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science for a changing world

Science and Water Availability

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U.S. Department of the Interior
U.S. Geological Survey

Role of science and technology?

To obtain maximum economic benefit from our water resources, while respecting environmental values, we need:

Technologies that help enhance supply and use resources efficiently

Scientific knowledge and tools to inform public and private decisions

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4 science & technology issues that are critical to water availability

Water for ecosystem services

Ground water storage depletion

Climate change and water storage

Supply enhancing technologies

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What do we know about off-stream water use?

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Water withdrawals by category

Livestock

Less than 1 percent

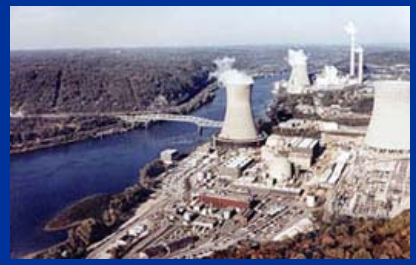
Domestic

Less than 1 percent

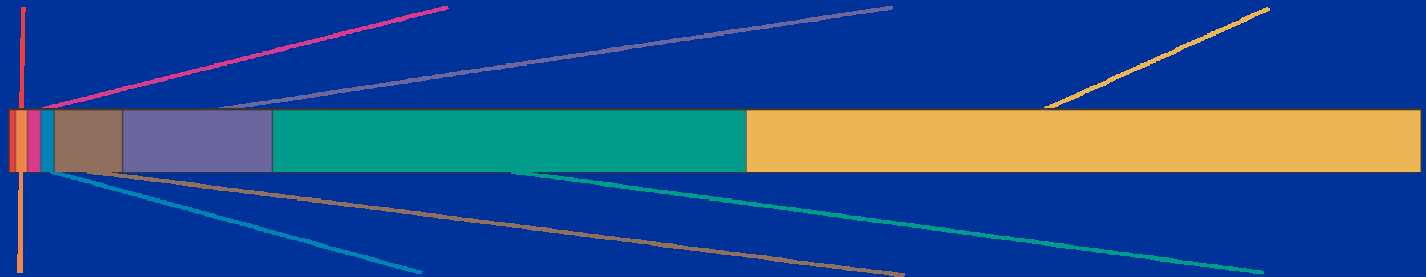
Public Supply

11 percent

Thermoelectric power



48 percent



Less than 1 percent

Mining

Less than 1 percent

Aquaculture

5 percent

Industrial

34 percent

Irrigation

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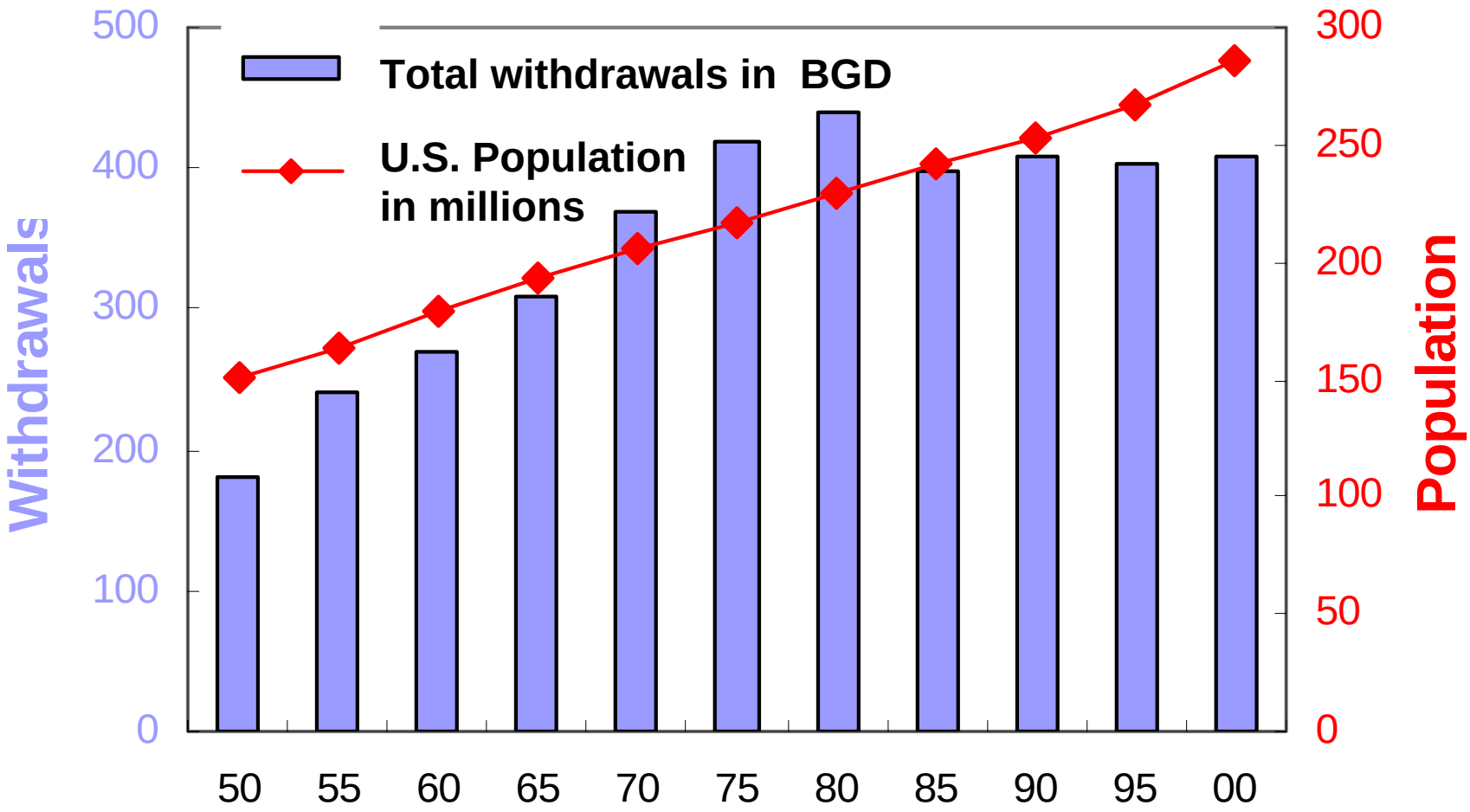
Total withdrawals and population



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3 key facts about off-stream water use

- Water use remains stable despite population growth
- Chief water uses for the U.S. are power generation and agriculture: both have been stable for 20 years
- Personal water use is rising, but not faster than population growth

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What about instream use

“Ecosystem Services” ??

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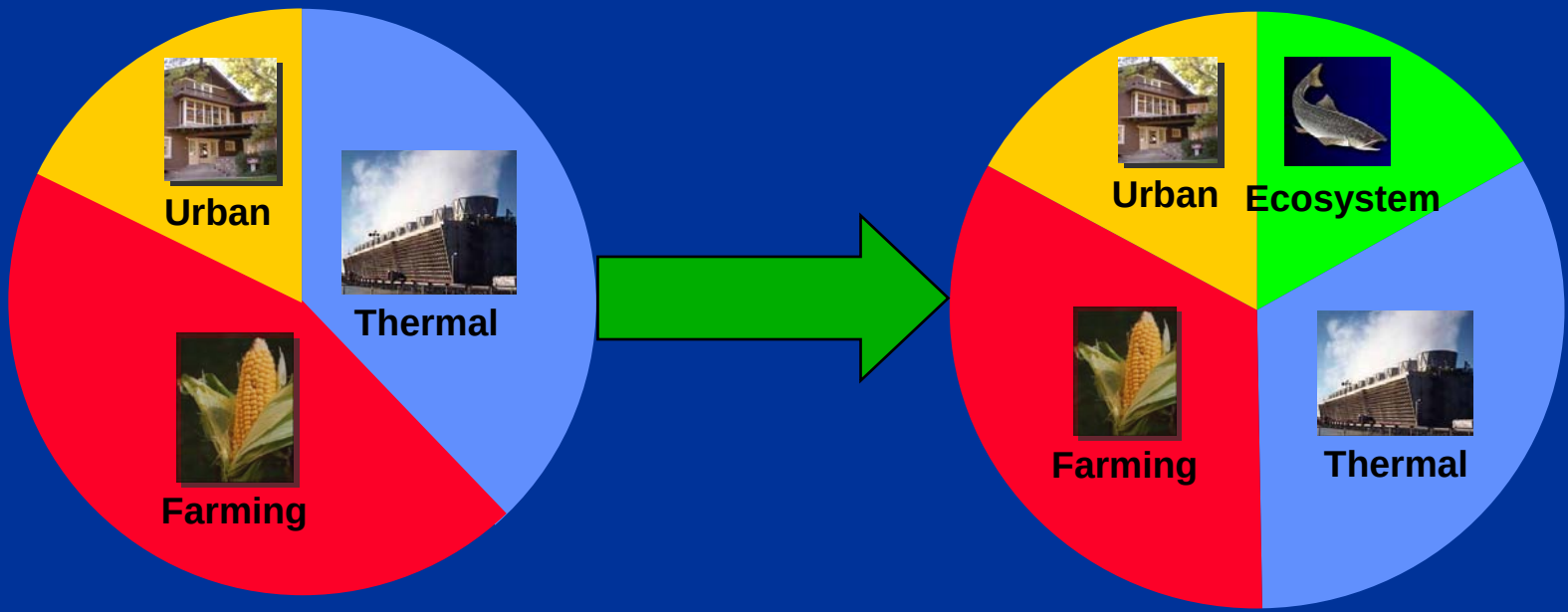
The Demand for Ecosystem Services is a Major Driver of the Changes in Water Allocations



