Urban Forest Management in the age of Climate Change

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Philadelphia's Parkland Forests

- City began acquiring land in 1855
- Most forests in the system are no more than 130 years old.
- Prior to 1800 areas were primarily planted with natives
- By 1970 the park had lost half the species that were present in 1880

Scenery in Fairmount Park.

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Philadelphia Parks

- 11,200 acres – 13% of all city land
- 5,600 acres of ‘natural areas’ include the watershed and estuary parks
- Park lands have 1.1 million trees; 38% of total canopy

Forest Management 1998-2013

- Focused on returning systems to their historical range of biotic characteristics and processes
- Significant clearing of invasive plants and replanting with species common at early to mid-20th century
- Creation of meadow areas to augment habitat types

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Courtesy of the Green Seattle Partnership–City of Seattle Contact Mark Mead

PRESENT

Forested natural areas are dominated by deciduous trees, mainly big-leaf maples and alders, nearing the end of their life. After decades of neglect, non-native invasive plants, such as English ivy and wild clematis, cover the ground and grow up into the tree canopy.

IN 20 YEARS

Invasive plants outcompete and grow over existing native vegetation, blocking the sunlight plants and trees need to thrive. English ivy now dominates the tree canopy, making the trees weak, top heavy and susceptible to windfall. Eventually, trees die or fall over.

IN 50 YEARS

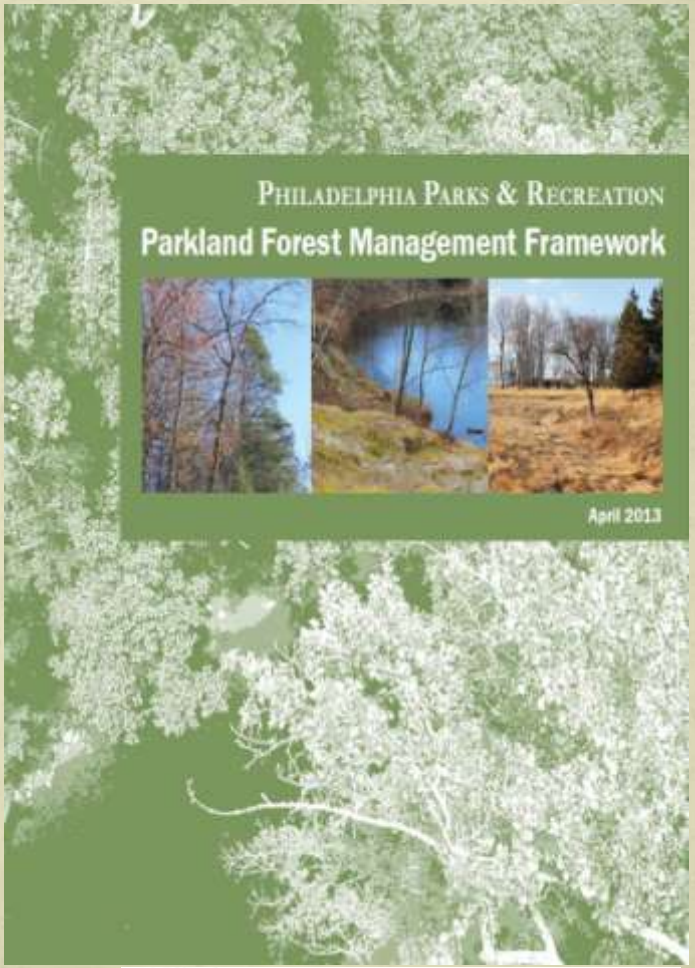
The trees are gone. Only a few native shrubs struggle to survive the stress of competition with invasive plants.

IN 100 YEARS

The forest is destroyed. Native trees can no longer establish on their own. We are left with a dense "ivy desert." Very few plant species can live, and forest biodiversity is gone. Such conditions provide homes for rats and scarce habitat for more desirable urban wildlife.

Forest Management Framework 2013

- Focus on the resource conditions in need of ecological enhancement, restoration and management.
- Advocates for "adaptive management" approach – integrating design, management and monitoring used to systematically test assumptions in order to adapt and learn.



