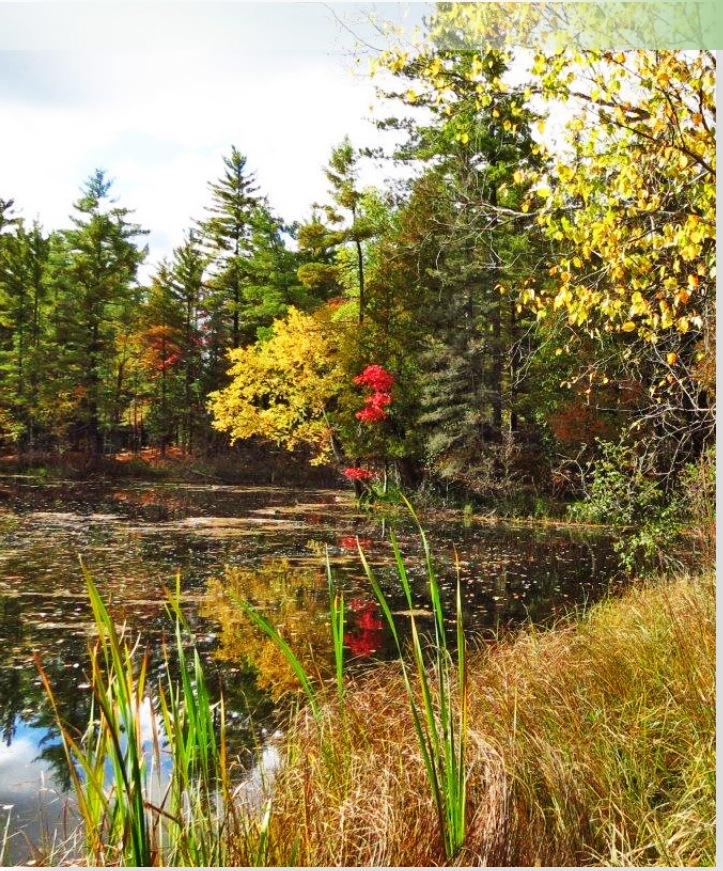


PENNSYLVANIA CLIMATE EFFECTS

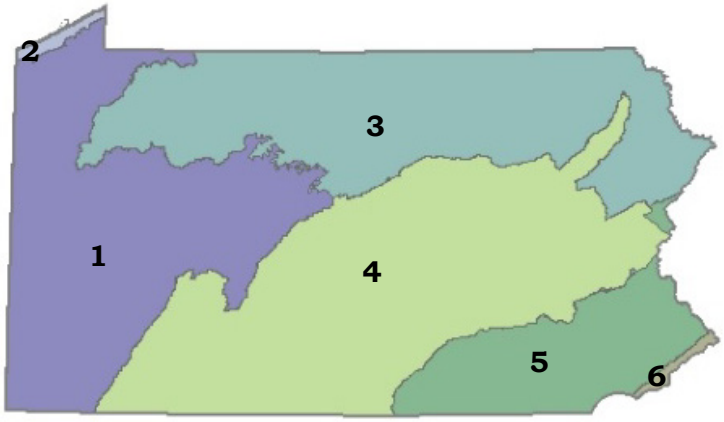
HEAT AND HARDINESS ZONES

PREDICTED FOREST CHANGE

The region's forests will be affected by a changing climate during this century, but individual tree species will respond uniquely to climate change, depending on their particular silvics and ecological tolerances in a given location.

The vulnerability of many common species were assessed using the Climate Change Tree Atlas, which simulates changes in projected tree species suitable habitat in Pennsylvania. Tree Atlas results for Pennsylvania regions can found at: https://forestadaptation.org/PA).

Some trees were not modeled by Tree Atlas. For these species, climate change effects can be assessed by examining future projections of hardiness zones and heat zones for regions of Pennsylvania (right). Current hardiness zones and heat zones are used to determine suitability for planting. As temperatures increase, it is expected that hardiness and heat zones will shift.



