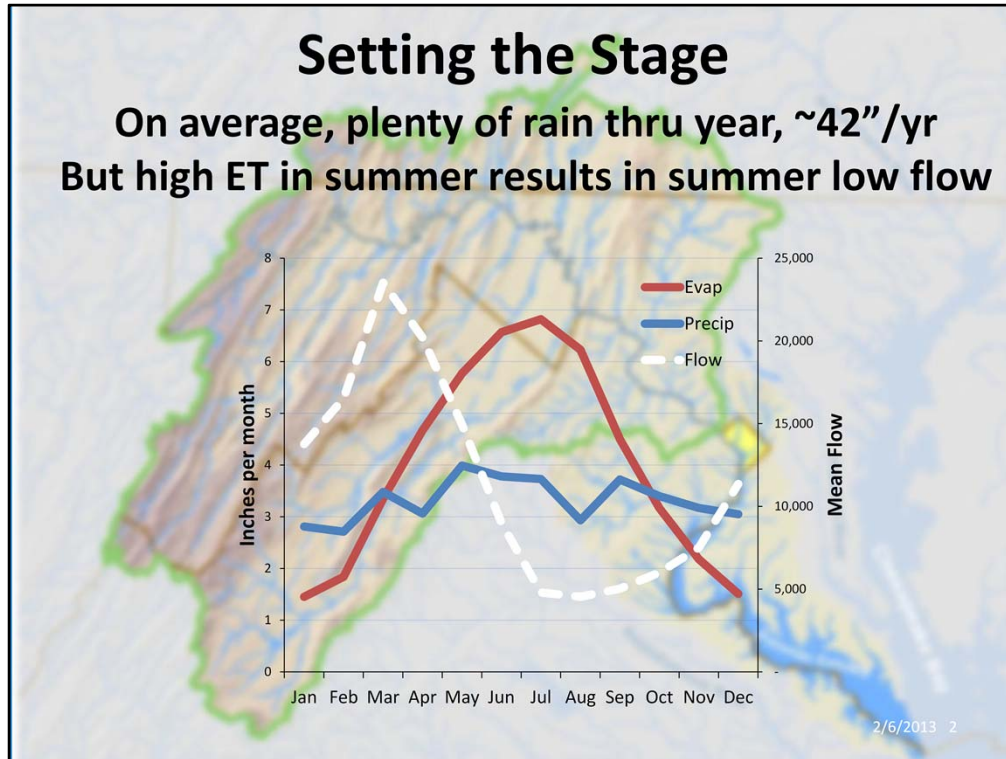


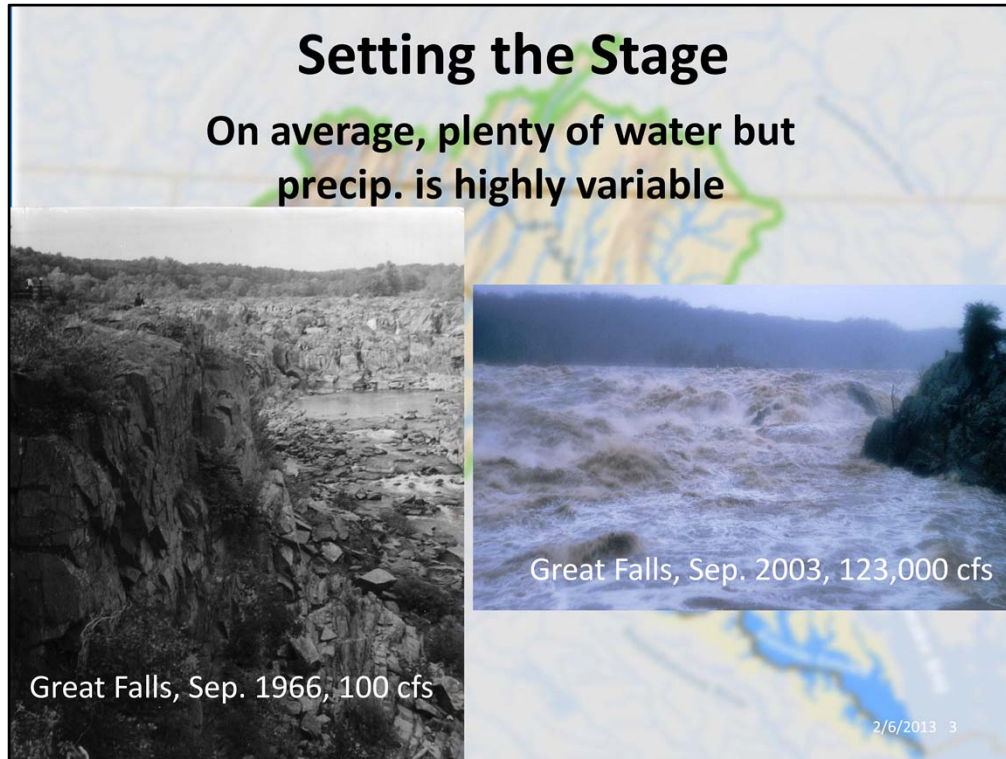
Setting the stage for the discussions later today about what are the most important issues for Potomac basin water management

