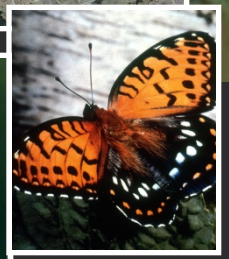
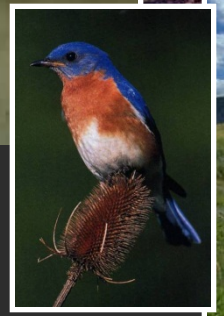
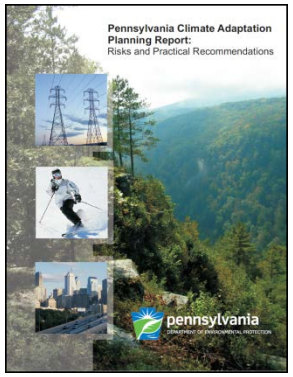



CLIMATE-INDUCED CHANGES IN HABITAT AND COMMUNITY COMPOSITIONS: HOW DO WE BEGIN TO ADAPT THE FIELDS OF ECOLOGY AND RESTORATION

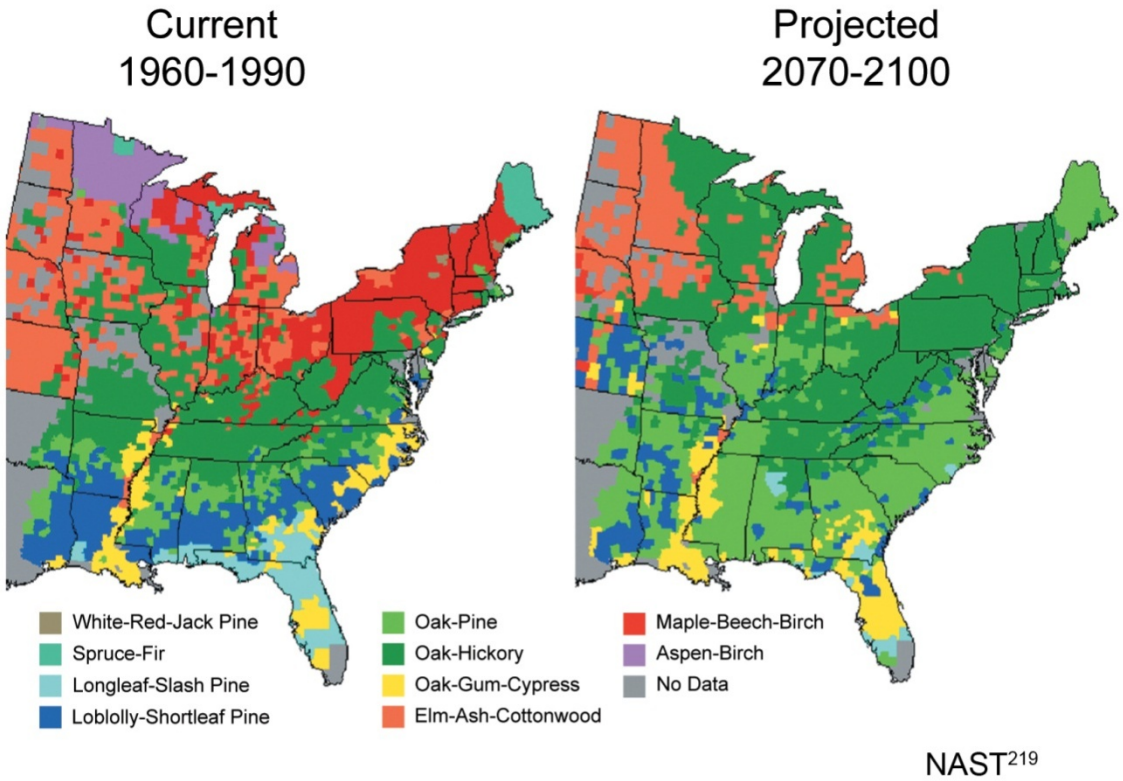
Diane Husic, Dept. of Biological Sciences
Moravian College, Bethlehem, PA (dhusic@moravian.edu)

How did I get interested in this topic?

- Restoration work at the Lehigh Gap (The Palmerton Superfund Site)
- PA Climate Change Adaptation Working Group (on Natural Resources)
- Participation in RINGOs/the UNFCCC process
- The Eastern PA Phenology Project
- Book Review/Review of the scientific literature/IPCC-SREX report



Projected changes in forest types in the eastern U.S.



The maps show current and projected forest types. Major changes are projected for many regions. For example, in the Northeast, under a mid-range warming scenario, the currently dominant maple-beech-birch forest type is projected to be completely displaced by other forest types in a warmer future.[244]

USGCRP (2009). *Global Climate Change Impacts in the United States* . T.R. Karl, J.M. Melillo, and T.C. Peterson (eds.). United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

http://downloads.globalchange.gov/usimpacts/allimages/7-Ecosystems/7-Hi%20res/7-Ecosystems-pg-81.jpg

SER Position Statement on Global Climate Change - 2007

- Joint conference with Ecological Society of America: "Ecological Restoration in a Changing World

The loss of vital ecosystem functions and services reduces biological resilience and adaptability, further increasing our vulnerability to the adverse impacts of global climate change

Former SER chair, Keith Bowers

"SER strongly urges …organizations as well as private institutions to plan, finance, and coordinate ecological restoration projects as part of a comprehensive global strategy for <u>mitigating</u> climate change and its effects."

From 2007 SER Statement

Review of the Literature

- **Textbooks on Ecological Restoration have little mention of climate change**
- **Peters (1985)**

  ***In the case of major changes in global climate**, we may have to depend upon the lessons and techniques of ecological restoration ecology **to save** many **species**—and even whole communities.*

- **Lavendel (2003)**

  Some practitioners are reluctant to take potential climate-change scenarios into account because the scale of most restoration projects is smaller than the landscape-scale at which climate change is currently modeled.

Review of the Literature – Key Issues

- **Issues mentioned in 2003 (Lavendel in *Ecological Restoration*)**
  - Rising sea levels
  - Providing refugia and migration corridors

    (ideas go back to the 1980s)
  - Emergence of new ecological communities

- **2006 (Harris *et al.* in *Restoration Ecology*)**
  - "static conservation and restoration objectives"
  - Ecosystem assemblages or functioning ecosystems?
  - Resilience and adaptability will be dependent on genetic diversity

    (Recommendations to broaden genetic and species diversity in restoration and forestry go back to at least 1992)

Review of the Literature

- **Heller and Zavaleta (2009)** on biodiversity management in the face of climate change:

> *Broadly, adaptation requires* ***improved regional institutional coordination, expanded spatial and temporal perspective, incorporation of climate change scenarios into all planning*** *and action, and greater effort to* ***address multiple threats and global change drivers simultaneously*** *in ways that are responsive to and* ***inclusive of human communities.***

> ***However, in the case of many recommendations the how, by whom, and under what conditions they can be implemented is not specified.***

Review of the Literature

- **USDA Forest Service (2006)** publication:

  Ecosystem Restoration: A Framework for Restoring and Maintaining the National Forests and Grasslands

- Forest growth and productivity
- Changing composition of forests/species vulnerability
- Much focus on climate change and forest disturbances

  Frequency, intensity, duration, and timing of:

  - fire,
  - drought,
  - introduced species, insect and pathogen outbreaks,
  - hurricanes, windstorms, ice storms, or landslides

