

Adapting to a Changing Climate: Risks & Opportunities for the Upper Delaware Region

A collaborative effort of:

- **The Common Waters Partnership**
(<http://www.commonwatersfund.org/partners>)
- **The Pinchot Institute for Conservation** (www.pinchot.org)
- **The Model Forest Policy Program Climate Solutions University** (<http://www.mfpp.org/>)

Geographic Focus:

- **Common Waters Fund priority counties in PA (Wayne, Pike & Monroe), NY (Sullivan & Delaware) and NJ (Sussex & Warren**

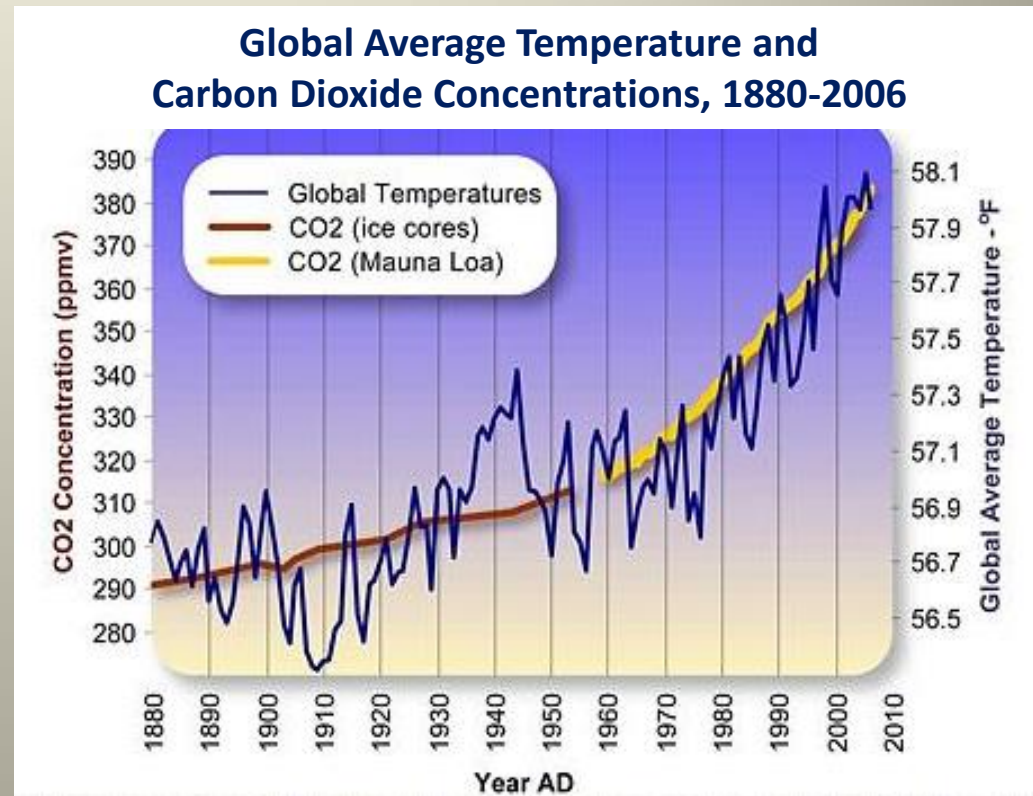
What Do We Hope to Accomplish?

- **Examine how a changing climate could affect forests, waters and communities of the Upper Delaware region, both now and in the future**
- **Strategize ways to reduce risks and protect our resources and people.**
- **Share our findings with and hear feedback from communities in the Upper Delaware region.**



Climate Change is Real & Now

- Rising CO₂ and global temperatures since 1800's
- The 2001-2010 decade is the warmest since 1880
- Number of cold days and record low temperatures has declined/number of hot days and heat waves has risen
- Each of the last three decades has been hotter than the one before
- Impacts in the US vary by region