- A) Some basic facts about the hydrologic and human context
- B) Selected examples of water issues that ICPRB has been engaged in recently.



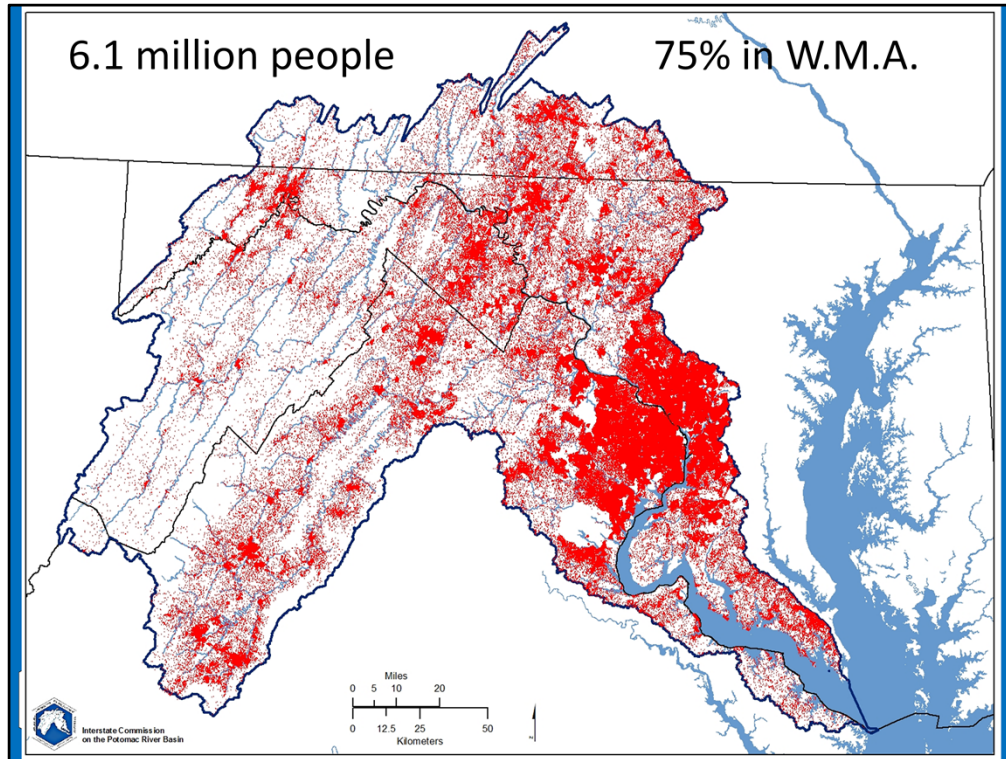
Setting the stage: On average, Potomac is water rich, but there is an annual cycle of high and low flows

- D.A.: 14,670 sq. mi. with 11,600 sq. mi. above head of tide
- Mean annual precipitation is about 42" (lots of precip!)
- And average monthly rainfall is approximately uniformly distributed throughout the year (blue line).
- But annual cycle of high evapotranspiration in Summer (red line), results in annual cycle of high river flow in Winter and low river flow in Summer (white line).