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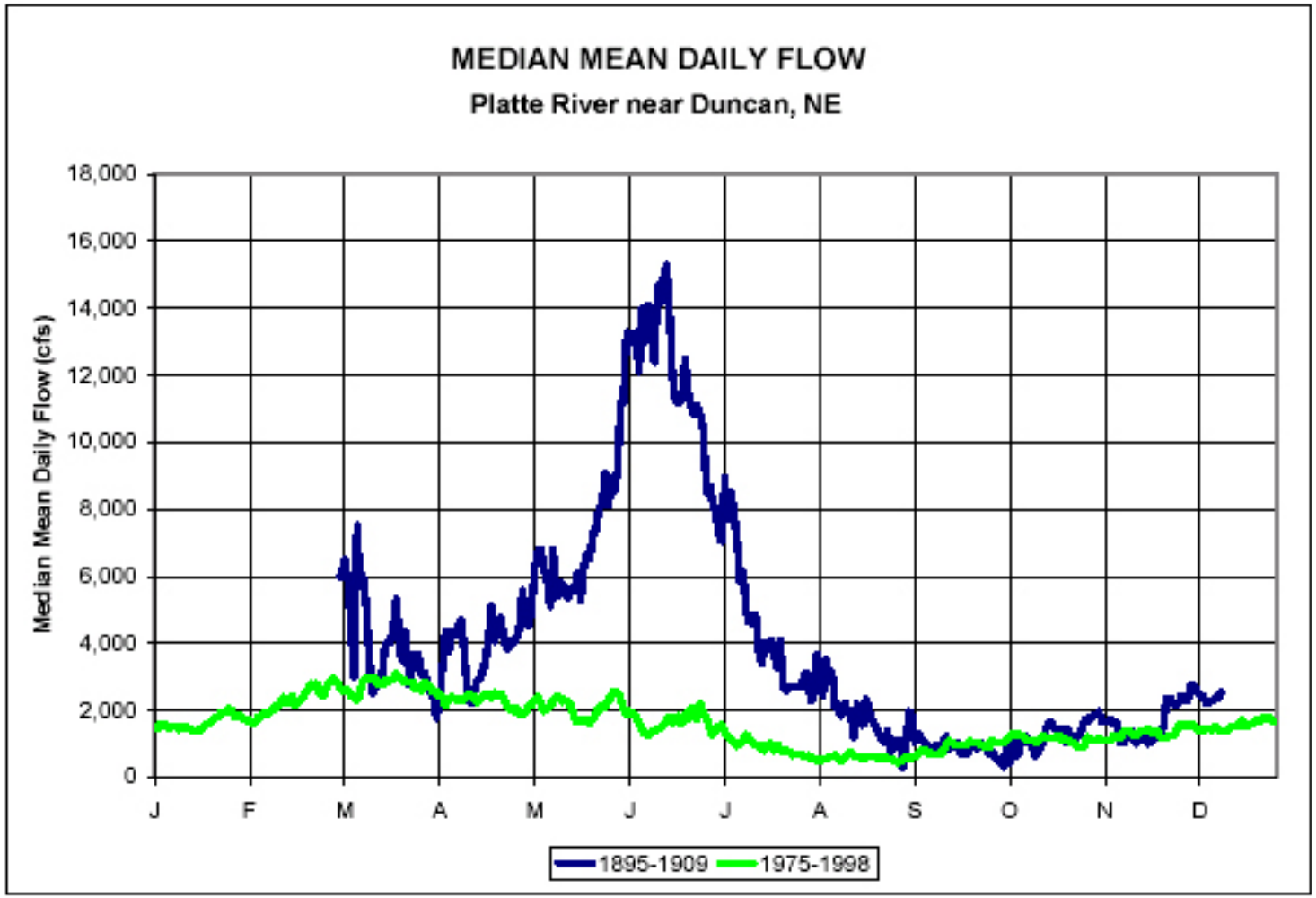