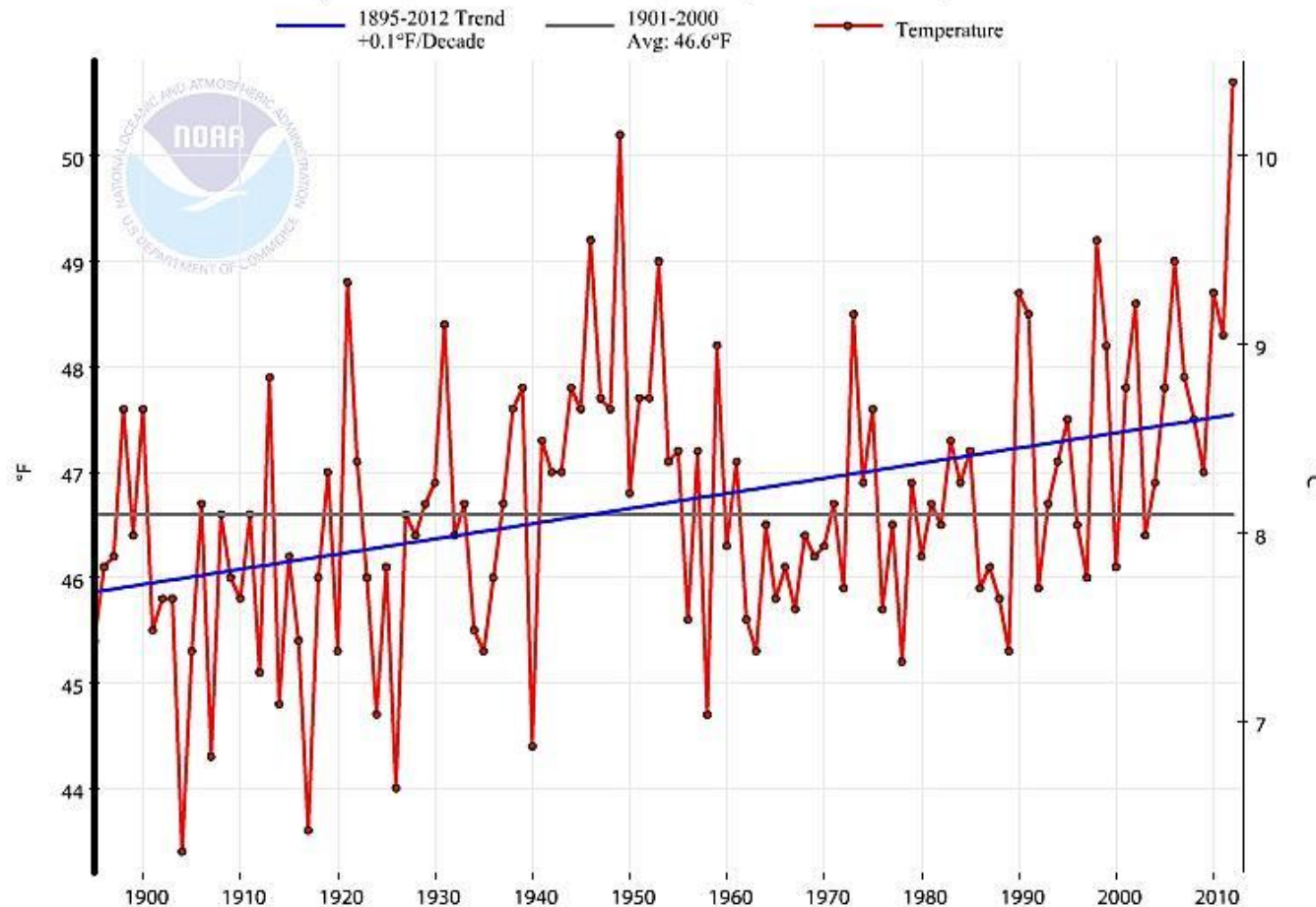


Source: Woods Hole Research Center

Observed Trends

Increasing average temperatures across the region

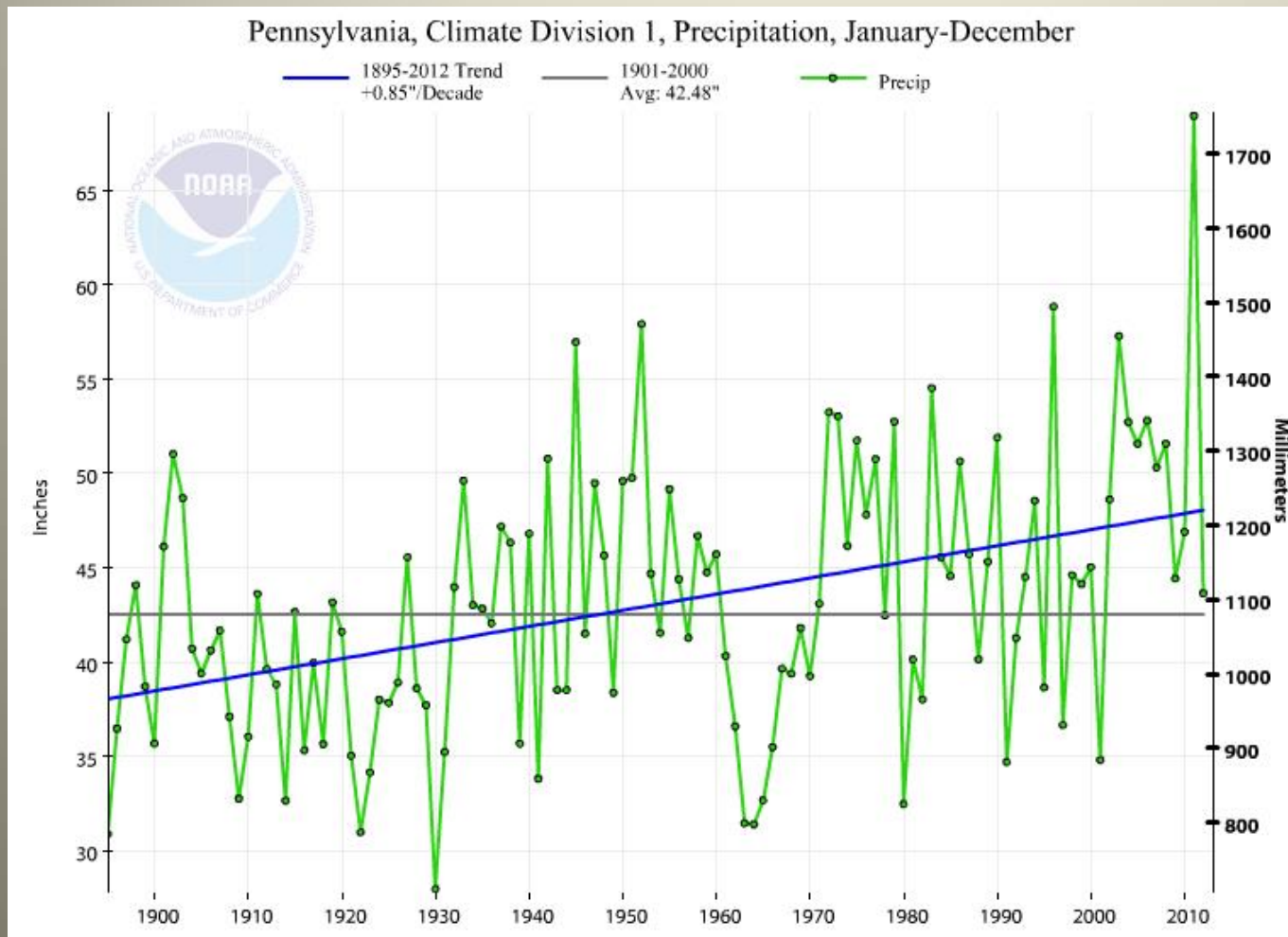
Pennsylvania, Climate Division 1, Temperature, January-December



Source: NOAA

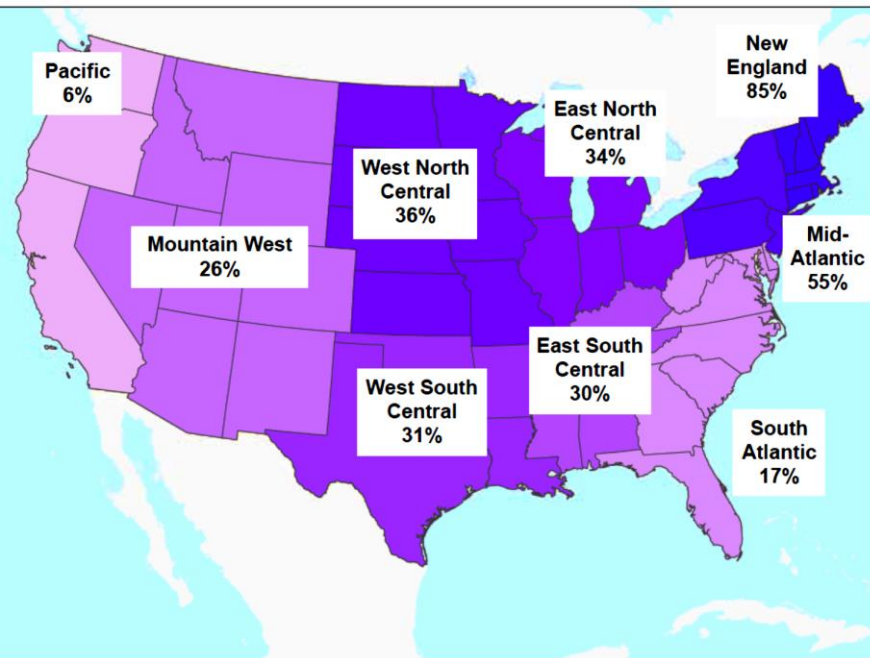
- Spring has advanced by approx. 4 days
- Loss of snow pack/warmer winters
- Dates of river and lake ice melt have advanced by 1 - 2 weeks

