CLIMATE CHANGE – Increasing Uncertainty in the Management of the Delaware River Basin

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Delaware River Basin Commission

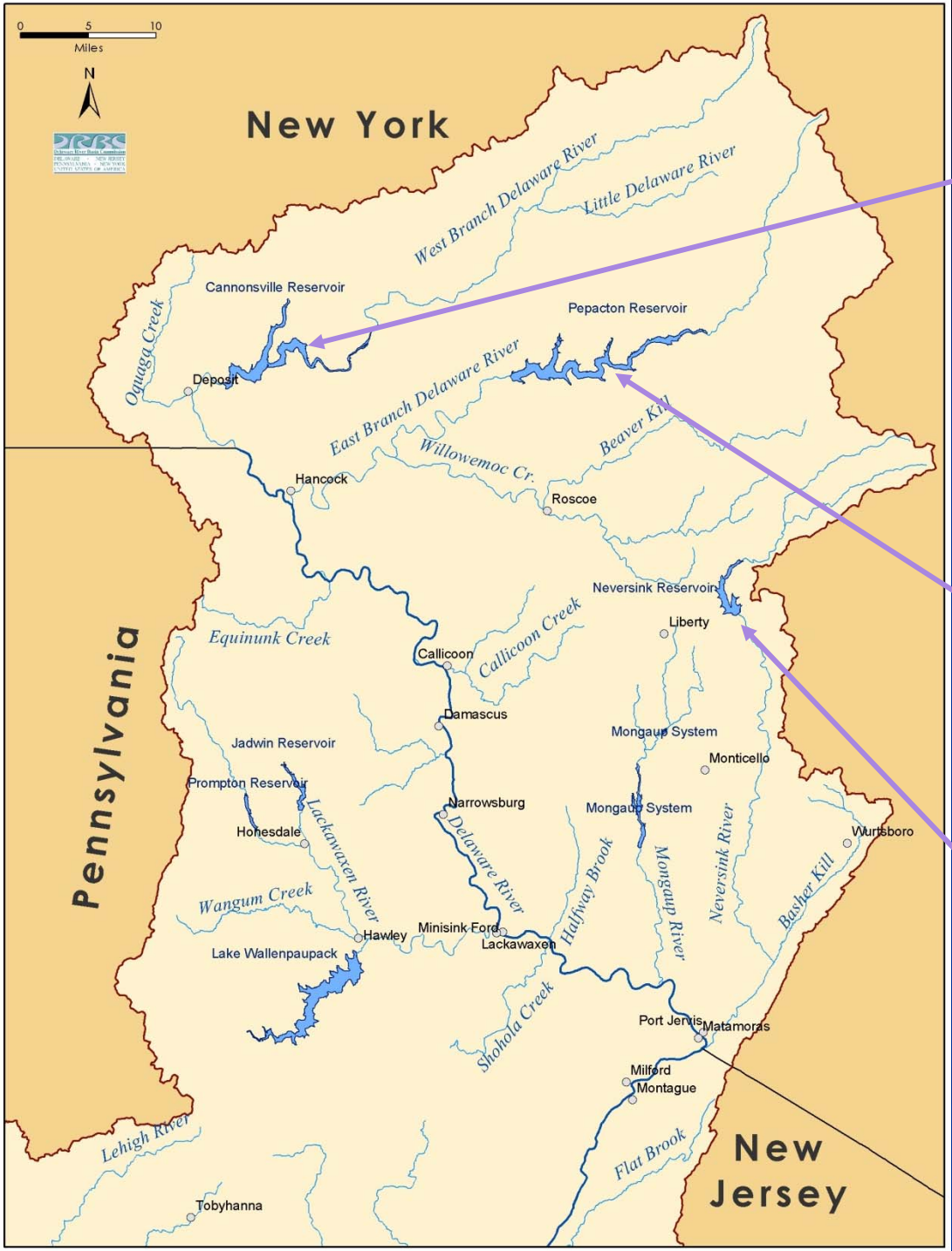
Delaware River Watershed Facts

- Nearly 15 million people (about 5% of the U.S. population) rely on the waters of the basin
- Drains 13,539 mi² , or 0.4 of 1% of the continental U.S. land area
- 216 tributary streams
- 4 states, 42 counties, 838 municipalities
- 25 Congressional Districts

Delaware River

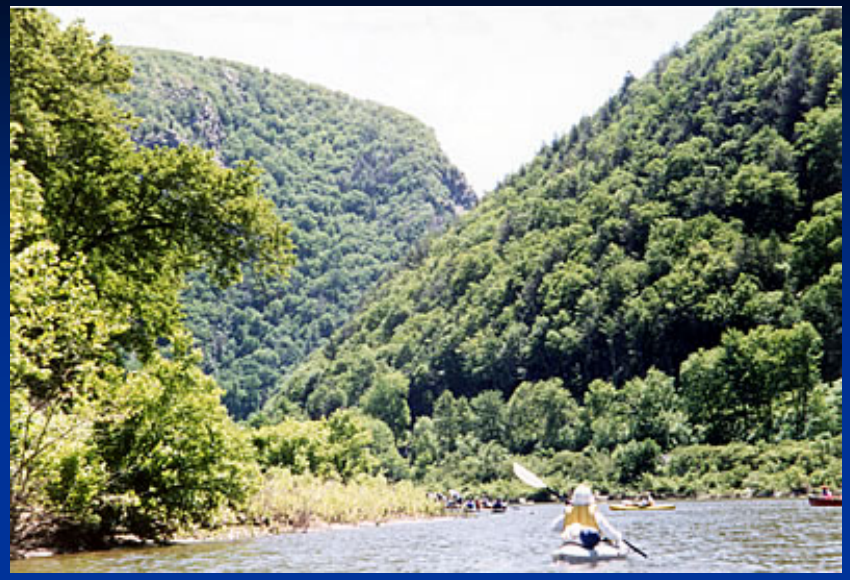
Longest Undammed River
East of the Mississippi

330 miles



Photos Courtesy NYC DEP

Delaware Water Gap Region



Zone Designations for the Delaware Estuary

The Delaware River Port Complex (including docking facilities in Pa., N.J., and Del.) is the largest freshwater port in the world.