Physiographic Regions of Pennsylvania

- 1 – Western Allegheny Plateau
- 2 – Erie and Ontario Lake Plain
- 3 – Northern Allegheny Plateau
- 4 – Ridge and Valley
- 5 – Piedmont
- 6 – Coastal Plain

MORE INFORMATION:

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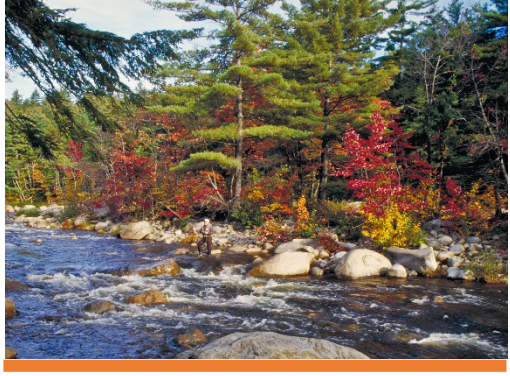
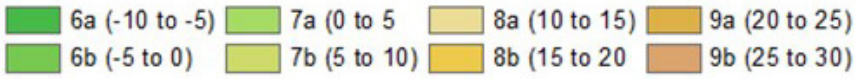
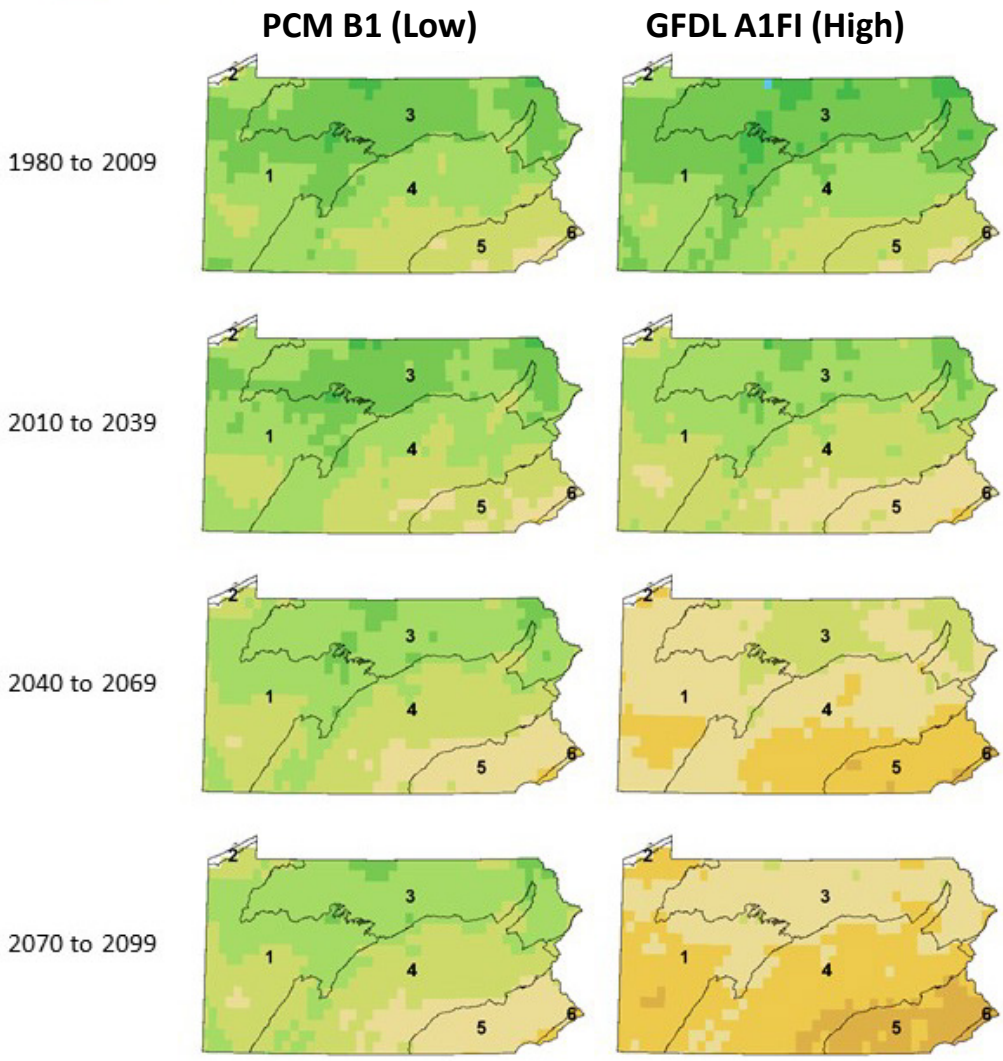
Patricia Leopold (pleopold@mtu.edu) Mid-Atlantic Climate Change Response Framework Coordinator, Northern Institute of Applied Climate Science



