well across a wide range of climate and growing conditions is a good start. From left, Flashfire® Maple, Emerald Sunshine® Elm and Redpointe® Maple.



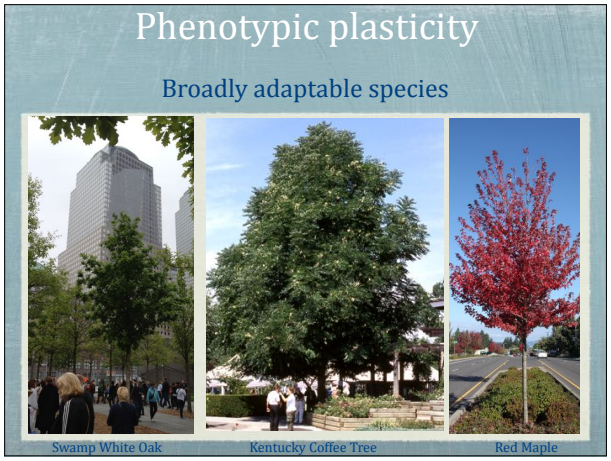
56

Trees with a broad native range tend to be more adaptable to varied growing conditions. The USDA Natural Resource Conservation Service PLANTS Database identifies the native range of trees. https://plants.usda.gov



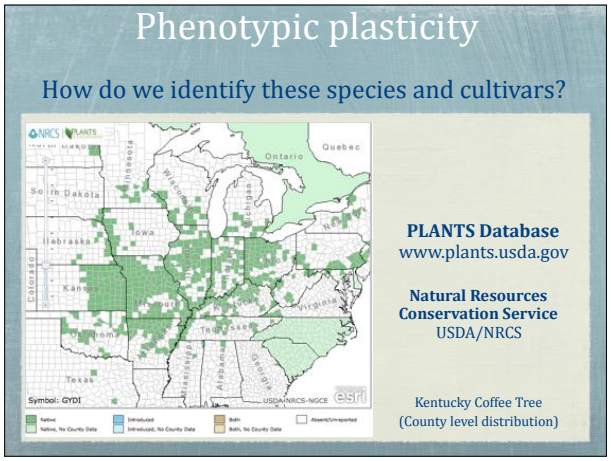
57

Phenotypic plasticity is the ability of an organism to change its **phenotype** in response to changes in the environment.



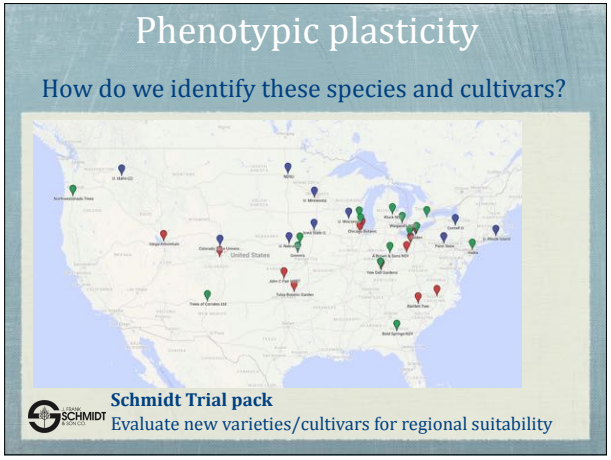
58

Examples of three North American native species with broad native ranges – performing well in urban settings. From left, 9/11 Memorial Plaza, New York City, Royal Botanical Gardens, Burlington, Ontario, Canada; street tree planting of Redpointe® Maples along Hogan Road, Gresham, Oregon.



59

PLANTS Database identifies range and distribution to the county level. Arboretums, universities, municipalities, state nursery associations, state and federal urban forestry offices have great resources for identifying adaptable, resilient trees.



60

PLANTS Database identifies range and distribution to the county level. Arboretums, universities, municipalities, state nursery associations, state and federal urban forestry offices have great resources for identifying adaptable, resilient trees.

61

Pink Flair® Cherry proved more hardy than anticipated by surviving performance trials with our collaborators at North Dakota State University.