Delaware River Basin Commission

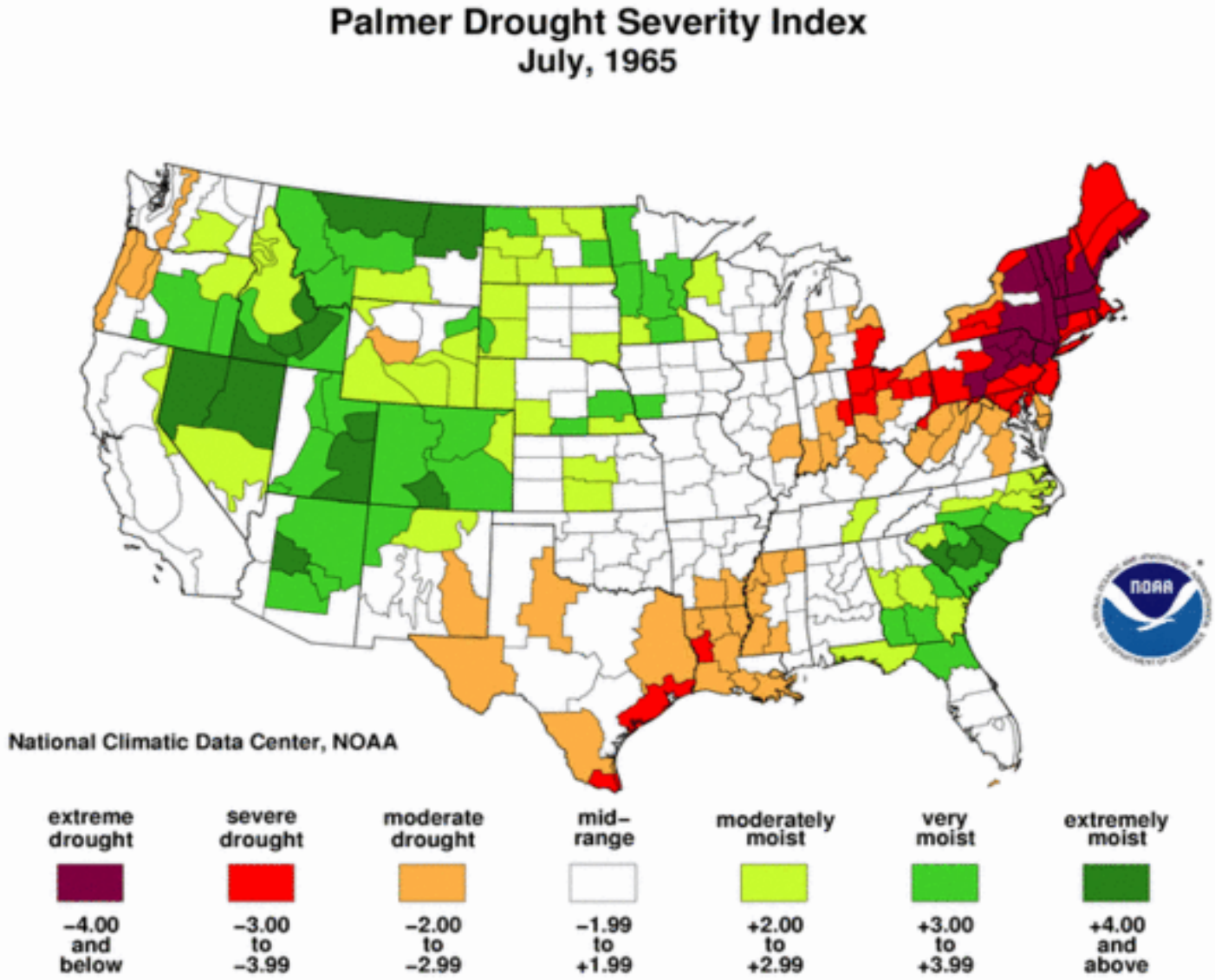
WHAT DOES DRBC DO?

- ✓ Manages Resources on a Watershed Basis
- ✓ Regulates Water Quality & Quantity
- ✓ Directs a Fair Distribution of Water
- ✓ Plan for Best Use of Water Resources
- ✓ Coordinates / Facilitates
- ✓ Educates about Water Resources