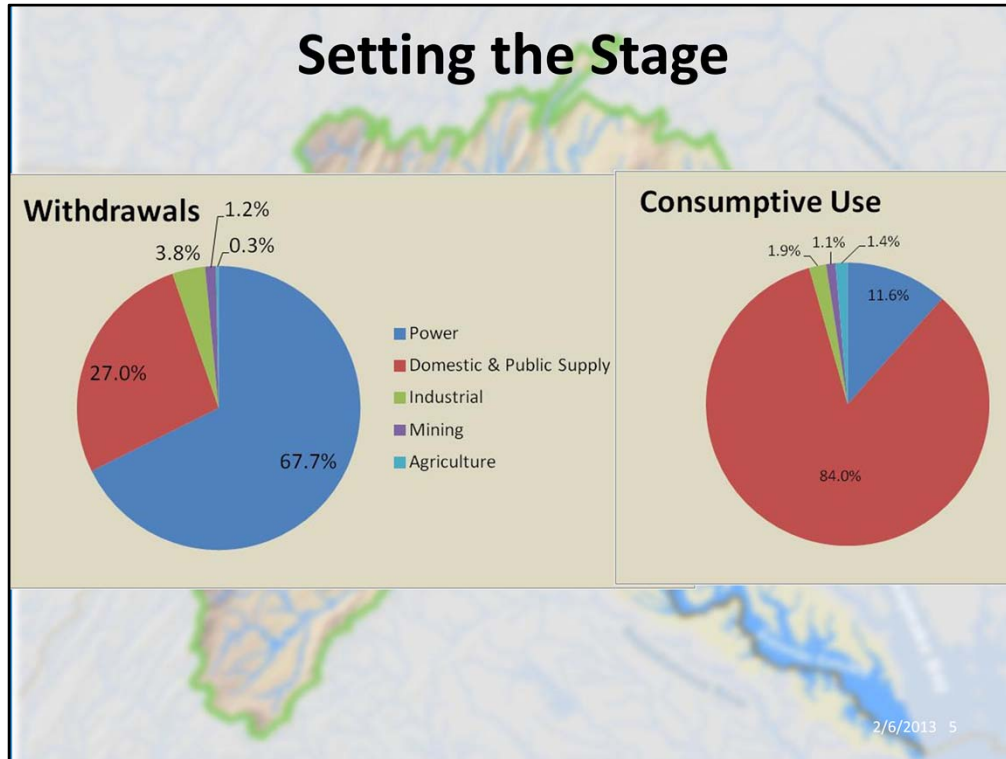
Setting the stage: high flow variability / minimal flow regulation

- Superimposed on this annual cycle is high variability in weather patterns - with periods of drought and periodic flooding.
- Photographs show flow at Great Falls, from nearly identical vantage points, in September in different years.
- Potomac River flow is nearly unregulated. There are approximately 450 dams scattered throughout the watershed but nearly all of them are small and run of river. The one major dam on the Potomac River, Jennings Randolph, is 235 miles upstream from Little Falls and provides some low flow augmentation and flood control