Increasing average precipitation across the region

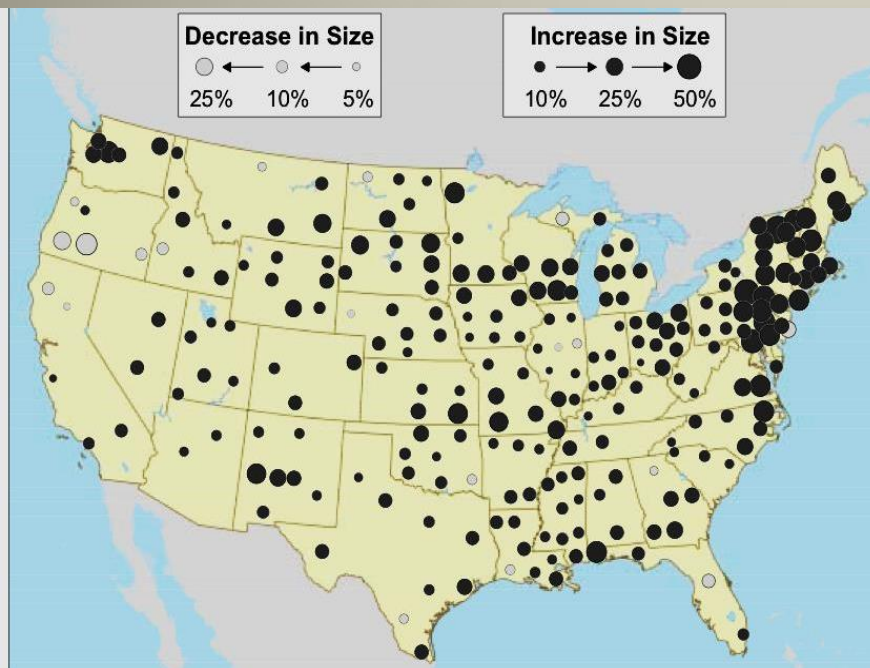


- Less winter precipitation as snow and more as rain
- Earlier peak stream flows
- Flooding

Observed Trends



1948-2011



- Extreme downpours happening more frequently
- The biggest storms are getting bigger
- Extreme storms are responsible for a larger percentage of annual precipitation
- Longer intervening dry spells

Observed Trends

Flooding and Repetitive Loss in the Upper Delaware Region

County	State	Number of Repetitive Properties	Total Payouts for Repetitive Properties	Average payouts per year
Warren	New Jersey	225	\$24,543,943	\$846,343
Sullivan	New York	94	\$6,427,868	\$221,650
Delaware	New York	72	\$4,197,593	\$144,745
Monroe	Pennsylvania	45	\$8,972,739	\$309,405
Pike	Pennsylvania	27	\$1,405,386	\$48,462
Wayne	Pennsylvania	21	\$1,471,365	\$50,737
Sussex	New Jersey	5	\$279,726	\$9,646
	TOTAL	489	\$47,298,620	\$1,630,987

Note: A property is considered a repetitive loss property when there are 2 or more losses reported which were paid more than \$1,000 for each loss. The 2 losses must be within 10 years of each other and be at least 10 days apart. Losses from 01/01/1978 – 02/28/07 that are closed are considered.

Source: Analysis of Repetitive and Severe Repetitive Loss Properties in the Delaware River Basin, DRBC, April 2007, pg.8

Projected Trends

Continued increases in temperature and precipitation

Year (Emissions Scenarios)	Estimated Change in Avg. Temperature (°F)	Estimated Avg. Temperature (°F)
2050 (B1)	4	51.5
2050 (A1B)	5	52.5
2050 (A2)	5	52.5
2080 (B1)	5	52.5
2080 (A1B)	6.5	54
2080 (A2)	7	54.5
Estimated Past Average Temperature (1951-2006): 47.5°F		
<i>Source: Climatewizard.org</i>		

Year (Emissions Scenarios)	Estimated Change in Avg. Precipitation	Estimated Avg. Precipitation
2050 (B1)	4%	44.2
2050 (A1B)	8%	45.9
2050 (A2)	12%	47.6
2080 (B1)	8%	45.9
2080 (A1B)	8%	45.9
2080 (A2)	16%	49.3
Past Average Precipitation (1951-2006): 42.5"		
<i>Source: Climatewizard.org</i>		

Climate Change Affects Many Sectors



Forest Impacts

Forest health and productivity
Invasive species
Forest composition



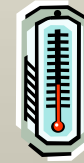
Human Health Impacts

Heat waves
Infectious diseases
Air quality



Water Impacts

Water supply
Water quality
Competition for water



Climate Changes

- Temperature
- Hydrologic changes
- Extreme Weather



Economic Impacts

Infrastructure damages
Flood losses
Tourism/recreation impacts
Loss of ecosystem services