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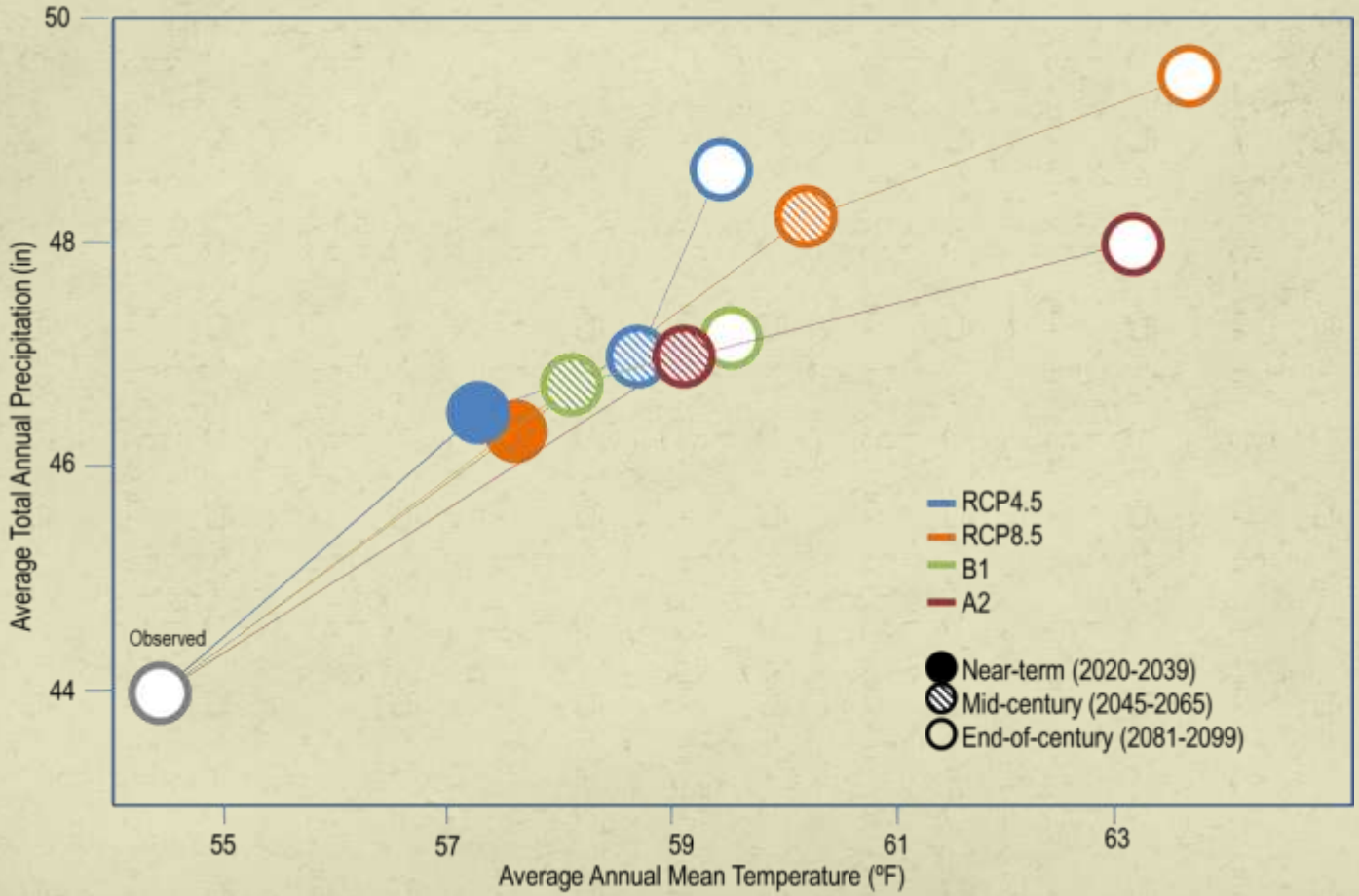
A warmer, wetter future….



ICF Incorporated, L.L.C.