62

Based on long-term Trial Pack performance in South Carolina that proved superior heat and drought resistance, Dr. Michael Dirr recommended that the Spartanburg Men's Club replace failing Yoshino Cherries with Pink Flair® Cherries.

63

An example of what we discover via JFS Trial Pack: Better heat AND cold resistance than we had anticipated. Surviving and doing well in Fargo, North Dakota as well as Central Georgia.

64

Per Trial Pack: performed better than anticipated in the humid Southeast, where fall colors are bright. Doing great in the Midwest and may be a good candidate for the Upper Midwest and New England as the climate continues to warm and become less suited for sugar maples of local provenance.

65

More heat tolerant and drought tolerant than we had anticipated. We learned of superior tolerance of high pH, alkaline soils from Trial Pack feedback and from our customers.

66

Early on, Trial Pack results told us that Redpointe® Maple was more hardy as well as more heat-resistant than anticipated. Since its introduction in 2006, it has proven far more heat and drought tolerant than anticipated and is planted across a wide range of climates and growing conditions. Map pinpoints locations of top 200 purchasers during the years 2014-2017.

67

Coming up! Morton Arboretum Conference Nov. 18-19 - Managing Urban Forests in a Changing Climate. Download the handout to find links for quick access to these studies.

68

Planning for a warmer future, researchers across the country and around the world are testing species for drought and heat tolerance.

69

Dr. Greg McPherson of USFS chose these two temperate zone species for a 20-year performance trial that began in 2016.

70

71

72

Native oak populations have good potential for cultivar development. Examples include Bailey Nurseries selection of *Quercus velutina,* "Majestic Skies," and various selections of Bur Oak and Swamp White Oak. The *International Oaks* Facebook group is an online gathering place for oak experts and aficionados.

73

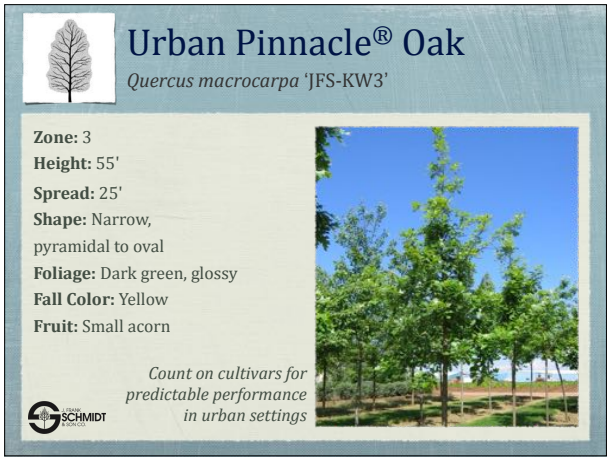
Cultivar selections of this adaptable and resilient native species are making their way into the nursery trade. Swamp White Oaks grown from seed are pictured in the fields of Spring Grove Nursery, Mazon, IL.

74

Cultivars promise predictable performance. Glossy leaves, symmetrical form, uniformly upright and open branch angles and vigorous growth are hallmarks of this easy-care selection of Swamp White Oak.

75

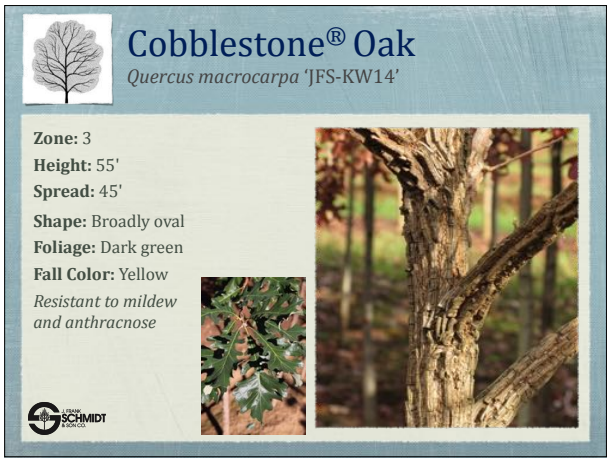
Dr. Michael Dirr hugs one of his "babies" growing at JFS. He and his wife Bonnie spotted this unusually upright form of the species and sent budwood to us for propagation, trial and introduction. After more than a decade of trial and observation, we deemed it worthy of introduction.