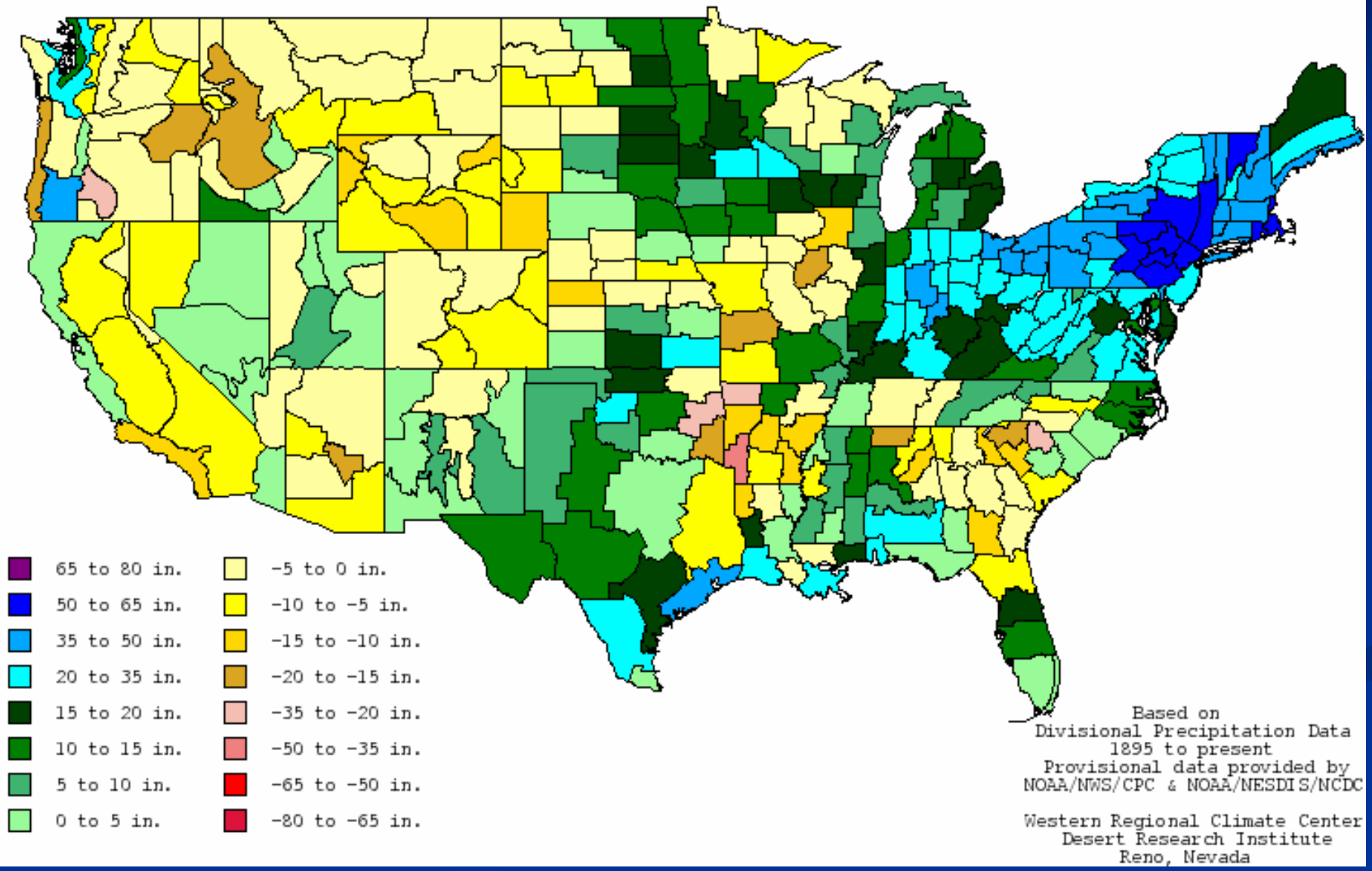
Discussion Topics

- Changing Trends
- Potential Impacts to the Delaware System
- Potential Solutions
- Needs from the Scientific and Engineering Community

Drought of the 1960's

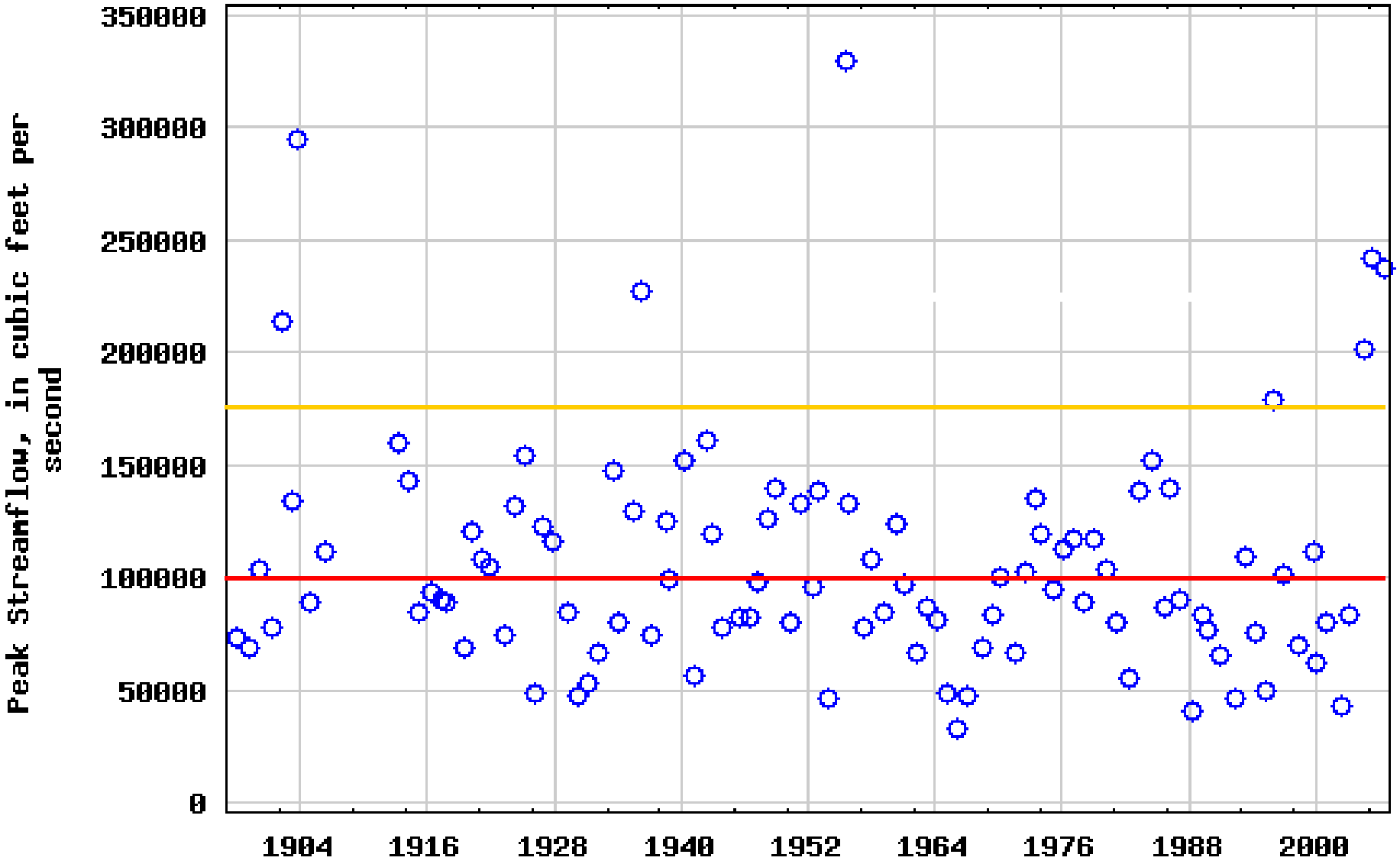


72-month Accumulated Precipitation Departure from Normal through the end of January 2008



USGS

USGS 01463500 DELAWARE RIVER AT TRENTON NJ



Future Scenarios

- Equal or Increased Precipitation
- Greater Intensity of Storms
- Increasing Temperatures
- Potential for Extended Droughts
- Some Increase in Sea Level Rise
  - (0.5 m – 5 m by 2100)