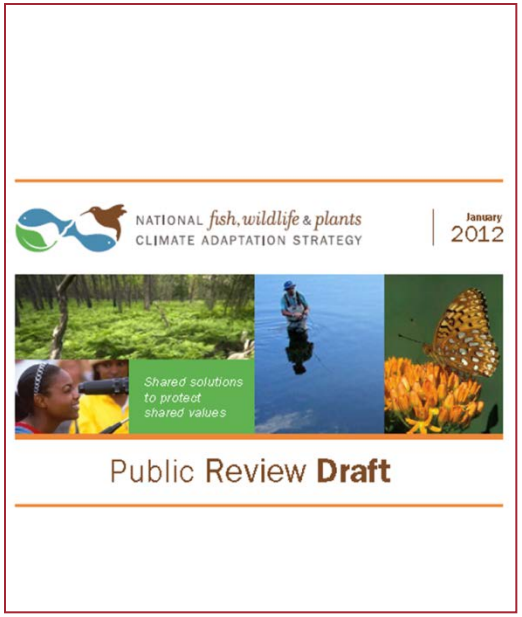
Review of the Literature

- **Harris *et al*. (2006):**

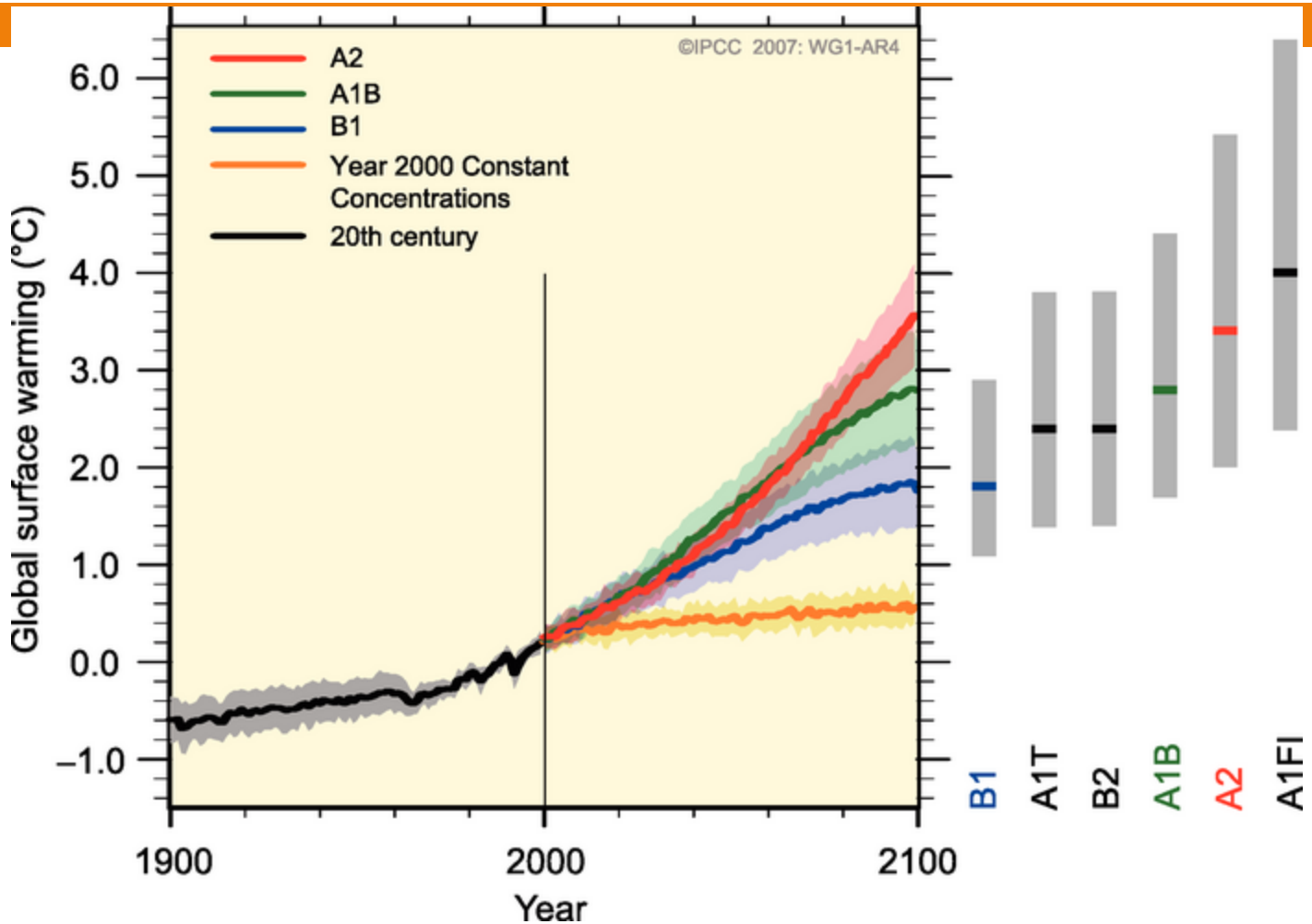
  Does the theory and practice [of restoration] *developed over the past few decades* ***fit the realities of our brave new world?***

- **How much are the climate science, conservation, ecology, and restoration "circles" talking to each other and sharing ideas, data, and best practices?**

- **Next week: Inaugural National Forum on Adaptation**



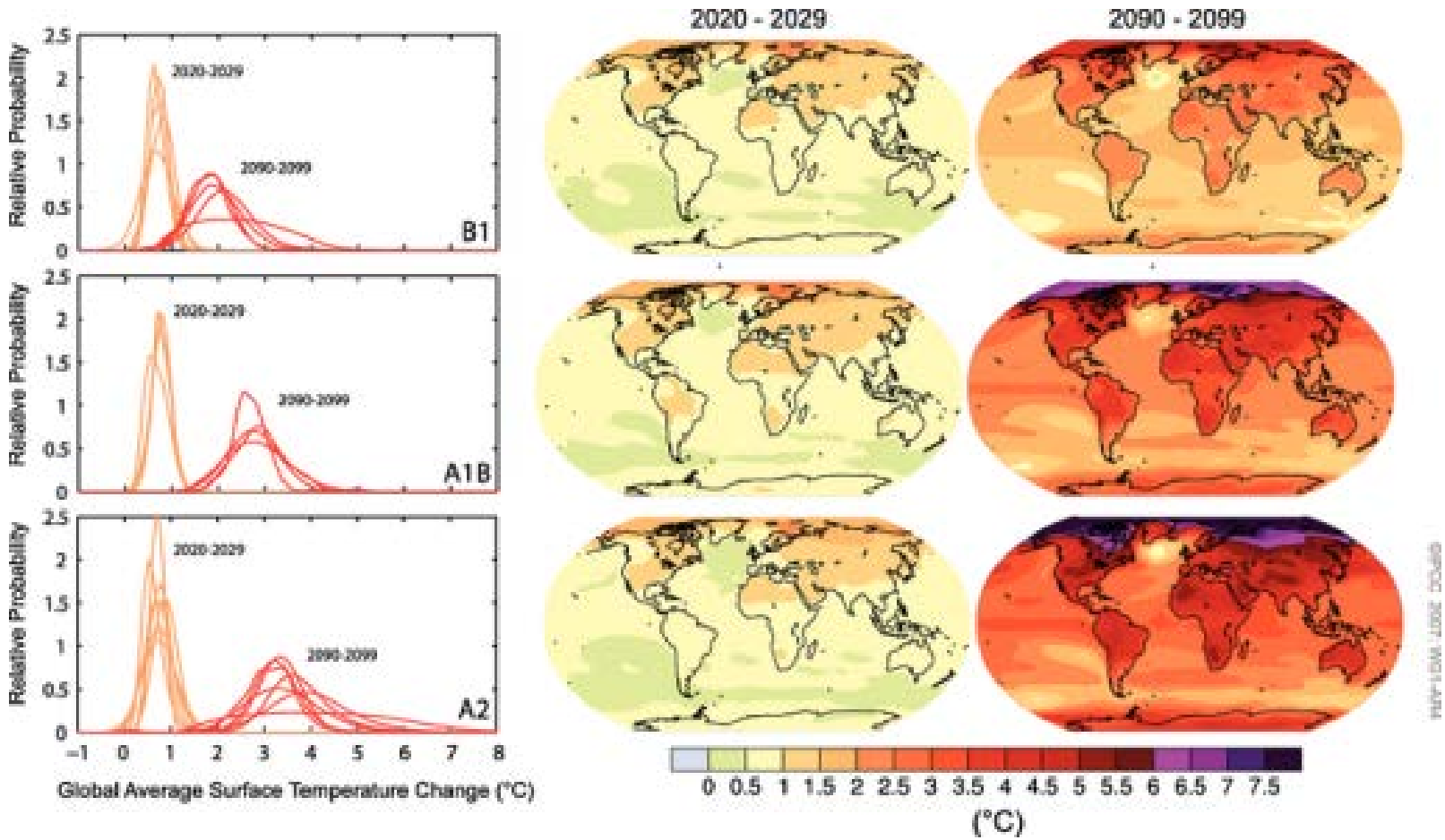
Projections of global surface warming under different emission scenarios