FUTURE HARDINESS ZONES

The plant hardiness zone map is based on minimum annual temperature and can be used as an indicator of cold-tolerance of plants. Average minimum temperatures break subzones into increments of 5°F. Changes in temperature may lead to a shift of one to three higher hardiness zones through the end of the century. The charts below the maps highlight the shifts for each region over time.





Regions of Pennsylvania

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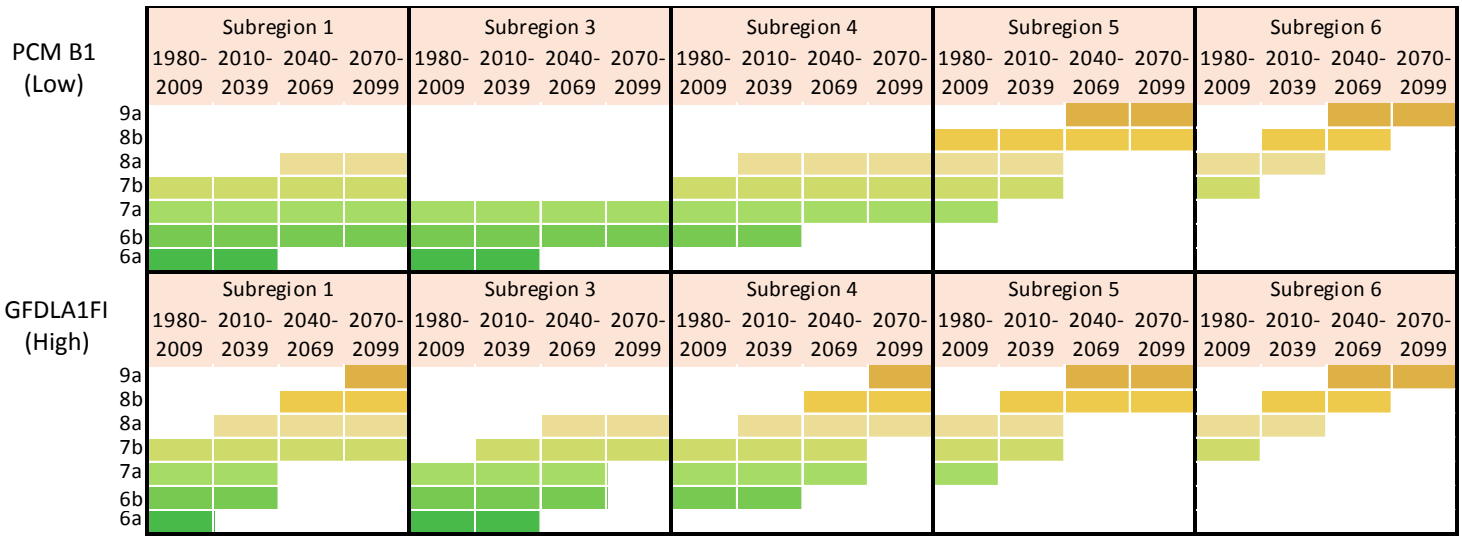
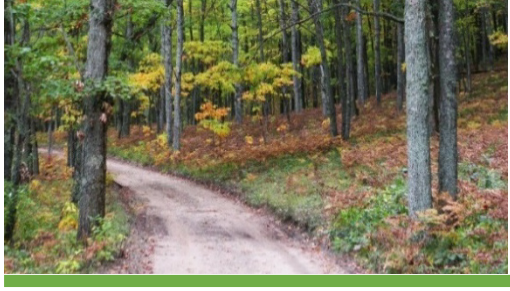
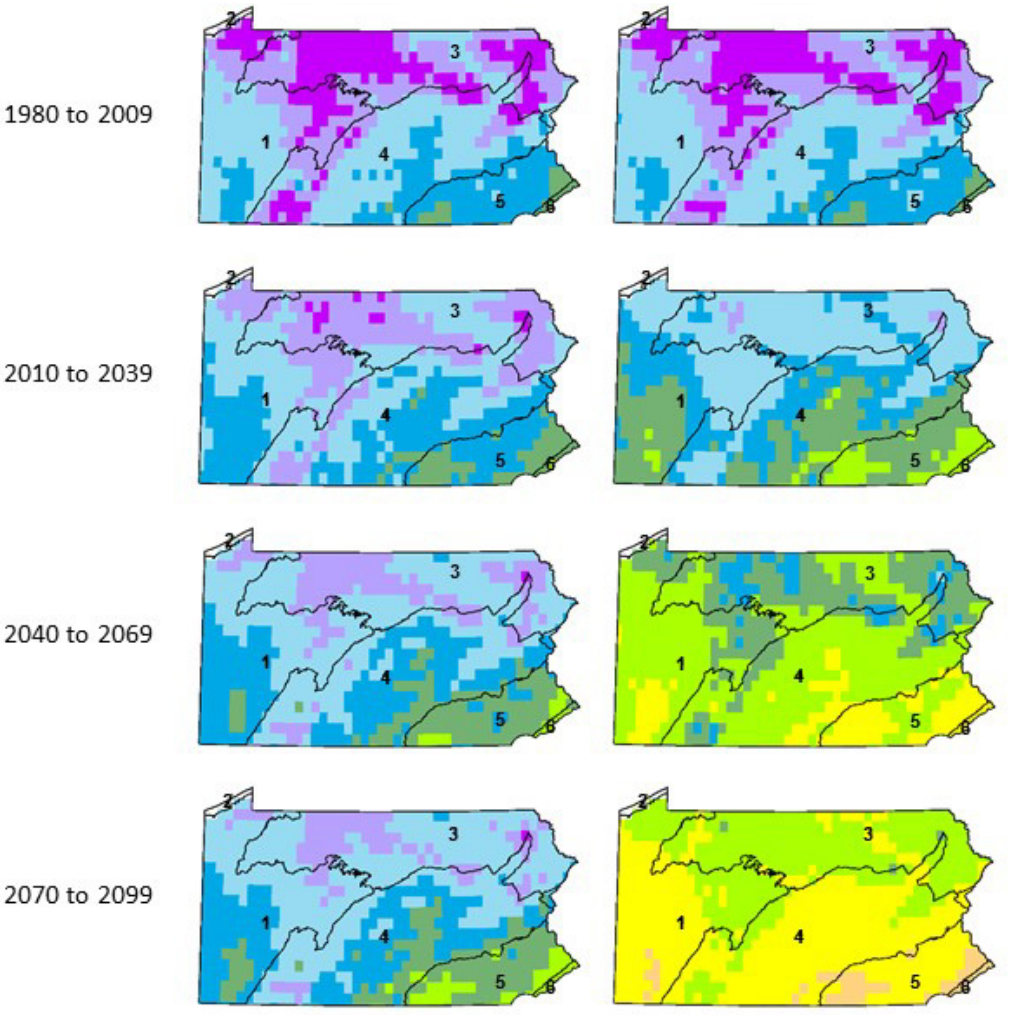