Potential Impacts

- Water Supply
  - Prolonged Droughts
  - Evapotransporation
  - Loss of Snow Pack
  - Salinity – Sea Level Rise
  - Infrastructure
  - Coupled with Increasing Demand

Changes in Snowpack and Timing of Snowmelt

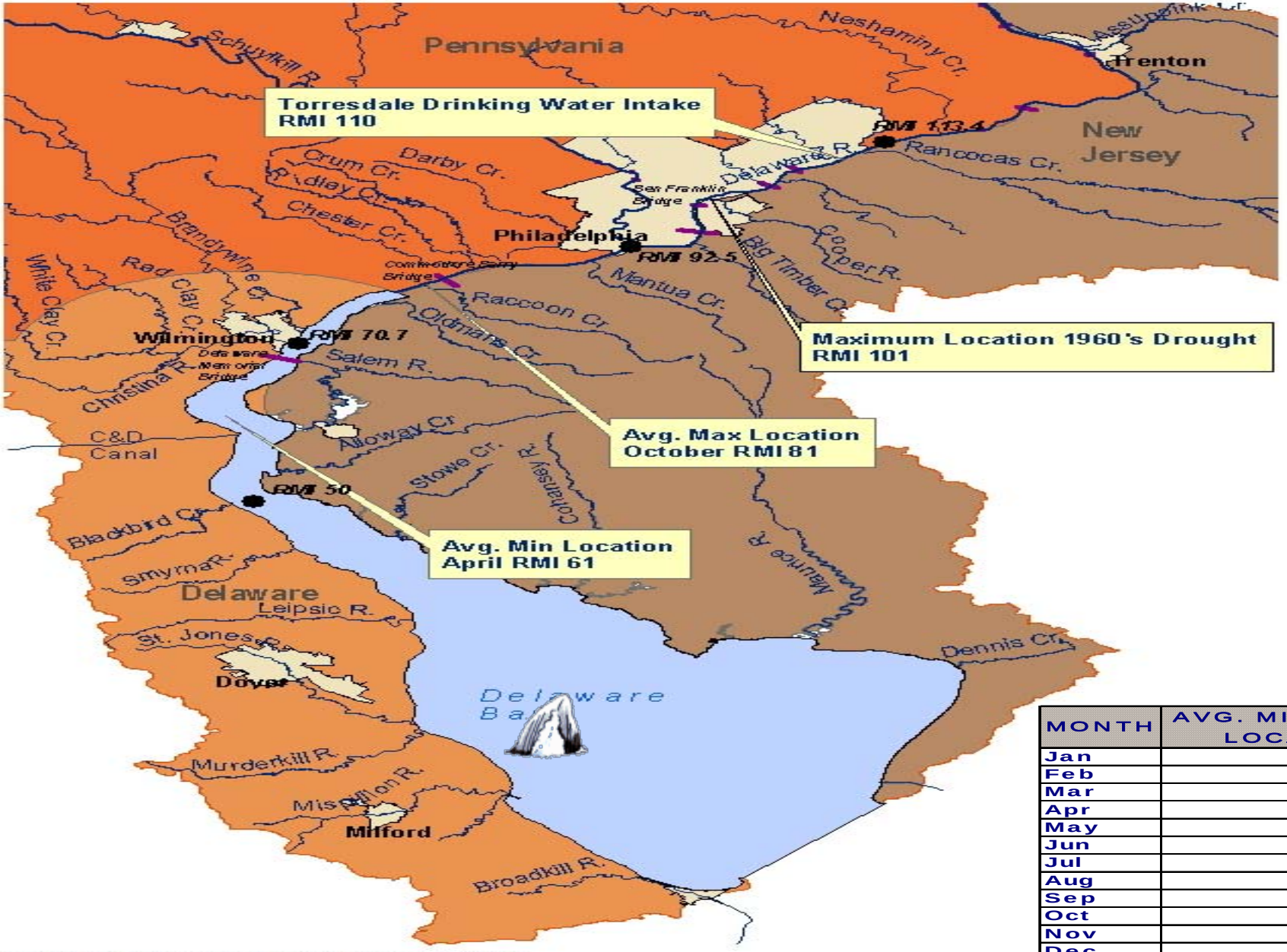
- There will be less snow in the winter; this affects water supply for many who depend on the melting of snowpack as a water source. The timing of snowmelt may also change, prompting water resource managers to change how water supply reservoirs are managed.

The Changing Face of Winter

If higher emissions prevail, a typical snow season may become increasingly rare in much of the Northeast toward the end of the century. The red line in the map captures the area of the northeastern United States that, historically, has had at least a dusting of snow on the ground for at least 30 days in the average year. The white area shows the projected retreat of this snow cover by late-century to higher altitudes and latitudes, suggesting a significant change in the character of a Northeast winter.

from *Confronting Climate Change in the U.S. Northeast*, 2007
Northeast Climate Impacts Assessment

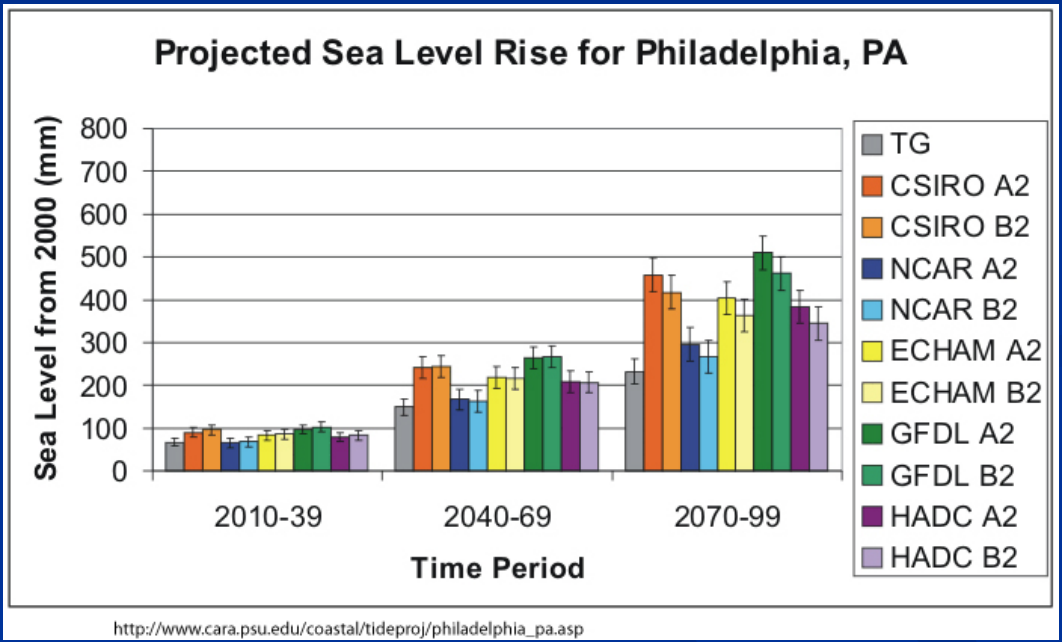
Annual Maximum and Minimum Salt Line Locations Along the Delaware River