IPPC. Climate Change 2007: Working Group I: The Physical Science Basis

http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-spm-5.html

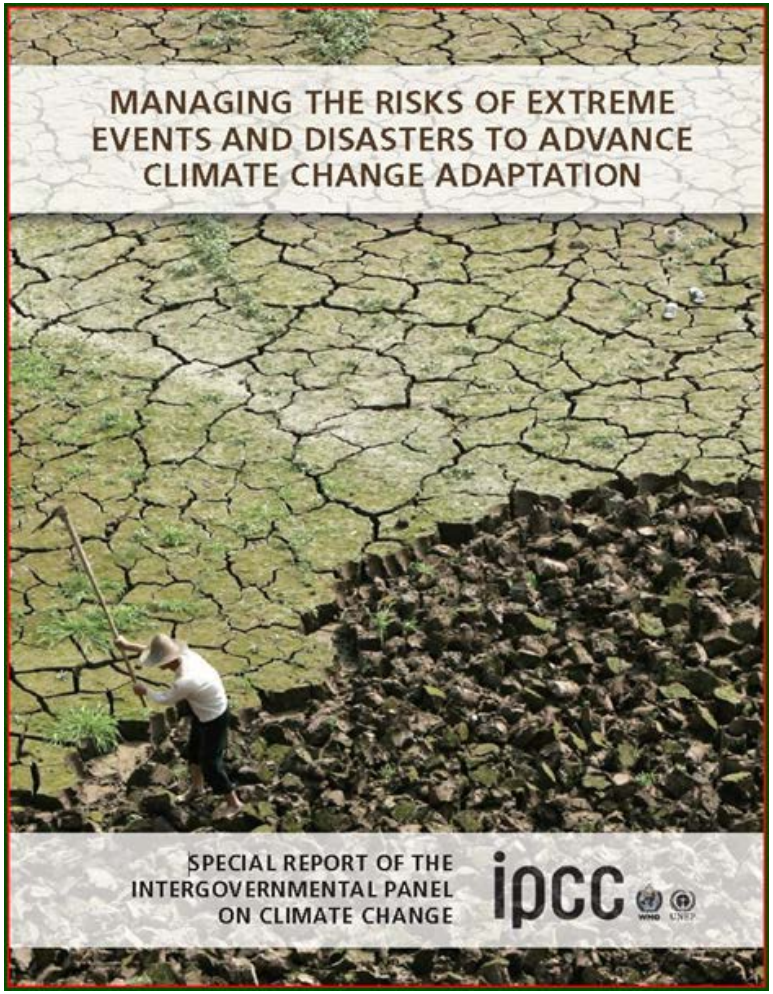
Future Scenarios: Projections of Surface Temperature



IPPC. Climate Change 2007: Working Group I: The Physical Science Basis

http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-spm-6.html

The 2012 IPPC SREX Report



Predicted climate-related changes for the mid-Atlantic region

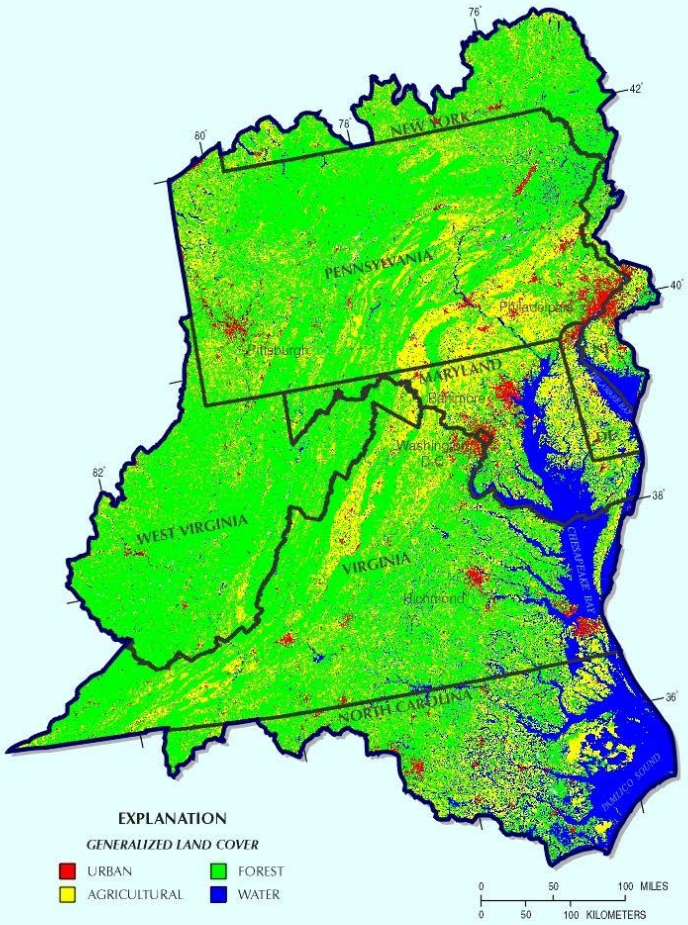
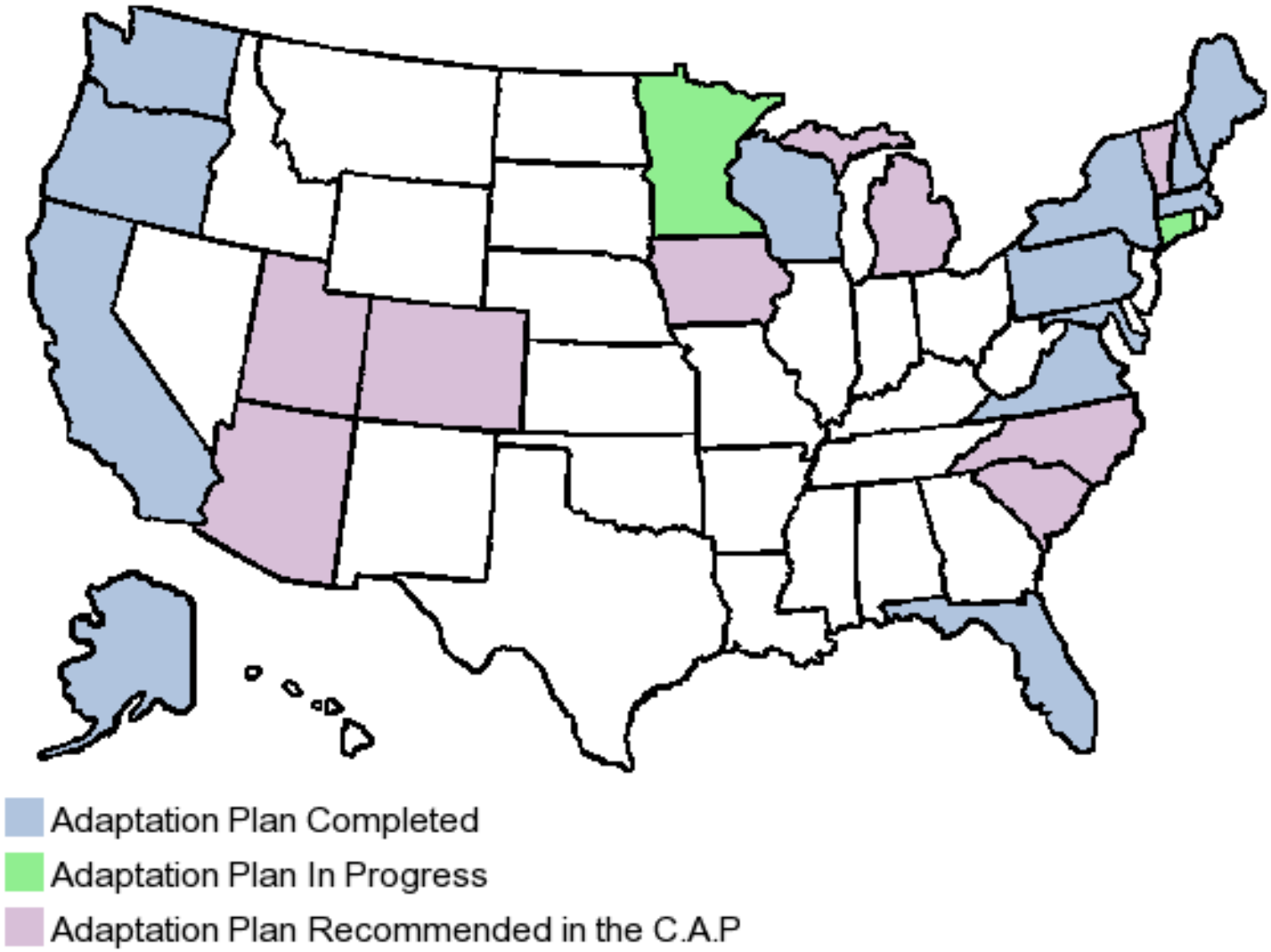