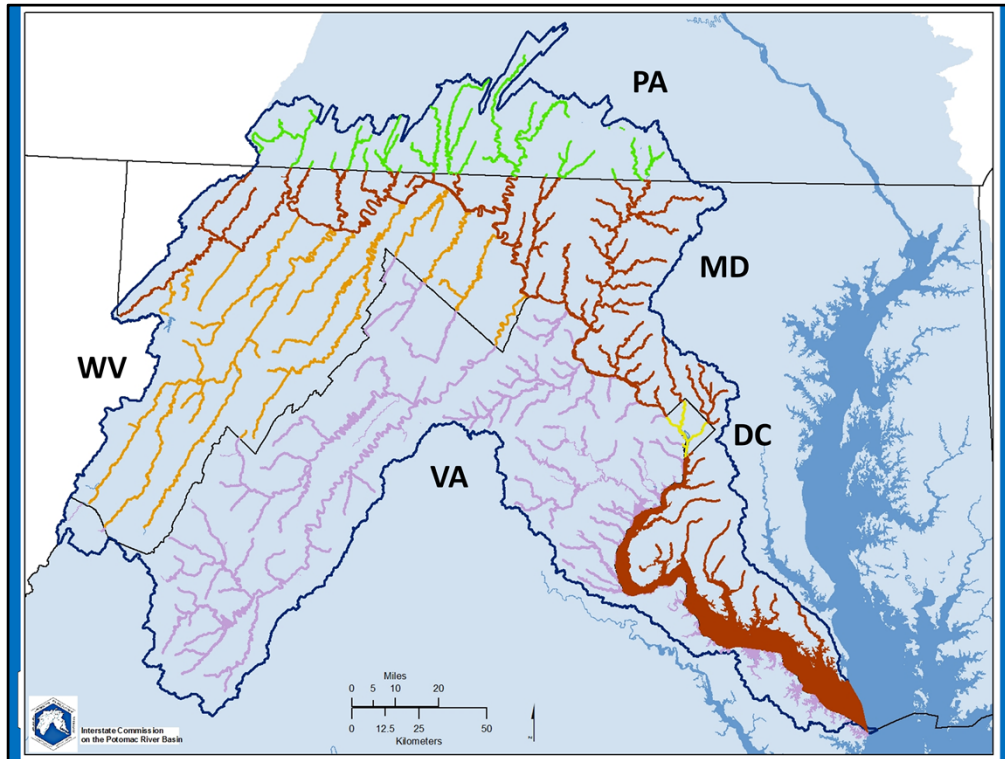
Setting the stage: population

- 6.1 million people
- Of whom 75% reside in the Washington Metro Area
- This spatial distribution of population drives the spatial distribution of demand for water and the distribution of impacts on water quality.



Setting the stage: Basinwide water use

- Withdrawals
 - 2/3 of withdrawals are for power
 - 1/4 for domestic and public water supply
- Consumptive use
 - 84% is domestic and public supply,
 - Power a distant second at a bit under 12%
- The other use sectors, Industrial, Mining, and Agriculture are “bit players”
- Cautions
 - This is basinwide picture & may be different in specific subwatersheds
 - Data on agricultural withdrawals is very poor



Setting the stage: The political context is a shared watershed

- An interstate watershed (four states + DC), with no single regulatory authority or water resources management framework varying among the jurisdictions

Water Resource Issues Potential Focus for IWRSS

- *Water Availability and Use*
- *Climate Change*
- *Flows and the Impact on Water Quality*
- *Flood Management*
- *Drought Management*
- *Potomac River Ecosystem*

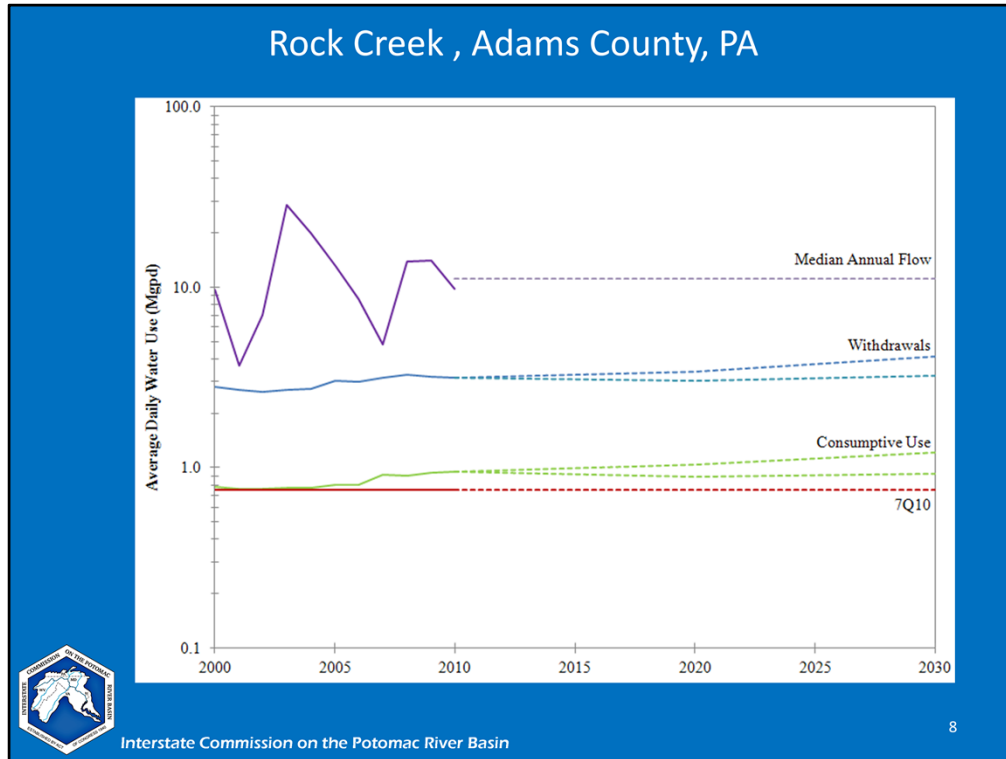


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Water resources issue areas of potential focus for IWRSS that workshop attendees voted on at registration