76

77

Unusually small acorns and upright, narrow growth habit indicate suitability for urban use.



78

Predictable performance, size and form. Corky bark at a young age.

79

City foresters have recently recognized this overlooked species as a good urban performer. Find details on the website of the Society of Municipal Arborists, www.urban-forestry.com

80

Three columnar oak cultivars: Kindred Spirit® and Regal Prince® are hybrids of English x Swamp White Oak (*Q. warei*).
Streetspire® Oak is a hybrid of English and White Oaks (Q. robur x Q. alba, *syn. Q. bimundorum*)

81

Introduced to the trade more than 30 years ago, this hybrid of English and White Oak has proven to be extremely adaptable and is a resilient urban tree.

82

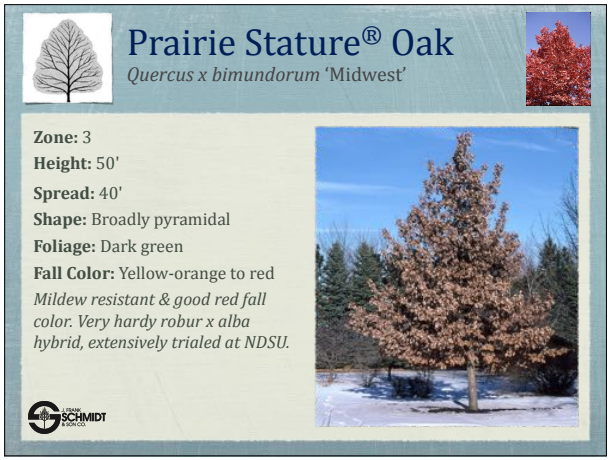
Introduced to the trade more than 30 years ago, this hybrid of English and White Oak has proven to be extremely adaptable and is a resilient urban tree.

83

This new introduction (2012) is of the same cross as the successful and widely adaptable Crimson Spire™ Oak.

84

The narrowest of our *Q. robur x Q. alba* selections. Streetspire® Oak is on its left.



85

Another excellent hybrid of English Oak and White Oak: Quercus x bimundorum (As defined in the Oregon State University Landscape Plants database: *bimundorum*: Latin, *bi*, two, and *mundus*, worlds, hence Two Worlds, because it is a hybrid of *Q. robur* English Oak (from the "old world") and *Q. alba* White Oak, native to Eastern North America (i.e., the "new world").

86

(Same cross as the well-known Crimson Spire Oak)

87

Selected by Earl Cully, combines the best characteristics of two species – Fastigiate English Oak and Swamp White Oak. Also known *as Quercus x warei* 'Long' (This interspecific cross is named in honor of Dr. George Ware - 'warei')

88

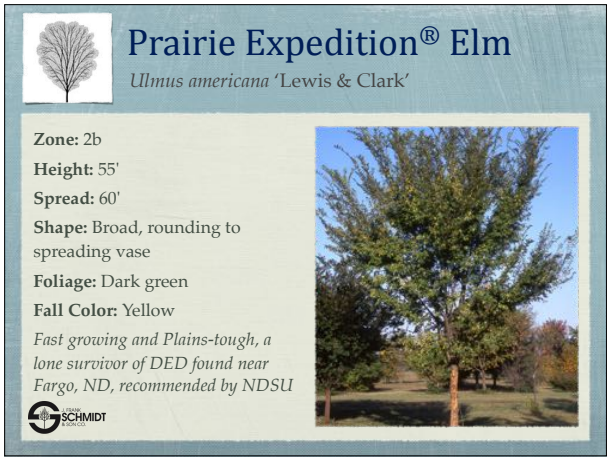
Bur x English Oak hybrid, selected by plantsman Earl Cully of Heritage Trees, Indiana

89

A new addition to the commercially available cultivars of disease-resistant American Elms. Selected and trialed over a long period of time by Princeton Nurseries and co-introduced by JFS in 2016.

