

# Forest Adaptation Planning and Practices

March 30, 2017



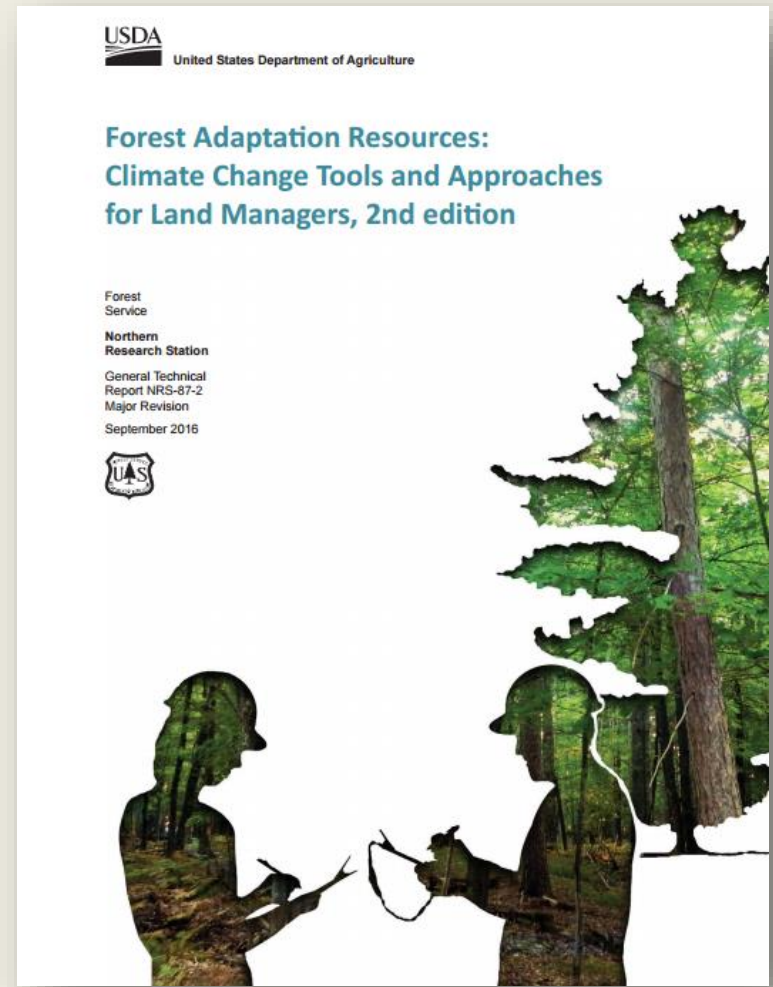
# Two Questions

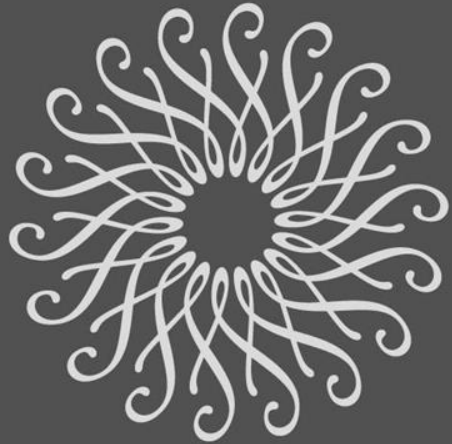
1. How might climate change affect the resources that I manage?
2. What actions could help prepare for those effects?



# Forest Adaptation Resources

- Designed for a variety of land managers with **various goals** and **objectives**
- Tailored to **eastern forests in rural and urban areas**
- **Does not make recommendations**
- Two menus of adaptation **strategies & approaches**, including one for urban forest ecosystems

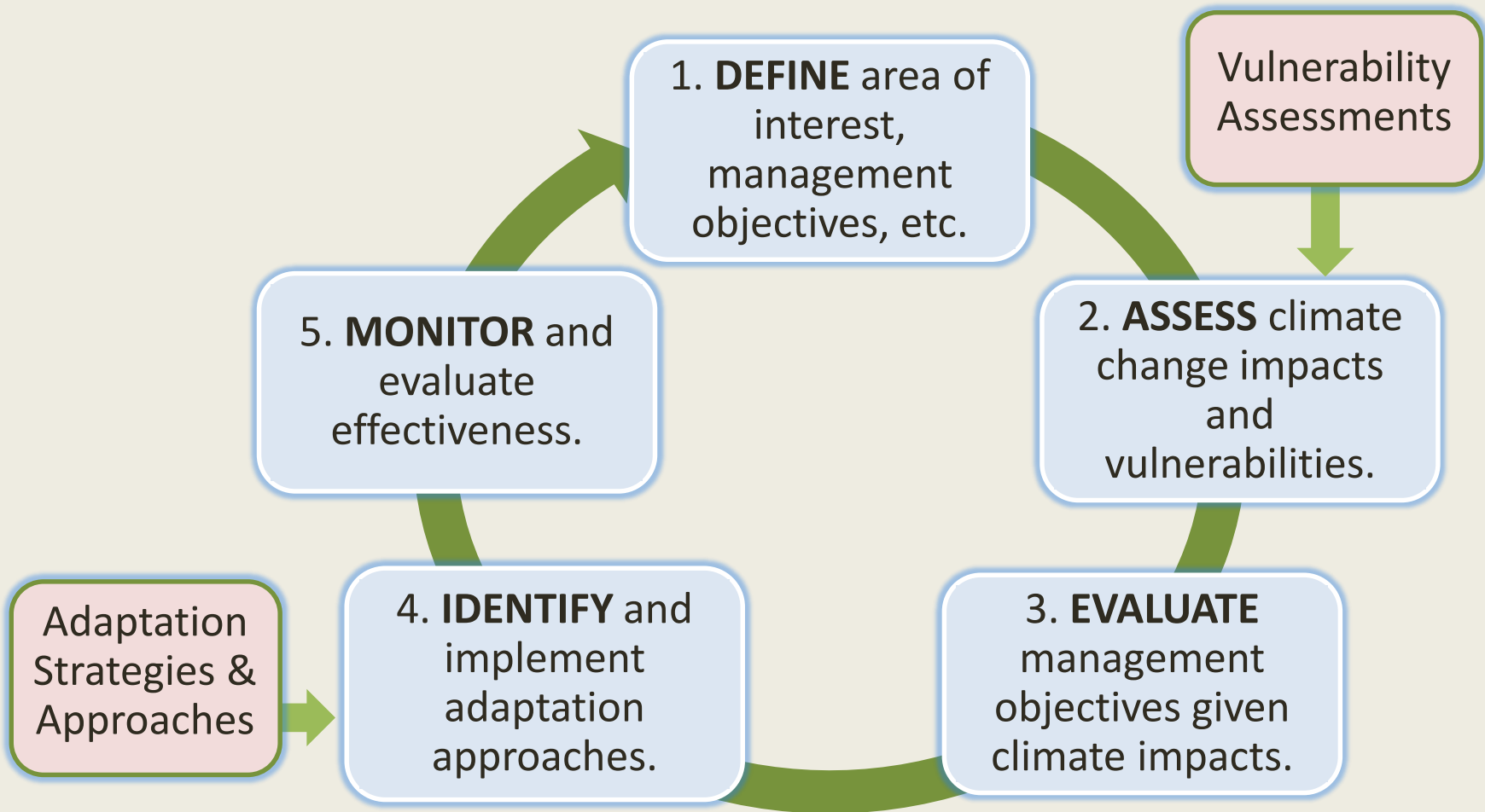


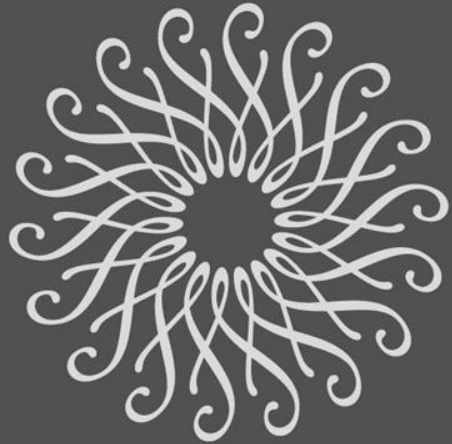


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# Adaptation Workbook

# Adaptation Workbook





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Step 1

**Step 1:** DEFINE location, project, and time frames.

**Key Question:**

- Where are you working?
- What are your management goals and objectives for this area?



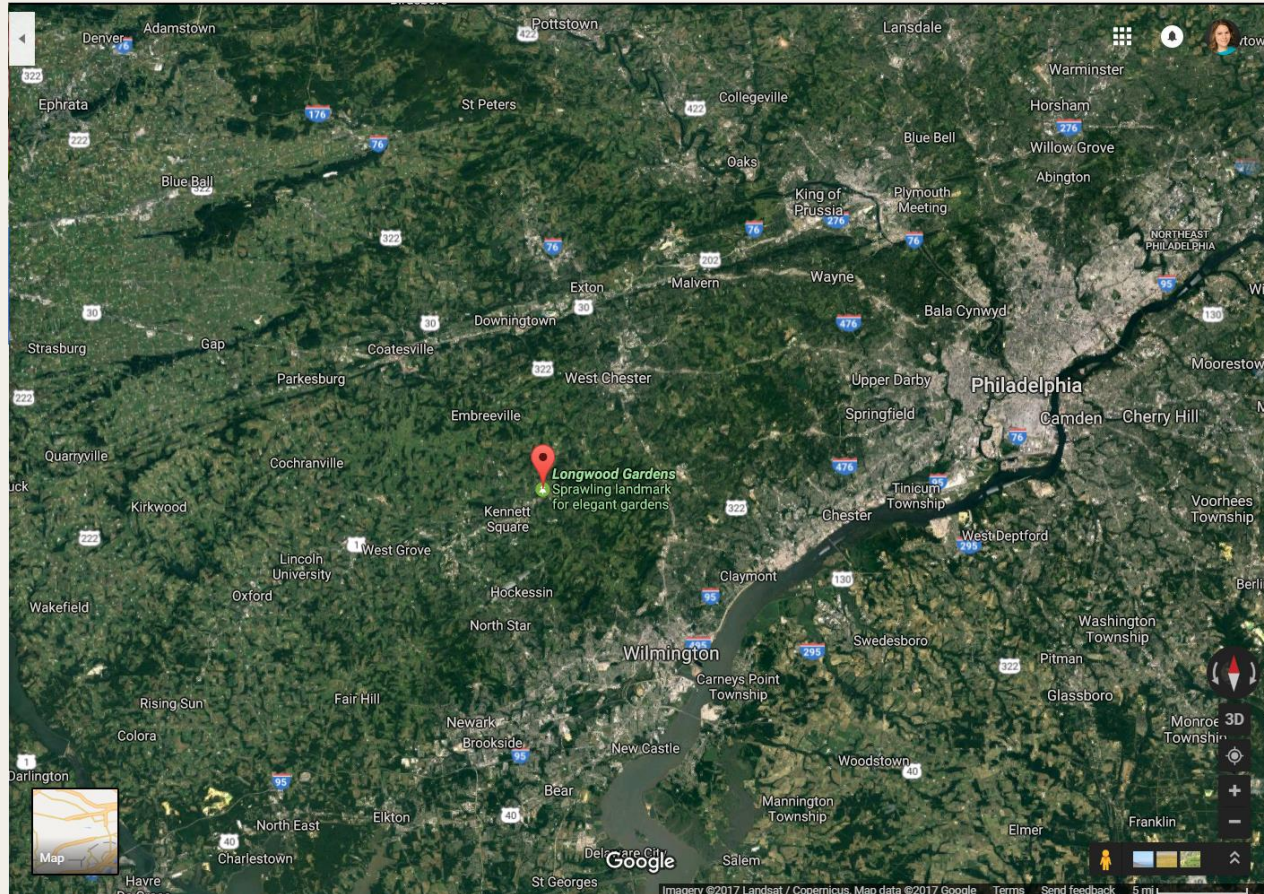
# Introductions

Walk the rest of us through what your project is about (location, key goals/objectives)

A few *brief* comments, please!

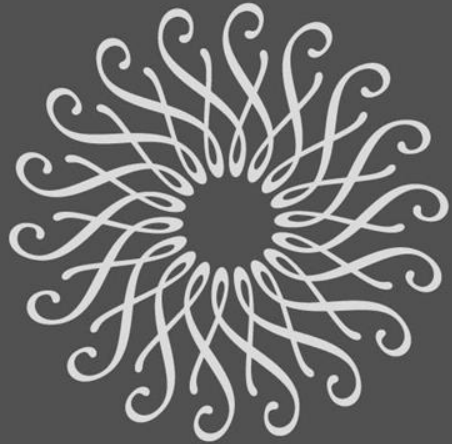


# Project Location?



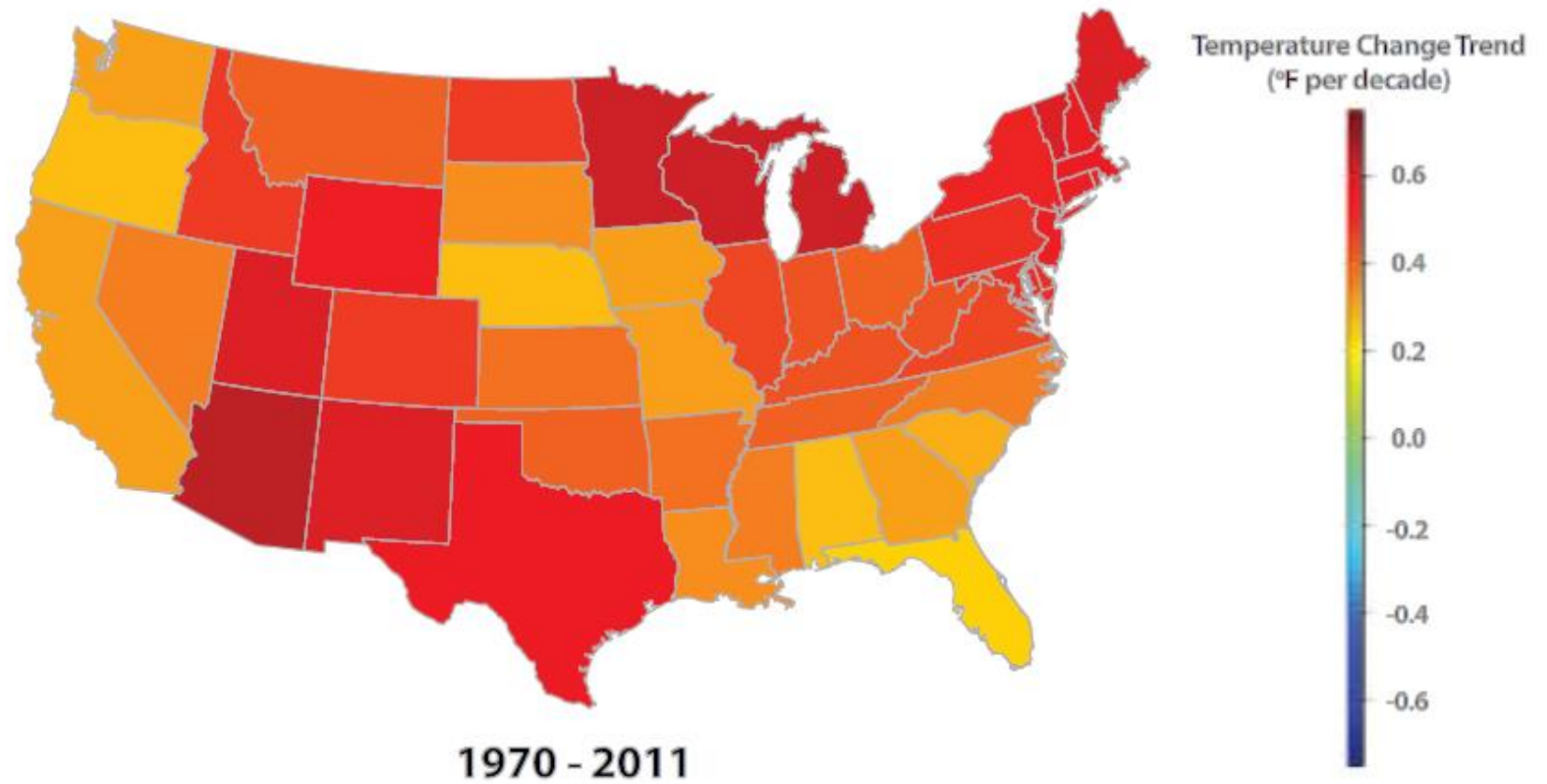
# Impacts of Climate Change on Trees and Ecosystems in the Delaware River Valley





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Local observations



# Temperature Changes

- Mean Annual temperature increase of 2-3°F
- Greatest warming in the winter
- More warming on the coast

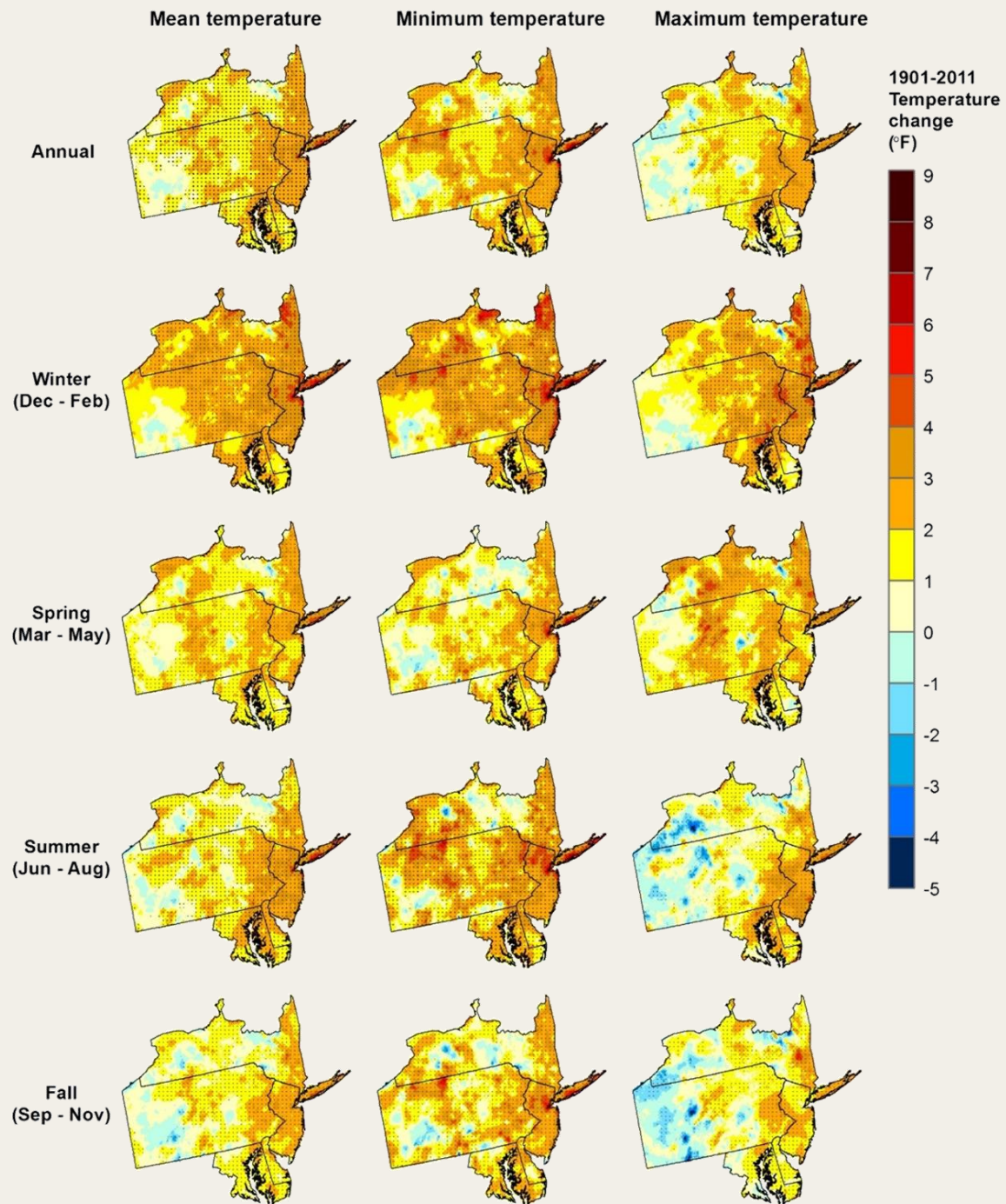
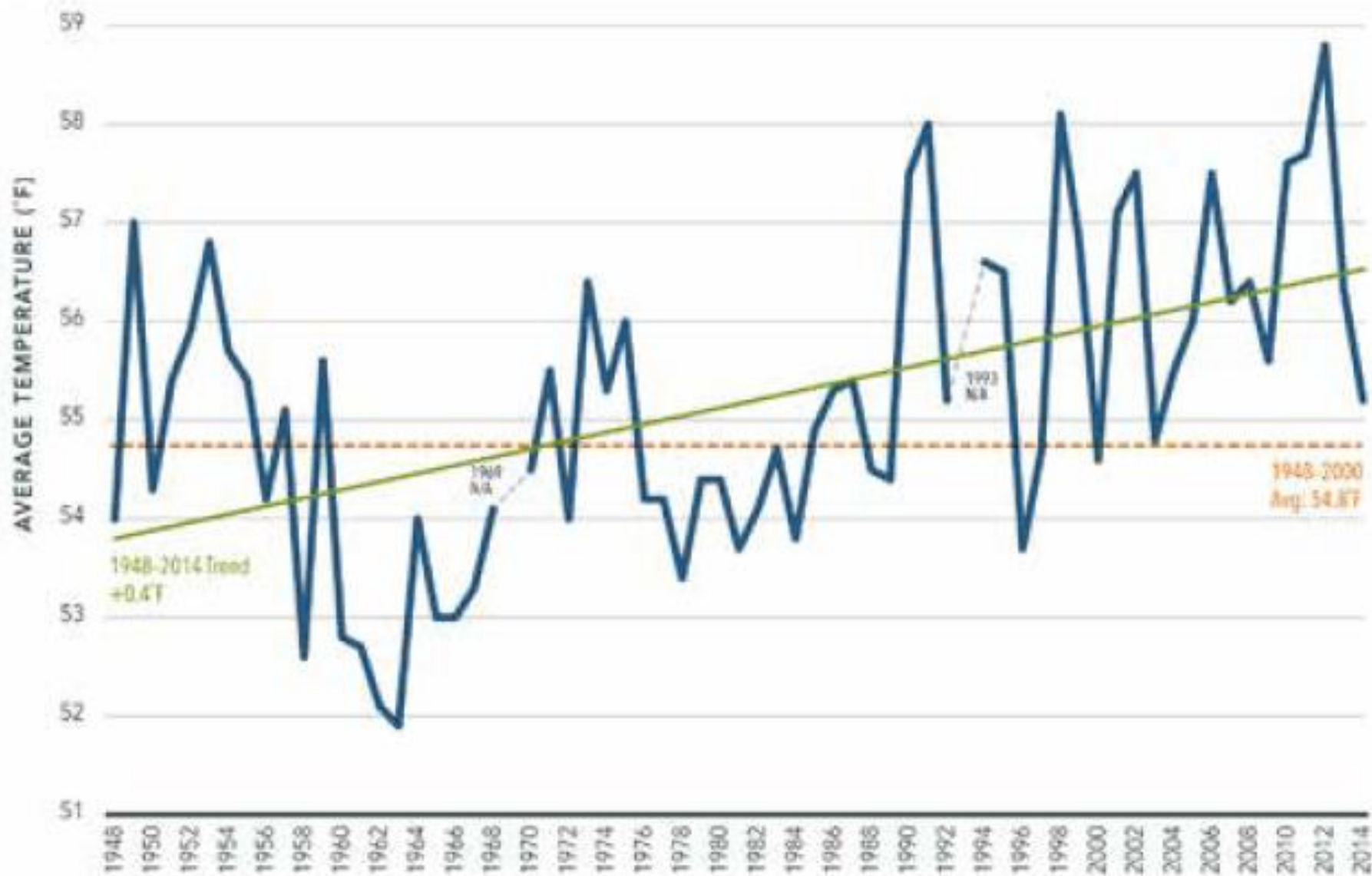