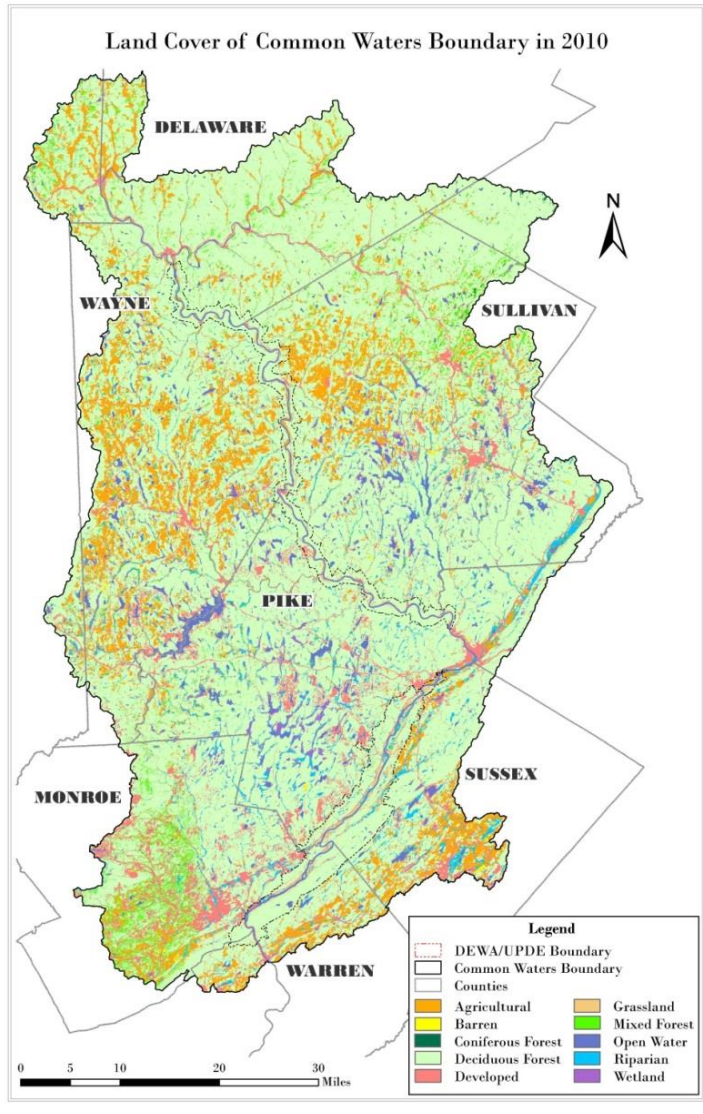


Agriculture Impacts

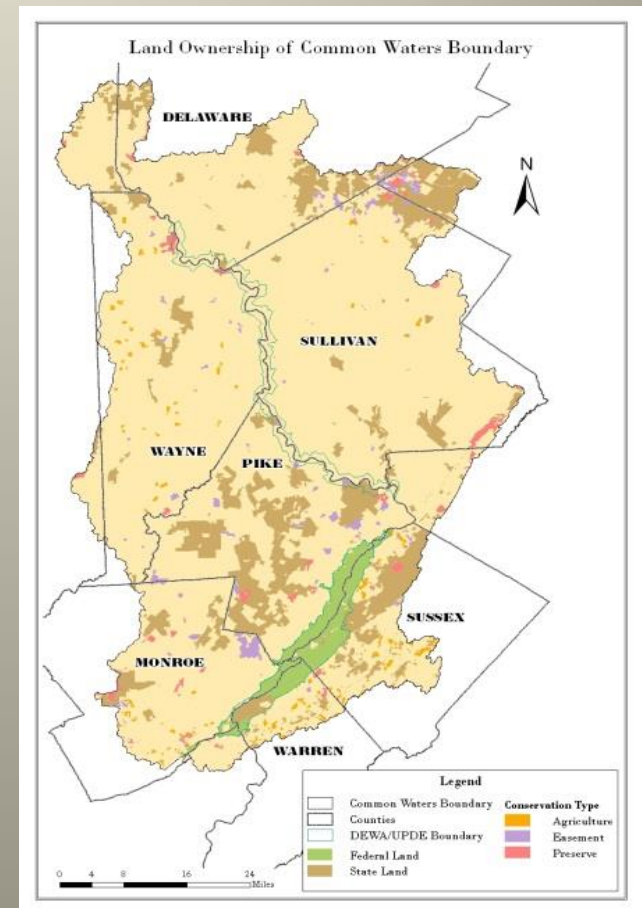
Crop yields
Water demands
Insects & weeds

Current Conditions & Trends

- **Predominantly rural**
- **Approx 75% Forested**
- **Approx. 10% Agricultural**
- **Healthy protected lands acreages**



Land Cover	2010%
Agricultural	9.69%
Barren	0.10%
Coniferous Forest	0.10%
Deciduous Forest	71.33%
Developed	7.17%
Grassland	0.60%
Mixed Forest	3.49%
Open Water	2.46%
Riparian	3.10%
Wetland	1.97%



Source: NPS DWGNRA

Current Conditions & Trends



- UPDE watershed 4500 sq. mi of 13,500+ total basin
- 2 Scenic Rivers segments
- Ecologically intact
- Supports diverse aquatic & terrestrial species
- Overall excellent water quality
- Water Supply for 16+ million



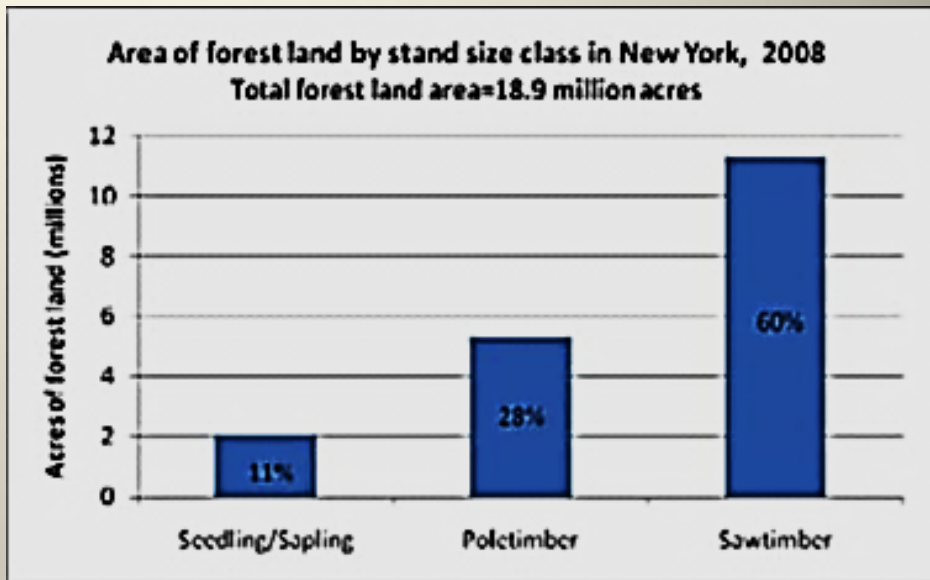
Healthy Forests = Clean Water



Current Conditions & Trends

Some indicators of long-term forest unsustainability:

- Even-aged
- Maturing
- Dominated by larger, saw timber-sized trees
- Uniform in structure & lacking in diversity
- Not fully stocked
- Privately owned with aging demographic



Source: NY DEC (top), Pinchot Institute (bottom)



Other Existing Forest Stressors



Source: Pike Co. Conservation District



Source: Pike Co. Office of Community Planning

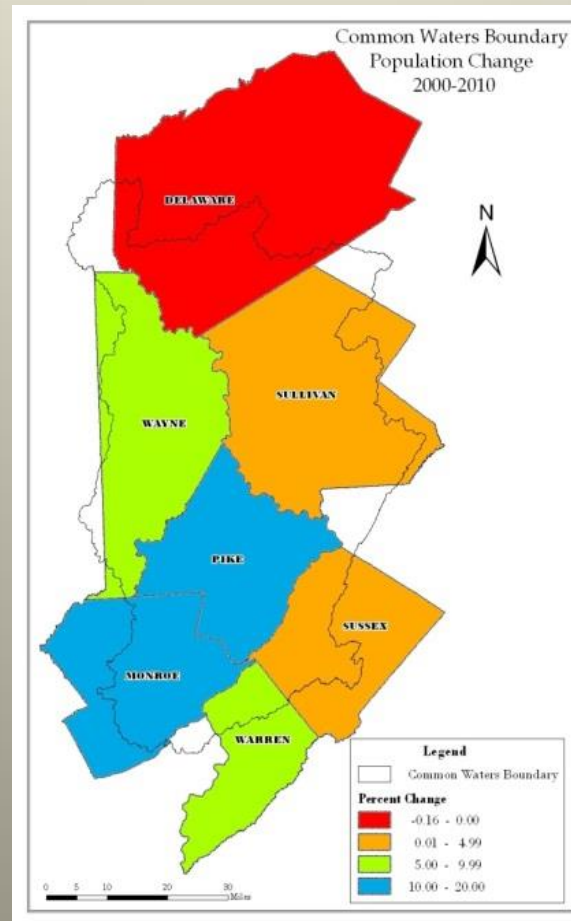
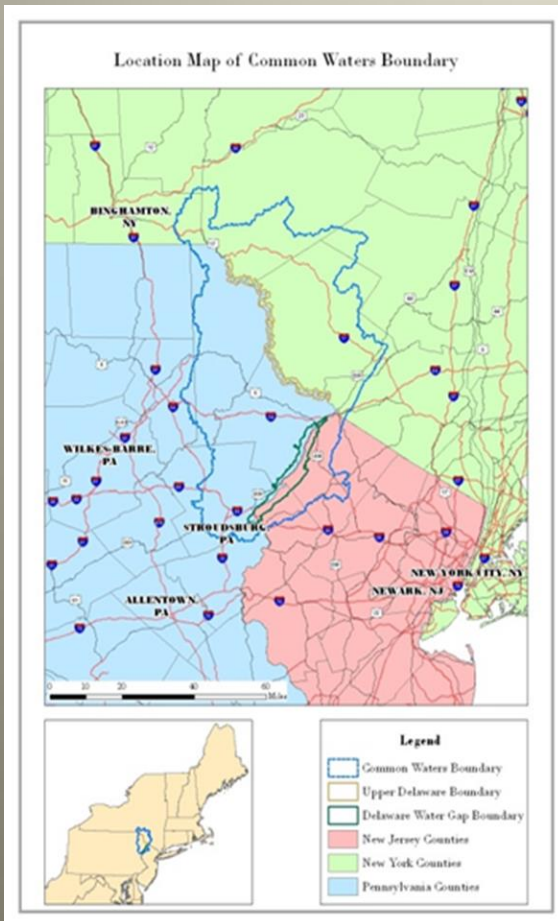