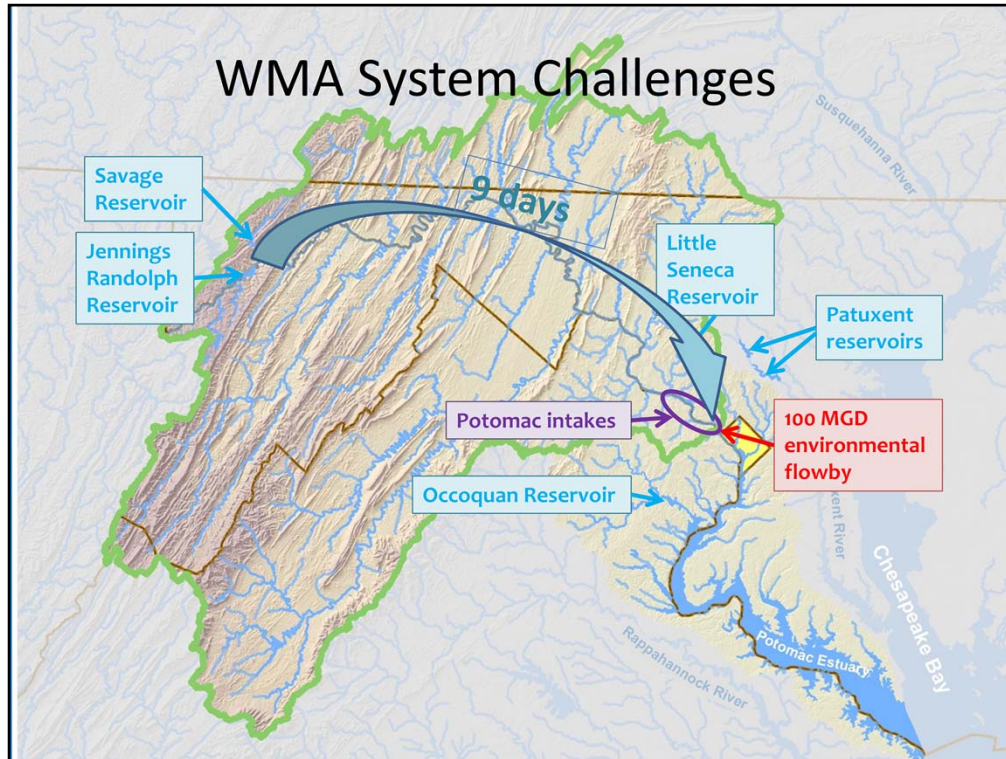
In next several slides I will present selected illustrative examples of these issue areas, drawn from recent work at ICPRB.



Water Availability and Use

- Although the Potomac Basin is generally considered water rich, water use exceeds availability under low flow conditions in some watersheds (e.g. the Rock creek watershed of Adams County).

Average daily withdrawals and consumptive use by year compared to median annual flow and the 7Q10 in the Rock Creek watershed of Adams County, PA