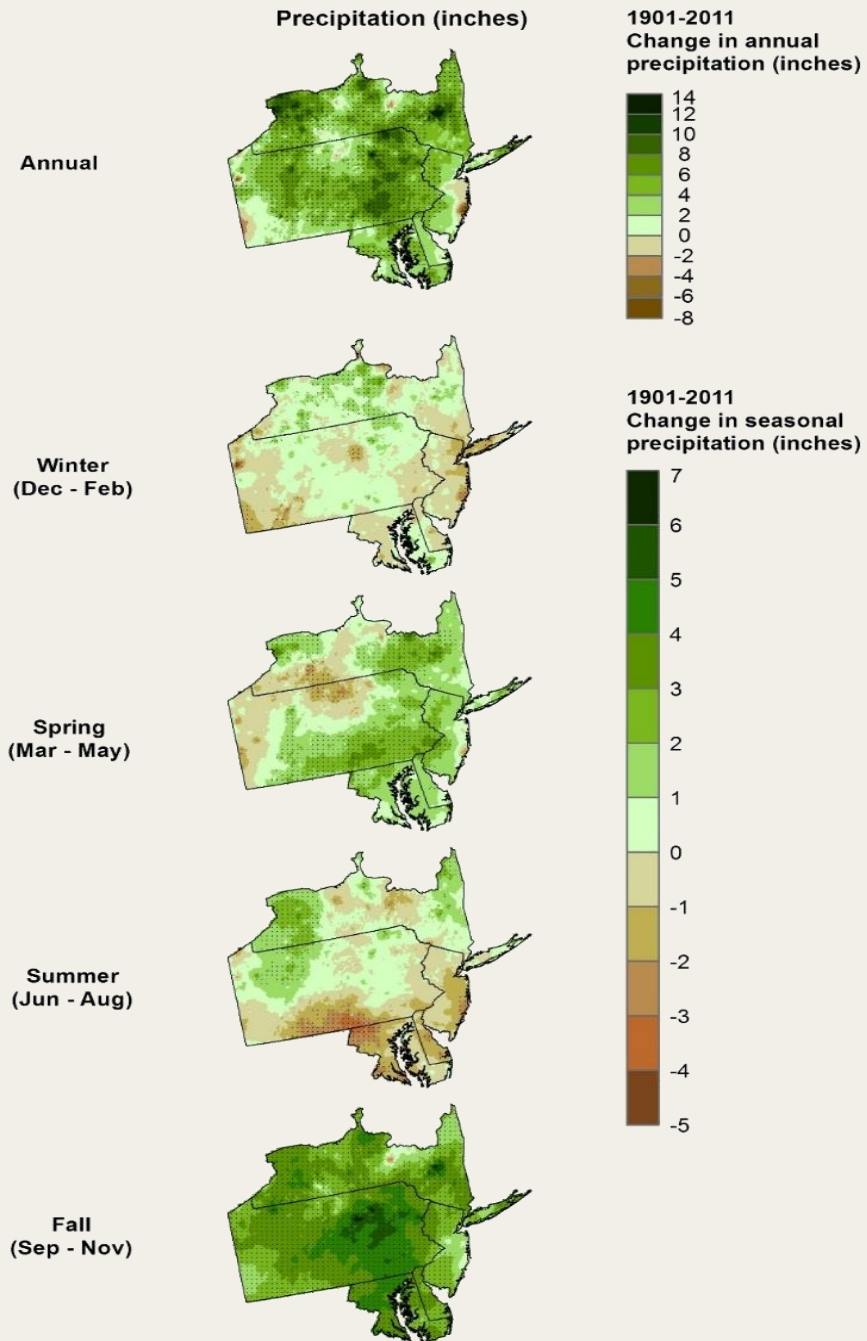
FIGURE 1

ANNUAL TEMPERATURE TREND FOR PHILADELPHIA, 1948-2014



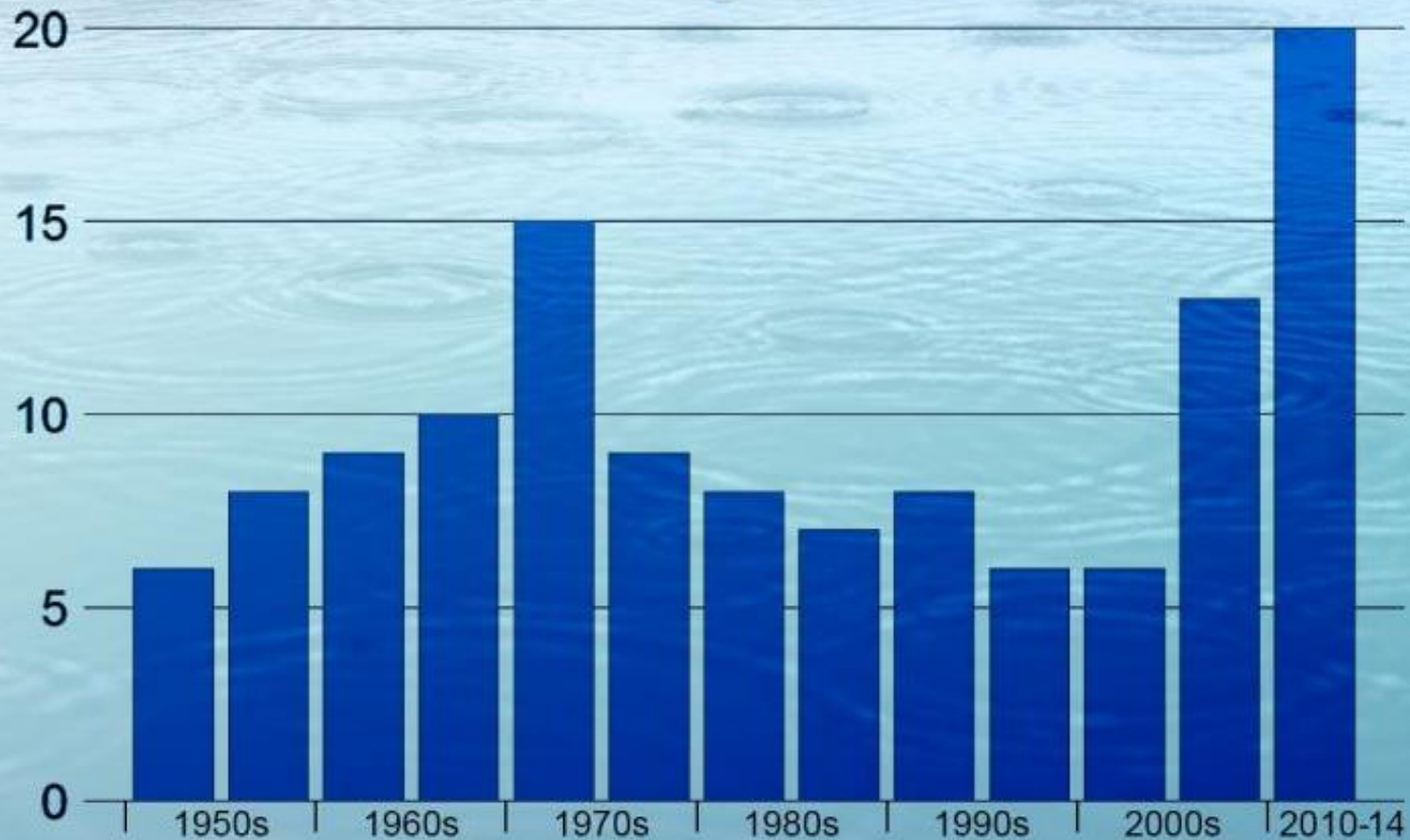
# Precipitation Changes

- More annual precipitation
- Little change in winter precip.
- Spring is wetter
- Summer slightly drier
- Fall much wetter



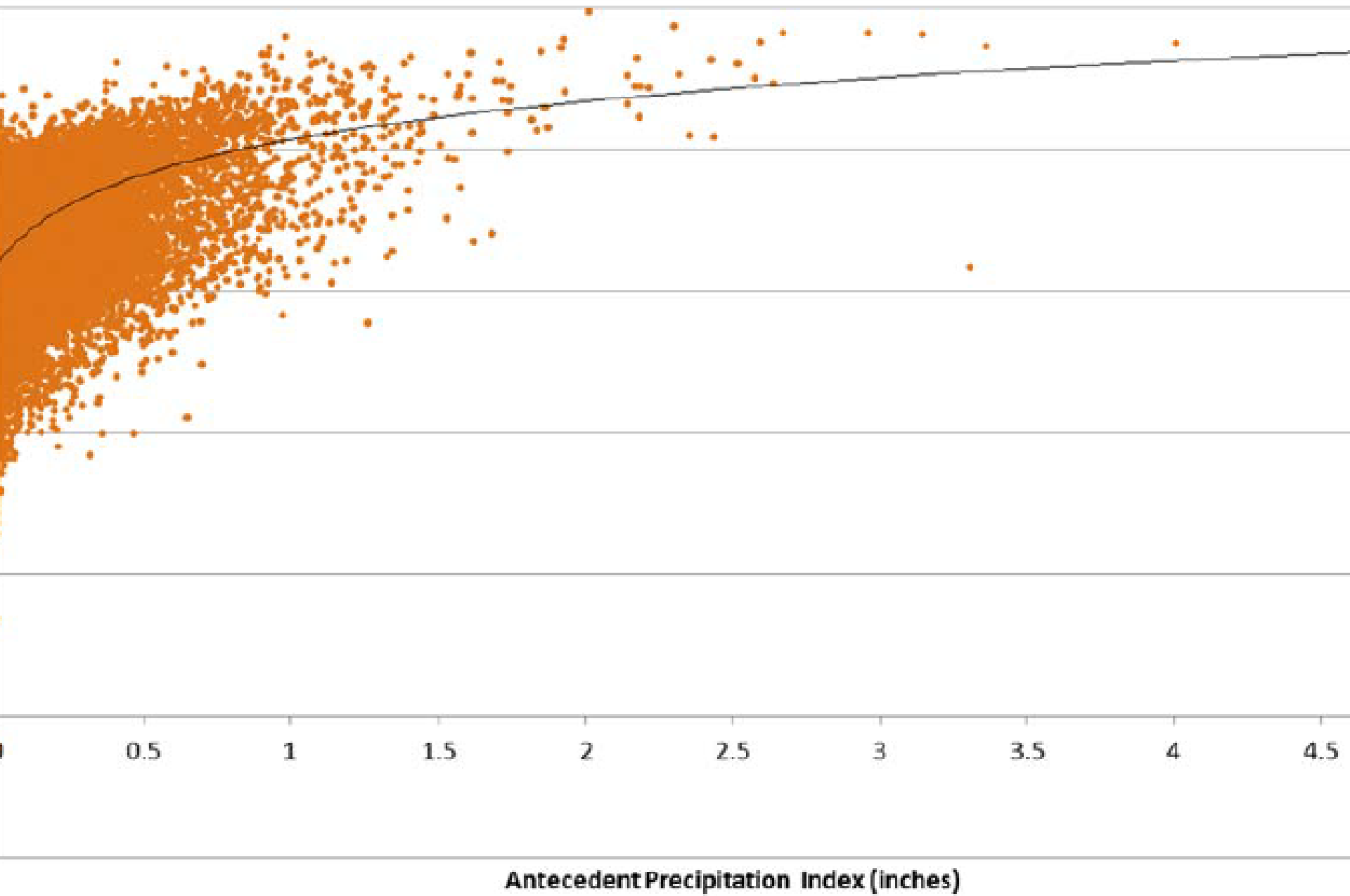
# HEAVY PRECIPITATION

Philadelphia / Days with 2" or More



1950 through 2014. Each bar represents a 5 year total.  
Source: Applied Climate Information System ([rcc-acis.org](http://rcc-acis.org))

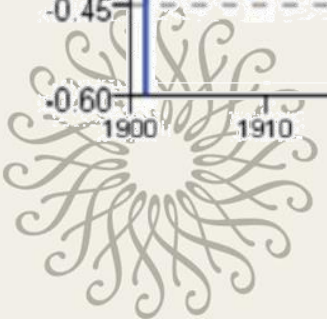
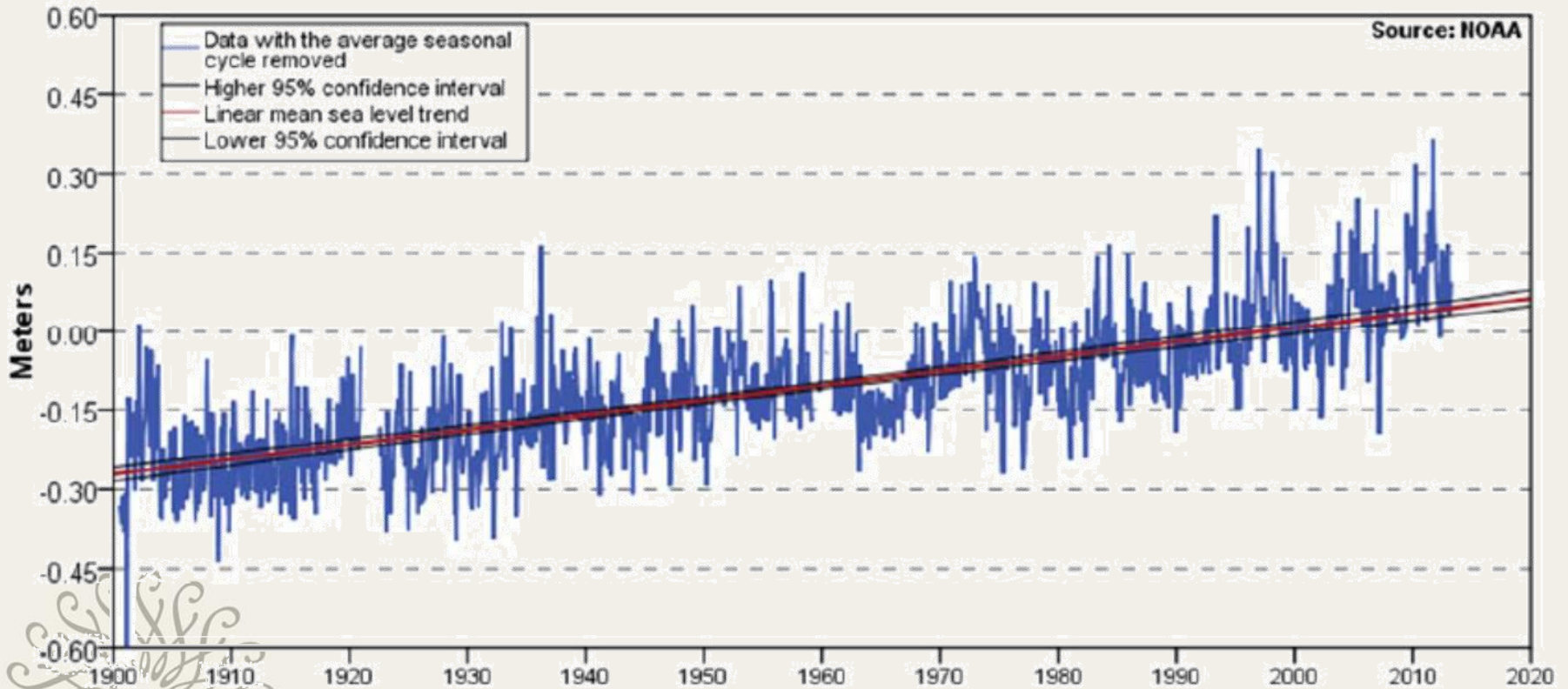
**Figure 4 – Correlation of Antecedent Precipitation Index and Daily Mean Discharge (1949-present)**

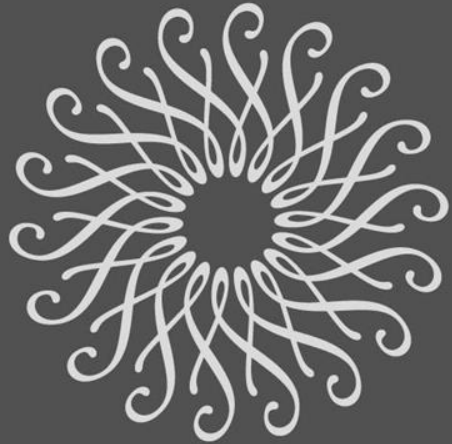


# Sea Level is Rising

Figure 5 – Mean Sea Level Trend in Philadelphia (NOAA Tides and Current, 2014)

Philadelphia, PA       $2.79 \pm 0.21$  mm/yr



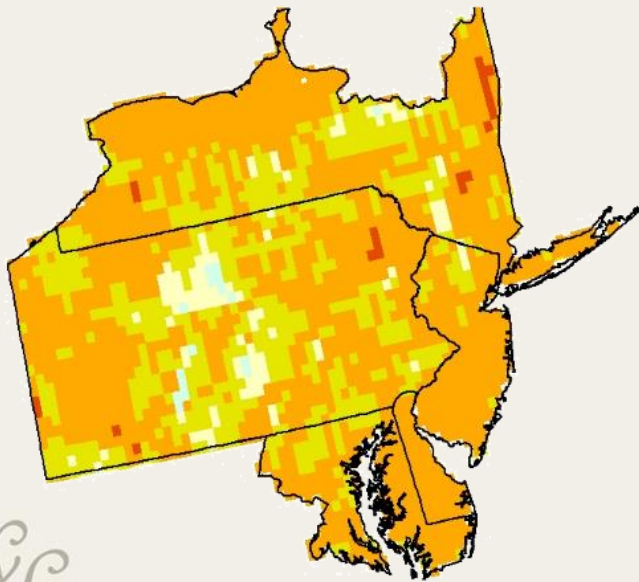


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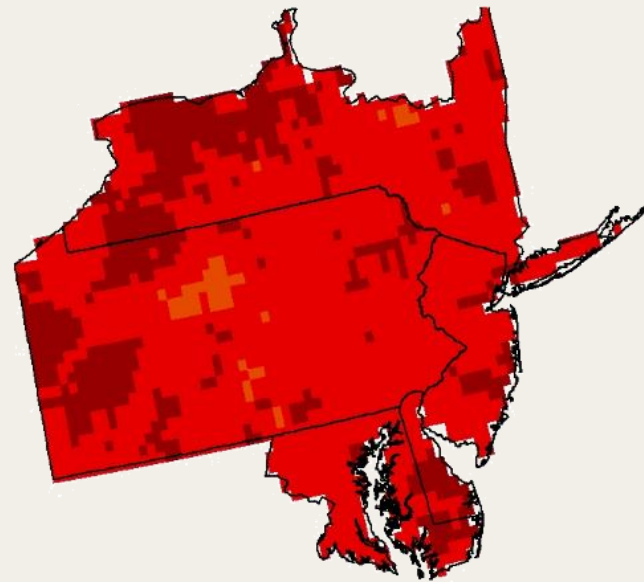
Local projections