FUTURE HEAT ZONES

The heat zone map is based on number of days exceeding 86 °F (30 °C) and can be used as an indicator of heat stress on organisms. Changes in temperature may lead to a shift of one to five higher heat zones through the end of the century. The charts below the maps highlight the shifts for each region over time.

2: 1 to 7 | 3: >7 to 14 | 4: >14 to 30 | 5: >30 to 45 | 6: >45 to 60 | 7: >60 to 90 | 8: >90 to 120 | 9: >120 to 150



Regions of Pennsylvania

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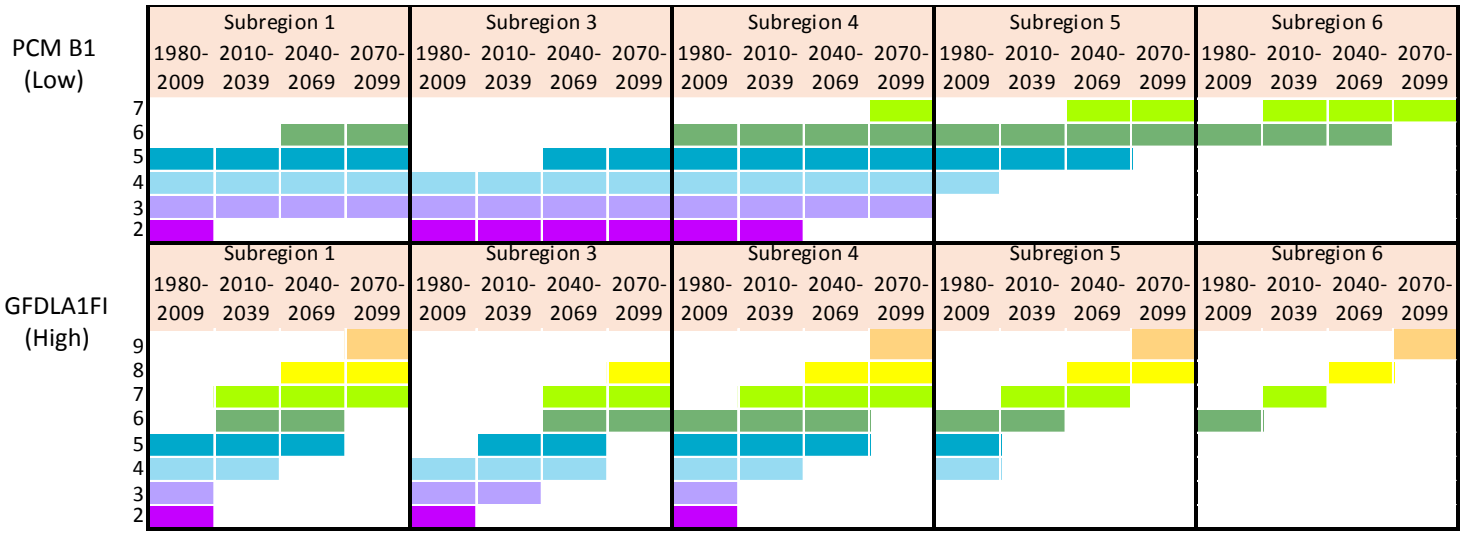


SPECIES VULNERABILITY

The climate change effect was calculated by comparing the species' published heat zone tolerance to the map of projected heat zones. Vulnerability was rated by comparing a species' projected climate change effect to its adaptability score (Table 2). For example, Ailanthus (an invasive species) and hawthorn were rated low vulnerability largely due to no change in heat zones and high adaptability score, suggesting these species will do well under a range of future climates. Adaptability scores are calculated from biological and disturbance factors that may make a species more or less able to adapt to future stressors.

Table 1. Potential effects of shifts in hardiness and heat zones for tree species in regions of Pennsylvania that do not have Tree Atlas species distribution modeling. There were no heat or hardiness zone data for subregion 2, which was too small for analysis.

				Subregion 1		Subregion 3		Subregion 4		Subregion 5		Subregion 6	
Common Name	Hardiness zone range	Heat zone range	Adapt-ability	Climate change effect	Vulner-ability	Climate change effect	Vulner-ability	Climate change effect	Vulner-ability	Climate change effect	Vulner-ability	Climate change effect	Vulner-ability
Ailanthus*	5 to 8	8 to 1	high	●	L	●	L	●	L	●	L	●	L
American hazelnut	4 to 8	9 to 1	medium	●	M	●	M	●	M	●	M	●	M
Downy serviceberry	3 to 7	7 to 1	high	●	L	▼	M	▼	M	▼	M	NA	NA
Gray dogwood	3 to 8	8 to 3	medium	▼	H	●	M	●	M	●	M	▼	H
Hawthorn, smooth	5 to 8	8 to 3	high	●	L	●	L	●	L	●	L	●	L
Norway maple*	4 to 7	7 to 1	high	●	L	▼	M	▼	M	▼	M	NA	NA
Norway spruce*	3 to 8	8 to 1	medium	●	M	●	M	●	M	▼	H	▼	H
Redosier dogwood	3 to 8	8 to 1	medium	▼	H	●	M	▼	H	▼	H	NA	NA
Scots pine*	3 to 7	7 to 1	medium	▼	H	●	M	▼	H	▼	H	NA	NA
Serviceberry	4 to 8	9 to 3	high	●	L	●	L	●	L	●	L	▼	M
Smooth sumac	2 to 8	8 to 1	high	●	L	●	L	●	L	●	L	●	L
Southern catalpa	5 to 9	9 to 5	medium	●	M	●	M	●	M	▲	L	●	M
Staghorn sumac	4 to 8	8 to 1	high	▼	M	●	L	●	L	●	L	▼	M
Witchhazel	4 to 8	8 to 1	high	●	L	●	L	●	L	●	L	▼	M

Table 2. Matrix used to determine vulnerability. Vulnerability is based on heat and hardiness zones (L=low; M=moderate; H=high).