Source: PADCNR

- **Fragmentation/Parcelization**
- **Conversion to non-forest uses**
- **Invasive plants, insects & diseases**
- **Poor regeneration**
 - **High deer densities**
 - **Unsustainable harvesting practices**

Existing Non-Climate Water Stressors

- Proximity to Major Metro Areas
- Population Growth

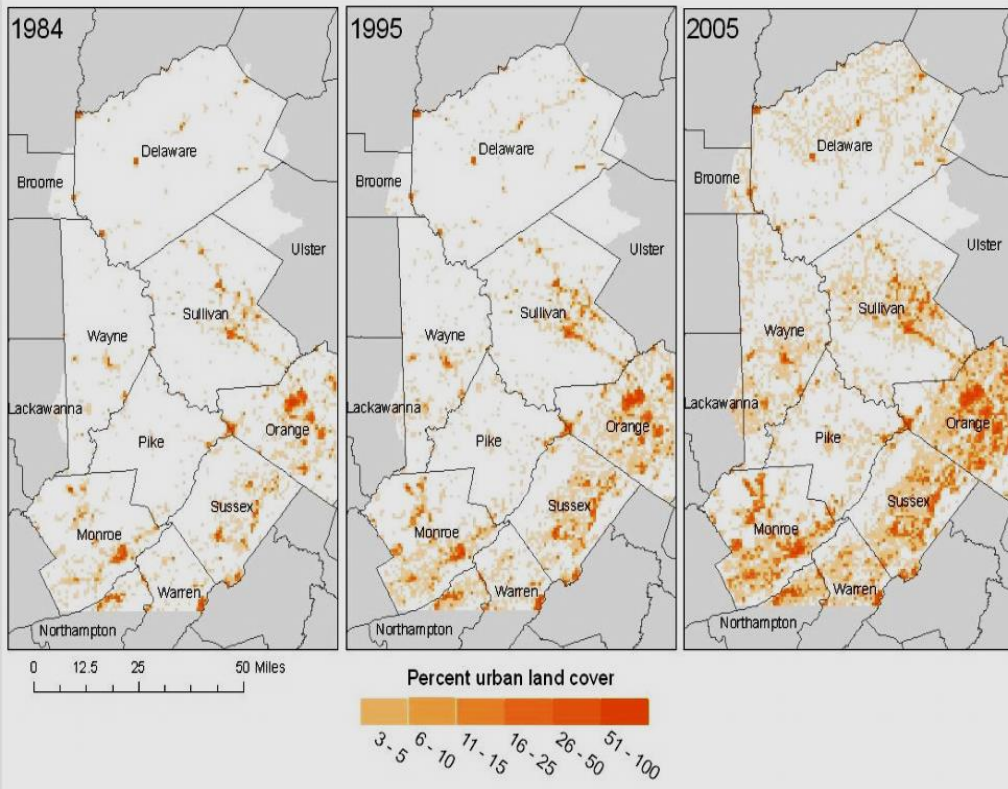


Percent Change in Population of Upper Delaware Counties 2000-2010

County	% Change
Sussex County NJ	3.34
Warren County NJ	6.11
Delaware County NY	-0.16
Sullivan County NY	4.34
Monroe County PA	22.45
Pike County PA	23.90
Wayne County PA	10.69

Source: NPS DWGNRA

Existing Non-Climate Water Stressors



Source: Jantz and Morlock

- **Land Use Changes**
 - Increased impervious cover
 - Forest fragmentation
 - Water quality impacts
- **Inconsistent land use standards**

Existing Non-Climate Water Stressors



Source: USACE Livingston Manor, NY Interim Feasibility Report

- Floodplain development
- Stormwater management
- Aging infrastructure



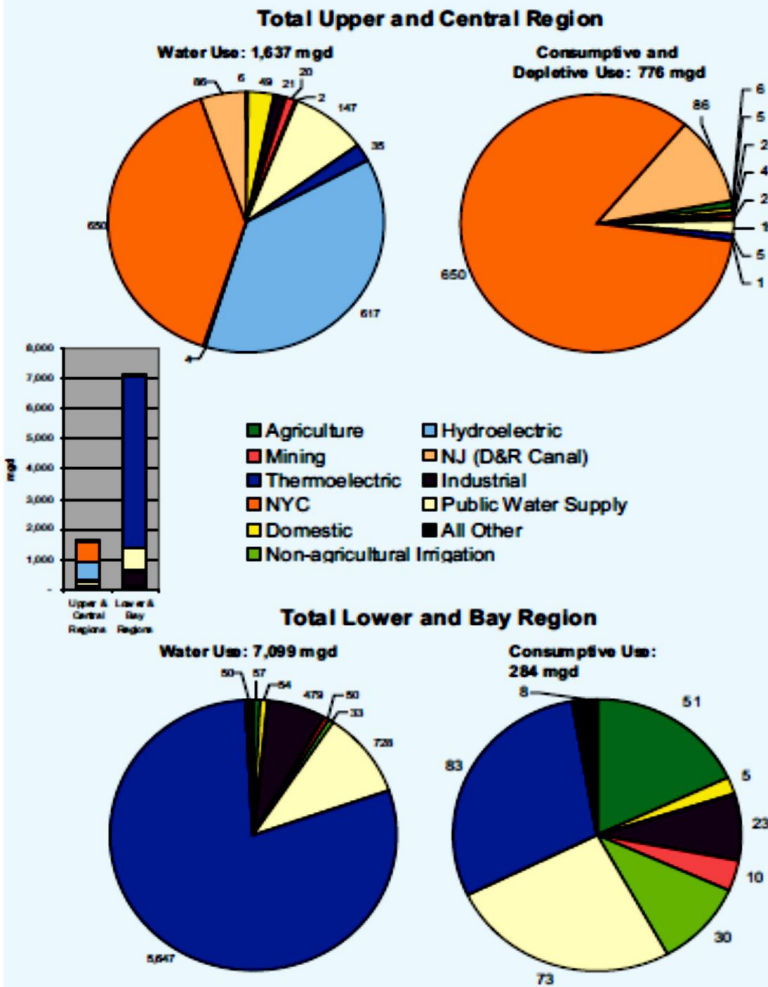
Source: Pike Co. Office of Community Planning