90

A new addition to the commercially available cultivars of disease-resistant American Elms. Selected and trialed over a long period of time by Princeton Nurseries and co-introduced by JFS in 2016.



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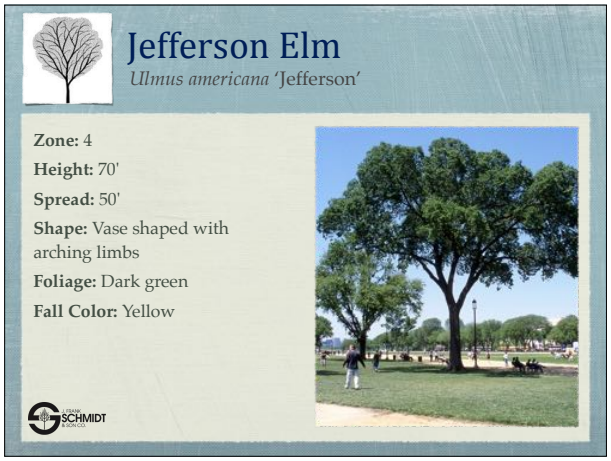
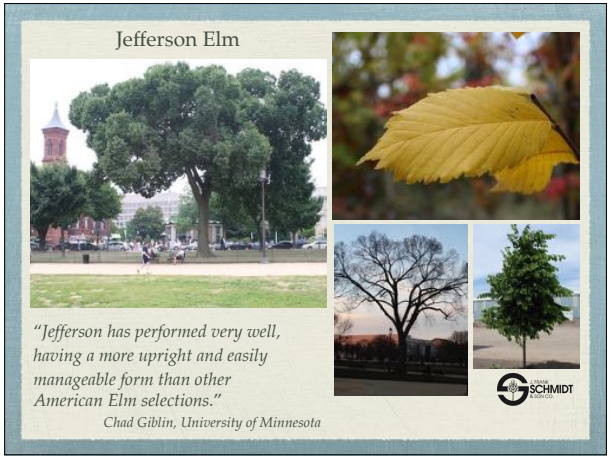
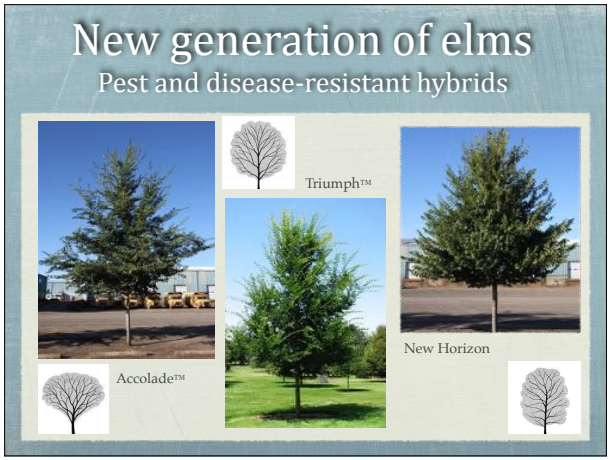


92

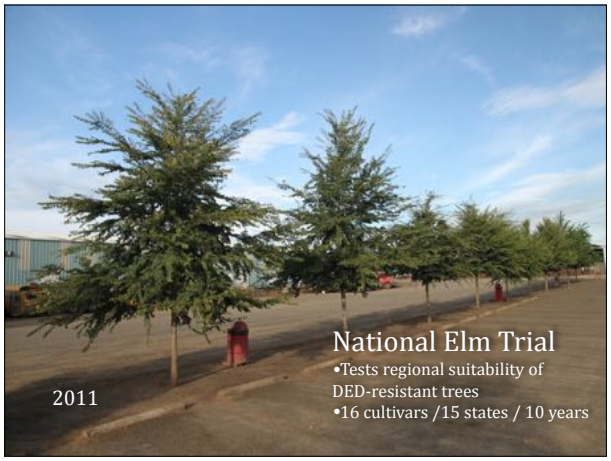
A “must-see” stop on the Washington, DC, tree-tourist trail. The magnificent original tree grows on the Capitol Mall near the Smithsonian Castle and the carousel, near Jefferson Drive. A co-introduction of the National Park Service and the US National Arboretum.