Figure 2-9.—Median mean daily flow in the Platte River at Duncan, Nebraska, in 1895-1909 versus 1975-1998. (Source: U.S. Geological Survey gauge data.)

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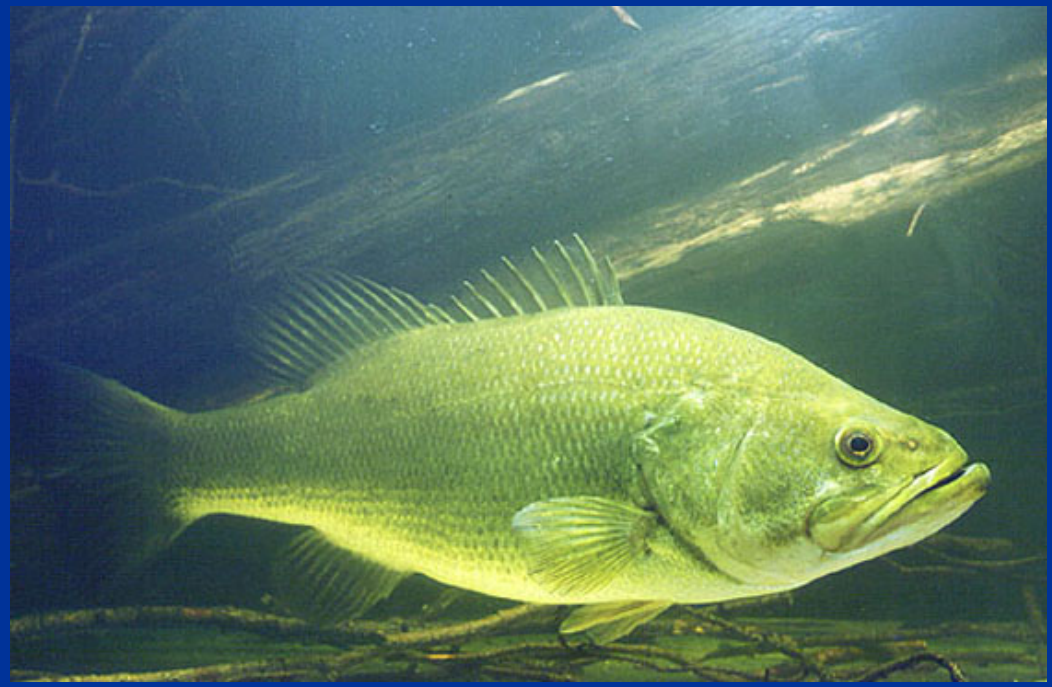
The biota now has a place at the negotiating "table"



The difficulty in agreeing on what the biota need results in ill-defined property rights, harming all interests

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- ***When the systems were designed the question was:***
- **How much water can we reliably withdraw from the river?**

- ***Today's question is:***
- **How much water do we need to leave in the river?**

Science was needed then and is needed now

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Role of Science: Evaluation of Ecosystem Requirements

- *Old paradigm*
- Minimum flow
- Static channel
- Surface water
- Single species

- *New paradigm*
- Whole hydrograph
- Dynamic channel
- *And* ground water
- Community