Figure 1. Generalized land cover in the Mid-Atlantic region (Vogelmann and others, 1997).

http://md.water.usgs.gov/publications/wrir-97-4139/fig1.jpg

State Climate Change Adaptation Plans – as of February 2012



http://www.c2es.org/what_s_being_done/in_the_states/adaptation_map.cfm

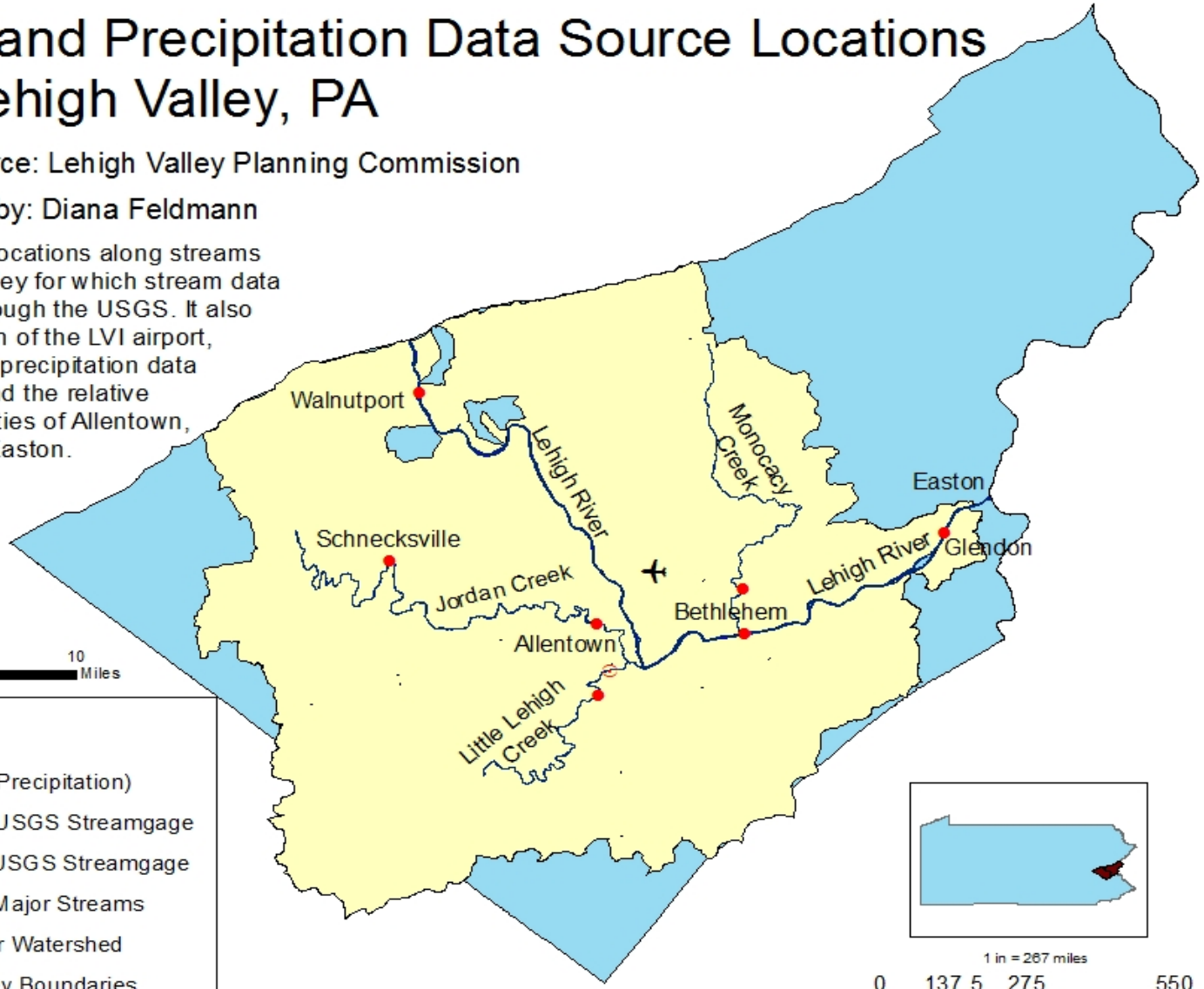
Tropical Storm ‘Lee’ - 2011

Stream and Precipitation Data Source Locations in the Lehigh Valley, PA

Map Data Source: Lehigh Valley Planning Commission

Map prepared by: Diana Feldmann

This map shows locations along streams in the Lehigh Valley for which stream data was available through the USGS. It also shows the location of the LVI airport, which was where precipitation data was recorded, and the relative locations of the cities of Allentown, Bethlehem, and Easton.