Drought Management

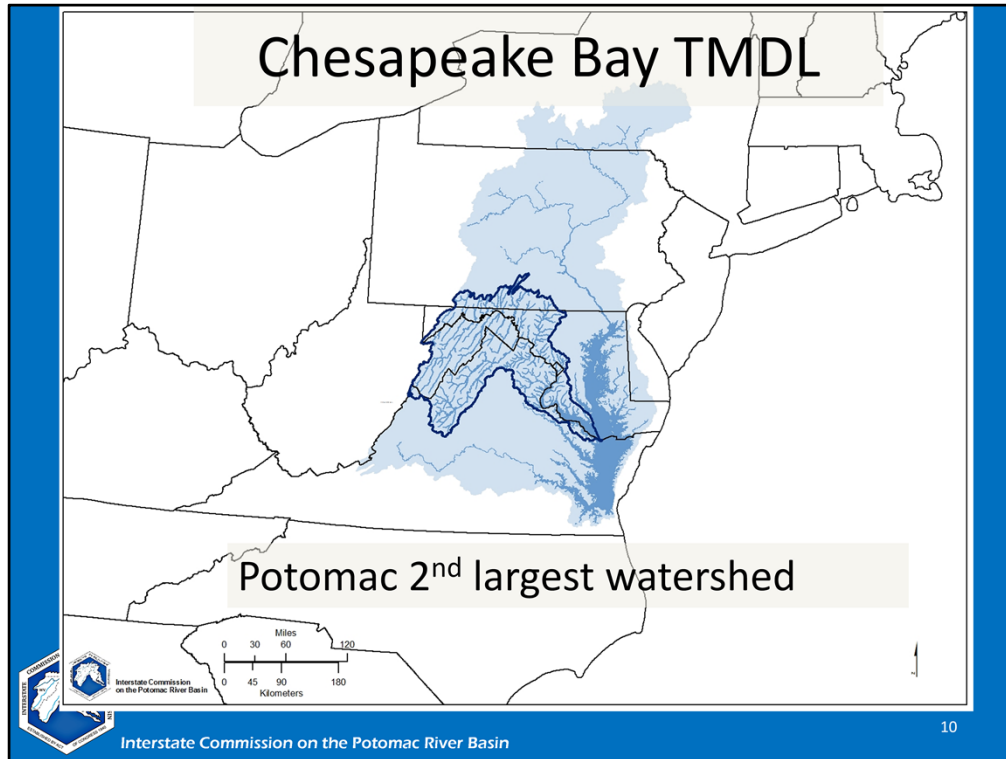
1. This slide illustrates the resources available to the Washington Metropolitan Area (WMA) water utilities
2. 75% of WMA demand is provided by Potomac River
3. Peak demand is about 500 mgd, which exceeds minimum flow of record (unaugmented by reservoir releases)
4. Utilities must allow for a minimum 100 mgd environmental flowby at Little Falls

Challenge is to manage storage resources to augment Potomac River flow as needed to meet demand and meet the Little Falls flowby in such a way that storage is maintained for longest possible time (most severe drought)

- Note the 9 day travel time from Jennings Randolph and Savage – effectiveness of system management depends on ability to forecast unaugmented flow 9 days into future.

Threats:

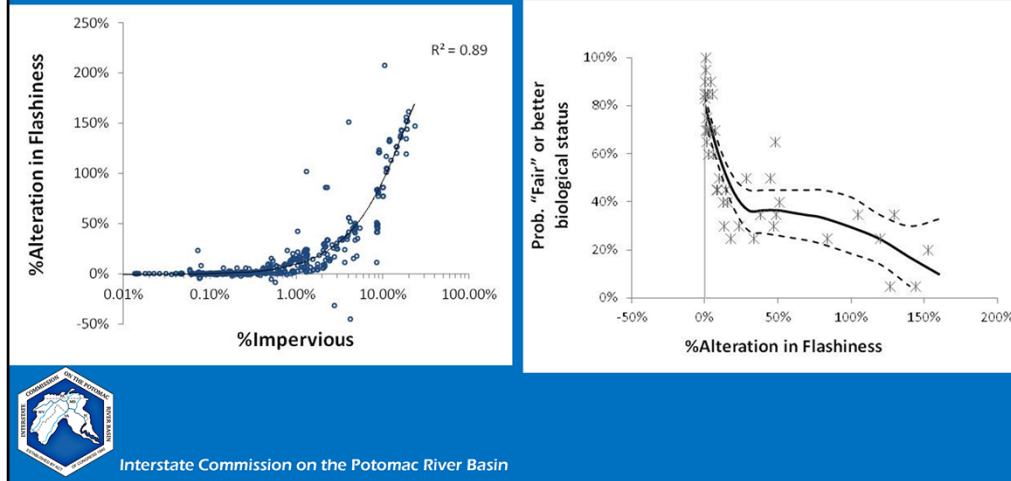
- Future increases in consumptive use upstream of WMA – predicted to increase approx. 1 mgd/year.
- Climate change impacts
- Population growth within MWA



Potomac River Ecosystem

- Chesapeake Bay TMDL is the major focus of water quality improvement efforts in this region
- Pollutants are N, P, and sediment
- Potomac river contributes 22% of flow to Bay, second only to the Susquehanna
- Connection with a discussion of water resources issues is that flow, especially stormwater, is both cause and delivery mechanism for pollutants and urban development is major cause of increased stormwater flows.