MONTH	AVG. MID-MONTH LOCATION
Jan	68
Feb	68
Mar	67
Apr	61
May	64
Jun	67
Jul	72
Aug	77
Sep	79
Oct	81
Nov	80
Dec	74

Based on average mid-month locations of the 250 mg/L 7-day average chloride concentration (salt line).

- Jeopardize water supply due to increased salinity levels. Both surface water and groundwater withdrawals in the estuary will be affected.
- Increase river flows to push back salt line
- Increase costs for water purveyors – moving intake pipes upstream or building desalination plants.



NYC RESERVOIR STORAGE DECLINES TO RECORD LOWS

Cannonsville Reservoir is located on the West Branch of the Delaware River

November 26, 2001
record low storage for Cannonsville,
3.245 bg or 3.39% of capacity.

Cannonsville Reservoir under normal conditions.

Cannonsville Reservoir (6.5% of capacity).

Potential Solutions

- New Reservoirs
- New Mainstem Reservoir
- Reduce Demand
- Sea Barriers

Potential Impacts

- Water Supply
- Flood Inundation
  - Increased Precipitation
  - More Intense Storms
  - Non-Tidal River – Old Towns
  - Coastal Surge

September 2004

April 2005

June 2006

Three Major Floods along the Main Stem Delaware River in less than Two Years


Reservoirs in the Delaware River Basin
New York
Pennsylvania
New Jersey
Maryland
Delaware
Atlantic Ocean
Cannonsville Reservoir
Pepacton Reservoir
Neversink Reservoir
Lake Wallenpaupack
Mongaup System
F. E. Walter Reservoir
Beltzville Reservoir
Merrill Creek Reservoir
Blue Marsh Reservoir
Nockamixon Reservoir
Marsh Creek Reservoir
Deposit
Hancock
Milford
Montague
Delaware Water Gap
Easton
Phillipsburg
Allentown
Reading
Pottstown
Trenton
Philadelphia
Camden
Wilmington
Salem
Dover
Milford
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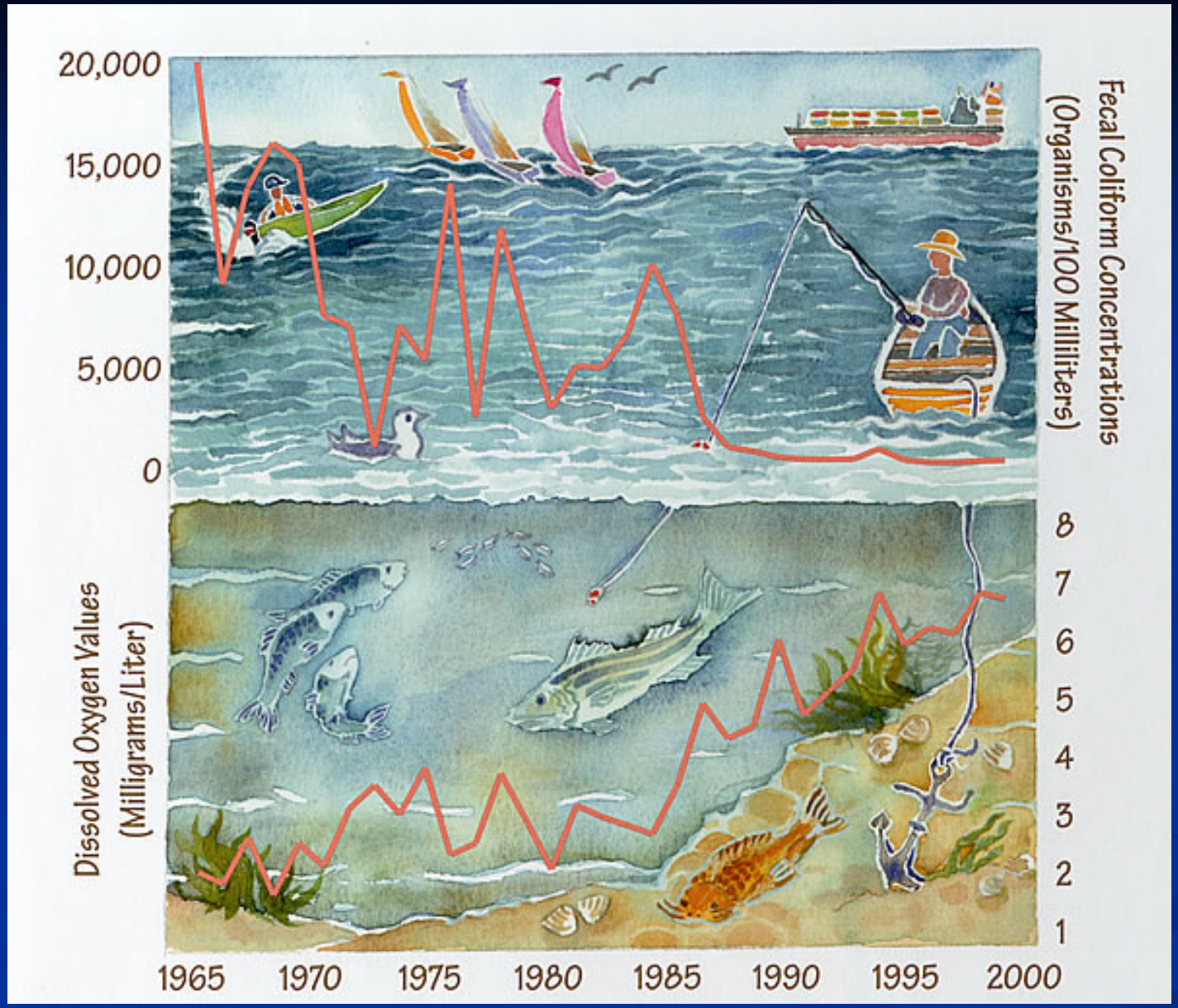
Potential Solutions