# Warmer mean annual temperature

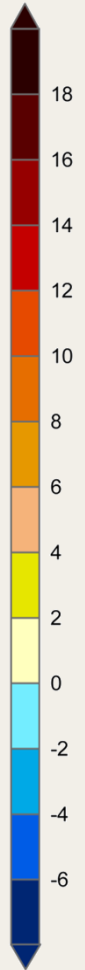
**Low Emissions**



**High Emissions**

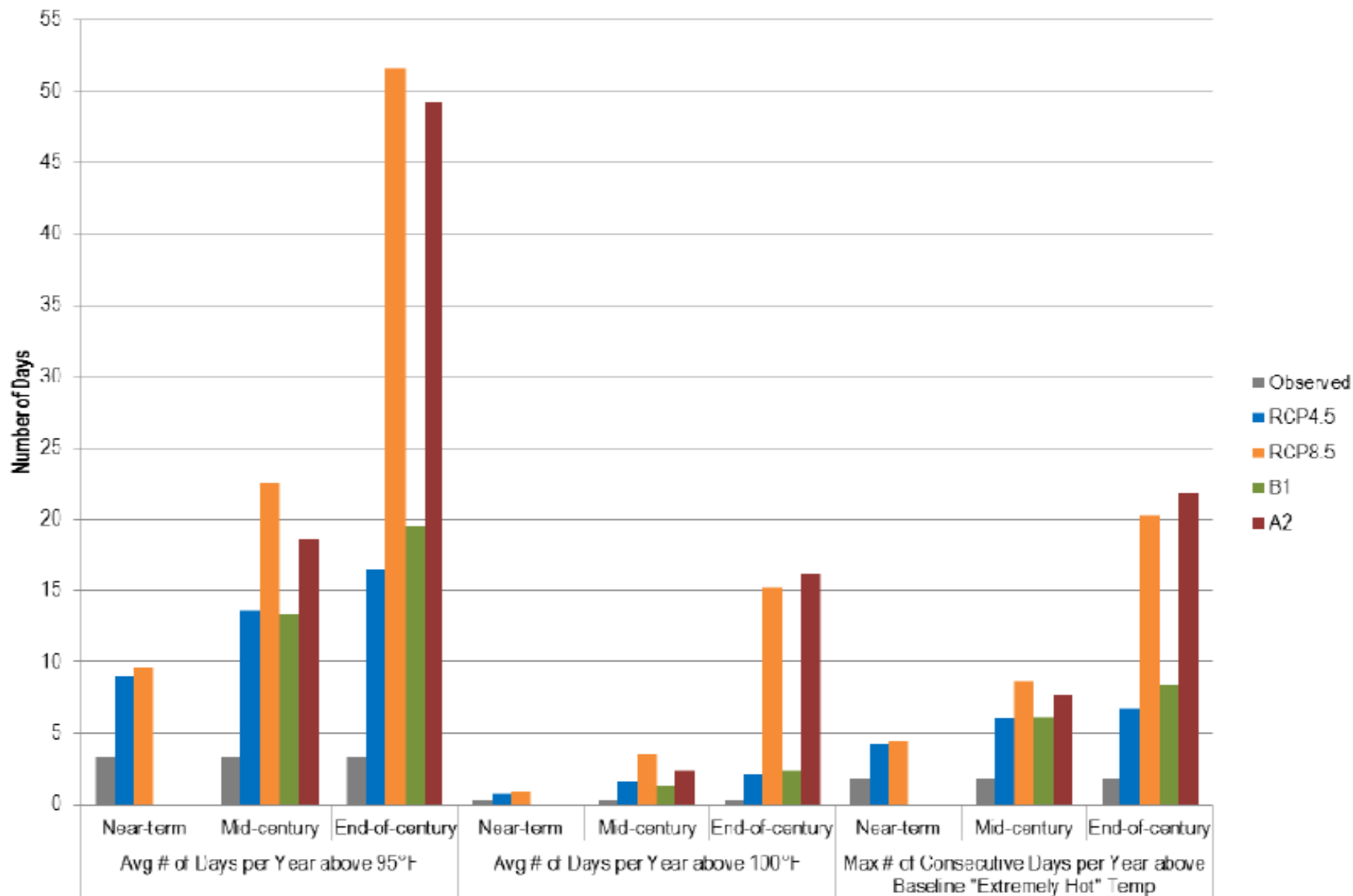


° F



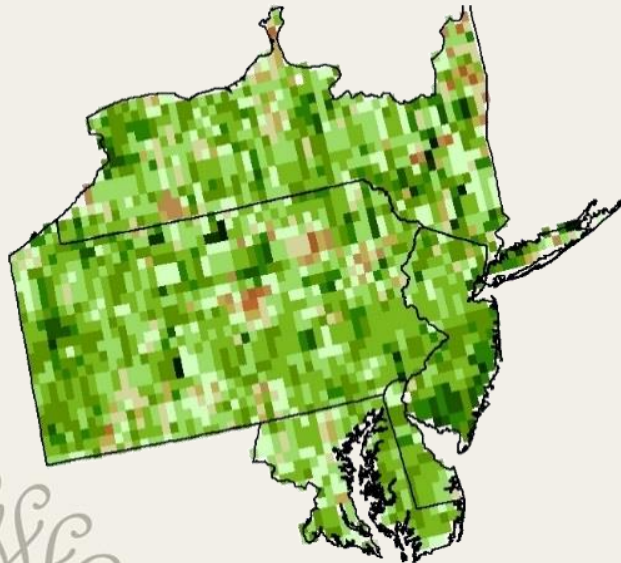
# More Hot Days

Figure 2 – Projected Temperature Extremes in Philadelphia

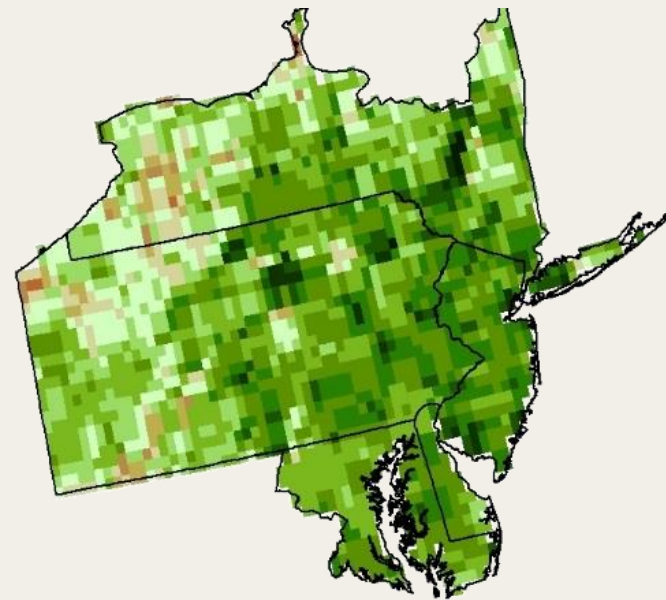


# More Precipitation

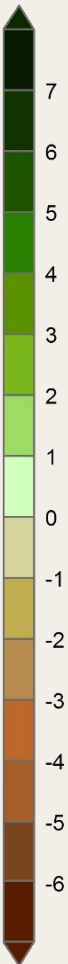
**PCM B1**



**GFDL A1FI**



inches



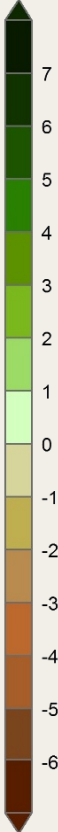
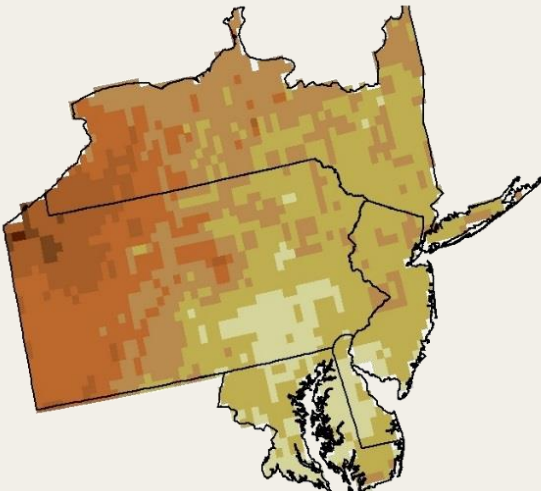
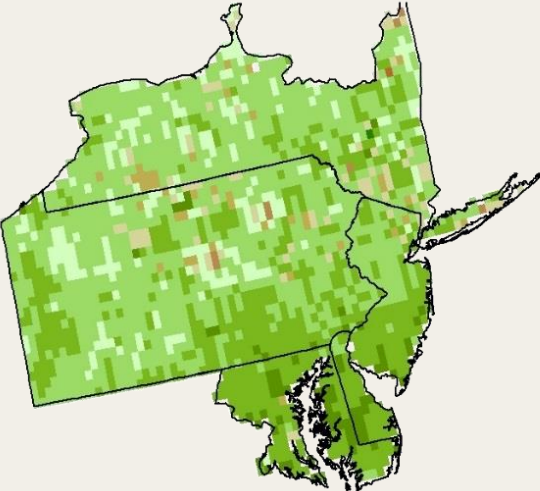
# Seasonal Precipitation

PCM B1

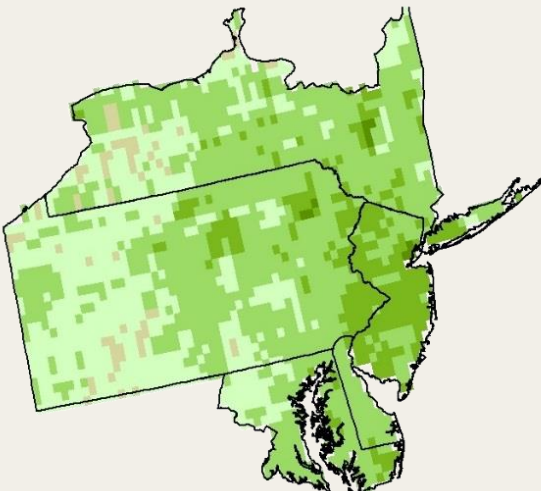
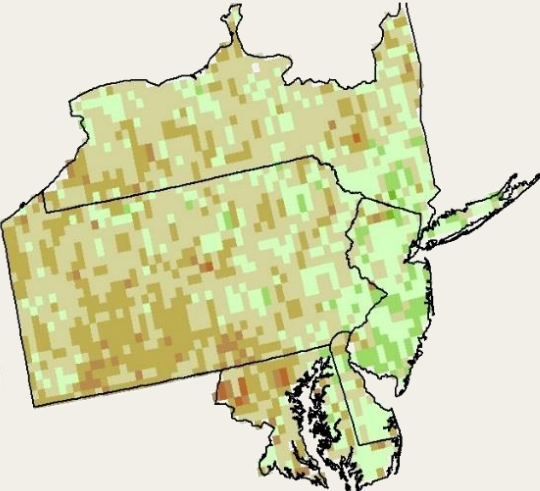
GFDL A1FI

inches

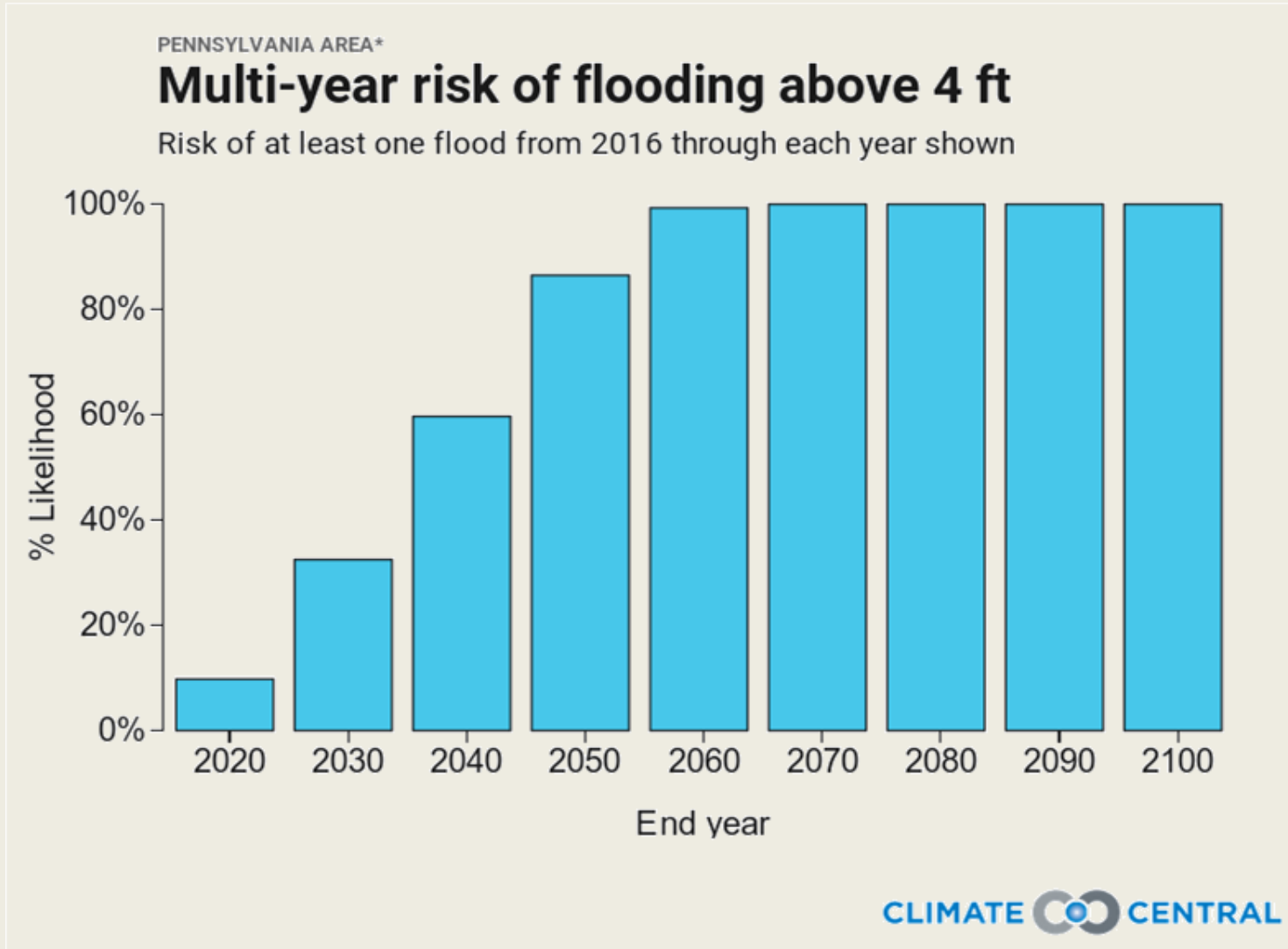
Summer



Fall

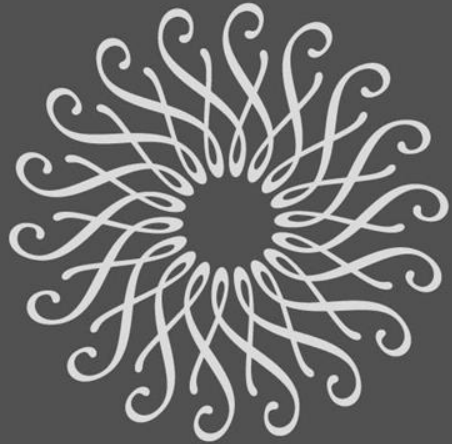


# Sea Level Rise



Nearly 9 square miles of land lie less than 4 feet above the high tide line in Pennsylvania.





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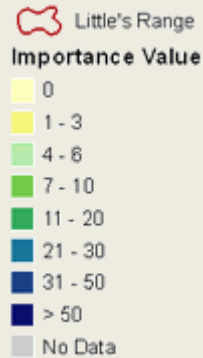
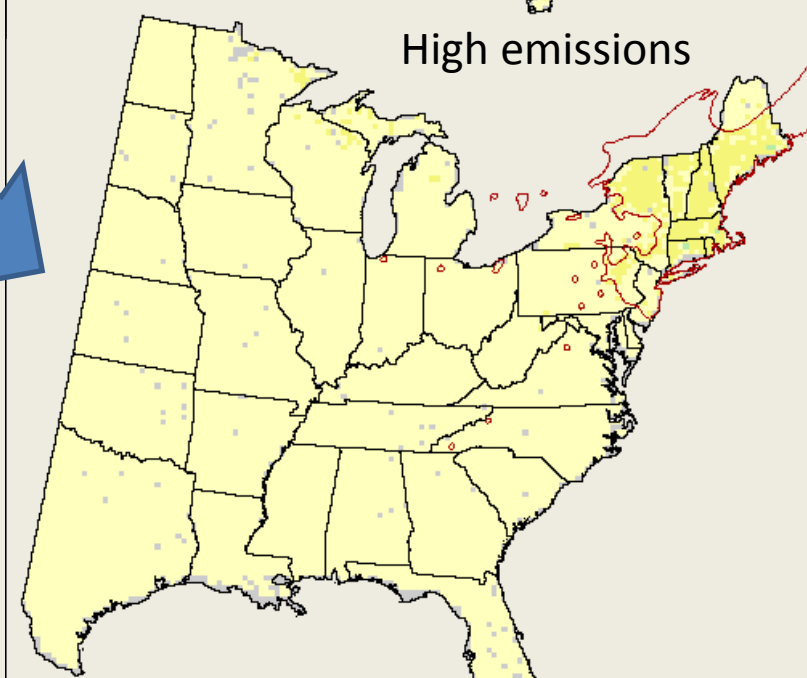
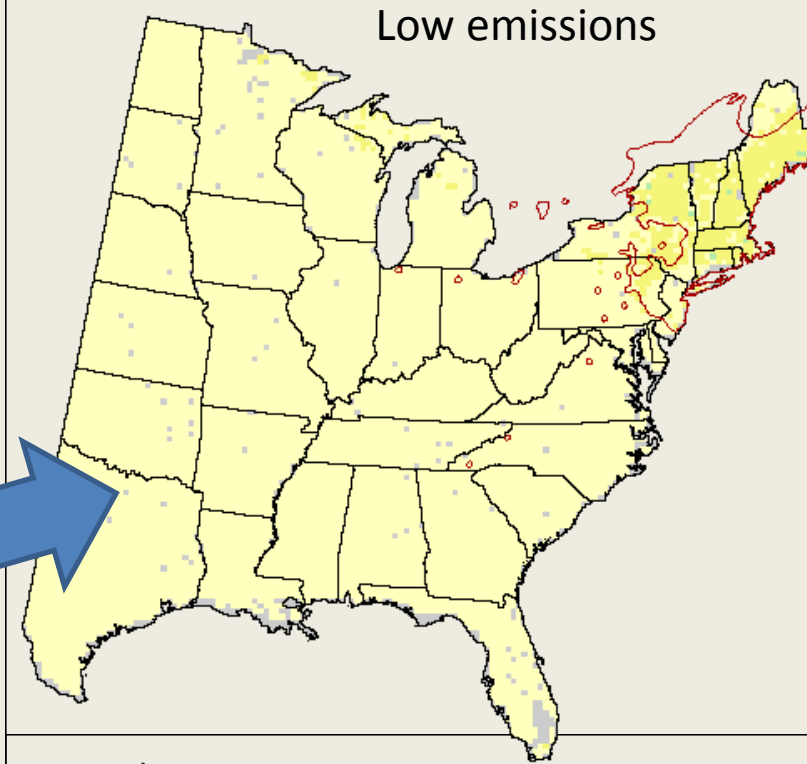
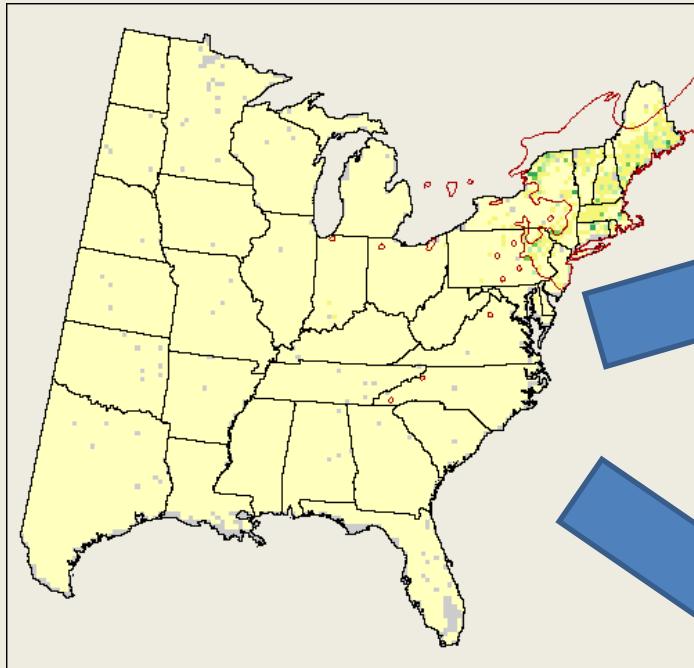
Implications for Trees and Forests