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USDA
Plant Hardiness Zone Map
Pennsylvania
Average
Annual Extreme Minimum Temperature 1976-2005
Temp (F) Zone Temp (C)
-20 to -15 5a -28.9 to -26.1
-15 to -10 5b -26.1 to -23.3
-10 to -5 6a -23.3 to -20.6
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
5 to 10 7b -15 to -12.2
Erie
Scranton
State College
Altoona
Pittsburgh
HARRISBURG
Reading
Allentown
Philadelphia
0 15 30 60 Miles
0 25 50 100 Kilometers
ars
Agricultural Research Service
OSU
Oregon State University


USDA Plant Hardiness Zone Map
North Carolina
Boone
Asheville
Charlotte
Greensboro
Chapel Hill
RALEIGH
Fayetteville
Greenville
Wilmington
Elizabeth City
Average Annual Extreme Minimum Temperature 1976-2005
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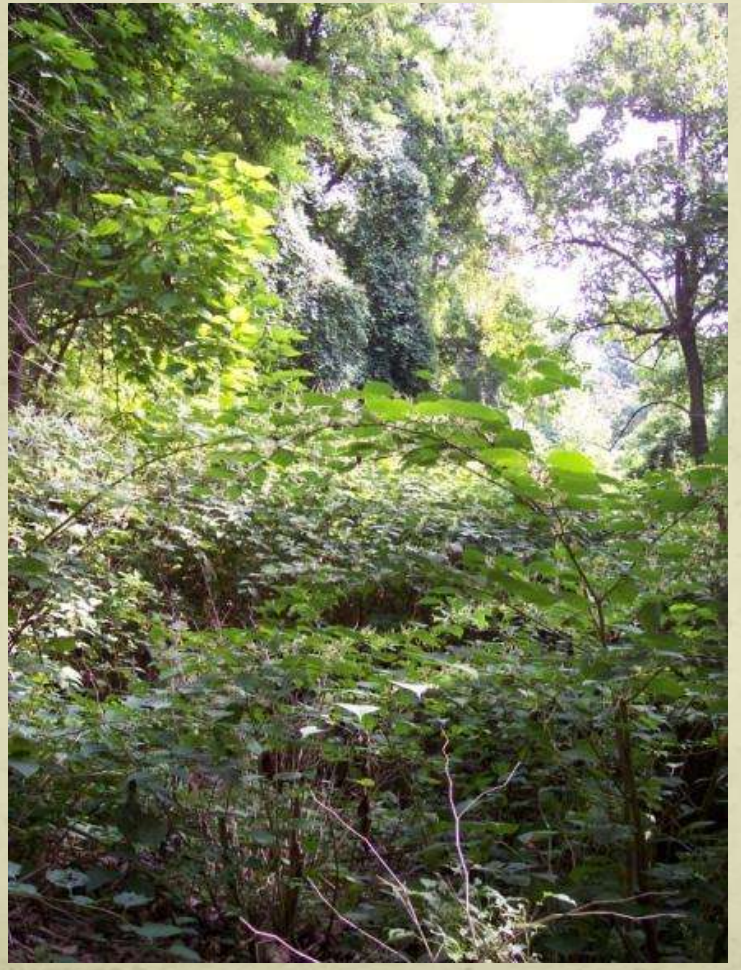
-5 to 0 6b -20.6 to -17.8
0 to 5 7a -17.8 to -15
5 to 10 7b -15 to -12.2
10 to 15 8a -12.2 to -9.4
15 to 20 8b -9.4 to -6.7
0 15 30 60 Miles
0 25 50 100 Kilometers
ars
Agricultural Research Service
OSU
Oregon State University

Climate driven changes

Growth Rates Increase



- Growing seasons in PA are projected to increase by 29-43 days during the 21st century.
- Increased CO2 levels
- Increased Nitrogen levels through increased mineralization and nitrification

Growth rates are expected to increase

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Climate driven Change

- Median Tree Migration Rates
  - Latitude +/- 10 miles per decade
  - Altitude +/- 36 feet per decade

- Models project that, on average, the climate envelopes of 130 North American tree species would shift north by 700 *k*m (435 miles) by the end of the century, and the average climate envelope would shrink by 12%.

Climate will change much more rapidly than most trees ability to adapt to this change

Range Shifts

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Climate driven changes

Phenological Issues

Insects, Pathogens & Invasive plants

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Novel Ecosystems

Novel ecosystems result when species occur in combinations and relative abundances that have not occurred previously within a given community.

Those combinations of species that arise through **human action**, **environmental change**, and the impacts of the deliberate and inadvertent **introduction of species** from other regions.

(Hobbs et al 2006).