Lack of answers leads to *Gridlock*

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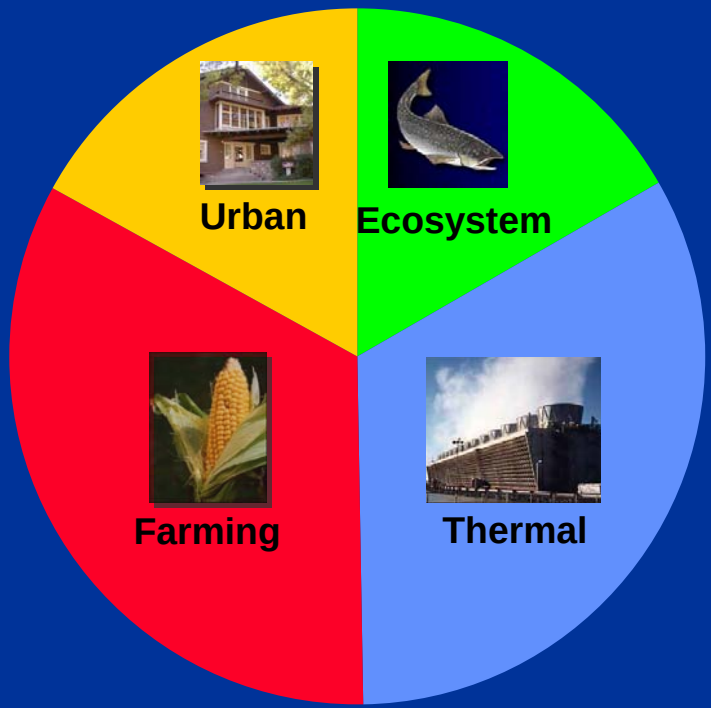
The “pie” might be shrinking because ground water in storage is being depleted



Depletion impacts:

- Wells
- Streamflow
- Riparian vegetation
- Subsidence
- Water quality
- Future generations

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Ground-water declines are not just a feature of the western US