N

1 in = 5 miles

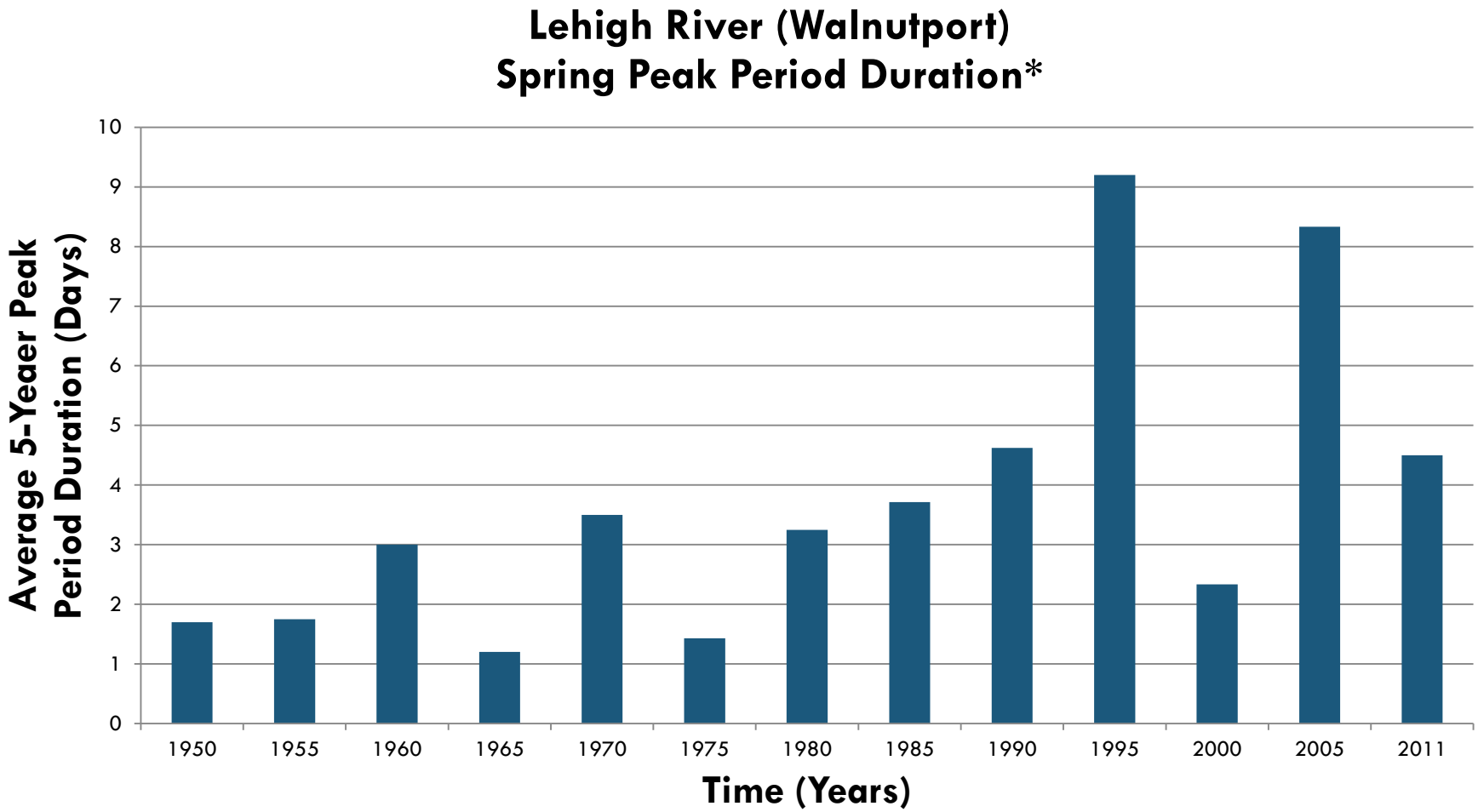
0 5 10 Miles

Legend

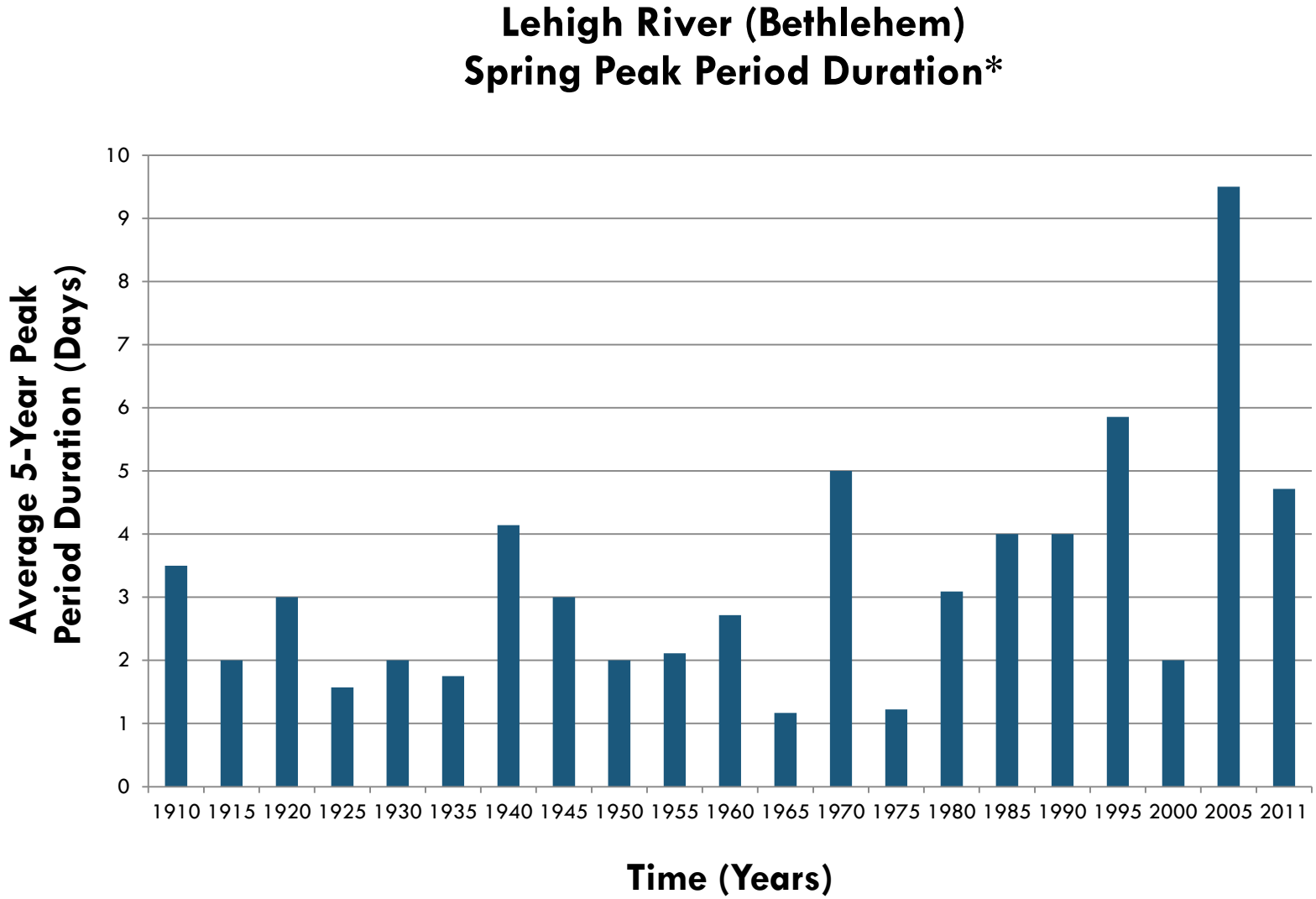
- LVI Airport (Precipitation)
- Short Term USGS Streamgage
- Long Term USGS Streamgage
- Rivers and Major Streams
- Lehigh River Watershed
- Lehigh Valley Boundaries