Heat/Hardiness Zone Effect	Adaptability Score		
	Low	Medium	High
Decrease	High	High	Moderate
No Change	Moderate	Moderate	Low
Increase	Moderate	Low	Low

▲ Climate change was considered to have a positive effect on habitat suitability if the species gained one or more mapped heat zones at the end of the century.

● Climate change was considered to have a neutral effect on habitat suitability if the species did not gain or lose mapped heat zones at the end of the century.

▼ Climate change was considered to have a negative effect on habitat suitability if the species lost one or more mapped heat zones by the end of the century.

*Species marked with an asterisk are nonnative and may be considered invasive or problematic in some locations. Species that are marked NA have not been detected in current inventory data or modeled to be present in the future; however, there may be planted examples of these species in certain locations.

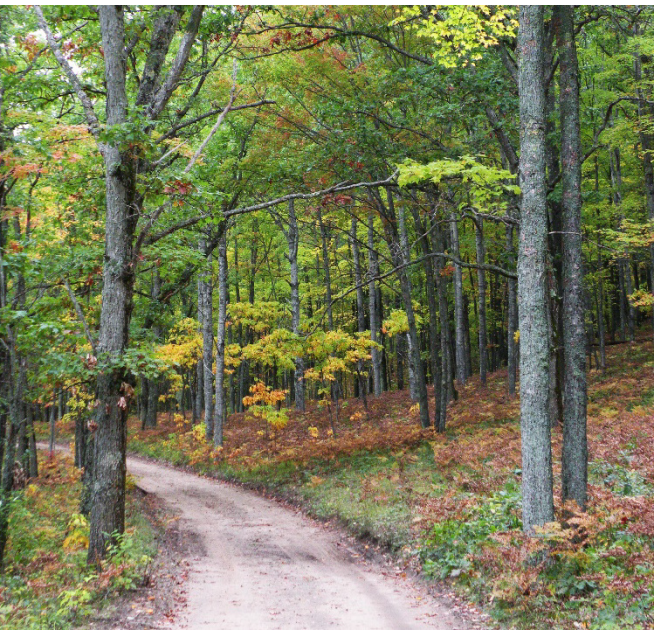
Find a list of tree species with Tree Atlas results at: ForestAdaptation.org/PA

The general trends derived from these models can be combined with local knowledge and management experience to judge risk on a particular site. Examples of characteristics that make systems more adaptable include high species diversity, landscape connectivity, and the ability to bounce back following a disturbance, such as a drought, flood, windstorm, or fire. Managers can use scientific information from the Mid-Atlantic Forest Ecosystem Vulnerability Assessment and other sources to better understand which places may be most vulnerable. Resources are available to help forest managers and planners incorporate climate change considerations into forest management. A set of Forest Adaptation Resources is available at www.forestadaptation.org.

MORE INFORMATION

Information on heat zone and hardiness zone projections was summarized from Matthews, S.N., Iverson, L., Peters, M., Prasad, A.M., 2018. **Assessing potential climate change pressures throughout this century across the Conterminous United States: mapping plant hardiness zones, heat zones, growing degree days, and cumulative drought severity throughout this century.** U.S. Department of Agriculture, Forest Service. Northern Research Station Research Map NRS-9, Newtown Square, PA, p. 31.

www.forestadaptation.org/PA



pennsylvania DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

NIACS Northern Institute of Applied Climate Science

This technical summary is a result of a collaboration between the Northern Institute of Applied Climate Science and Pennsylvania DCNR. 2018. Available at https://forestadaptation.org/PA. More information on DCNR commitment to address climate change can be found at www.dcnr.pa.gov/Conservation/ClimateChange.