93



94



95

Our own truck parking lot near our loading docks were the site of an informal performance trial that mirrored the national study conducted by universities across the US. Find details and a link to results of the recently-concluded trial at www.jfschmidt.com/elmtrial

96

One of the most promising of the new *Ginkgo biloba* cultivars in the marketplace.

97

Young trees in our field and a beautiful mature specimen growing and thriving at Denver Botanical Garden. www.botanicgardens.org

98

Morton Arboretum study led by Andrew Bell – London Plane Trees are considered resilient and are expected to be good performers in the Chicagoland area over the long haul.

99

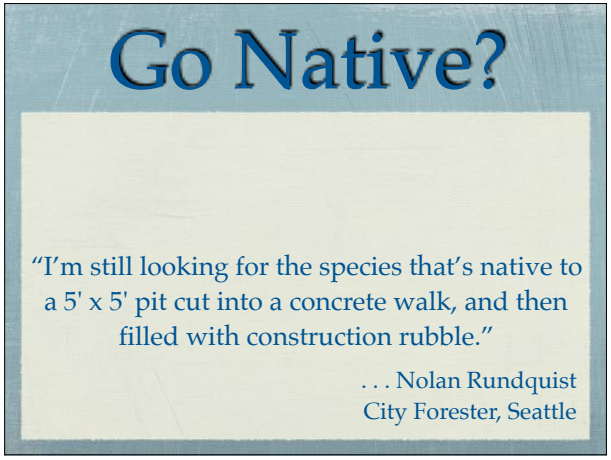
A versatile performer that rapidly became our best-selling ornamental crabapple since its introduction in 2003. In general, crabapples are among the most adaptable and resilient of ornamental flowering trees.

100

Trees flower profusely in varied climates – in Northeastern Washington and near Portland, Oregon, right.

101

Vanessa Parrotia is a narrow selection of the heat and drought tolerant, resilient species. New cultivars Ruby Vase and Persian Spire™ are also gaining favor in the marketplace. Named 2014 Urban Tree of the Year by the Society of Municipal Arborists



102

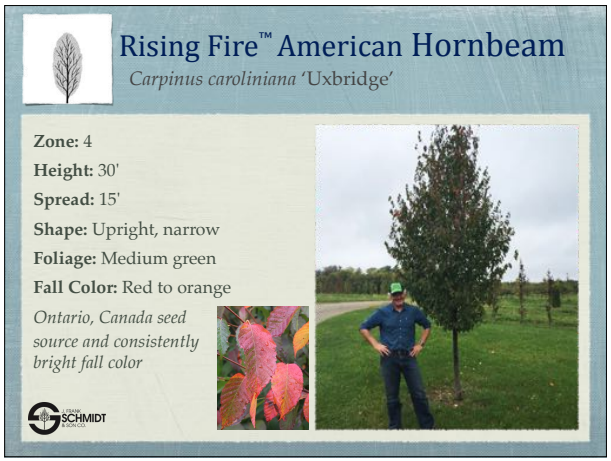
Native species are often expected to grow in environmental conditions that are a far cry from their native habitats.

103

A proven performer selected by Plantsman Earl Cully. Tree pictured is part of a grove at the Renaissance Schaumburg Hotel and Convention Center – site of iLandscape show. Green Whisper ® is a new cultivar – good vigor and upright, but more broadly pyramidal than this one. Species is a good candidate for selection of predictably cold hardy cultivars.