# Climate Change Tree Atlas

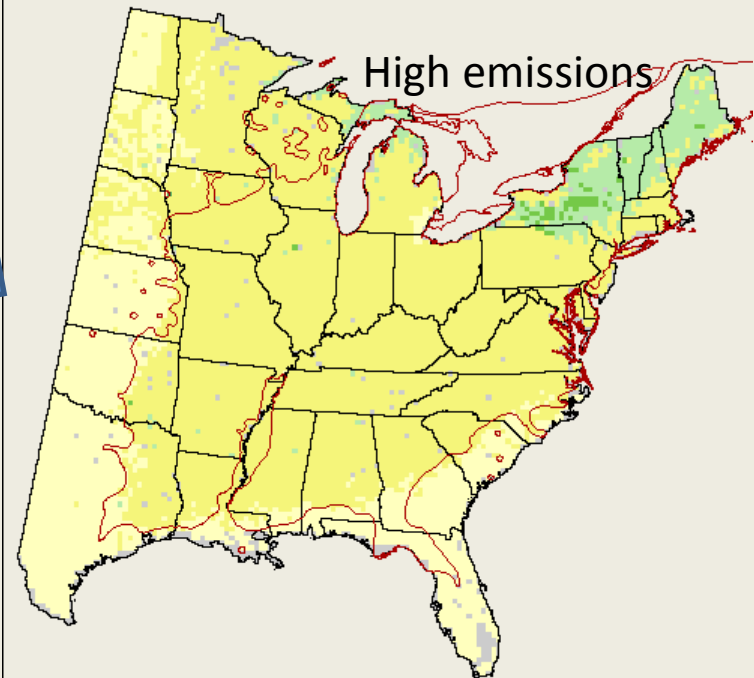
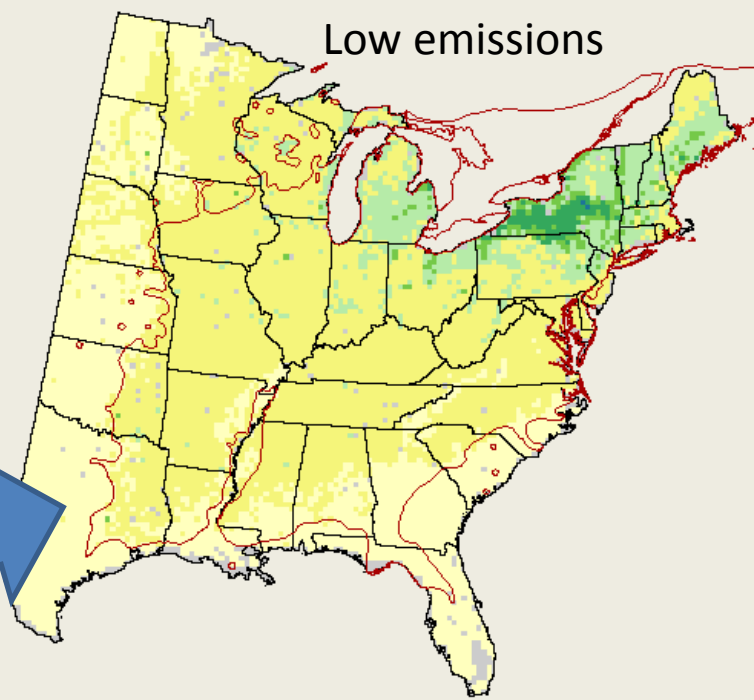
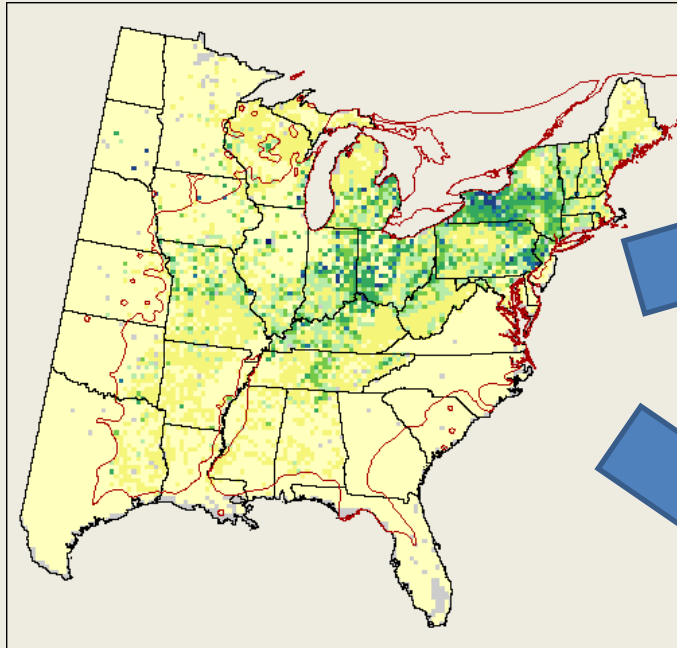
- Web-based tool developed by Dr. Louis Iverson and the Landscape Change Research Group
- Shows maps of statistically-modeled changes in suitable habitat
- 134 tree species
- [www.fs.fed.us/nrs/atlas/](http://www.fs.fed.us/nrs/atlas/)



# Gray Birch



# White ash



# Other Decreasers



white spruce



sweet birch



Atlantic white cedar



chestnut oak



red pine



eastern white pine



American basswood



northern white-cedar

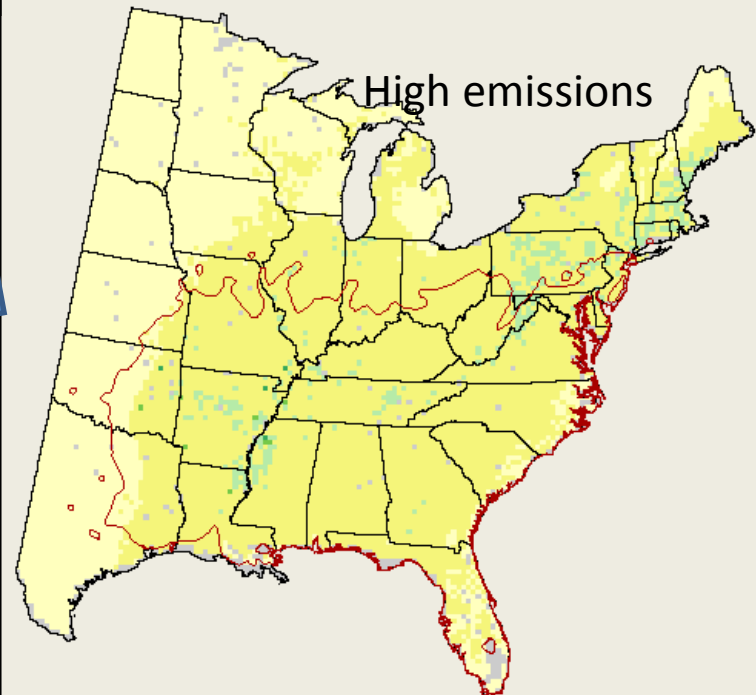
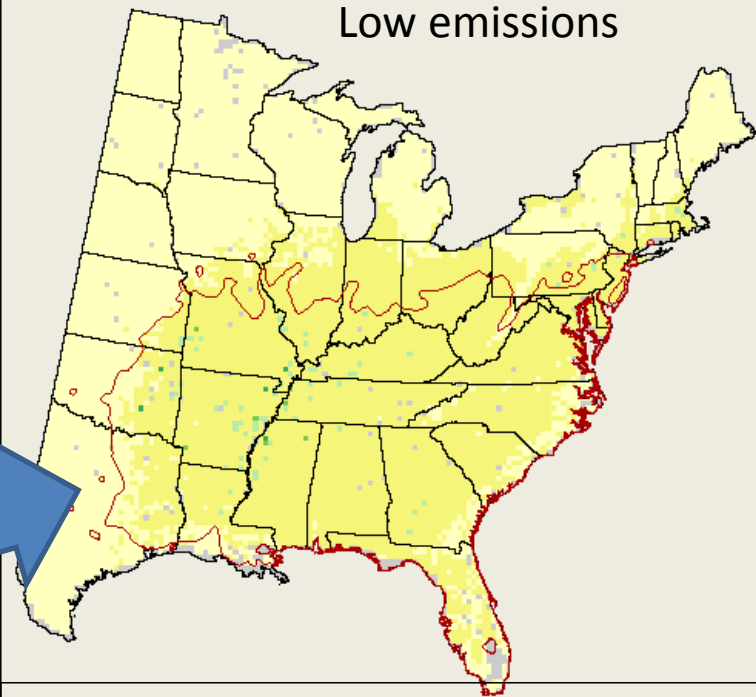
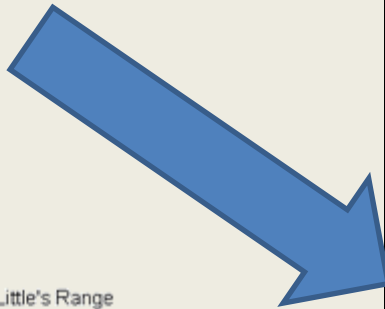
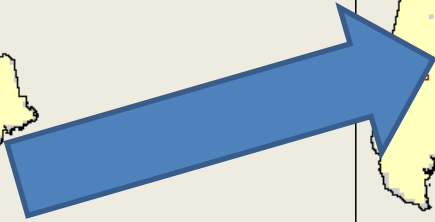
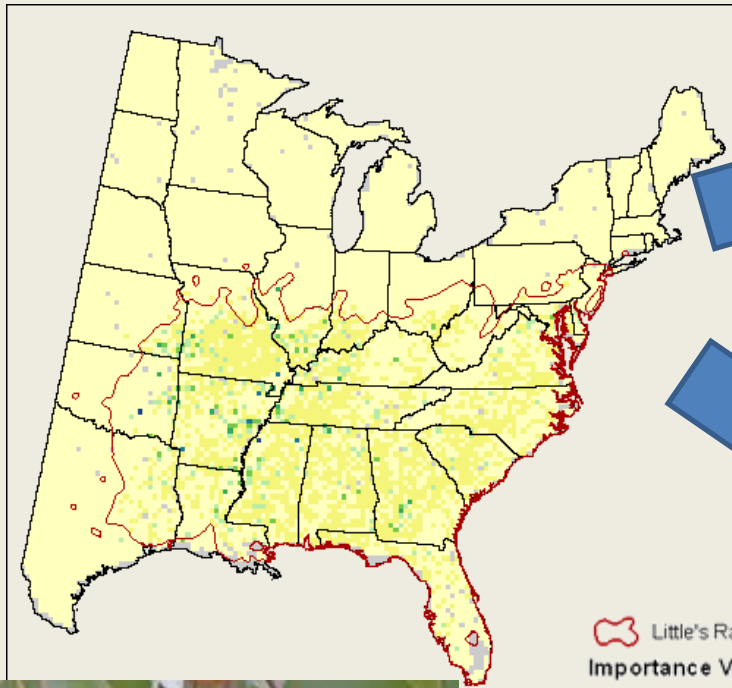


bigtooth aspen



Virginia pine

# Common Persimmon



# Increasers



southern red oak



blackjack oak



pin oak



post oak



bitternut hickory



shagbark hickory



shortleaf pine



loblolly pine

# Other increasers



pawpaw



black willow



American elm



Sweetgum



Eastern redbud



Persimmon



hackberry

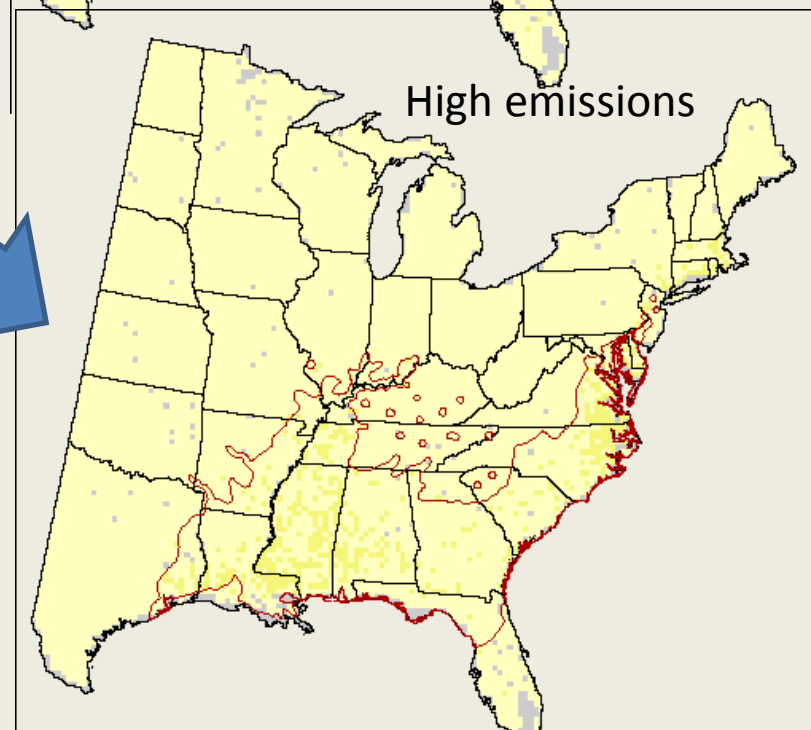
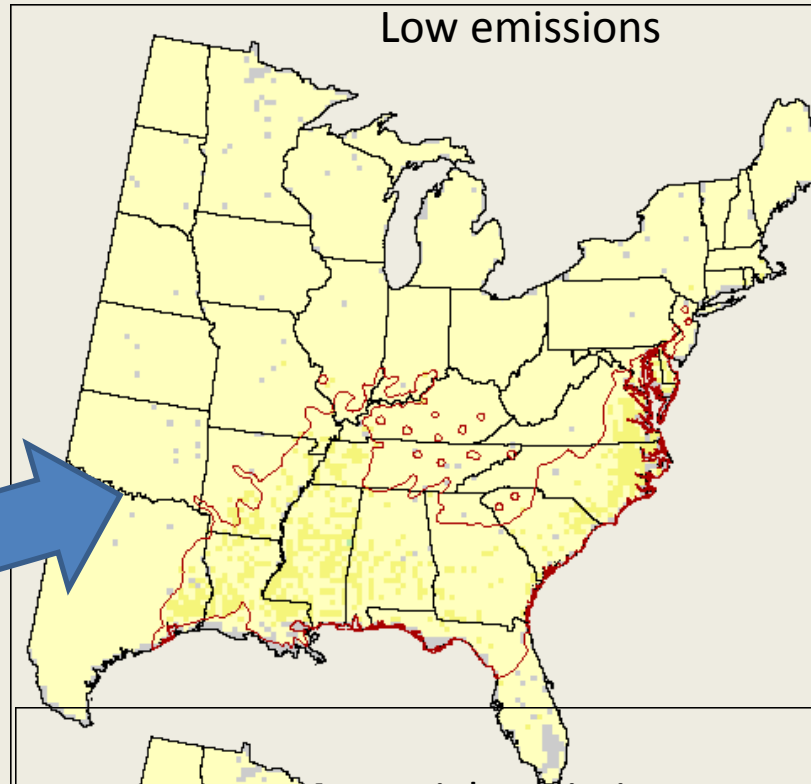
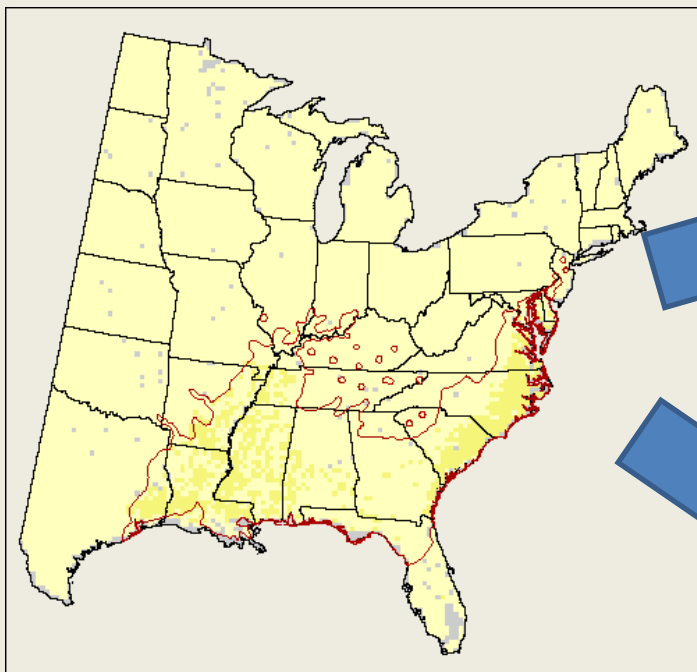


honeylocust



American holly

# Swamp chestnut oak



# New Habitat



Ohio buckeye



pecan



Shellbark hickory



black hickory



sugarberry



sourwood



winged elm



cedar elm

# More Species with New Habitat



pond pine



turkey oak



swamp chestnut oak



chinkapin oak



shingle oak



water oak



cherrybark oak



Shumard oak

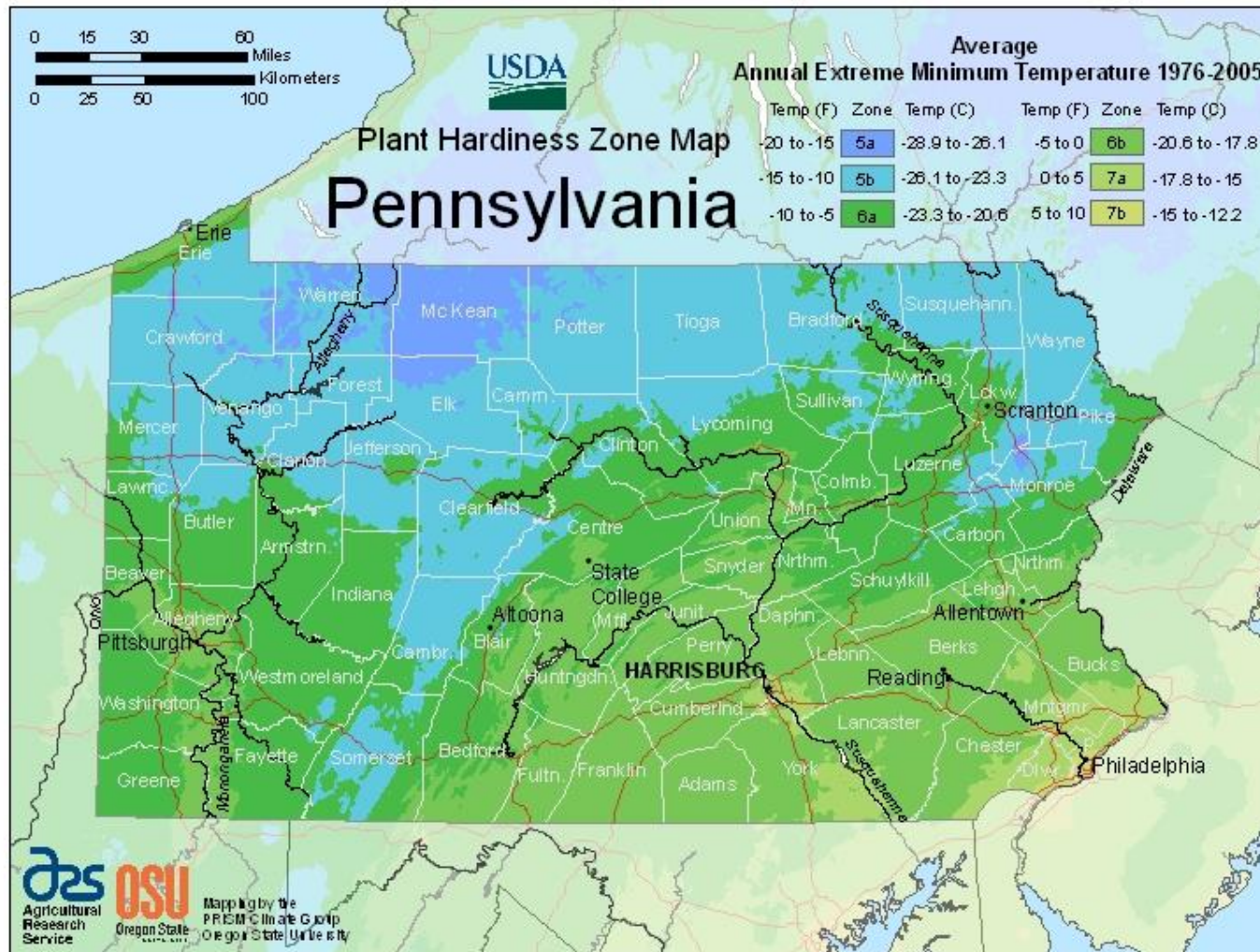


Baldcypress

# Non-Natives, Invasives, Cultivars?



# Current USDA Hardiness Zones



# Changes in Hardiness Zones

- Based on average minimum temperature
- Shift of a half to one and a half hardiness zones

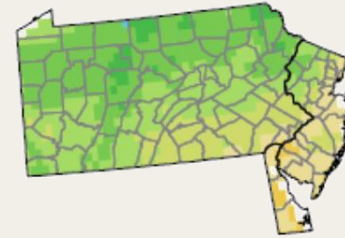
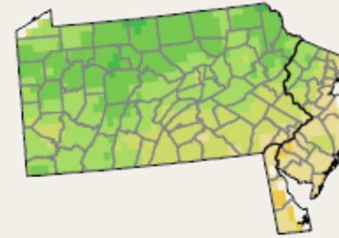
## Hardiness Zone

Temp (°F)	Zone
-40 to -35	3a
-35 to -30	3b
-30 to -25	4a
-25 to -20	4b
-20 to -15	5a
-15 to -10	5b
-10 to -5	6a
-5 to 0	6b
0 to 5	7a
5 to 10	7b
10 to 15	8a
15 to 20	8b
20 to 25	9a
25 to 30	9b
30 to 35	10a
35 to 40	10b
40 to 45	11a
45 to 50	11b
50 to 55	12a
55 to 60	12b