Source: WBRE TV

Existing Non-Climate Water Stressors

Fig. 1.11. Regional Water Withdrawals, Exports, and Consumptive Use

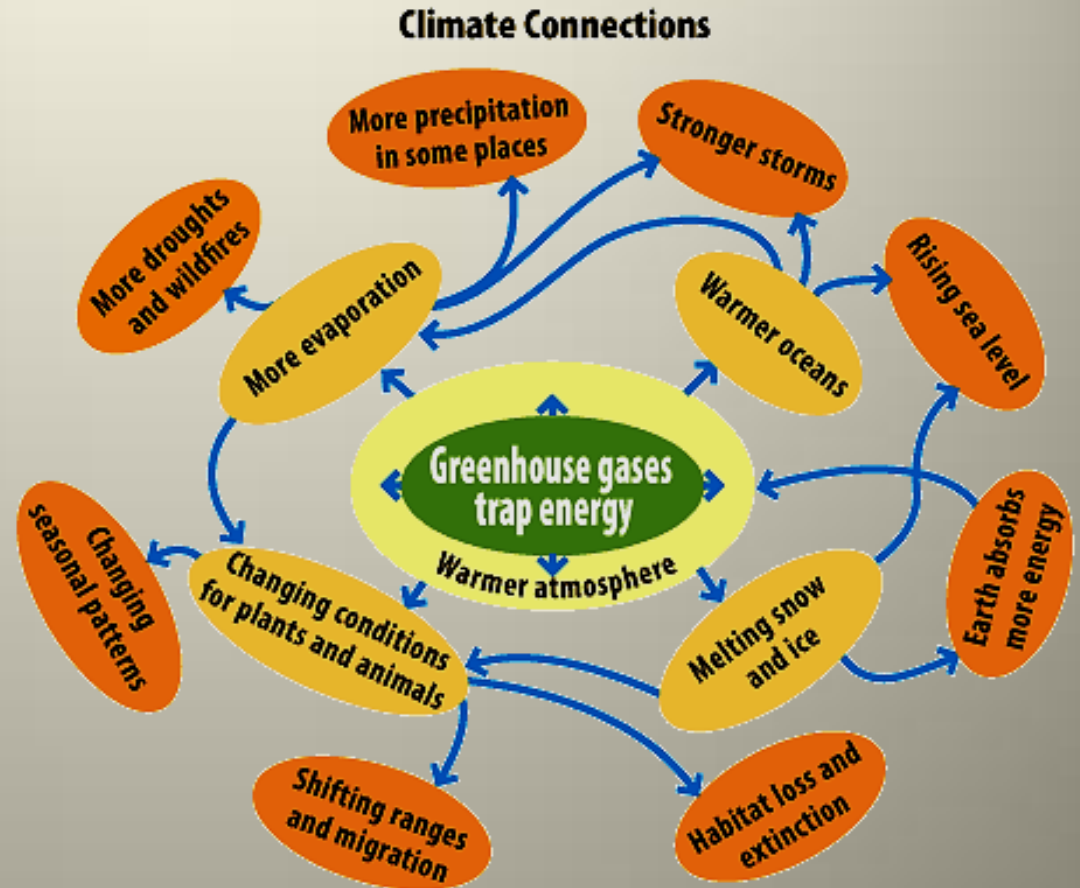


- Flow Management
- Competing Demands



Climate Changes Will Add to Forest and Water Stress

- Higher average air and water temperatures
- More extreme precipitation events
- More heat waves
- More seasonal drought
- Milder winters
- Shifts in growing seasons
- Decreased snow pack/earlier ice melt and spring high flows