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Managing Novel Ecosystems

- Maximize genetic, species, and functional diversity wherever possible
- Increase the viability of communities and ecosystems under uncertain climate regimes

New Paradigms: Experimentation

- Apply theory to develop new approaches to restoration on 3 large scale sites (20+ Acres) as experimental sites.
- Develop 4-5 different management techniques
- Accept that there may be contradictory goals
- Determine which variables will be measured
- Commit to a rigorous “experimental” design, including reference areas wherever possible
- Monitor
- Document Costs

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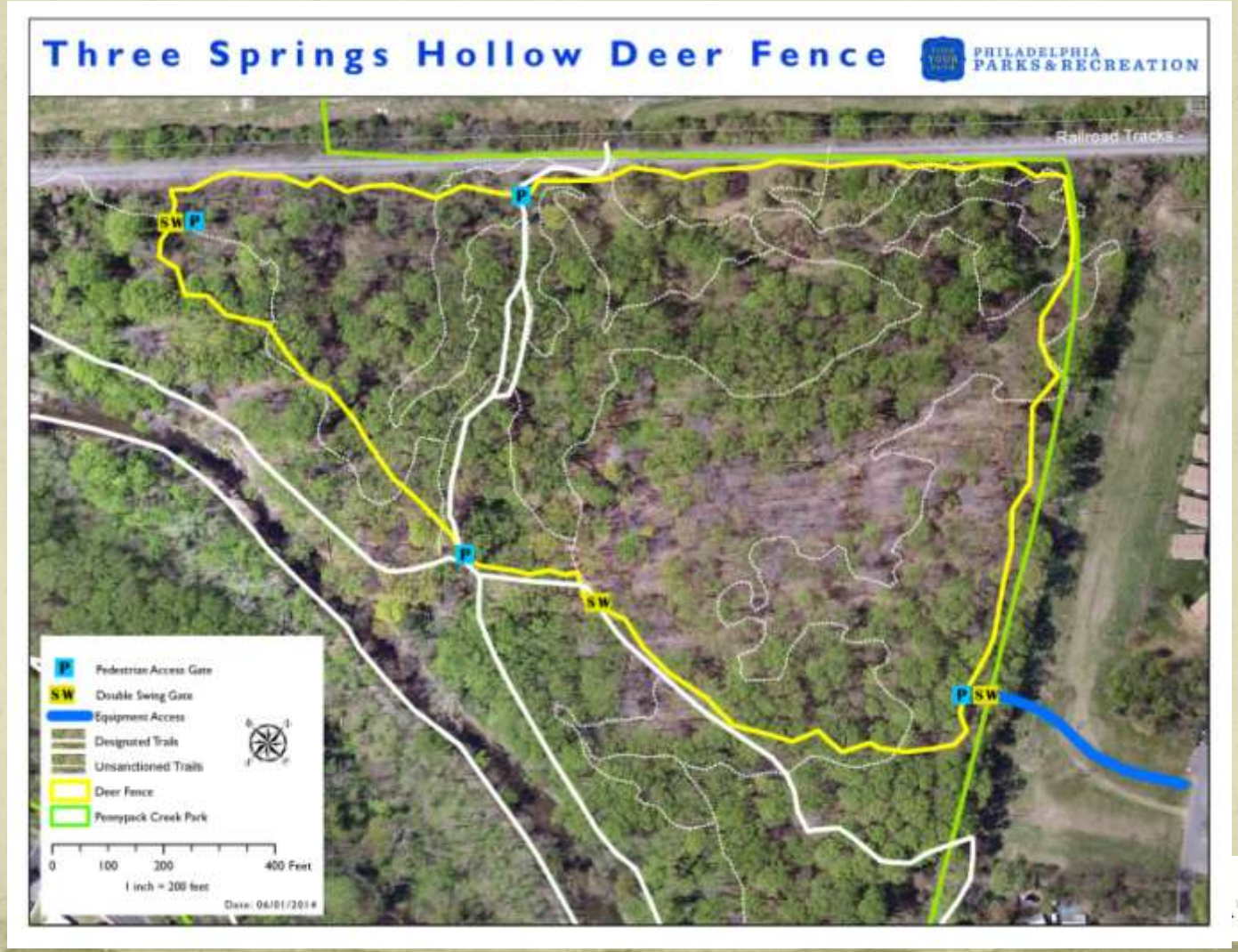
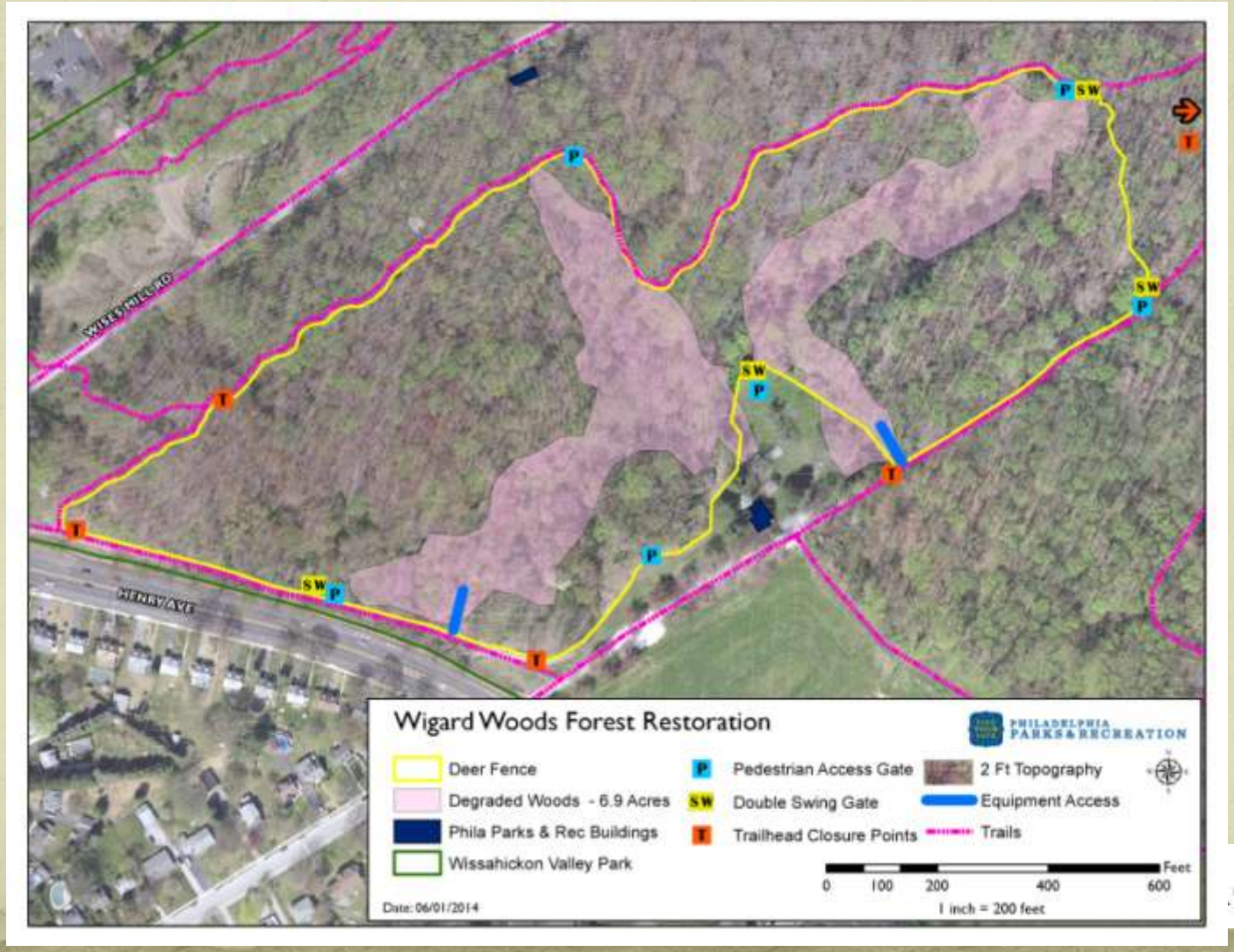
Pennypack Park Restoration Site



Wissahickon Restoration Site



Haddington Woods Experimental Site

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Existing Conditions

Deciduous Upland Hardwood Forest

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Species Age and Distribution