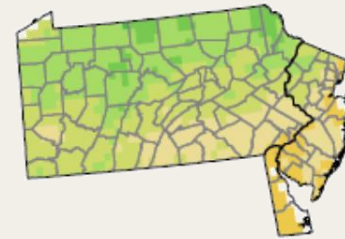
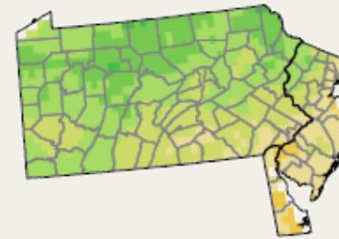
Low Emissions

High Emissions

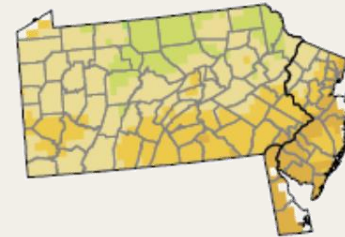
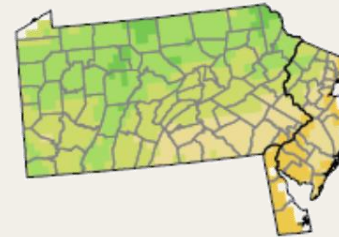
1980 - 2009



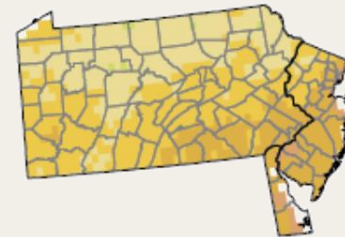
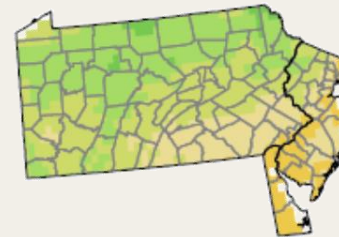
2010 - 2039



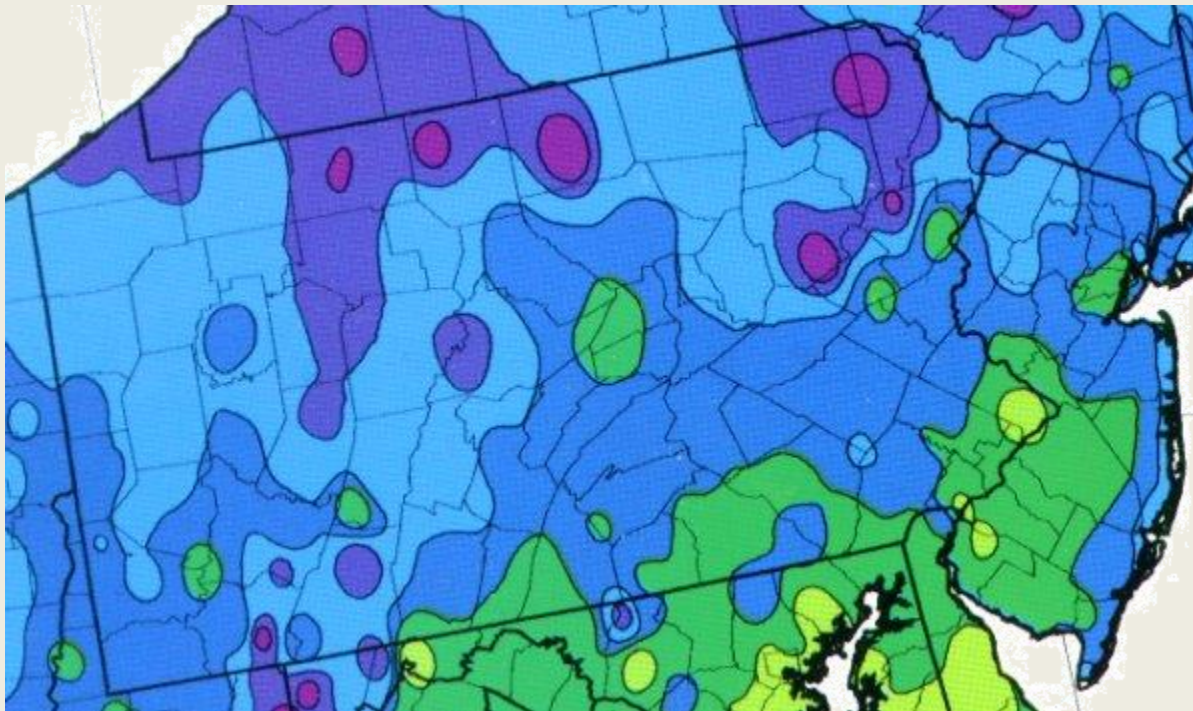
2040-2069



2070-2099



# Current AHS Heat Zones



Average Number  
of Days per Year  
Above 86°F  
(30°C)

Average Number of Days per Year Above 86°F (30°C)	Heat Zone
< 1	1
1 to 7	2
> 7 to 14	3
> 14 to 30	4
> 30 to 45	5
> 45 to 60	6
> 60 to 90	7
> 90 to 120	8
> 120 to 150	9
> 150 to 180	10
> 180 to 210	11
> 210	12

# Changes in Heat Zones

- Based on number of hot days
- Shift of 1-3 heat zones
- 1-2 months more hot days!

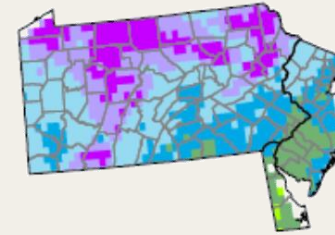
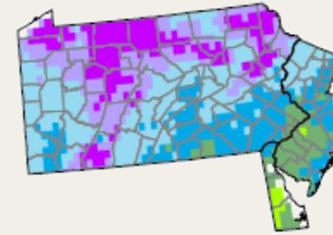
## Heat Zone (days over 86°F)



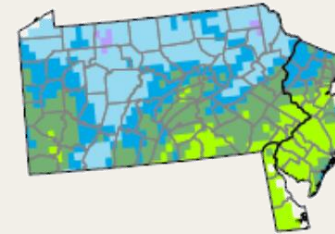
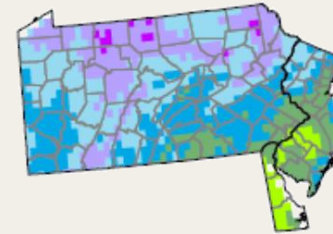
Low Emissions

High Emissions

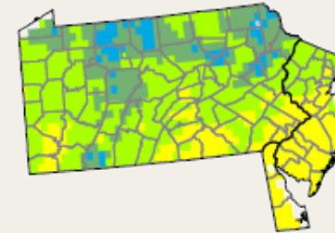
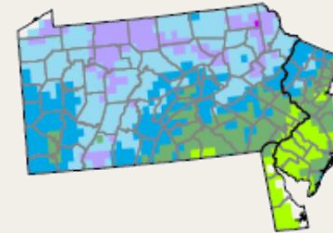
1980 - 2009



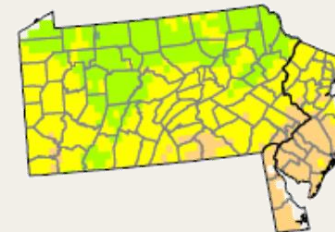
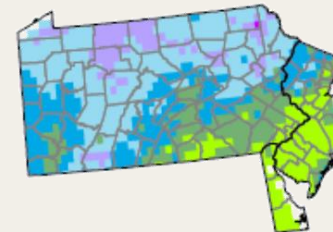
2010 - 2039



2040-2069



2070-2099



## Douglas Fir

Hardiness zone range: 4-7

Heat zone range: 1-7

May experience heat stress



## **Momi Fir**

Hardiness zone range: 6-9

Heat zone range: 1-10

Heat and hardiness zones  
within projected ranges



# Selecting trees based on heat and hardiness zone

- Hardy to zone 6, but may be able to experiment with trees that are hardy to zone 7 in some areas
- Have a hardiness zone upper limit of 8 or higher (or 9 or 10 for harsher sites and longer-lived species)
- Have a heat zone tolerance of 8 or (for long-lived species or urban sites, 9)

higher



# Adaptive Capacity

Ability of a species or system to cope with change



# Species with High Adaptive Capacity

- Pests, disease resistant
- Drought-tolerant
- Flood-tolerant
- Wind, ice-resistant
- Wide temperature tolerance
- Tolerates urban conditions (salt, pollution, restricted rooting conditions)
- Shade-tolerant
- Can be planted on a range of sites, soils
- Easily propagated and established once planted

# High Adaptive Capacity: Kentucky Coffeetree



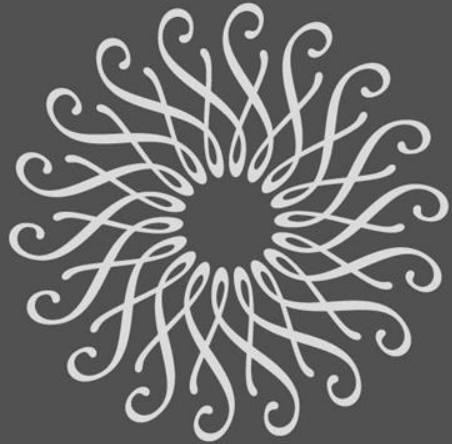
- No major pest/disease issues
- Adaptable to a range of soils, climates
- Urban-tolerant
- Low maintenance
- Widely available

# Low Adaptive Capacity: Tulip-Tree



- Highly susceptible to ice damage, weak wood
- Intolerant of salt
- Intolerant of drought
- Intolerant of flooding





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Other forest impacts

# Invasive species

- More carbon dioxide may favor weedy species
- Invaders can easily disperse to new areas
- Some may take advantage of longer growing seasons
- Tend to be disturbance-adapted



# Kudzu

Kudzu is reproducing in Pennsylvania (photo from Lebanon County)



# Hemlock Woolly Adelgid



UGA3225077

# Oak wilt



# Native Pests: Southern Pine Beetle



# Longer growing seasons

## Opportunities:

- More growth
- More carbon storage

## Risks:

- Invasive species
- “false springs”
- Invasive species
- Insect pests



# Salinity- “Ghost Forests”

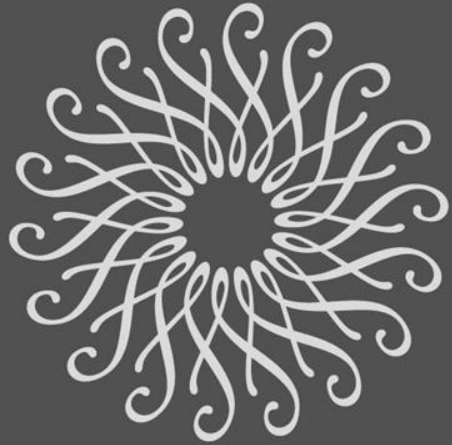
An aerial photograph showing a winding river or stream. The water is dark blue. On either side of the river, there are patches of green vegetation and large areas of dead, greyish-brown trees, known as ghost forests. The background shows a mix of green fields and dense forests.

*Ted Blanco/Climate Central*

# Key Impacts

- Warmer, especially in winter
- Longer growing season, heat and hardiness zone shifts
- Wetter, especially in winter and spring
- Sea level rise and greater salinity
- Species range shifts
- More stress from invasive species, pests, and diseases





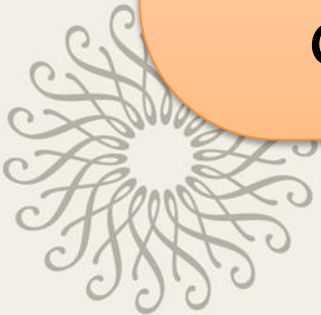
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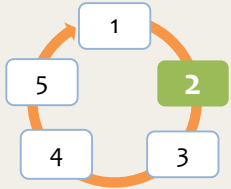
Step 2

## **Step 2:** ASSESS site-specific climate change impacts and vulnerabilities.

### **Key Question:**

- How might the area be uniquely affected by climatic change and subsequent impacts?
- How might regional impacts be different in the project area?





**Step 2:** ASSESS climate change impacts and vulnerabilities for the area of interest.

## Broad-scale Impacts and Vulnerabilities

Climate Change Impacts and Vulnerabilities for the Area of Interest

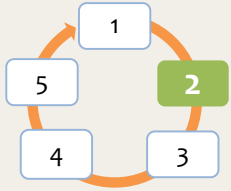
Vulnerability Determination

*Information on regionally-relevant climate change effects.*

*From research, vulnerability assessments, etc.*

*For example:*

- *Increased likelihood of extreme rain events*



**Step 2:** ASSESS climate change impacts and vulnerabilities for the area of interest.

Broad-scale Impacts and Vulnerabilities

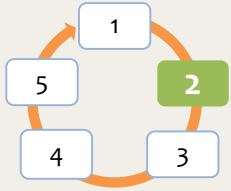
**Climate Change Impacts and Vulnerabilities for the Area of Interest**

Vulnerability Determination

*Site-based assessment of risk to regionally-relevant climate change impacts.*

*For example:*

- *Site is located in a floodplain with poorly drained soils. Dominant species are green ash and American elm.*



**Step 2:** ASSESS climate change impacts and vulnerabilities for the area of interest.

Broad-scale Impacts and Vulnerabilities

Climate Change Impacts and Vulnerabilities for the Area of Interest

**Vulnerability Determination**

*How vulnerable is the site to the effects of climate change?*

**High:** *Impacts exceed ability of ecosystem to cope; functions and services disrupted.*

**Moderate:** *Impacts will cause changes, but systems can cope*

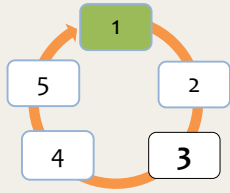
**Low:** *Ecosystems can readily cope with impacts; relatively few/minor negative impacts*

# Example: Working Woods, Holden Arboretum

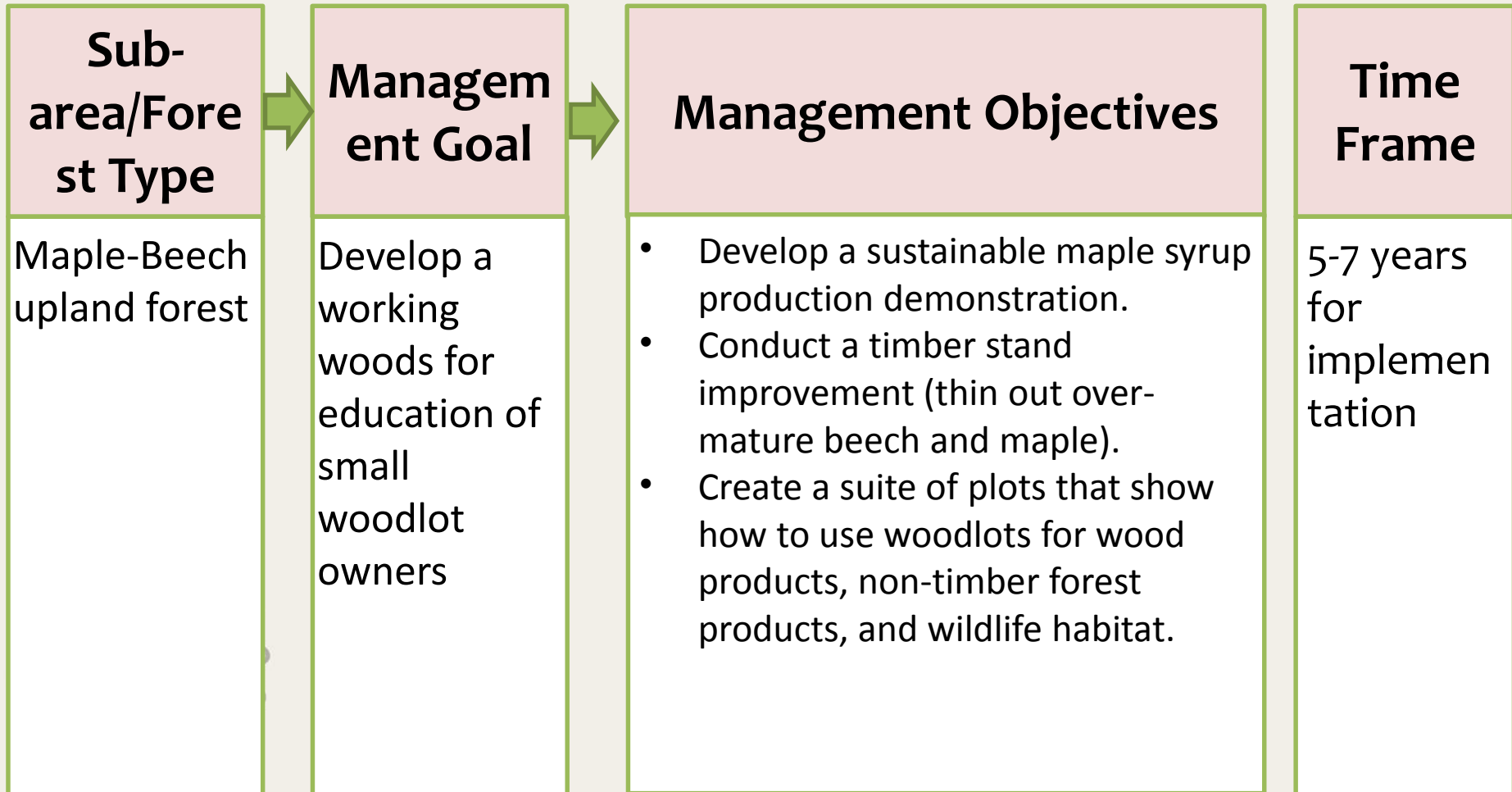


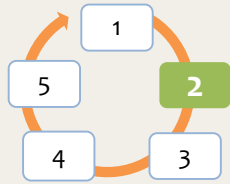
30 acre woodlot, Holden Arboretum, Willoughby, OH



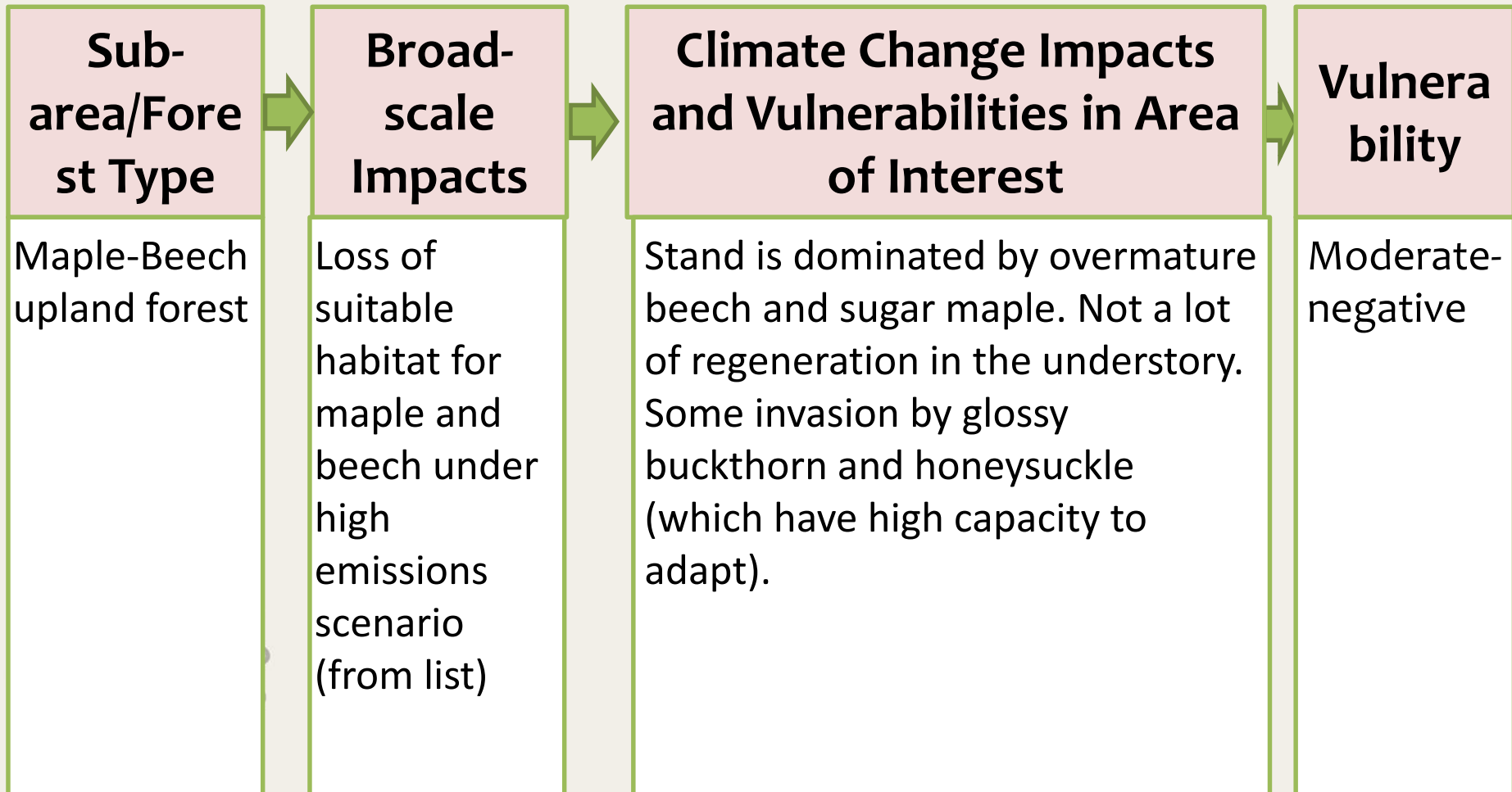


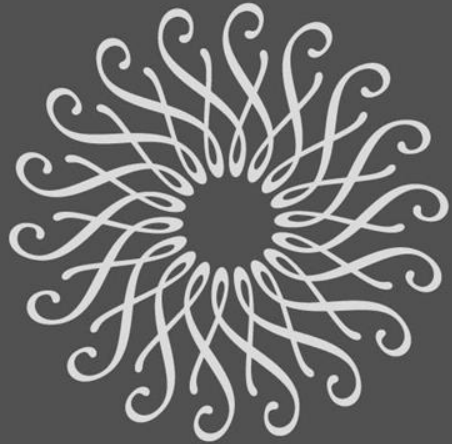
# Step 1: Example: Working Woods, Holden Arboretum





## Step 2: Example: Working Woods, Holden Arboretum





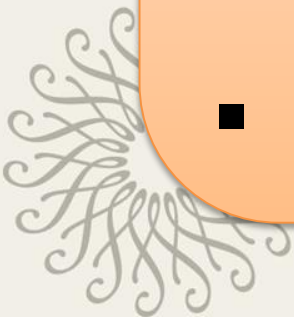
LONGWOOD  
GARDENS

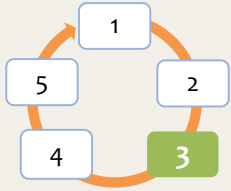
Step 3

**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

**Key Question:**

- What management challenges or opportunities might occur?
- Can current management meet management goals?
- Do goals need to change?