- Different Management of Existing Reservoirs
- Raised or New Reservoirs
- New Mainstem Reservoir
- Moving People from Harm's Way
- Flood Warning/ Flood Mapping

Potential Impacts

- Water Supply
- Flood Inundation
- Water Quality Impacts
  - Temperature
  - Dissolved Oxygen
  - Suspended Sediment



FECAL COLIFORM IS WAY

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and

DISSOLVED OXYGEN IS

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FROM 2 PPM TO 7!

Potential Solutions

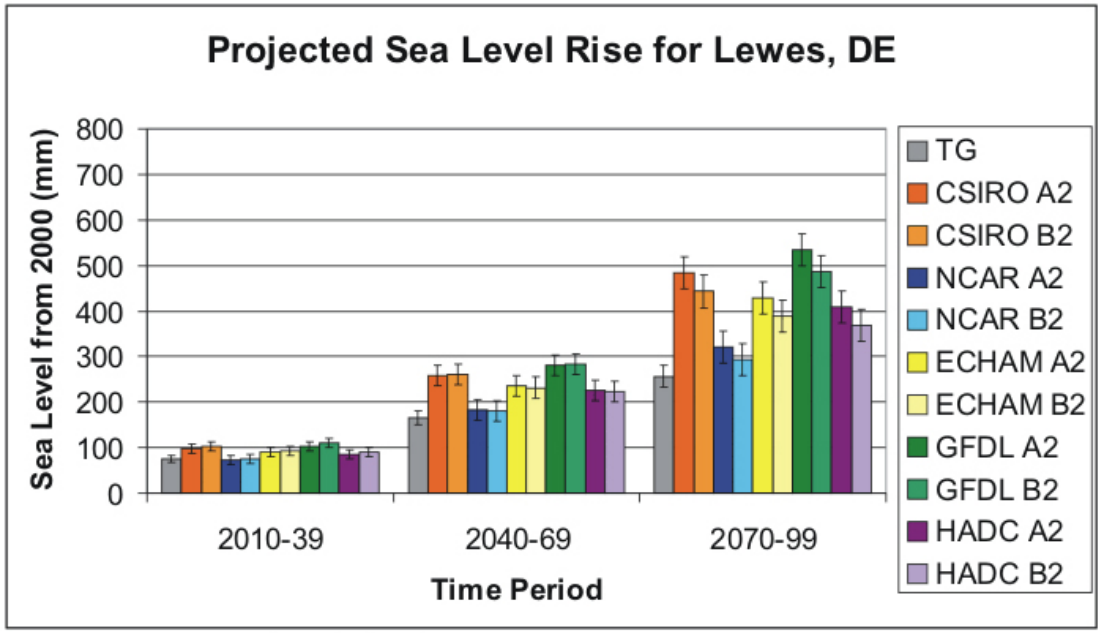
- First –Modeling of Scenarios / Impacts
- Issues –
  - Existing Water Quality Standards
  - Anti-Backsliding Rules
  - How to Handle Natural Changes –Tougher Regulation?
  - Should We Adapt to WQ Changes?

Potential Impacts

- Water Supply
- Flood Inundation
- Water Quality Impacts
- Biological Impacts
  - Wetlands Inundation
  - Change in Spring Thaw Flows
  - Migratory Patterns
  - Vegetation Changes
  - Invasive Species

Sea Level Rise - Impacts on the Delaware Estuary

- Reduce the amount of natural wetlands and marshes, which act as a buffer, helping reduce non-point source pollution and flooding severity. Wetlands are also an important habitat for wildlife, especially migrating birds and fish.



http://www.cara.psu.edu/coastal/tideproj/lewes_de.asp

- The animals, plants, and forests of the region may shift their habitat and ranges northward due to increased temperatures and potential decrease in water.
- Biodiversity among species may also decrease, which can also lead to an increase in invasive species.