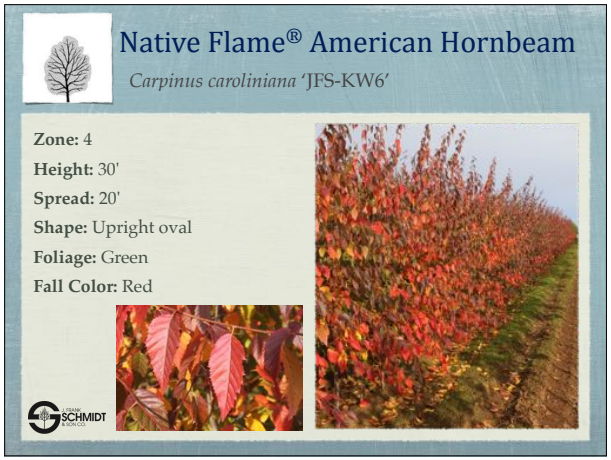
104

Discovered in Western Kansas and trialed extensively before co-introducing with Kansas State University. Parent tree, center, is pictured in winter. Laurence Ballard of University of Nebraska shows me the 4-inch caliper tree in their trial nursery on the Lincoln campus, grown from a bare root tree included in a JFS Trial Pack.



105

Harry Worsley of Uxbridge Nurseries, LTD, of Uxbridge, Ontario, Canada stands beside the parent tree of this new (2017), upright and narrow selection of American Hornbeam.



106

Native Flame® American Hornbeam is our selection of the hardy and durable North American native. More cultivars are on the rise. Johnson Nurseries of Wisconsin offers a strain of American Hornbeams selected from Wisconsin seed sources.

107

108

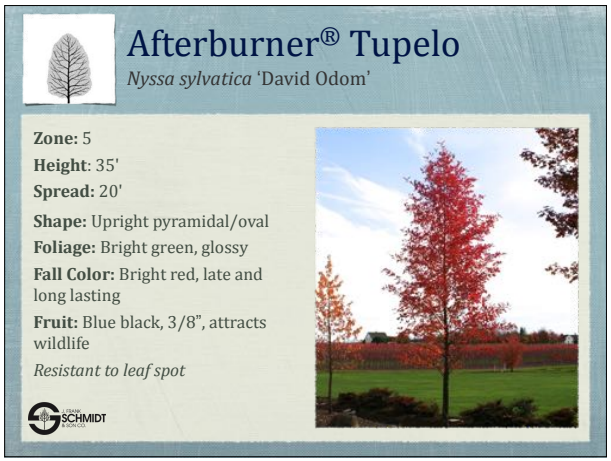
These Portland-area street trees are grown from seed. Little Volunteer Tulip Tree is a compact cultivar suited for small space landscapes.

109

Appears to be more hardy than is typical of the species – young trees in a Chicago-area customer's fields survived severe winter temperatures when others of the species (grown from seed) did not.

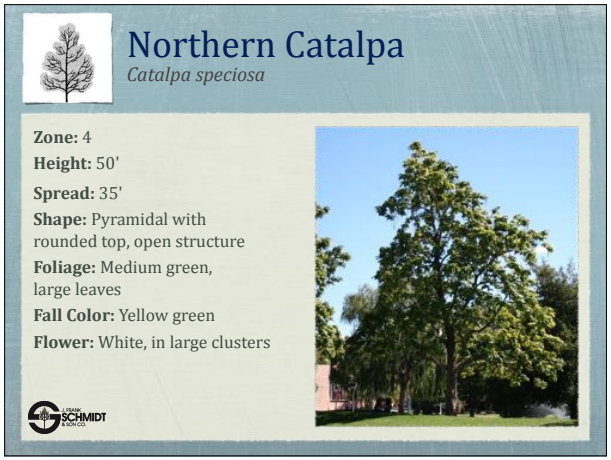
110

Perkins Pink Yellowwood is a pink-flowered selection that's been in the trade for years – seems there's room for selecting some top-performing city trees from this species. Surprisingly heat tolerant and cold hardy as well. This Yellowwood grove is thriving in the Olin-designed Director Park in downtown Portland.



111

Afterburner® Tupelo is one of several very nice cultivars of *Nyssa sylvatica* coming into the marketplace: Firestarter®, Gum Drop®, Red Rage®, Green Gable™. Cultivars afford predictable form and fall color, leaf spot resistance, fruiting character, etc.



112

Adaptable, tough, heat and drought tolerant. Good potential for cultivar development. Tree pictured grows on the University of New Mexico campus in Albuquerque.

113

Discovered in the northeastern corner of Kansas near the town of Hiawatha, hence the cultivar name. A narrow, upright form that shows great promise as a street and urban tree.

114

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