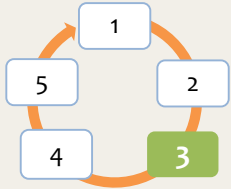


**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

## Purpose:

- Realistically assess the ability to meet goals and objectives under current management.

Can current management achieve goals?



**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

## Sub-areas, Management Objective

Challenges

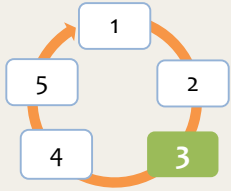
Opportunities

Feasibility under  
Current Management

Other Considerations

*From Step 1*





**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

Management Objective

Challenges

Opportunities

Feasibility under  
Current Management

Other Considerations

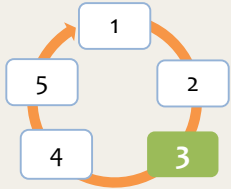
*How climate change impacts and vulnerabilities may make it more difficult to achieve the objective.*

*For example:*

- Reduced suitable habitat for target species*
- Reduced window for prescribed fire.*
- More watering required to establish young trees*

**\*\*Focus on challenges within control of your management (not global markets, policies, etc.)**





**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

Management Objective  
Challenges

Opportunities

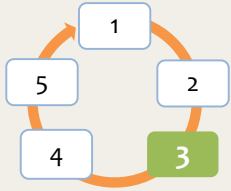
Feasibility under  
Current Management

Other Considerations

*How climate change impacts and vulnerabilities may make it easier to achieve the objective.*

*For example:*

- *Reduced competition*
- *Increased growth*
- *Climate conditions more in line with target species*



**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

Management Objective

Challenges

Opportunities

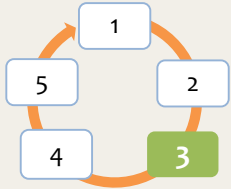
Feasibility under  
Current Management

Other Considerations

*Is current management adequate for meeting the objectives given climate change?*

**High: we can do it!**  
*Opportunities > Challenges*

**Low: We'll need more resources or effort.**  
*Challenges > Opportunities*



**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

Management Objective

Challenges

Opportunities

Feasibility under  
Current Management

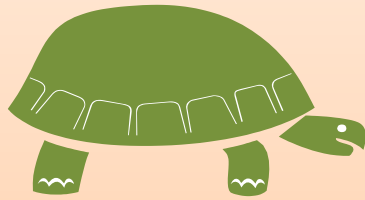
**Other Considerations**

*Social, administrative, financial, or other factors that also affect the ability to meet the objectives.*

*For example:*

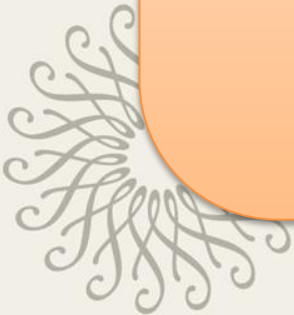
- Rare species or high social value – we'll manage for it regardless*
- Best chance of success – go for the long shot*

**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

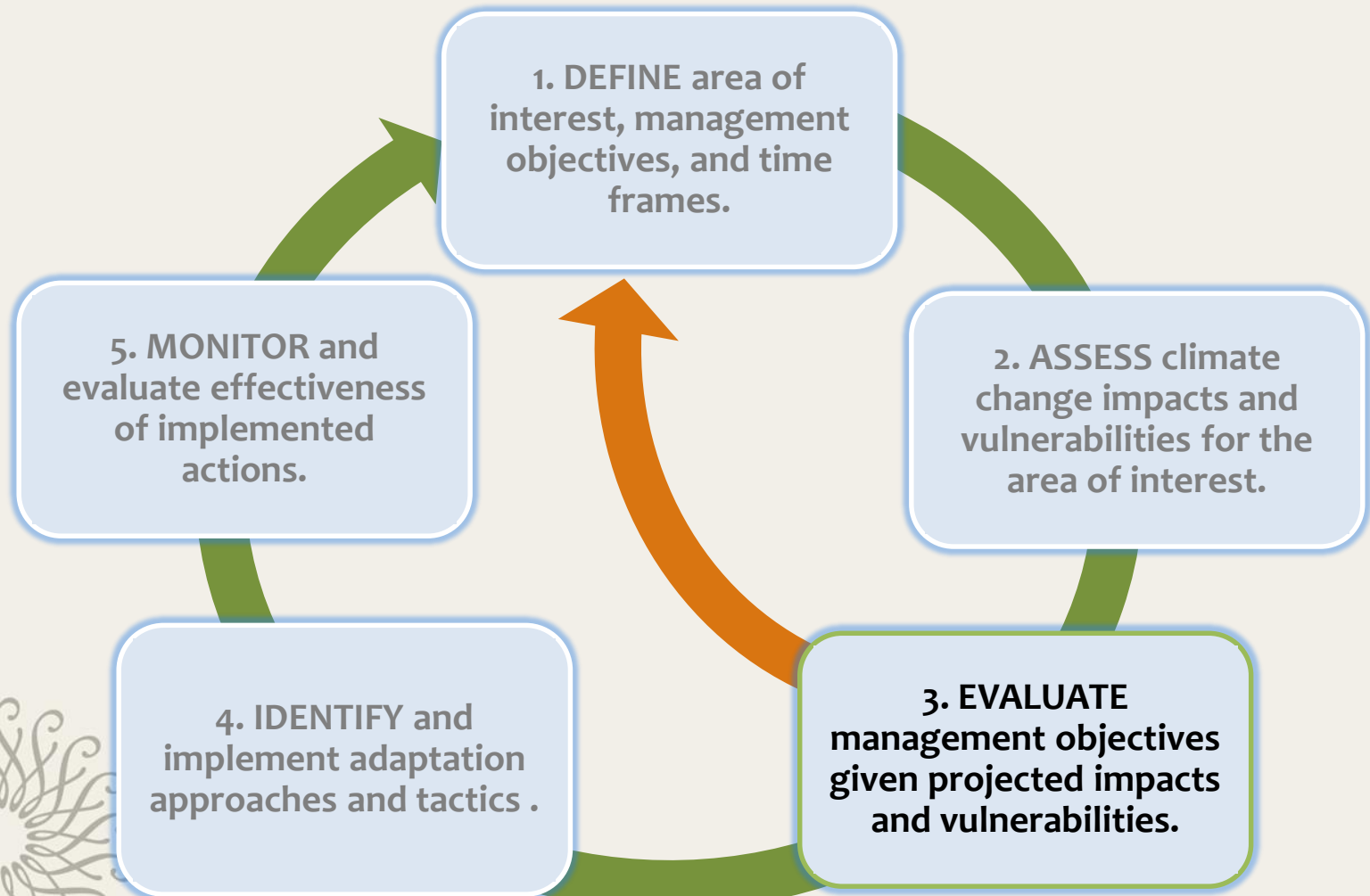


**Slow down!**

*Are you going to  
continue with these  
management objectives?*

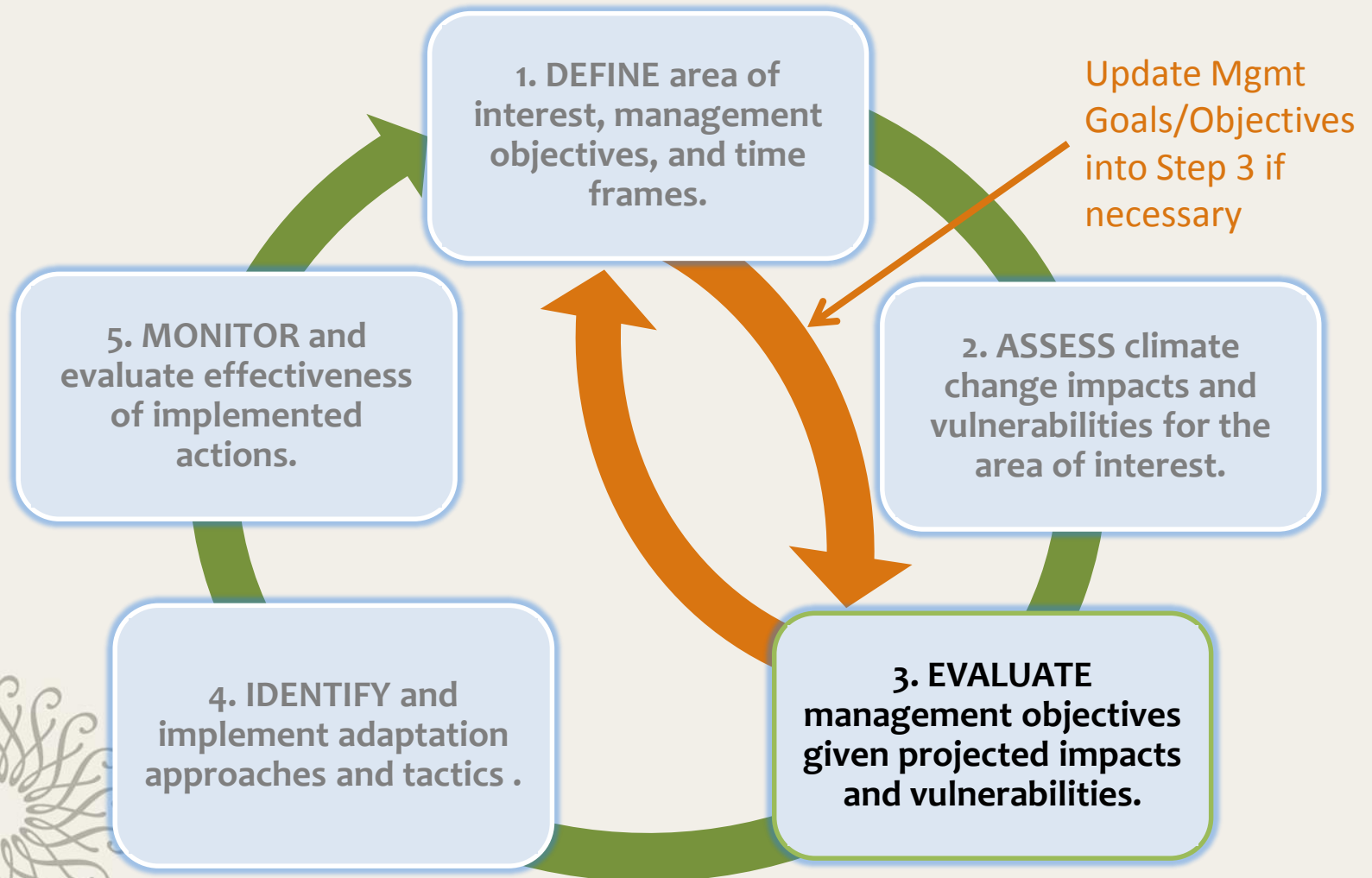


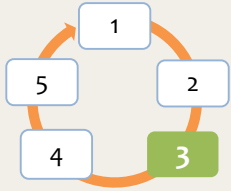
# Workbook Cycle: Step 3



*...or, RE-EVALUATE*

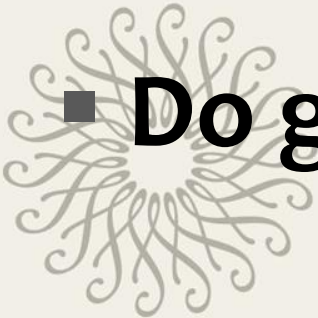
# Workbook Cycle: Step 3

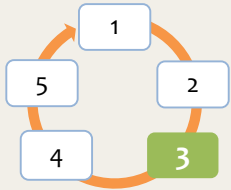




**Step 3:** EVALUATE management objectives given projected impacts and vulnerabilities.

- **What management challenges or opportunities might occur?**
- **Can current management meet management goals?**
- **Do goals need to change?**





## Step 3: EVALUATE management objectives given projected impacts and vulnerabilities.

### Mgmt. Obj.

Develop a sustainable maple syrup production demonstration.

### Challenges

Maple syrup may no longer be viable in the long-run if late winter conditions are not favorable or if sugar maple declines.

### Opportunities

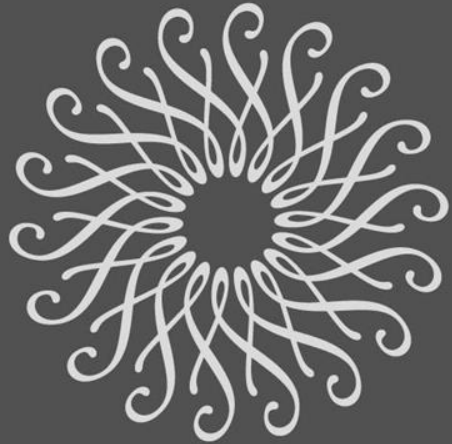
Flexibility to substitute other species for syrup if sugar maple declines (e.g., hickory, boxelder)

### Feasibility

Short term: moderate;  
Long-term: low (for sugar maple) moderate-high for others

### Other Considerations

Syrup production may be lower with alternative species



LONGWOOD  
GARDENS

Step 4

## **Step 4:** IDENTIFY adaptation approaches and tactics for implementation.

### **Key Question:**

- What actions can enhance the ability of the project area to adapt to anticipated changes and meet management goals?



# Adaptation Workbook Process

5. MONITOR and evaluate effectiveness of implemented actions.

1. DEFINE location, project, and time frames.

2. ASSESS site-specific climate change impacts and vulnerabilities

4. IDENTIFY adaptation approaches and tactics for implementation.

3. EVALUATE management objectives given projected impacts and vulnerabilities.

**Resource:** Climate Change Assessments



**Resource:** Adaptation Strategies & Approaches

What actions can be taken to  
**enhance the ability of a system  
to cope with change**  
*and*  
**meet your goals and objectives?**



# Actions for Adaptation

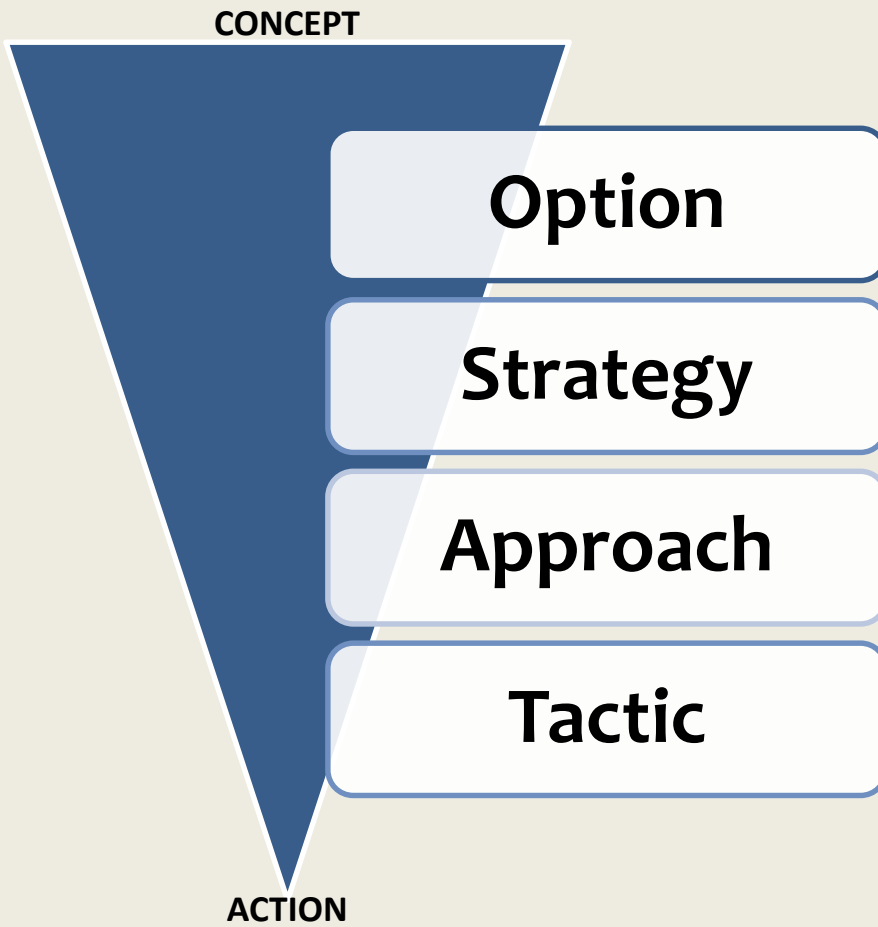
Adaptation actions are designed to specifically address climate change impacts & vulnerabilities in order to meet climate-informed goals/objectives.



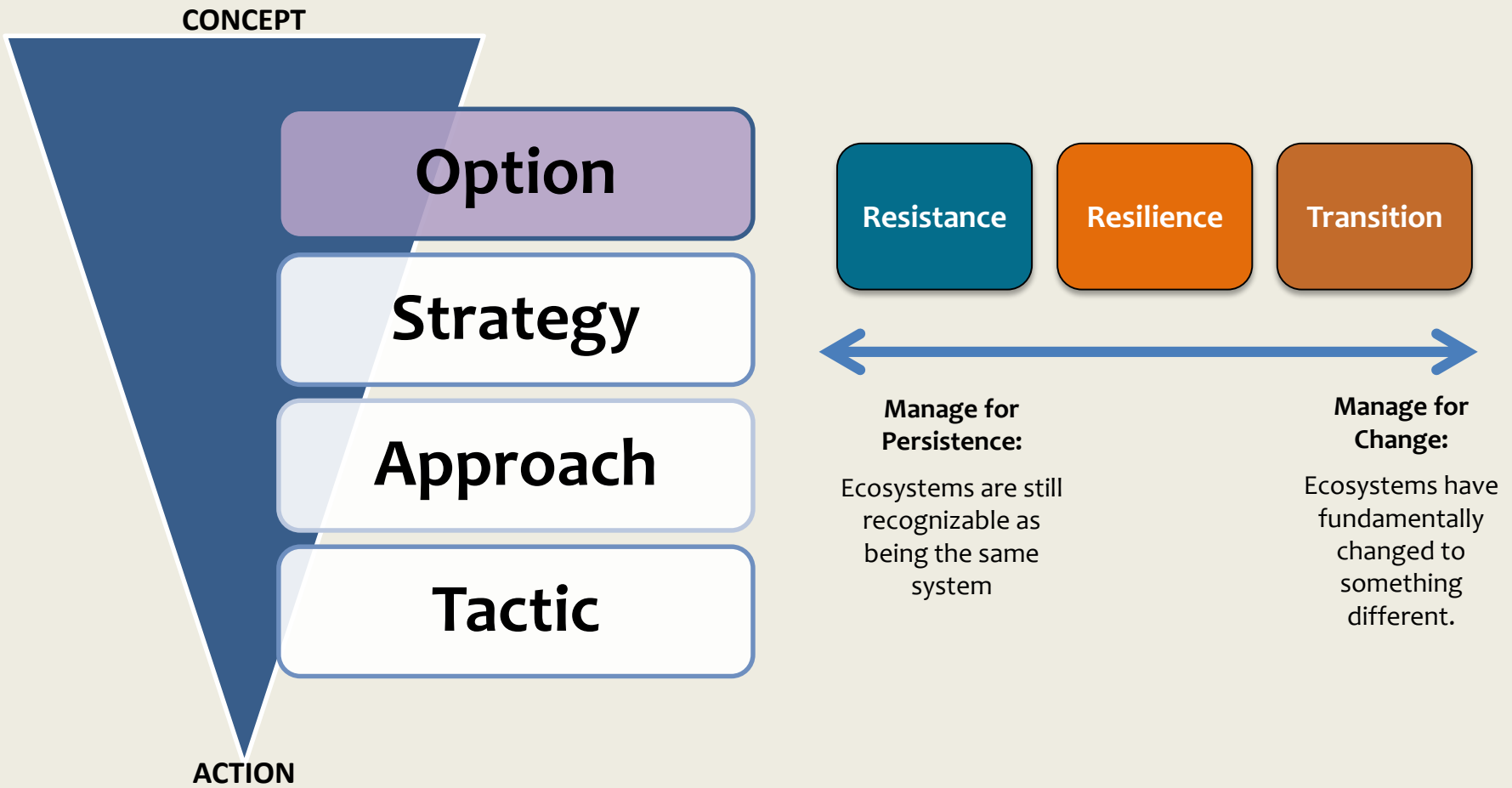
Actions might be the same/similar to what you're already doing, but its necessary to explore potential modifications to address climate change.