Changes in Forest Diversity for the MARA Region

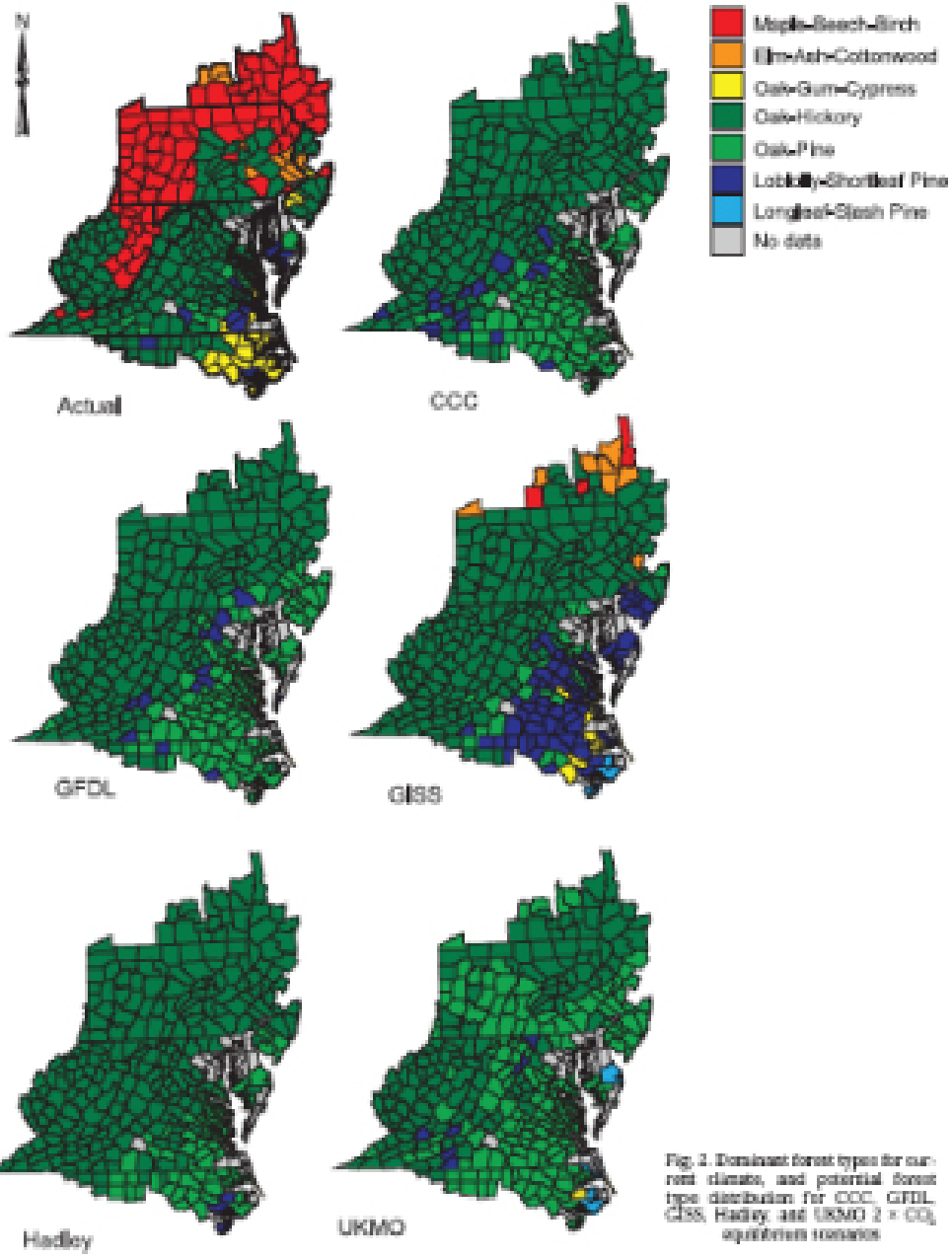
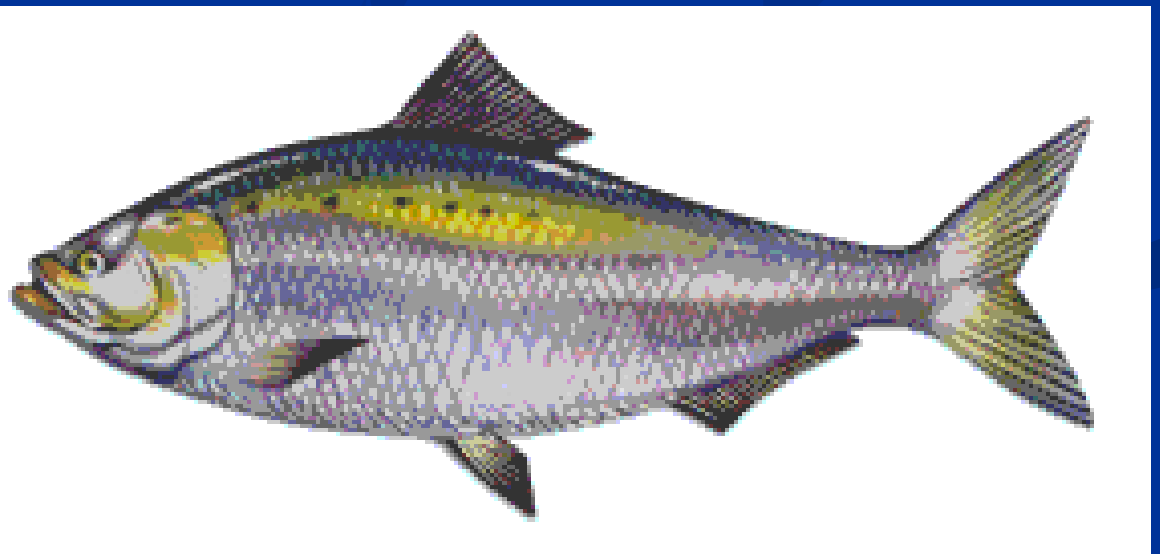


Fig. 2. Dominant forest types for current climate, and potential forest type distribution for CCC, GFDL, GISS, Hadley, and UKMO 2 × CO_2 equilibrium scenarios

http://www.cira.psu.edu/mara/index.html

- Already seen:
  - earlier bird migration and egg laying,
  - earlier peak discharges in snow-fed rivers,
  - earlier timing of spring blooms, and
  - changes in the range and timing of fish migrations in rivers (IPCC 2007)