Example from a confined aquifer in Southern Maryland

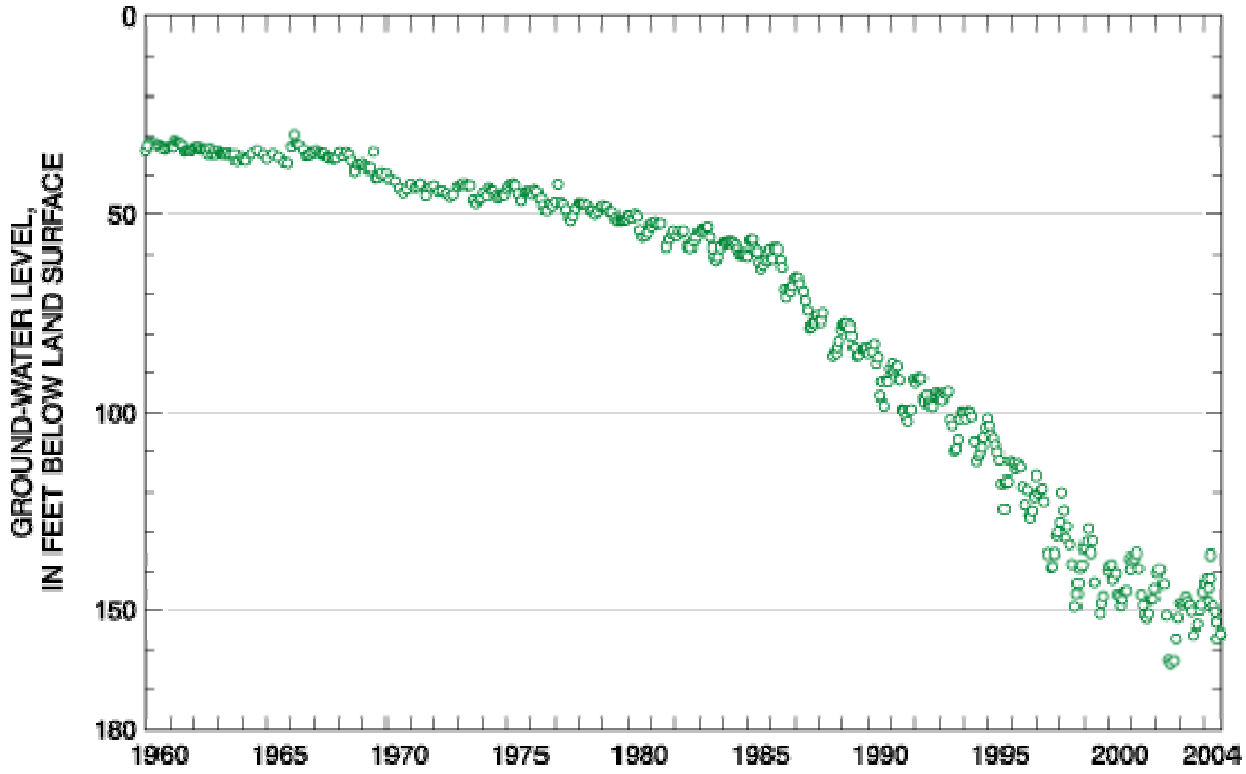

Figure 7. A 45-year ground-water hydrograph for confined-aquifer observation well CA Gd 6 near Solomons in Calvert County, Maryland, showing the declining water levels due to ground-water pumpage. Note the significant increase in rate of decline in the mid-1980s.

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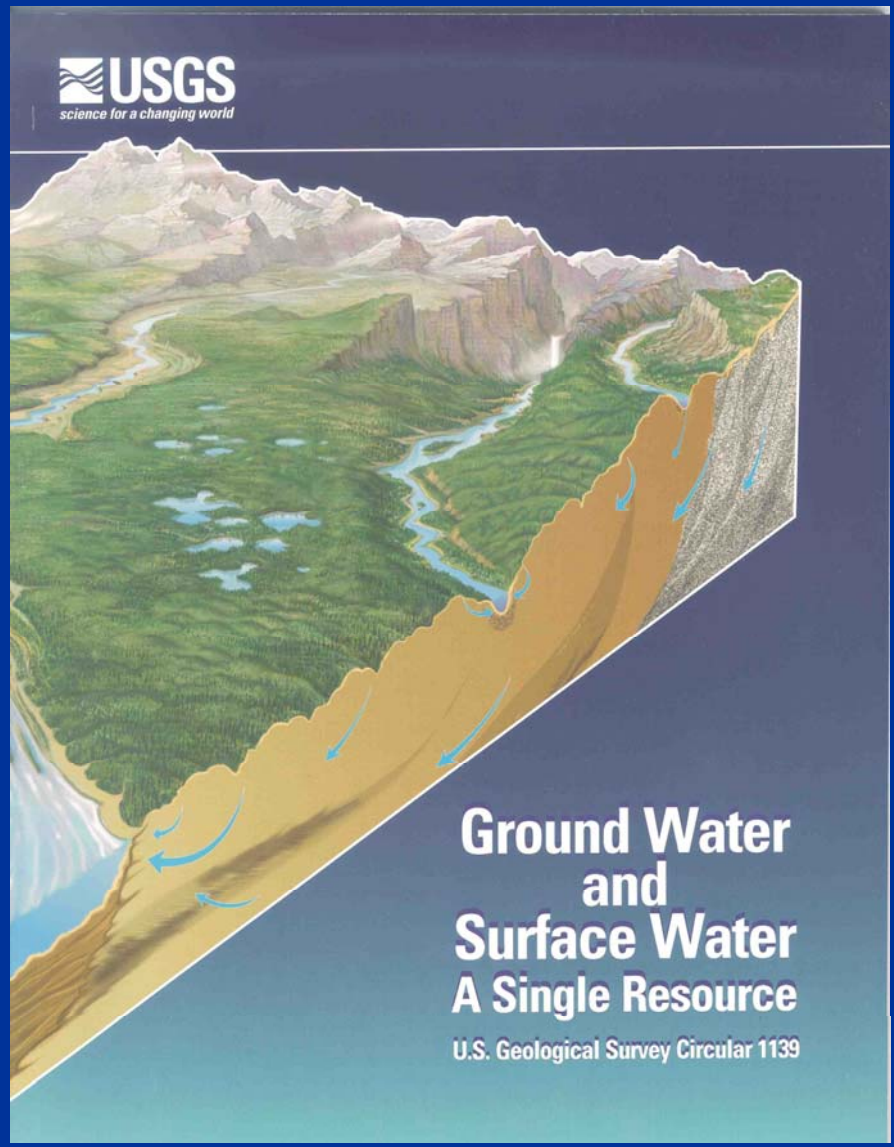
Ground water is vital to surface-water systems