1 in = 267 miles

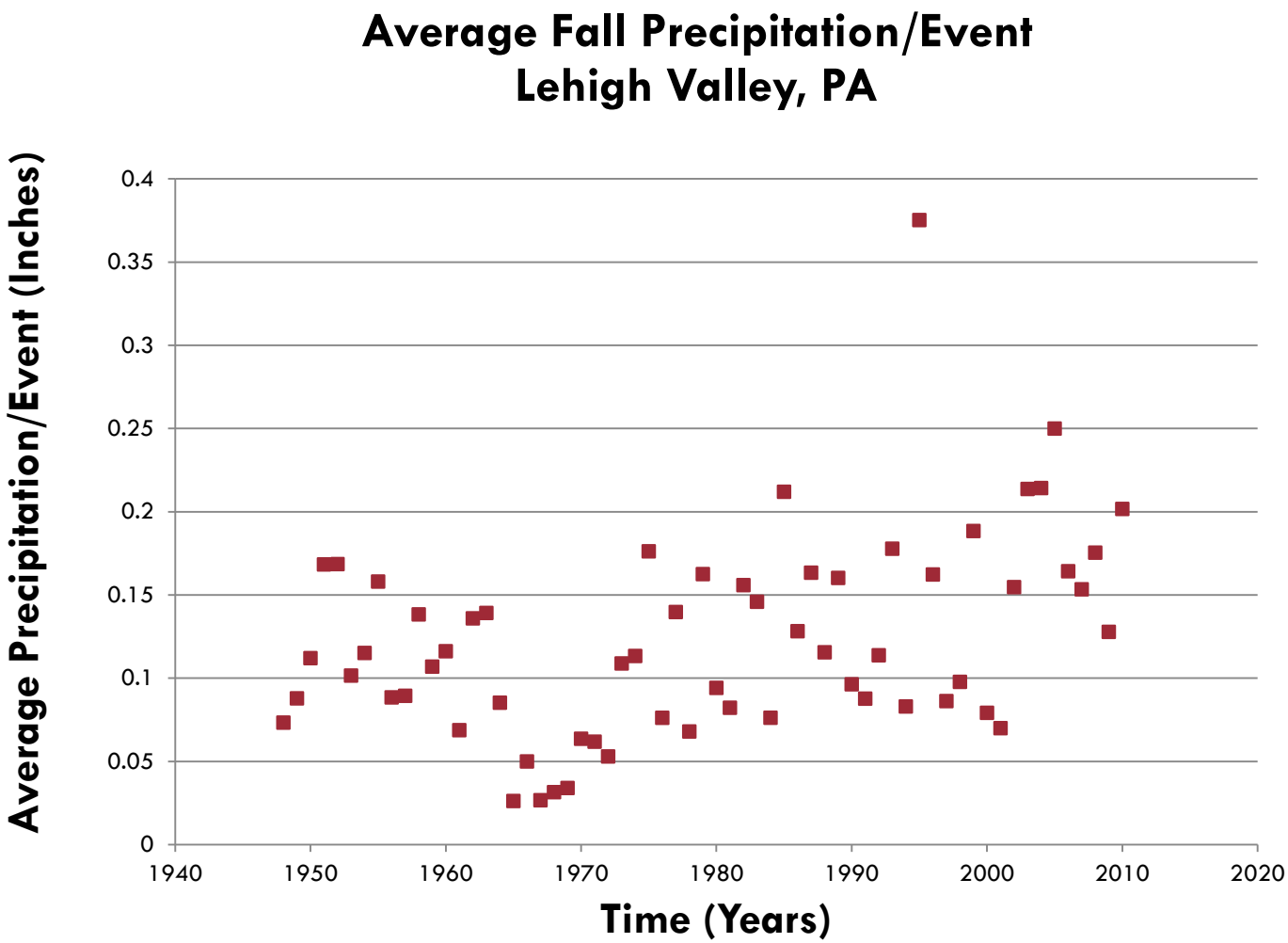
0 137.5 275 550 Miles



Increasing spring peak period duration for the Lehigh River at Walnutport (p-value = 0.0175; significant if $p < 0.05$)



Increasing spring peak period duration for the Lehigh River at Bethlehem (p-value = 0.0203)



Increasing trends for the average fall amount of precipitation per event (p-value = 0.00387)

Data from Weather Underground, Inc.

Each point is the seasonal average for one year.