American shad



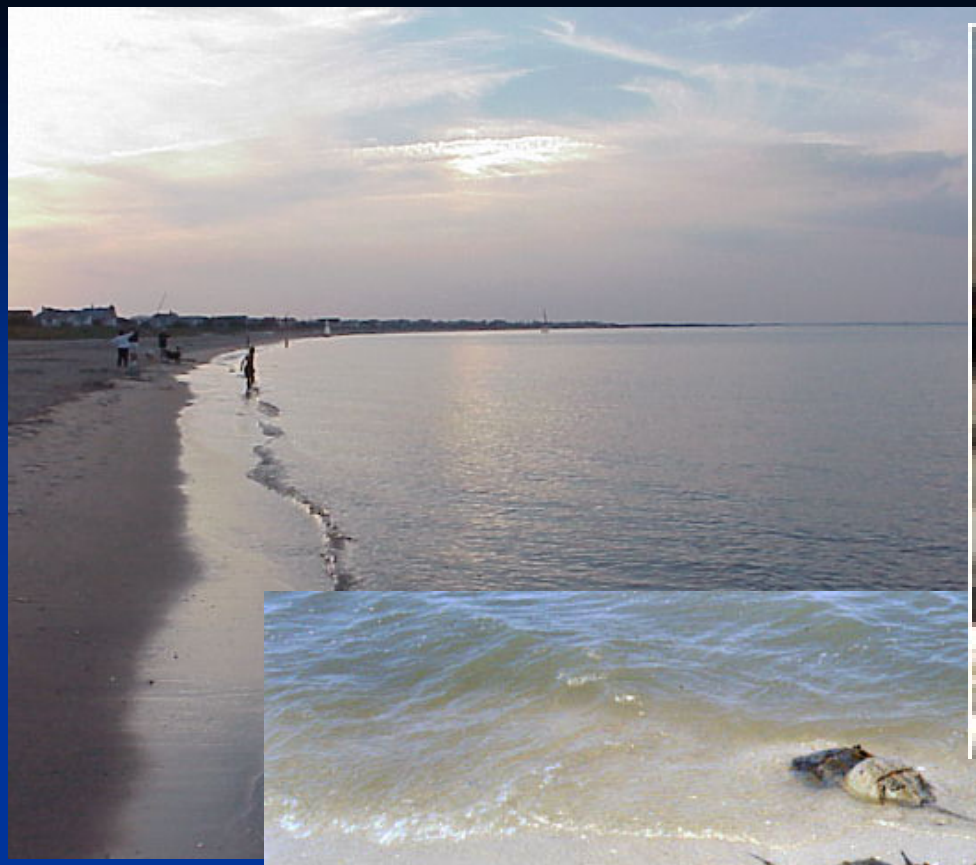


Photo courtesy of USFWS

Potential Solutions

- Adaptation?
  - Planting new species
  - Let cold water stretches convert to warmwater fisheries

Next Steps

- Mitigation of Causes
  - Control of Greenhouse Gases
  - Energy – Supply and Demand
- Mitigation of Potential Effects
  - Assess Future Demand
  - New models with uncertainty factors (e.g. drought of record)
  - Strategic Plans for Droughts, Floods, Sea Level Rise
- Adaptation (*vs* fighting change)
  - e.g. –Impact of change in forest species

Be Prepared

- Work with Water Management Partners to Assess Worst Case Scenarios
- Reduce Demand
- Address Supply/Storage Options
  - Large Structural Solutions *vs* Small, Local Changes

Will Many Small Changes Be Enough?

- Need for Upper Basin Storage
  - New Reservoirs and Flood Mitigation Dams?

    or
  - Combination of
    - Stormwater Infiltration
    - Protection of Headwaters
    - Stream Corridor Protection
    - Low Impact Development
    - Regional Planning
    - Floodplain Regulation

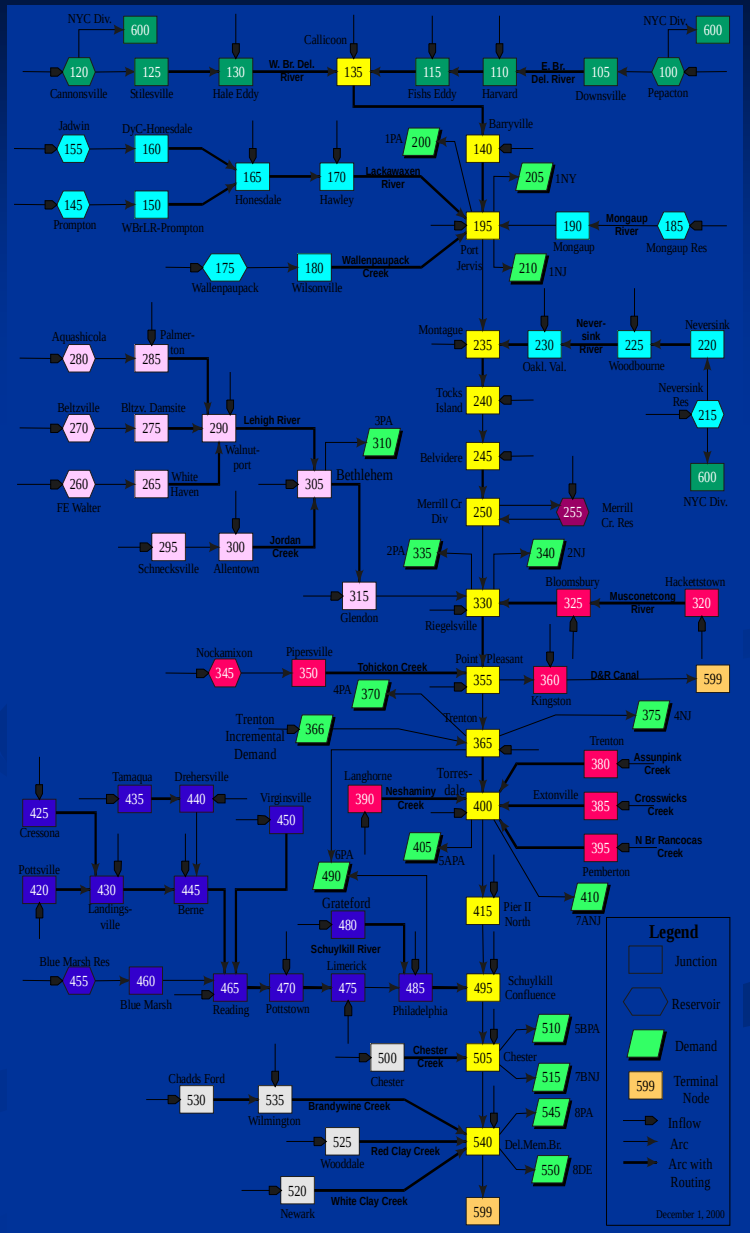
Conflicts

- Need To Manage For Even Greater Extremes
- Concern of Uncertainty Factor
- “Stationarity is Dead”
- Water managers like to be conservative –
  - Do not gamble with water
- Water for Supply, Instream Flows and Voids for Flood Mitigation

NEEDS

- Localized, Downscaled Climate Change Models
- Uncertainty Factors for Droughts and Floods
- Linking Models – CC/Hydrologic/Hydrodynamic/Water Quality
- Evaluation of Alternatives Effectiveness
  - Demand Reduction
  - Small, Local Solutions to Water Management
- Evaluation of Water Quality Implications

Daily Flow Modeling



NEEDS

- Studies of Sensitive Biological Communities
- Mid-Atlantic CC Consortium

Time for *ACTION* !!

Integrated Water Management in the Delaware River Basin
www.DRBC.net