Climate Risks to Forests

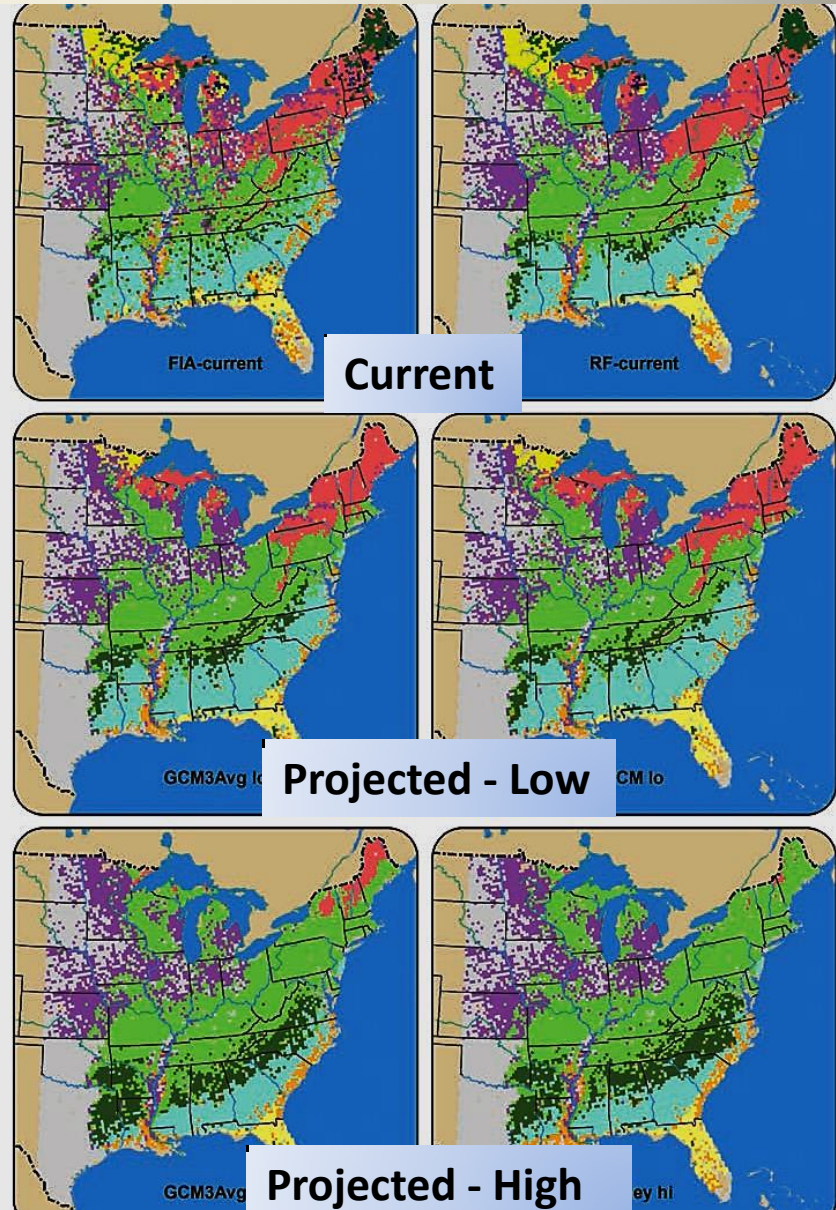
- Changes in tree species composition

↓ Spruce-fir

↓ Maple-birch-beech

↑ Oak-hickory

- Shifts in bird & wildlife habitat



Source: USDA Forest Service PNW-GTR-870

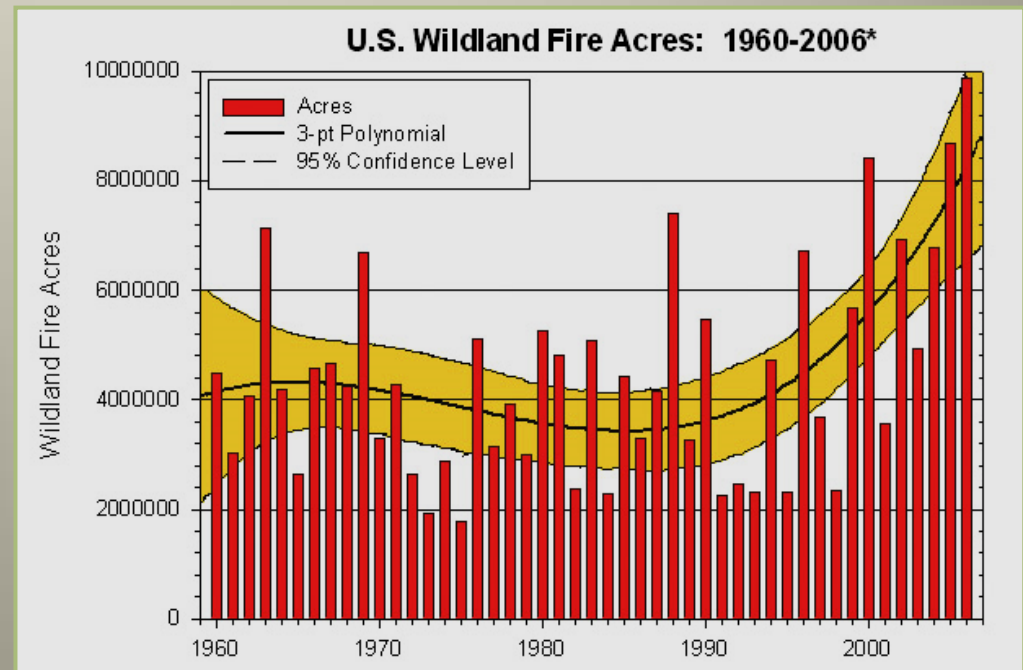
Climate Risks to Forests

- **Increased frequency and severity of disturbances**

- Insect outbreaks
- Pathogens
- Invasive species
- More deer
- Wildfires
- Extreme weather



Source: Grey Towers NHS

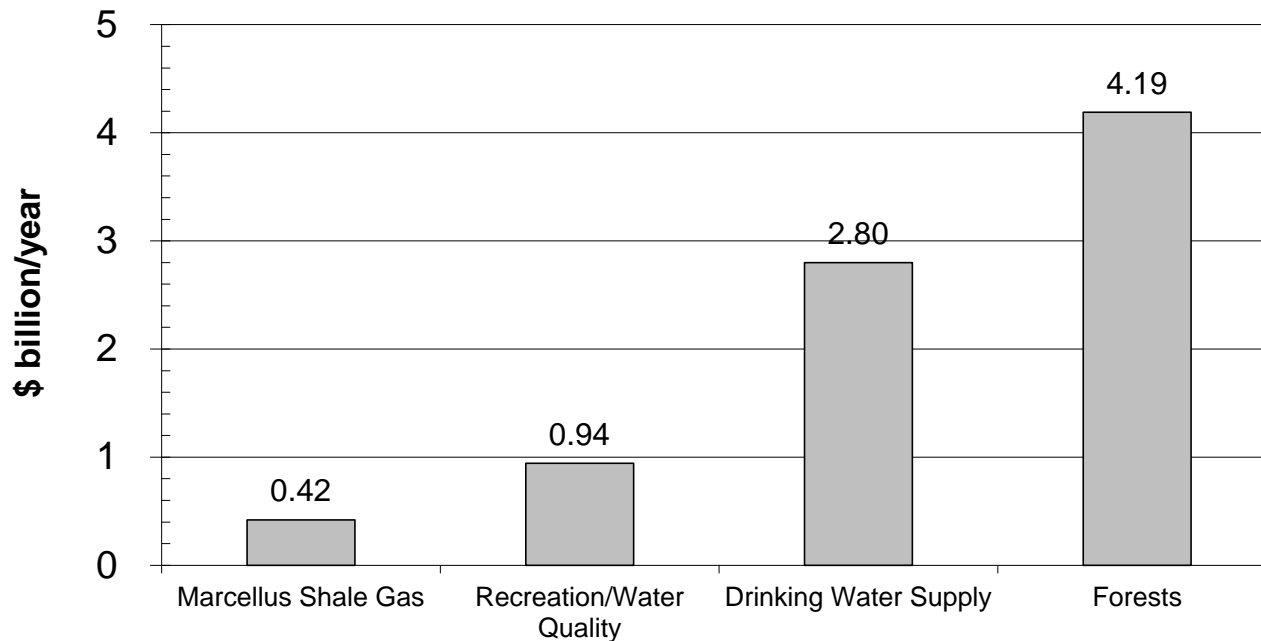


Source: US Forest Service

Climate Risks to Forests

Reduction in Valuable Ecosystem Services

Annual Economic Value of Resources
Upper Delaware River Basin



Source: Kaufman,
unpublished manuscript

- Carbon Sequestration
- Clean Air
- Stormwater/Flood Control
- Clean Water
- Erosion/Sediment Control
- Water Temperature Moderation
- Recreation
- Fish/Wildlife Habitat Benefits

Climate Risks to Water Resources

- **More frequent / more intense extreme precipitation events**
- **Water quality & habitat degradation**
- **Streambank erosion**



Source: Pike Co. Conservation District



Source: Pike Co. Office of Community Planning



Source: Pike Co. Conservation District

Climate Risks to Water Resources



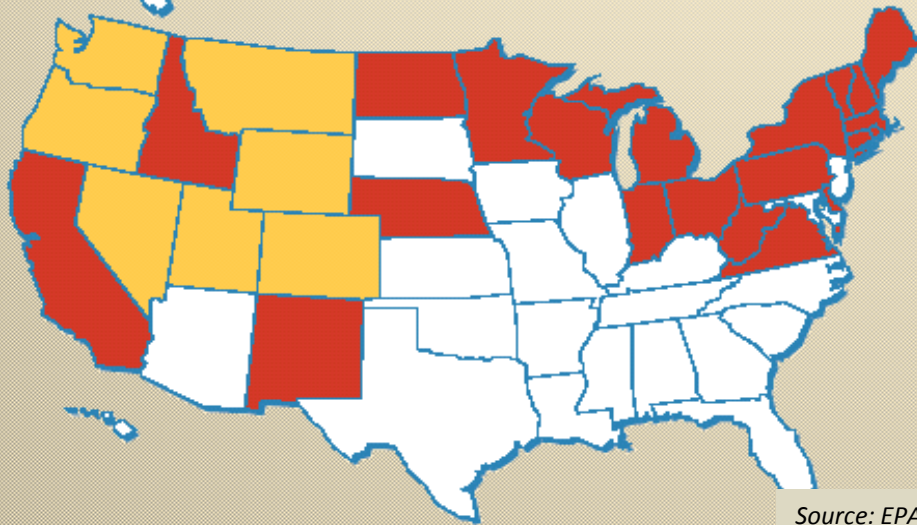
- **Seasonal drought**
- **More algae growth**
- **Increased evaporation from reservoirs**
- **Sea level rise and salt intrusion downriver**
- **More competition for less water**

Source: NY DEC

Climate Risks to Water Resources

Looking Ahead: Potential Loss of Stream Habitat for Trout & Salmon due to Climate Change (2050-2100)