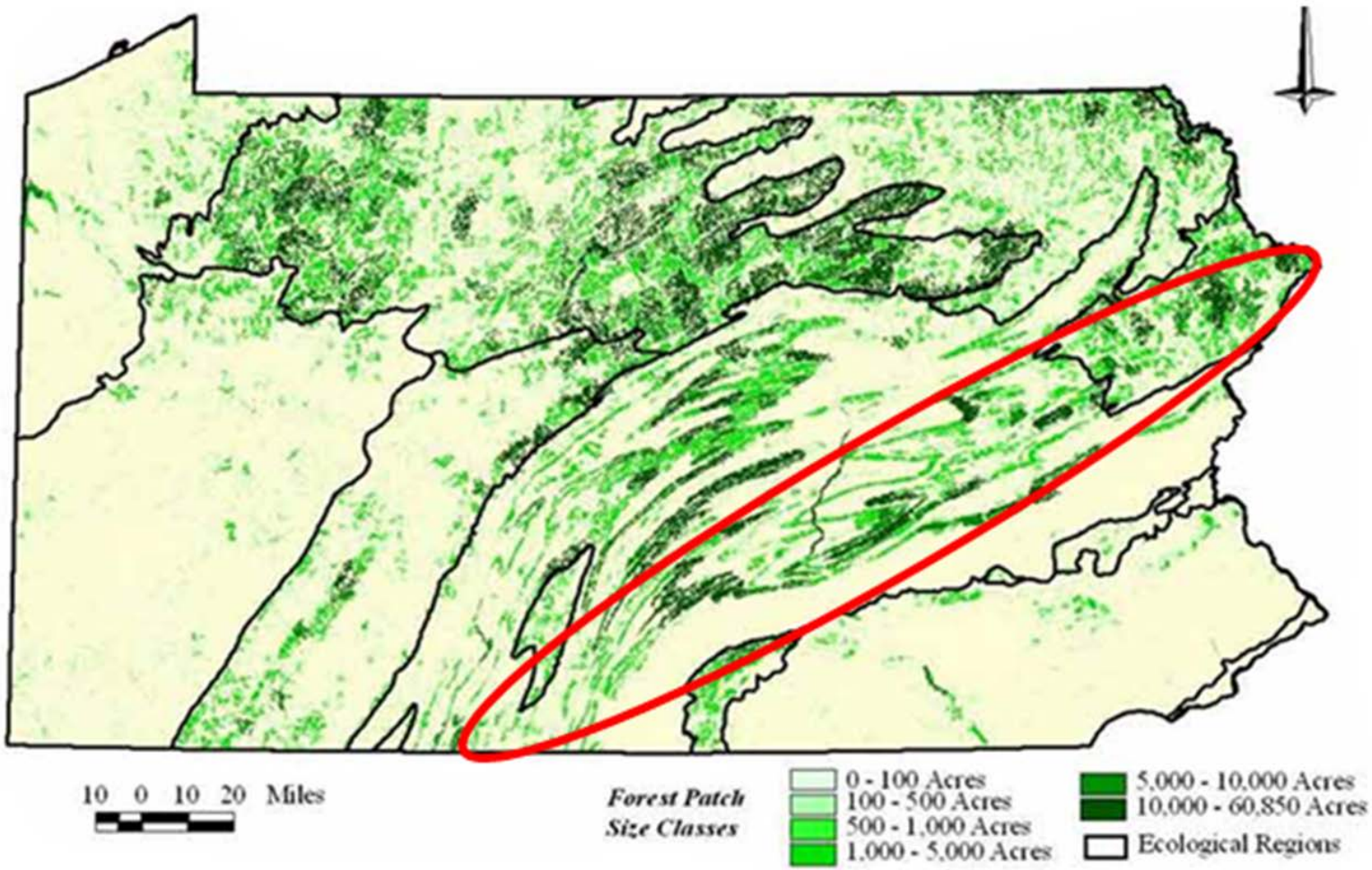
The Eastern PA Phenology Project

Eastern Pennsylvania
Phenology Project

Intergovernmental Panel on Climate Change
(IPCC)

- **Reports: 1990, 1995, 2001 and 2007 (AR 4)**
- **2007 Nobel Peace Prize shared between IPCC & Al Gore**

"Phenology – the timing of seasonal activities of animals and plants – is perhaps the simplest process in which to track changes in the ecology of species in response to climate change."



Core Forest of Pennsylvania. The red oval surrounds the **Kittatinny Ridge.**
Forest Wildlife Trends. Pennsylvania Department of Conservation and Natural Resources [online] 2004. Available from: http://www.dcnr.state.pa.us/wlhabitat/forest/forest_wildlife.aspx

Louisiana Waterthrush eBird data for PA: First Dates Observed in Spring (1977 – 2011)

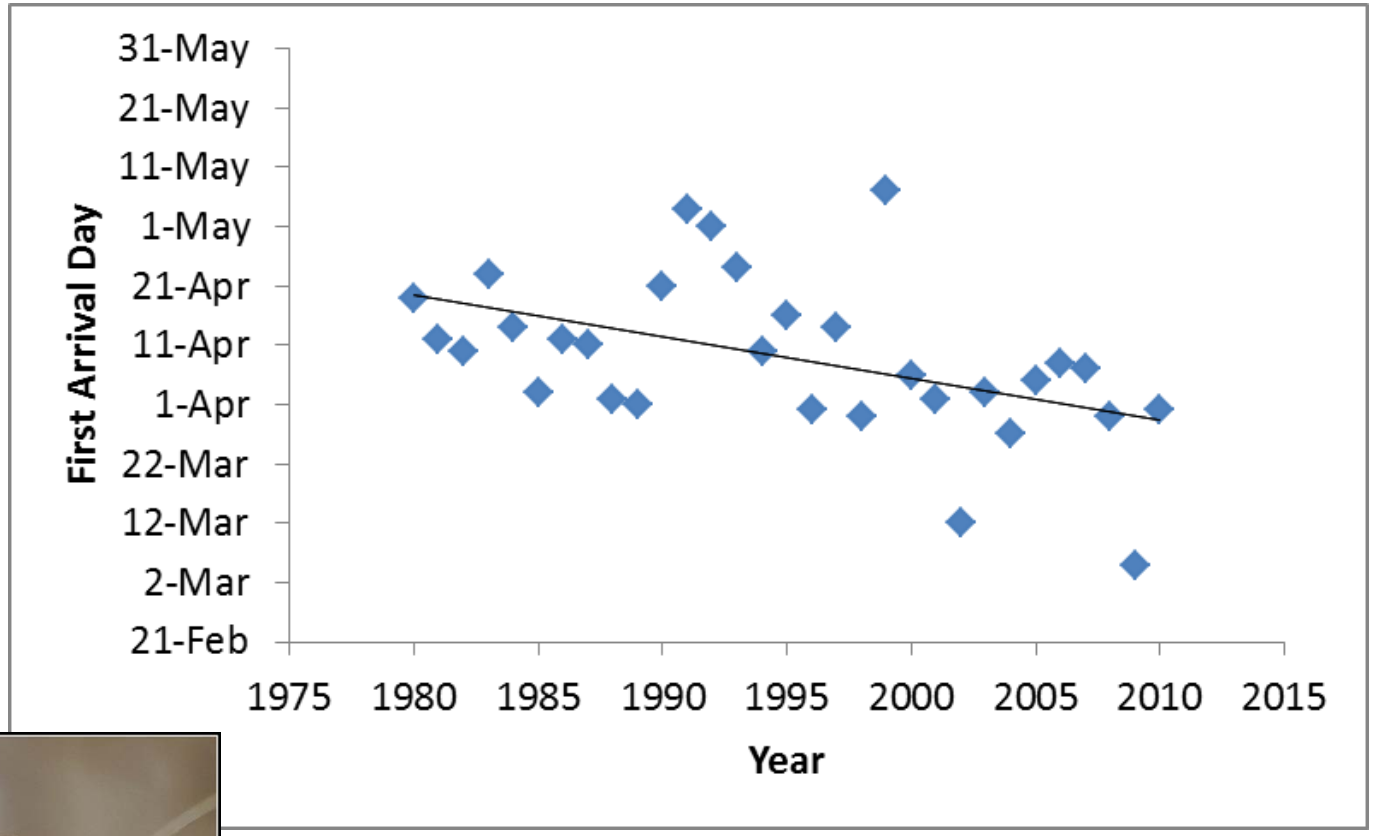


Photo credit: Terry Master

Arrival now **21** days earlier (eBird records for PA) and **23** days earlier (Eastern PA Phenology Project data) since 1970's

The Problem

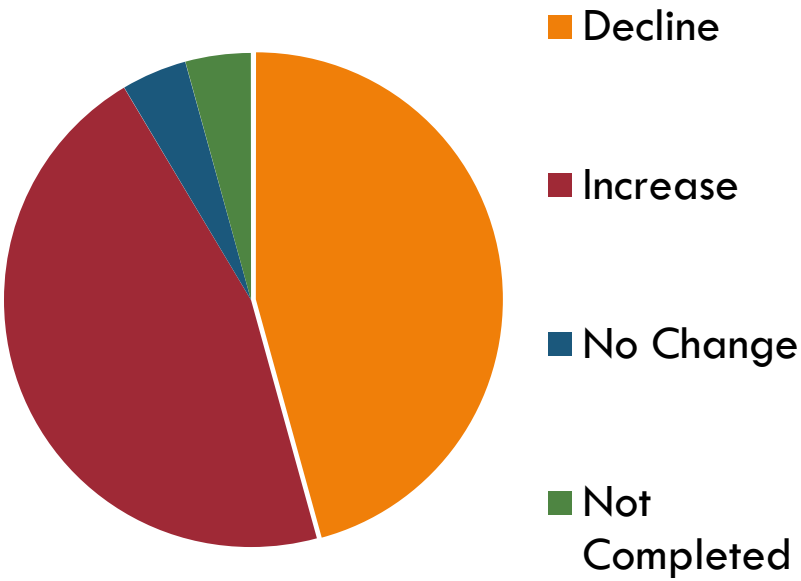
- In a long-term study within the Delaware Water Gap Recreation Area, **90%** of Louisiana Waterthrush nests have been found in Eastern Hemlock trees.