# Adaptation Strategies and Approaches



# Adaptation Strategies and Approaches



# Adaptation Options

**Resistance**

**Resilience**

**Transition**

Reduce impacts/  
Maintain current  
conditions

Forward-looking/  
Promote change



# Resistance Strategies

- Water during hot, dry periods
- Using systemic insecticides for Ash trees
- Protect/maintain cold-adapted trees on the north side of buildings/north facing slopes
- Install dry wells to control flooding



# Village of Hazel Crest, IL



Planting Shumard  
Oak over Dry Well

# Resistance Pros/Cons

## Pros

Usually in-line with current policies and management goals

Not usually controversial

May be best hope for at-risk species and ecological communities

## Cons

Costly

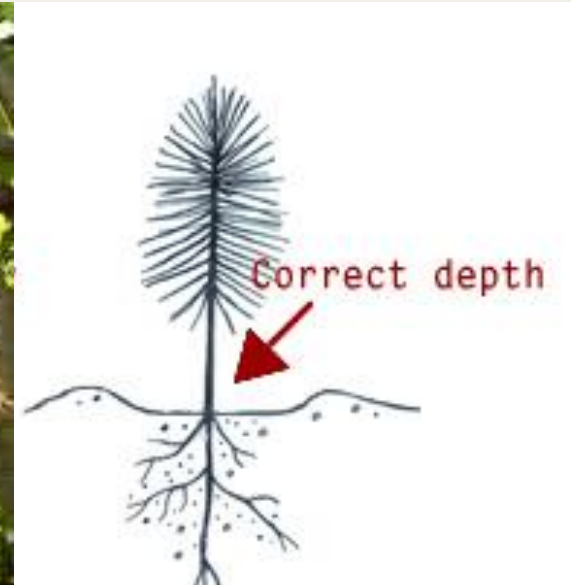
May not be effective in the long run

Time-intensive



# Resilience Strategies

- Plant native species that are not common in your neighborhood/location to enhance diversity
- Plant trees and other native plants that can withstand a variety of stressors (drought, flooding, wind) and are adapted to your soils
- Prune to reduce susceptibility to storm damage
- Plant trees at the proper depth for greater stability and health



# Urban Forestry Basic Training- Chicago



# Resilience Pros/Cons

## Pros

Usually in-line with current policies and management goals

Not usually controversial

May help reduce risks to other disturbances beyond climate change

## Cons

Management may not be sufficient to deal with unprecedented disturbances

Management decisions are often made with historic range of variability in mind instead of future change



# Transition Strategies

Incorporate rain gardens

Incorporate future-adapted species, seed sources

Consider transitioning to new plant community assemblages



# Riverside: Buckeye, accolade elm, pecan



# Transition Pros/Cons

## Pros

Ecosystems most likely to align with and withstand current and future conditions

May be less costly in the long run

## Cons

Up-front costs may be higher

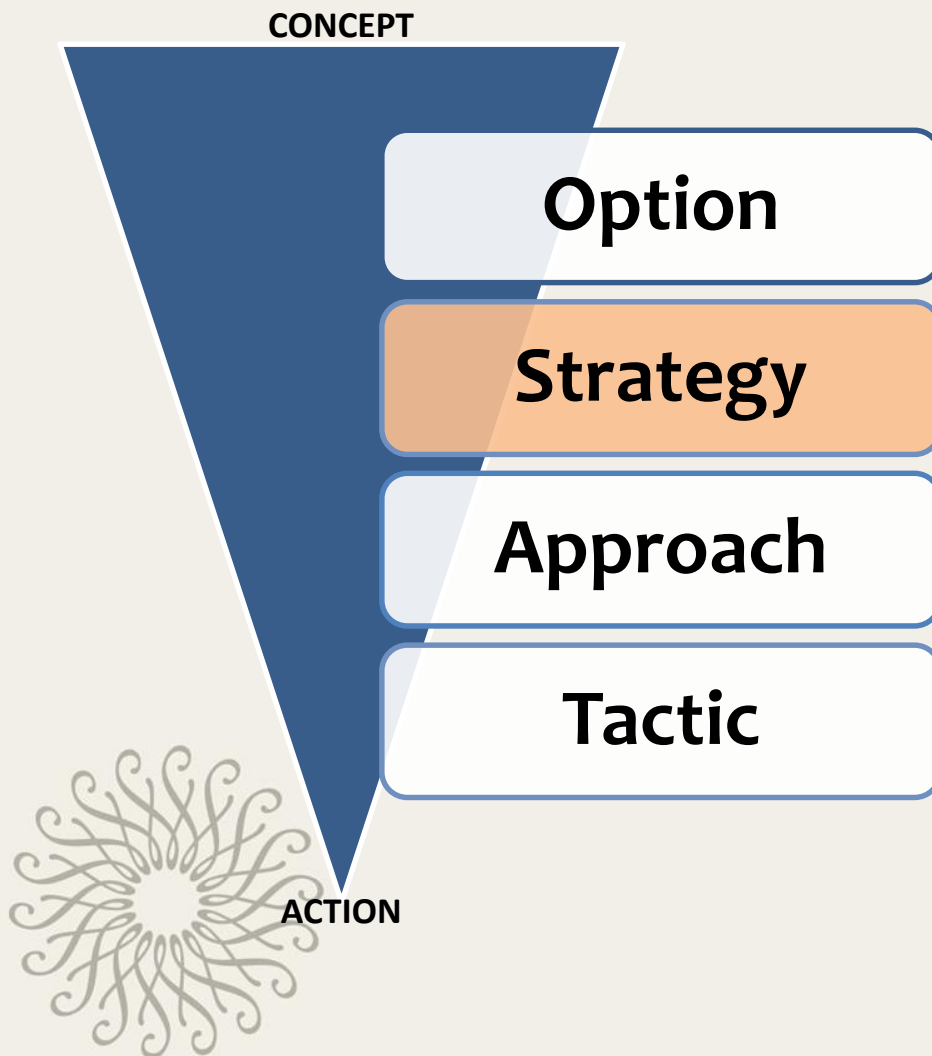
May be policy or social barriers to implementation

Uncertainty in climate projections

Risks associated with introducing new species/genotypes



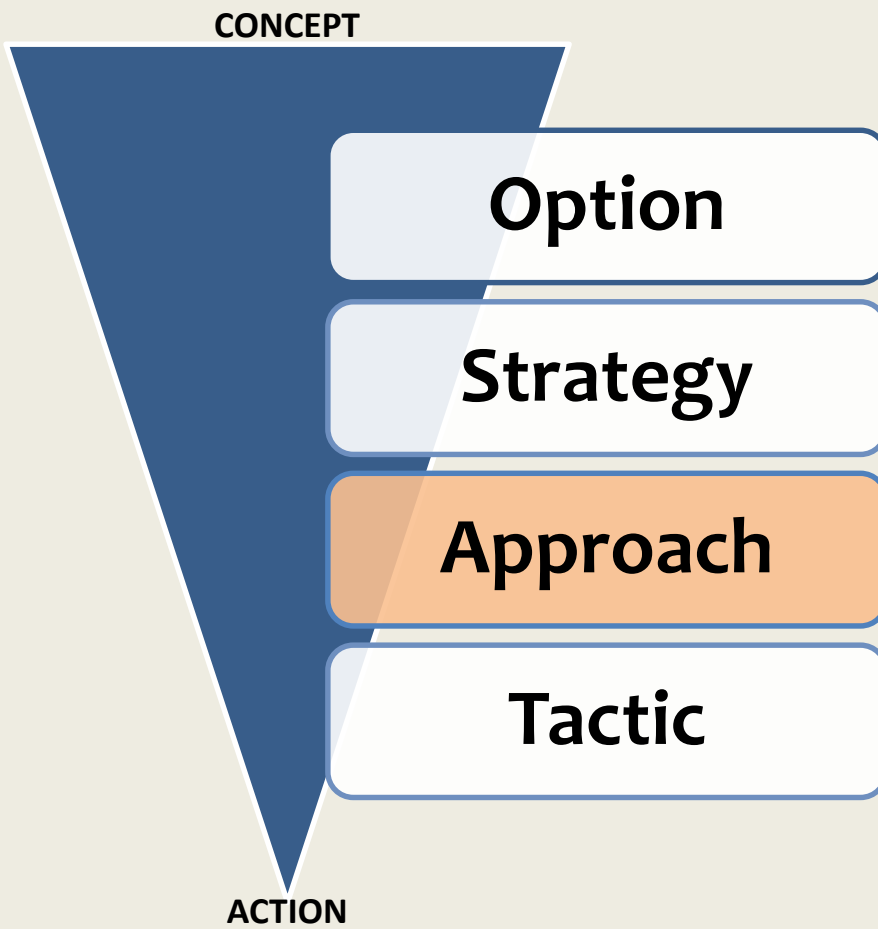
# Adaptation Strategies and Approaches



## Broad adaptation responses

- Sustain fundamental ecological functions
- Reduce the impact of existing biological stressors
- Reduce the risk and long-term impacts of severe disturbances.
- Facilitate community adjustments through species transitions

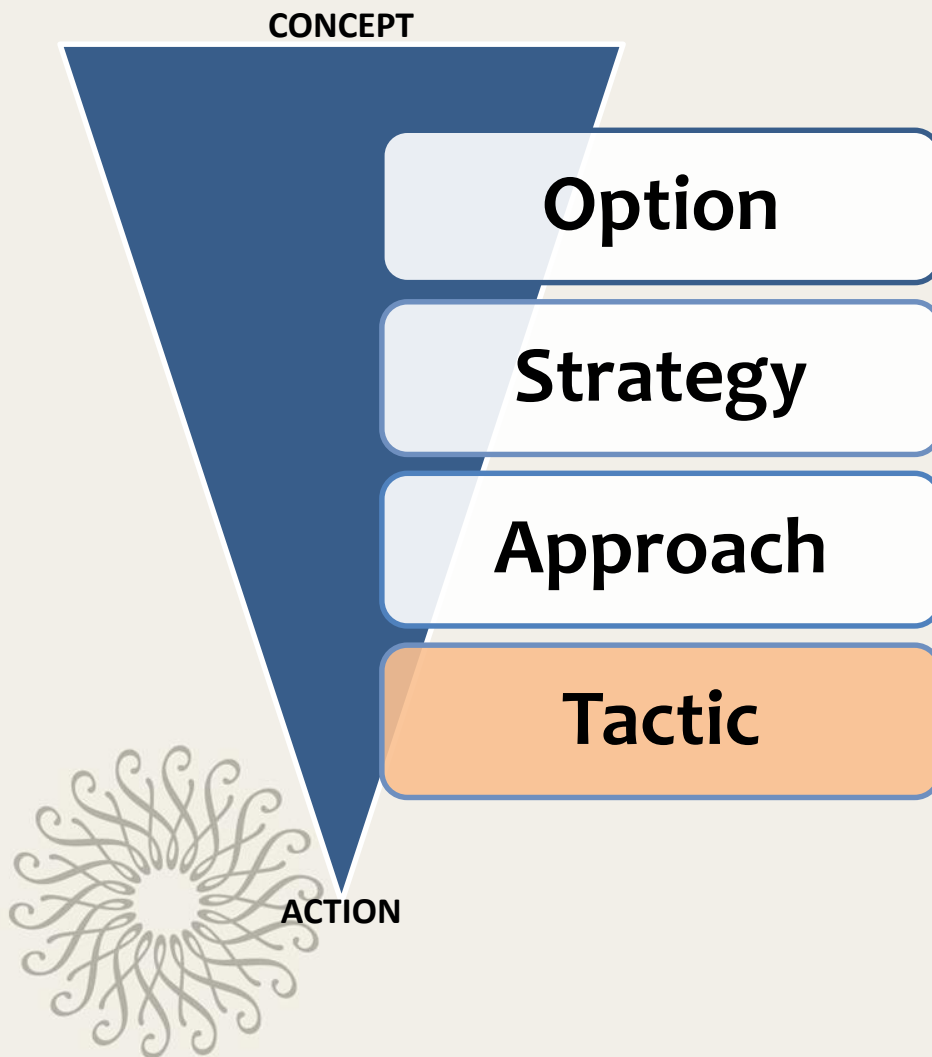
# Adaptation Strategies and Approaches



## More specific actions

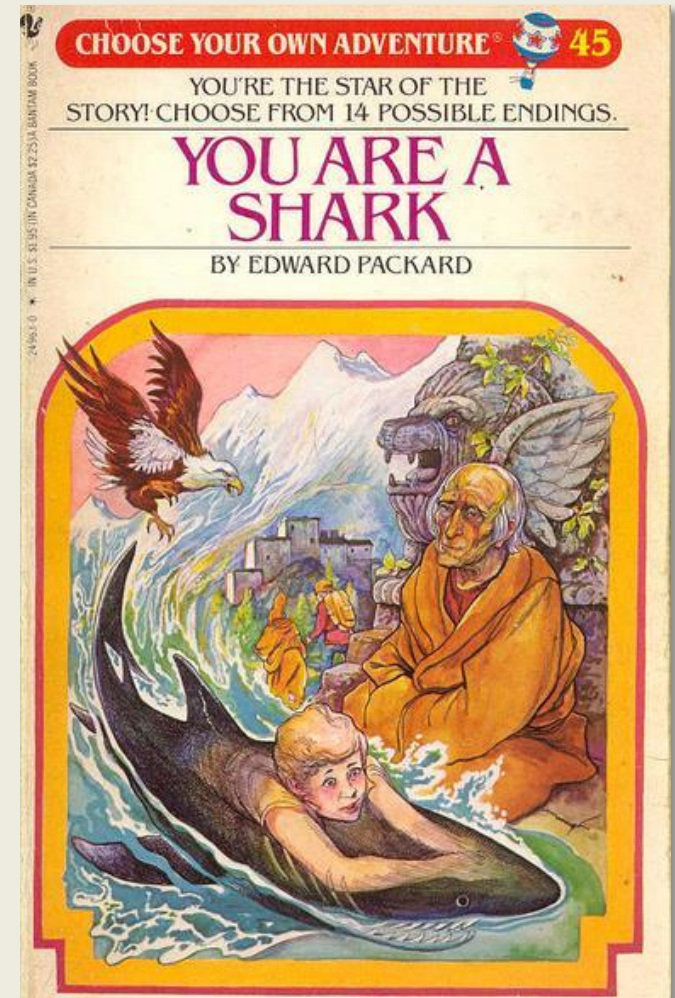
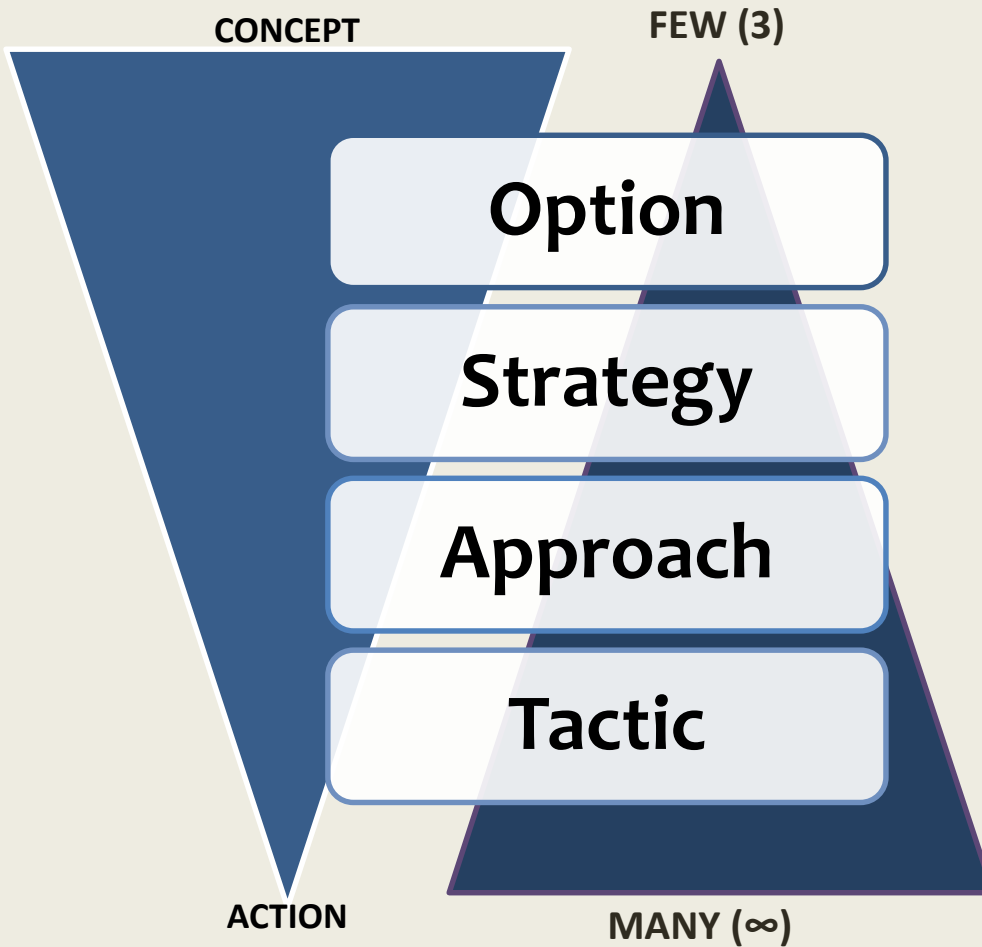
- Manage for species or genotypes with wide moisture and temperature tolerances.
- Introduce species that are expected to be adapted to future conditions.
- Move at-risk species to locations that are expected to provide habitat.

# Adaptation Strategies and Approaches



Prescriptive actions selected by producer that are designed for individual site conditions and management objectives

# Adaptation Strategies and Approaches



# Adaptation Strategies and Approaches

CONCEPT

Manage for persistence (resistance)

Maintain or create refugia

Establish artificial reserves for at-risk and displaced species

Regenerate, plant, and care for vulnerable species in arboreta and botanical gardens.

ACTION

# Adaptation Strategies and Approaches

CONCEPT

Manage for change (transition)

Facilitate community adjustments through species transitions

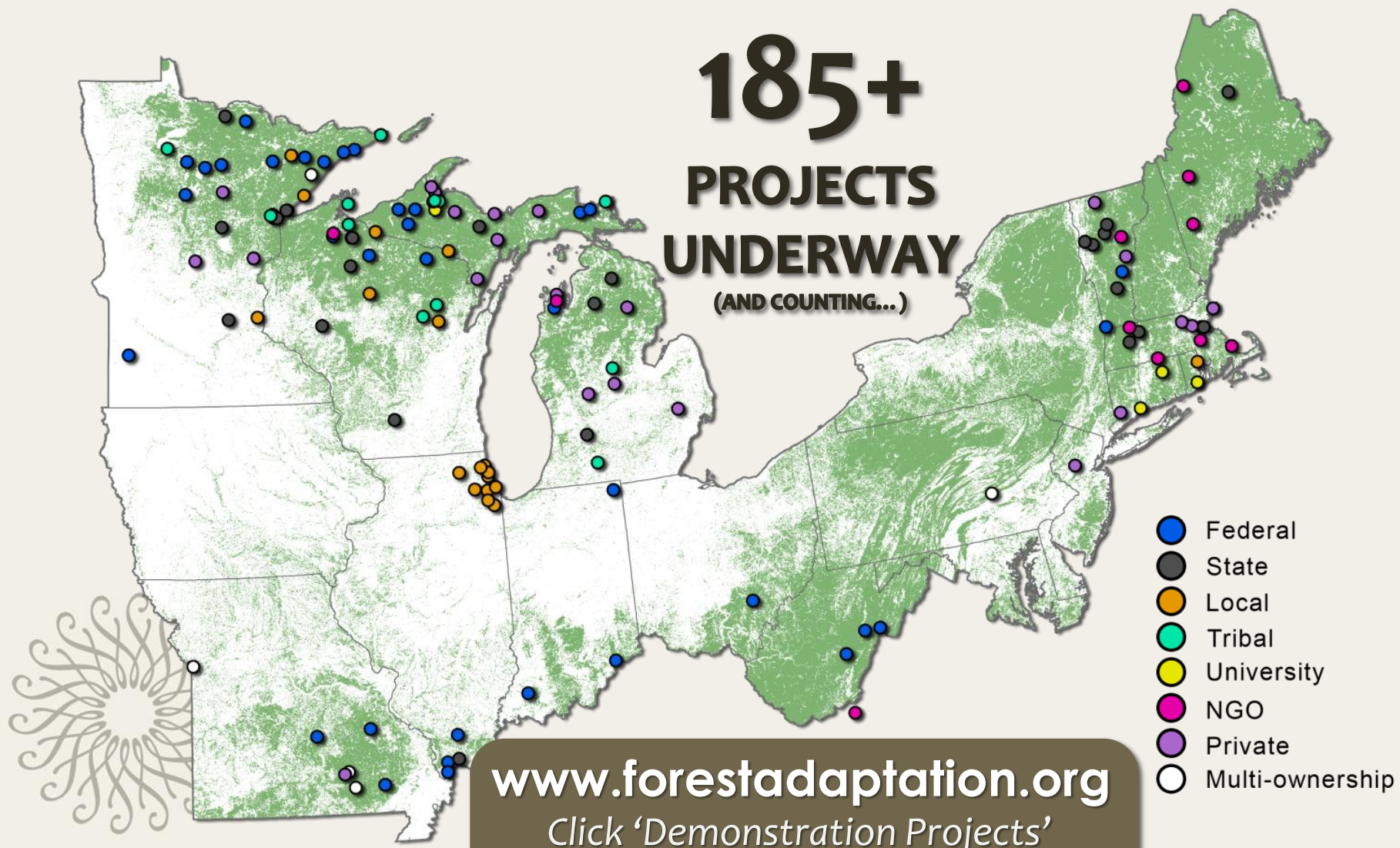
Introduce species that are expected to be adapted to future conditions.