Urban development changes flows and degrades aquatic ecosystem health



Potomac River ecosystem

Urban development changes flows and degrades aquatic ecosystem health

1. An issue is the negative impact of **development** (growth) and increasing **impervious surface** on stream biological health.
2. Impervious surfaces in urban areas increase the magnitudes and shorten the durations of storm-related high flows entering streams. Streamflows are flashier.
3. Stream biological communities are stressed. There are measurable declines in biological status.
4. Urban stormwater management is capable of reducing peak stormwater flows and slowing the delivery of rainwater to streams and rivers.

Climate Change Impacts on Ecosystems

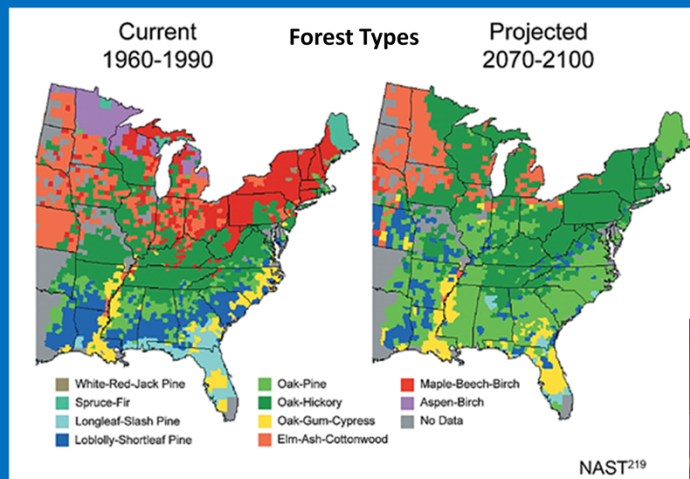


Photo by Drew Miller



Graphic by US Global Change Research Program, Cambridge University Press
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Climate change / Ecosystem

Climate change is shifting ecosystems northward

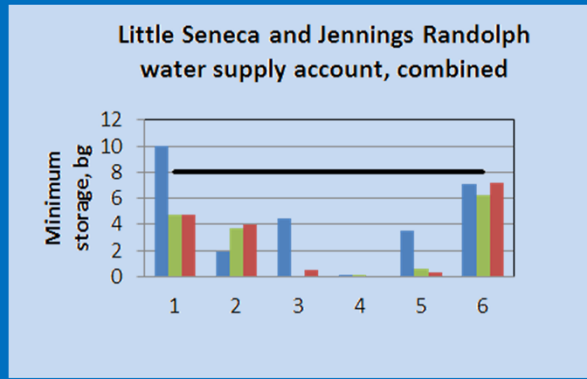
- creating changes in plant transpiration, runoff
- stressing aquatic species like the native brook trout.

Maps show current and projected forest types.

For example, in the Northeast, under a mid-range warming scenario, the currently dominant maple-beech-birch forest type (red) is projected to be completely displaced.

Climate Change Impacts on WMA System Reliability

(in absence of system changes)



Three Emission Scenarios used with Six Global Models:

Low Medium High Base

Draft results, December 2012



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Climate Change / Drought Management

- Recent evaluation of potential climate change impacts on WMA system reliability, simulated a moderately severe drought, 1999, with three different predictions of future changes in carbon emissions and six different Global Climate Change Models.
- Measure of system reliability is the minimum storage in reservoirs. (Higher minimum storage is better reliability)
- Out of 18 scenarios (3 * 6), 17 resulted in lower minimum storage and 4 essentially exhausted available storage.

Exotic Species



Potomac River Ecosystem: Exotic Species

- Fish: Of 117 species in the free-flowing and tidal freshwater river, approximately 20 % are non-native, including the smallmouth and largemouth basses and channel catfish.
 - The Northern snakehead and blue catfish are currently of most concern to the aquatic ecosystem, especially if they were to spread to upstream of Great Falls.
- Zebra Mussels: clogging intake pipes, changing filtering characteristics.
- Plants: Hydrilla ended up being relatively beneficial so far, but what may happen if the river remains warmer longer.

Water Resource Issues Top Three for Potential Focus

- *Water Availability and Use #1*
- *Climate Change*
- *Flows and the Impact on Water Quality #2*
- *Flood Management*
- *Drought Management #3*
- *Potomac River Ecosystem*



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Going into this workshop, you voted for these three topic areas as most important for IWRSS focus.