Seedling Regeneration

Mature Canopy Trees

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Invasive Vines

- Mile-a-Minute,
  P. perfoliatum
- Japanese Hop,
  H. japonicus
- Oriental bittersweet,
  C. orbiculatus

- Japanese Honeysuckle,
  L. japonica
- Porcelain Berry,
  A. brevipedunculata
- English Ivy,
  H. *heilx*

Encampments

Dumping

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White Tail Deer
Odocoileus virginianus

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Haddington Woods Reclamation

- Remove the overwhelming invasive species (vines)
- Erect deer fencing to eliminate browse damage
- Replant to re-establish a healthy forest stand
- Conduct experiments on restoration techniques and plant species
- Engage citizens in the process

Haddington Woods

Access and Planting Plan

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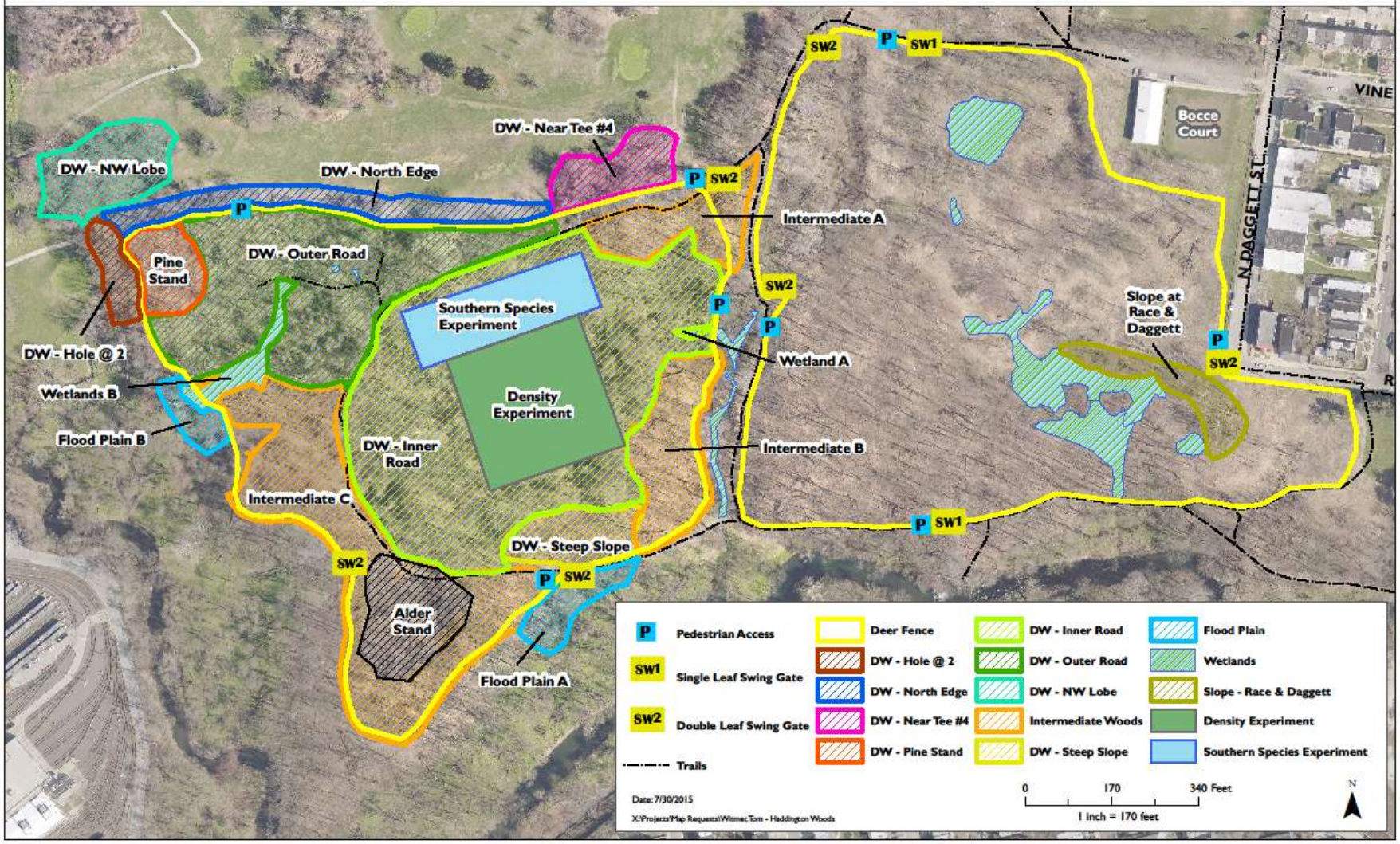

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Greenland Native Plant Nursery

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Experiment: Provenance testing

Goal

- To determine whether climate has or will moderate to the extent that historically southern species could be part of Philadelphia flora.