- Wooley Adelgid infestations are spreading westward and toward the northeast; problem made worse by warmer winters

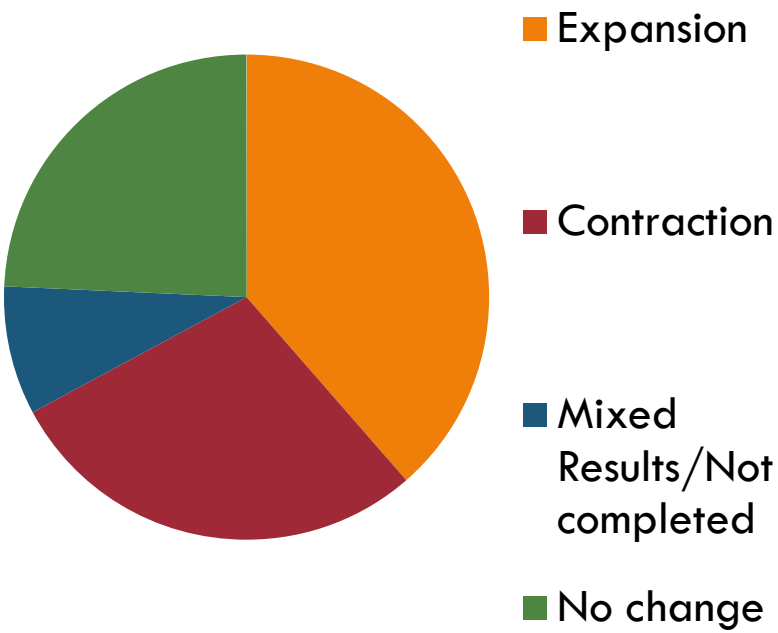
Bird Species	Change in First Arrival Date (in Days , Eastern PA Phenology Project)	Change in First Arrival Date (in Days, PA eBird data analysis)	Distance of Migration*
	(Years of Data to 2011)	(Years of Data to 2010)	
Great-crested Flycatcher	n.d.	-19 (30)	Long
White-eyed Vireo	-5 (29)	-18 (30)	Short
Worm-eating Warbler	-5 (28)	-18 (30)	Long
Rose-breasted Grosbeak	-22 (28)	-20 (30)	Long
Red-eyed Vireo	-5 (31)	-22 (30)	Long
Least Flycatcher	-14 (31)	-23 (30)	Long
Cerulean Warbler	-3 (31)	-19 (30)	Long
Purple Finch	-25 (41)	n.d	Short
American Redstart	-19 (31)	-14 (30)	Long
Yellow-billed Cuckoo	-19 (44)	-19 (30)	Long
Wood Thrush	-19 (44)	-19 (30)	Long
Scarlet Tanager	-6 (44)	-11 (30)	Long
Black-throated Green Warbler	-23 (36)	-22 (30)	Long
Acadian Flycatcher	-6 (41)	-15 (30)	Long
Louisiana Waterthrush	-23 (35)	-21 (30)	Long
Eastern Wood- pewee	n.d	-28 (30)	Long
Northern Waterthrush	-20 (44)	-26 (30)	Long

PA Breeding Bird Atlas Comparison 1983-1989 and 2004-2008

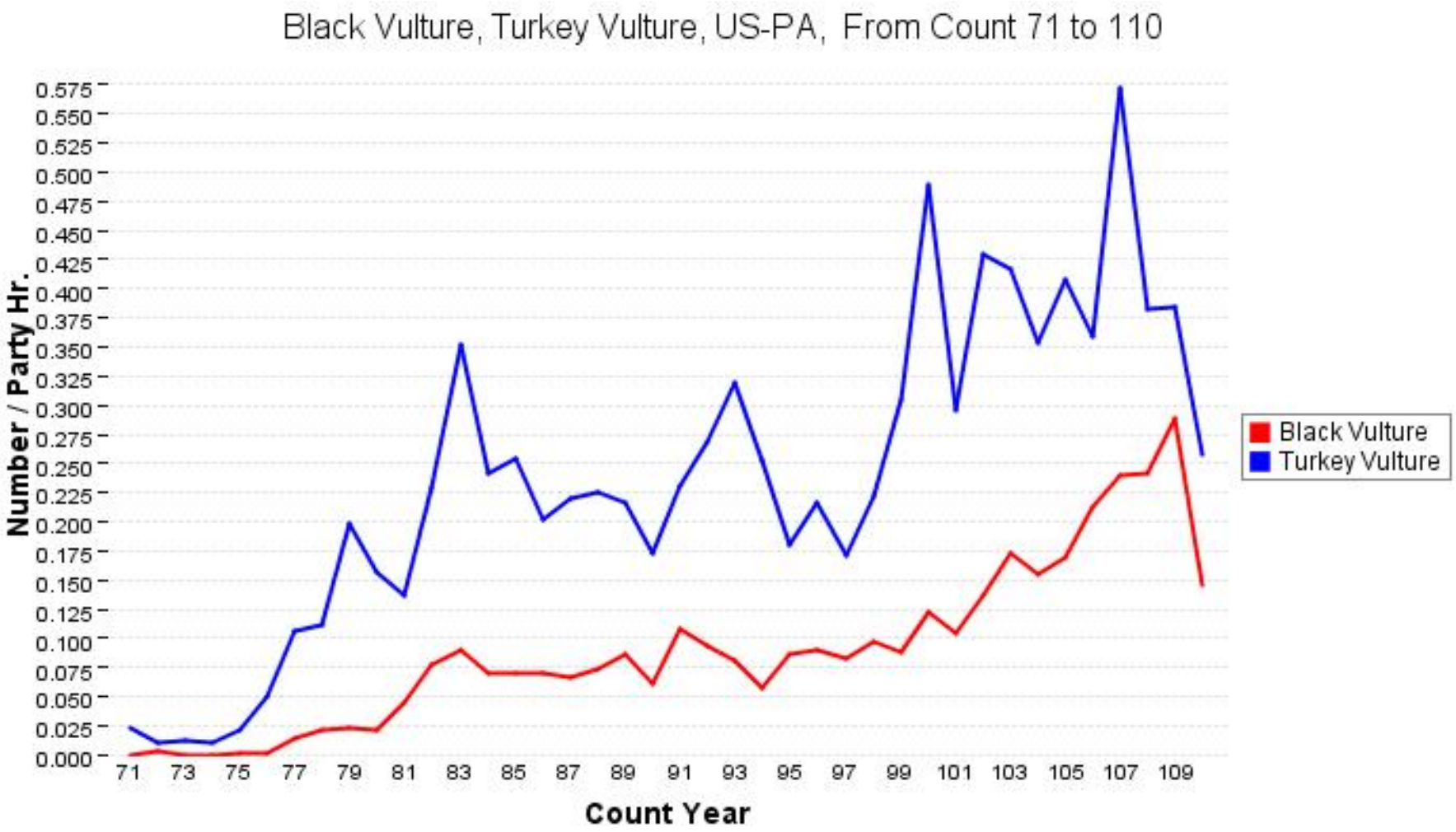
Changes in Population Size



Changes in Overall Range



Audubon Christmas Bird Count Data (1970/71 – 2009/10) for PA



Impact of Invasive Plant Species?

Oriental Bittersweet

Japanese Honeysuckle

Implications of such information for restoration?

Questions/Discussion

Eastern PA Phenology Project

http://watchingtheseasons.blogspot.com/

http://lgnc.org/research/phenology

To submit data: phenology@lgnc.org

Eastern Pennsylvania
Phenology Project