Incorporate osage-orange, mockernut hickory into new park plantings and monitor.

ACTION

# FOREST ADAPTATION DEMONSTRATIONS

Product of the Climate Change Response Framework



# The Nature Conservancy: Adaptation Forestry in Minnesota's Northwoods



Option: Resistance

Tactic: Bud caps to prevent deer browsing



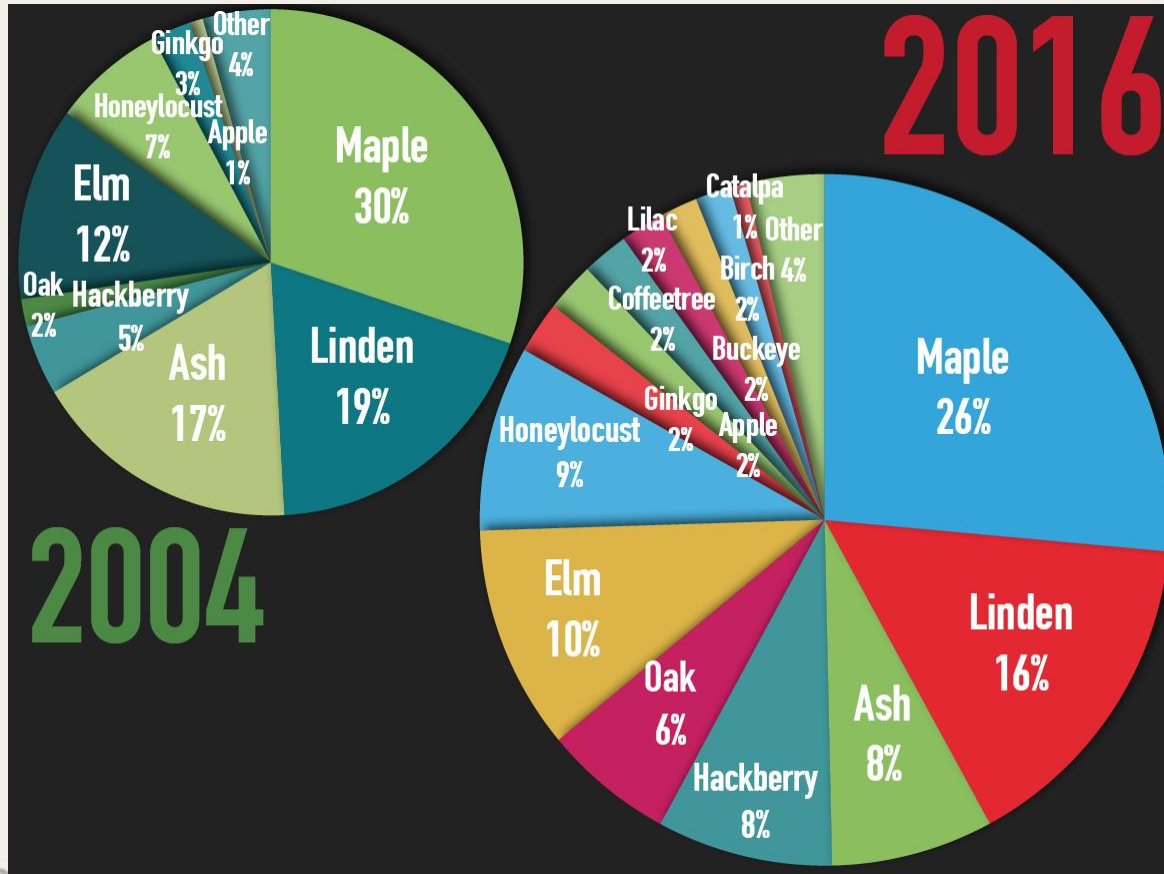
# Rajala Companies: Sugar Hills Forest Stewardship



Option: Resistance/Resilience

Tactic: Thinning to reduce competition for water and nutrients.

# Minneapolis: Planning for Diversity



Option: Resilience

Tactic: Increasing diversity of species, genera, and families across the city



# NRCS Forest Management Plan: Michigan



Option: Resilience.

Tactic: Retaining mature trees to diversify age structure and provide a seed source.



# Nelson Family: Climate-Informed Forest Stewardship Plans



Option: Transition.

Tactic: Incorporating native oaks into plantings that are expected to do well.





- 2017 Order
  - Manchurian alder
  - Hardy rubber tree
  - Dawn redwood
  - London Planetree
  - Shingle oak
  - Bald cypress
  - Cucumber Magnolia
  - Tulip Tree
  - Katsura
  - Pignut hickory \*
  - Shellbark hickory \*
  - Shagbark hickory \*
  - Osage Orange \*
  - Turkish hazel \*

## LONGWOOD



# Hennepin County: New Species Selection

Option: Transition

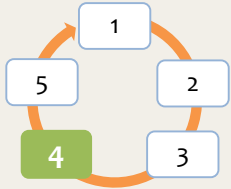
Tactic: Planting neo-natives or non-natives that are adapted to warmer climates.

## **Step 4:** IDENTIFY adaptation approaches and tactics for implementation.

### **Key Question:**

- What actions can enhance the ability of the project area to adapt to anticipated changes and meet management goals?





**Step 4:** IDENTIFY and adaptation approaches and tactics for implementation.

## Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

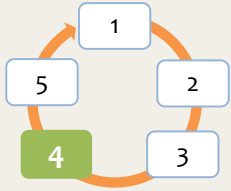
Practicability

Recommend Tactic?

*Select from the menu of adaptation strategies and approaches.*

*Pick those that help you:*

- 1. Meet management objectives*
- 2. Address biggest impacts*
- 3. Overcome challenges*
- 4. Capitalize on opportunities*



## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

Practicability

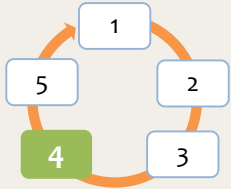
Recommend Tactic?

How the adaptation approach will be implemented.

For example:

- Restore fire through low-intensity prescribed burn every 3-5 years
- Increase genetic diversity by acquiring seed from one seed zone south

Note: There may be multiple approaches for a single tactic, or vice versa.



## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

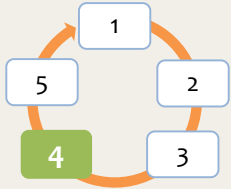
Practicability

Recommend Tactic?

Timing for the tactics

For example:

- Summer 2014
- Winter 2013-2016
- Within 3 years of...
- After...



## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

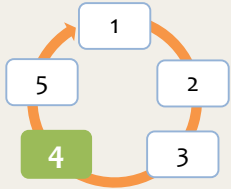
Practicability

Recommend Tactic?

Why it's good

For example:

- Addresses biggest or multiple challenges/impacts
- Capitalizes on opportunities
- Cheap, easy
- Co-benefits
- Likely to succeed



**Step 4:** IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

**Drawbacks and Barriers**

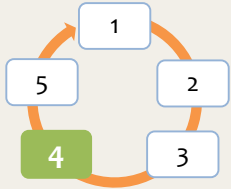
Practicability

Recommend Tactic?

Why it's not so good

For example:

- Negative side effects
- High cost or effort
- Social, financial, or other barriers
- Uncertainty of success



## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

Practicability

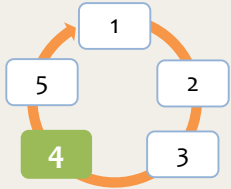
Recommend Tactic?

Is it both effective and feasible?

**High:** Yes to both!

**Moderate:** Yeah, but it will take some additional effort or planning...

**Low:** No, the barriers/drawbacks seem too big or the benefits too small.



## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

Adaptation Approach

Tactic

Time Frame

Benefits

Drawbacks and Barriers

Practicability

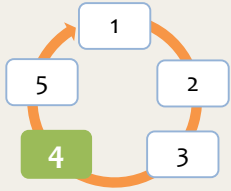
Recommend Tactic?

Given all this, is this tactic likely to be helpful?

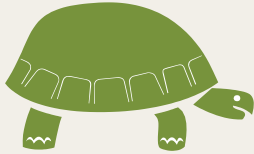
Also consider: trade-offs, urgency, likelihood of success, cost, and effort...

**Yes:** look to integrate into plan, prescription, or other activities

**No:** not useful at this time



**Step 4:** IDENTIFY and adaptation approaches and tactics for implementation.



**Slow down!**

*Are you going to continue with the adaptation tactics that have been selected?*



# Re-cap

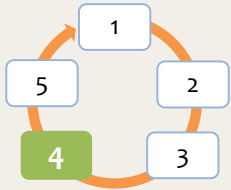
Best management principles, but applied in the context of climate change

Hierarchy helps organize and justify adaptation actions

Menu allows user to pick and choose actions that are relevant to their situation

Managers design tactics to suit particular needs





## Step 4: IDENTIFY and adaptation approaches and tactics for implementation.

### Adaptation Approach

Promote diverse age classes

Favor or restore native species that are expected to be better adapted to future conditions

### Tactic

- Remove overmature beech and maple that are expected to decline.
- Underplant with native species expected to do well under future climate change that could serve as syrup alternatives.

### Consider:

- Benefits: Reduces component of vulnerable trees. Favors species that could do well. Harvested wood can be sold, used in products. New trees can be used in demonstration plots to educate public on what they can do.
- Drawbacks/Barriers: A lot of up-front resources are required to implement tactics. New trees may be less profitable as timber and non-timber products.
- Practicability: High

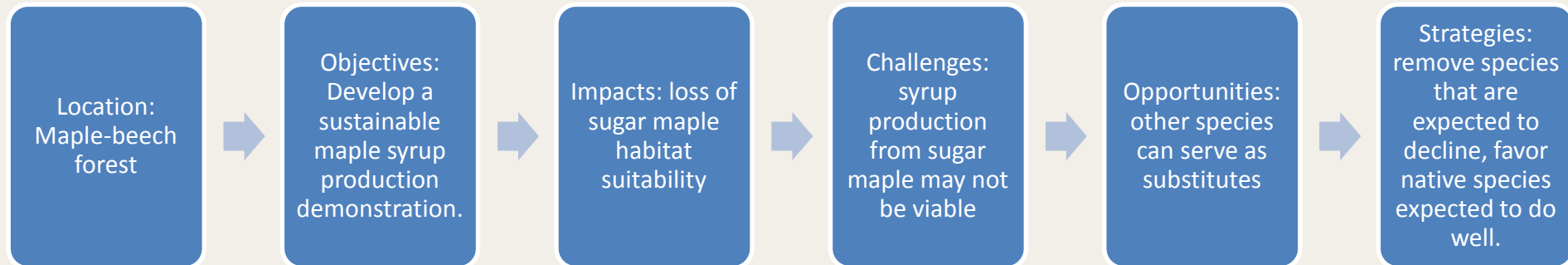
### Recommend Tactics?

Yes

Yes

# Review your strategies

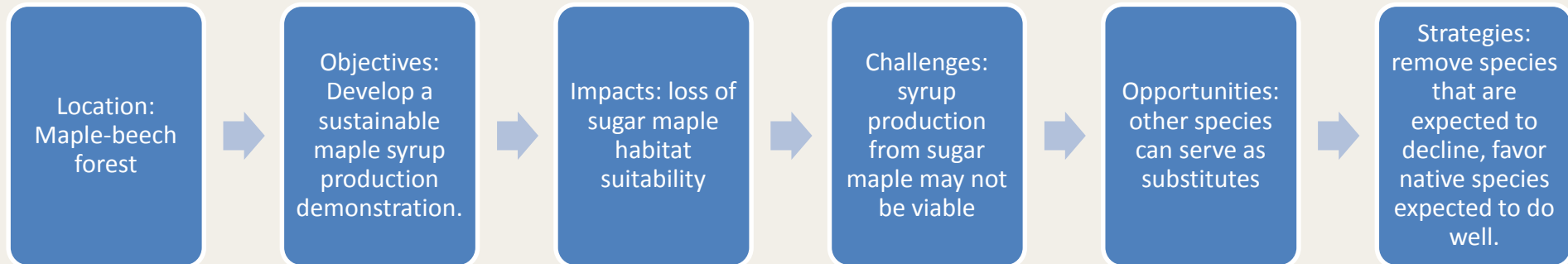
Holden Arboretum example:



Can you still meet your objective?

# Review your strategies

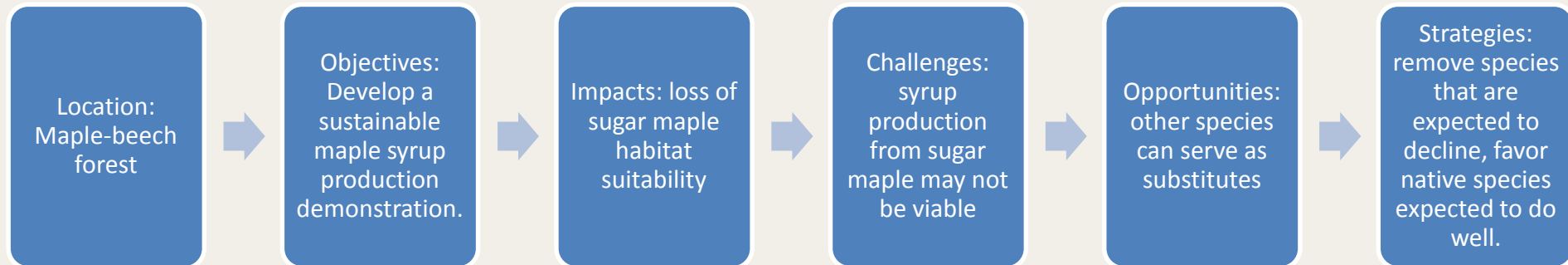
Holden Arboretum example:



Does it address your biggest impacts?

# Review your strategies

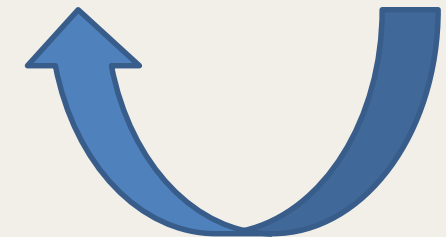
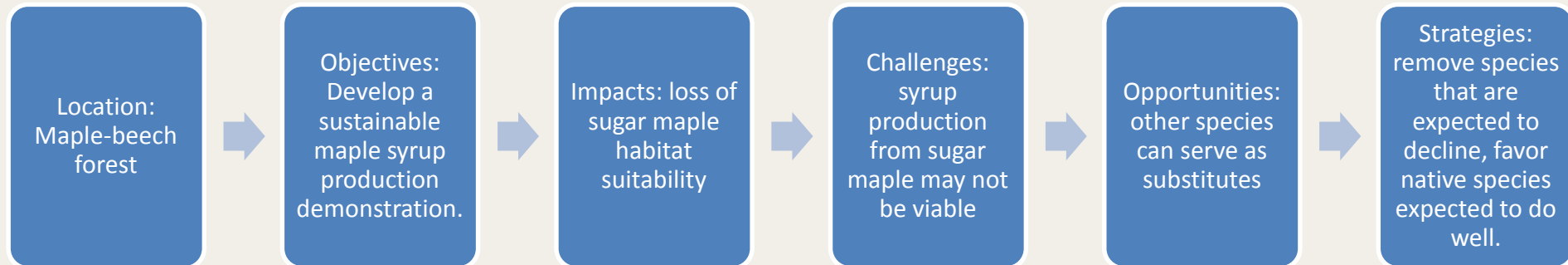
Holden Arboretum example:



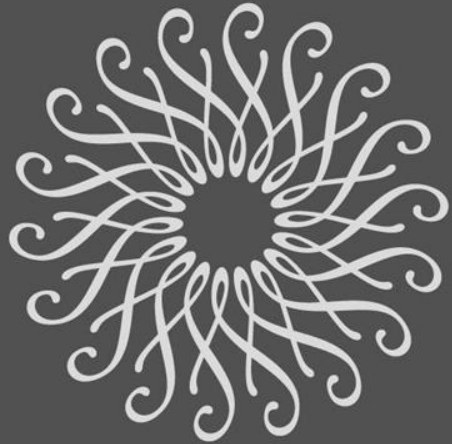
Does it help you overcome challenges?

# Review your strategies

Holden Arboretum example:



Does it capitalize on opportunities?



LONGWOOD  
GARDENS

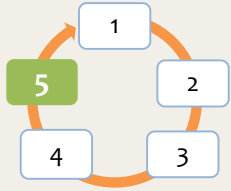
Step 5

## **Step 5:** MONITOR and evaluate effectiveness of implemented actions.

### **Key Question:**

- How do we know if the selected actions were effective?
- What can we learn from these actions to inform future management?





## Step 5: MONITOR and evaluate effectiveness of implemented actions.

Adaptation Monitoring Variable

Criteria for Evaluation

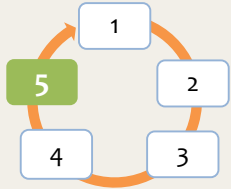
Monitoring Implementation

*What you're monitoring or measuring.*

*For example:*

- *Percentage success at 1, 2, 5, and 10 years after planting.*





**Step 5:** MONITOR and evaluate effectiveness of implemented actions.

Adaptation Monitoring Variable

**Criteria for Evaluation**

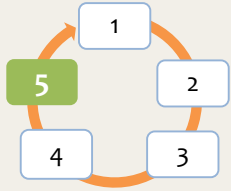
Monitoring Implementation

*Evaluation of success*

*For example:*

- *60% survival of non-local genotypes*





**Step 5:** MONITOR and evaluate effectiveness of implemented actions.

Adaptation Monitoring  
Variable

Criteria for Evaluation

**Monitoring  
Implementation**

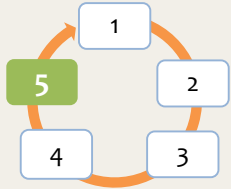


*How the monitoring will actually get done.*

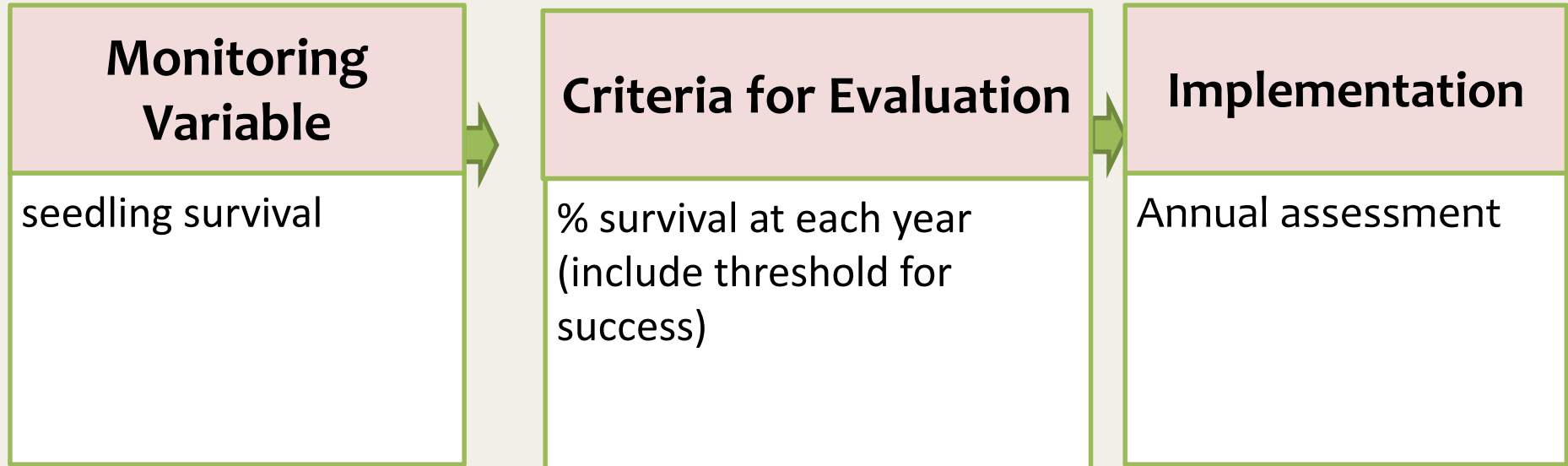
*Note: use existing monitoring when possible*

*For example:*

- *Regular post-planting stocking surveys.*
- *Supplemental surveys at 10 years.*



## Step 5: MONITOR and evaluate effectiveness of implemented actions.





***YOU MADE IT!***  
***(Congrats!)***

# To-do list:

## You folks:

Evaluations (please!)

Can we have a copy of your Workbook?

Keep moving these ideas forward!

Follow up with questions or ideas

Can we share your idea on [www.ForestAdaptation.org](http://www.ForestAdaptation.org)?

## NIACS:

-Share contact list & presentations from today

-Check in soon!

-Other ideas?

**Thanks everyone!**