Implementation

- Plant blocks of species of trees and shrubs that are at the northern extent of their range in Philadelphia or that have ranges that extend 300-400 miles south.
- 1/3 acre plots
- 3 replicates
- 11 tree and shrub species
- 12 of each in each plot

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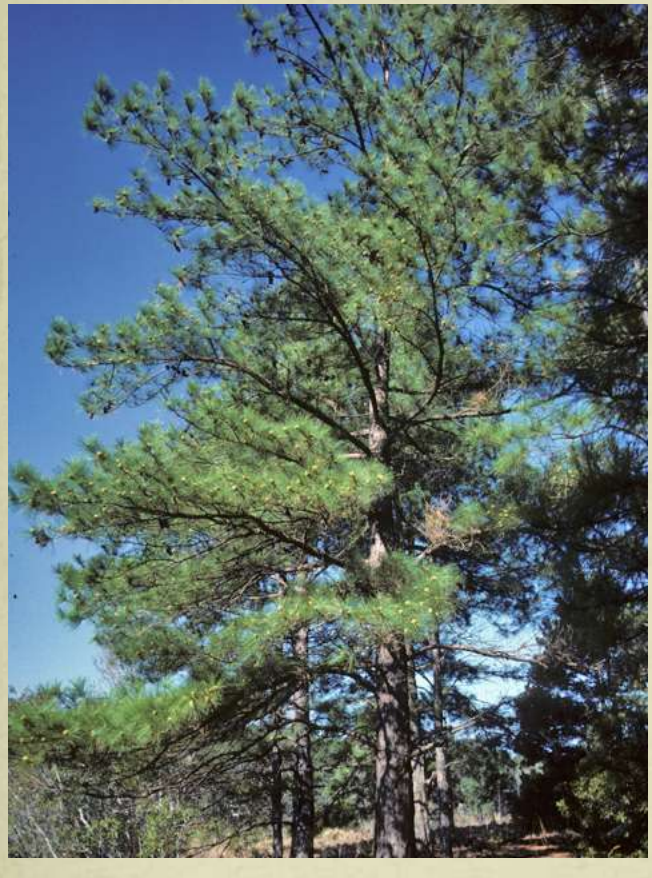
Experiment: Provenance testing



Pinus taeda Loblolly pine

Quercus falcata So. Red Oak

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Trees - Southern Species experiment				
Species		**# Planted Fall 2015**	**Size Container**	**# Dead/Oct 2016**
Cladastrus lutea	Yellowwood	37	#3	0
Halesia carolina	Carolina silverbell	38	#2	1
Pinus taeda	Loblolly pine	36	#2	2
Quercus falcata	Southern red oak	38	#5	8
Shrubs - Southern species experiment				
Species		**# Planted Fall 2015**	**Size**	**# Dead/Oct 2016**
Callicarpa americana	Beautyberry	38	#3	2
Calycanthus floridus	Carolina allspice	37	#3	0
Fothergilla major	Large fothergilla	36	#2	0
Hydrangea quercifolia	Oakleaf hydrangea	38	#3	4
Itea virginica	Virginia sweetspire	36	#2	0
Leucothoe fontanesiana	Fetterbush	37	#3	0
Morella cerifera	Southern wax myrtle	35	#3	6

Experiment: Planting Densities

Goal

- Plant trees at different densities to understand the role that density may have on establishment of both plantings and invasive species.

Implementation

- 16- 1/10th acre plots
- 608 trees: #2 and #7 size
- Densities ranging from 200/acre to 900/acre

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Website: https://phillyforestscience.org

- Allow staff and volunteers to record and upload data in the field.
- Let staff and researchers review the data, store it, and download it for further analysis.
- Provide the public with information about the experiments and give them a way to explore the data as it is being collected.
- Preserve the record of these long term experiments.

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