■ 50-100% Loss ■ 1-49% Loss
□ Not included in analysis

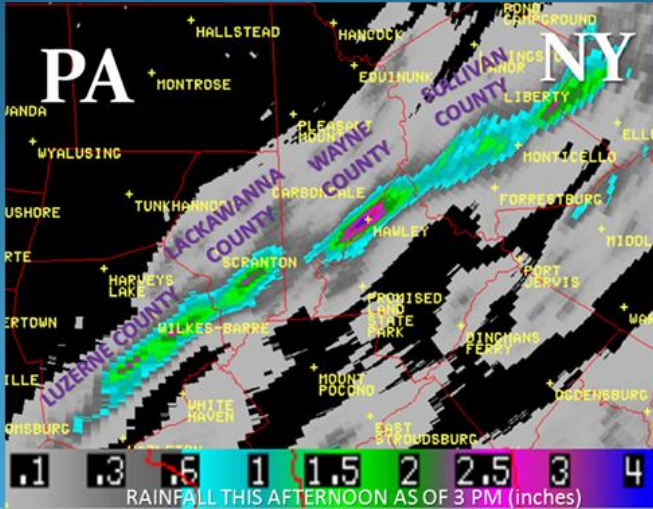


Source: EPA

- **Stream flow fluctuations**
- **Thermal stress to fish**
- **Declines in cold water fisheries and other sensitive species**

FLASH FLOOD WARNINGS IN EFFECT ALONG THIS LINE OF HEAVY RAINFALL

Training storms have produced 1 to 4 inches of radar-estimated rain



Economic Implications

- Flooding/flood losses/ property damages
- Municipal budget impacts



Source: USACE



Source: WBRE TV

Economic Implications

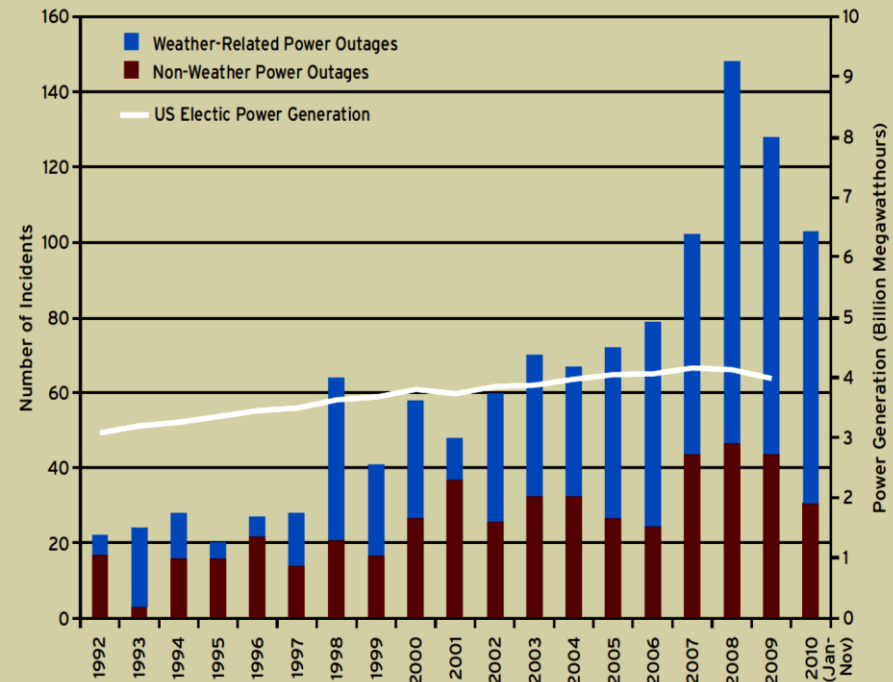
- Infrastructure damages
 - Roads/culverts/bridges
 - Dams
- Weather-related power disruptions
- Small business losses



Source: WBRE TV



MAJOR ELECTRIC POWER DISRUPTIONS



Source: NWF, 2011

Economic Implications

- **Flow and water quality related impacts on tourism and recreation**



Source: NPS



Source: FUDR



Source: Kittatinny Canoes



Agricultural Losses

- Direct crop damages
- Delayed planting or harvest
- Reduced milk production or crop yields
- Increased water demands
- More weeds and insects

Human Health Implications

REGIONAL WEATHER

Extreme Weather Events

Heat Waves
Hurricanes
Tsunami
Severe Drought

Changes in Temperature and Precipitation

Air pollution
Disease carriers
Contaminants

Flood
Destruction {
Mold and mildew
Contaminated food and water
Lack of shelter
Scarcities in food and water

Pollutants and allergens
Mosquitos, ticks, fleas, rodents
Water- and food-borne diseases

HEALTH OUTCOMES

Heat stress and stroke
Injury, illness, death
Asthma and respiratory disease
Malnutrition, starvation
Mental illness

Asthma, respiratory, heart & lung disease, cancer
Malaria, Lyme disease, encephalitis, hantavirus
Cholera, cryptosporidiosis, salmonella

Vulnerable populations are most at risk

Potential Strategies for Reducing Forest & Water Climate Risks

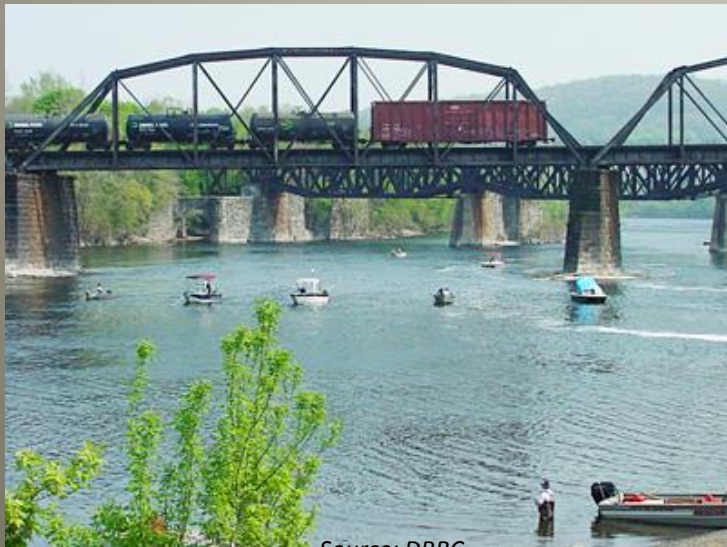


- **Generate active dialogue and information exchange about climate risks**
- **Maintain forest cover through policies that support forest conservation**
- **Provide a steady source of landowner \$\$ and technical support to promote forest health**
- **Manage deer & invasives through cooperative efforts**
- **Continue strategic voluntary easement/land acquisition programs**

Potential Strategies for Reducing Forest & Water Climate Risks



Source: Dave Soete



Source: DRBC

- Enhance local stakeholder representation in flow management policy-making
- Update floodplain management, riparian buffer and stormwater management standards
- Improve infrastructure to accommodate changing precipitation patterns
- Engage downstream water users who benefit from upstream forests and waters to invest in the Upper Basin

Your Thoughts?



Source: DRBC

- **What indicators of a changing climate have you noticed?**
- **What risks are of most concern to you and your community?**
- **Are there factors we haven't considered?**
- **What ideas do you have for reducing risks?**

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