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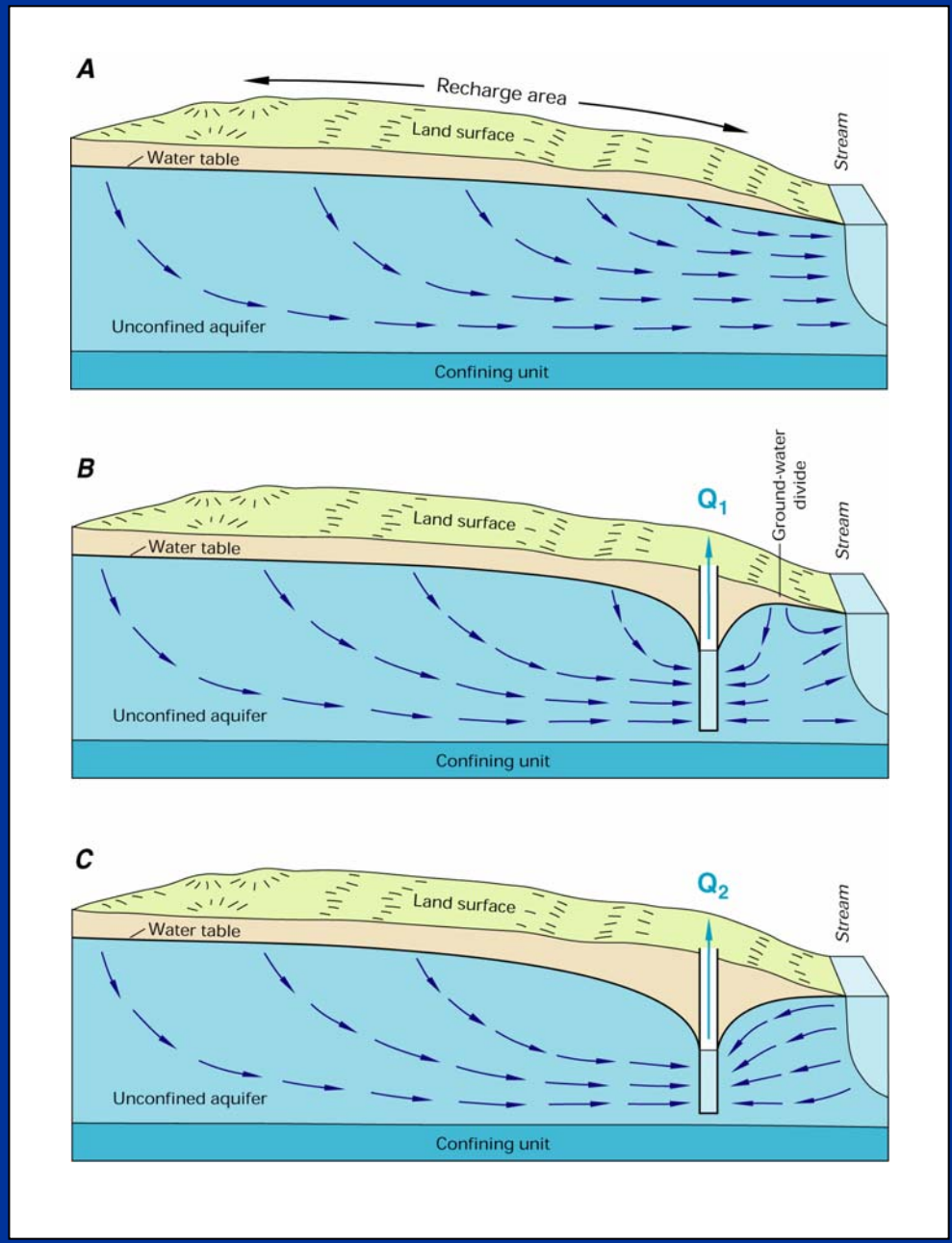
Influence of pumping on streamflow



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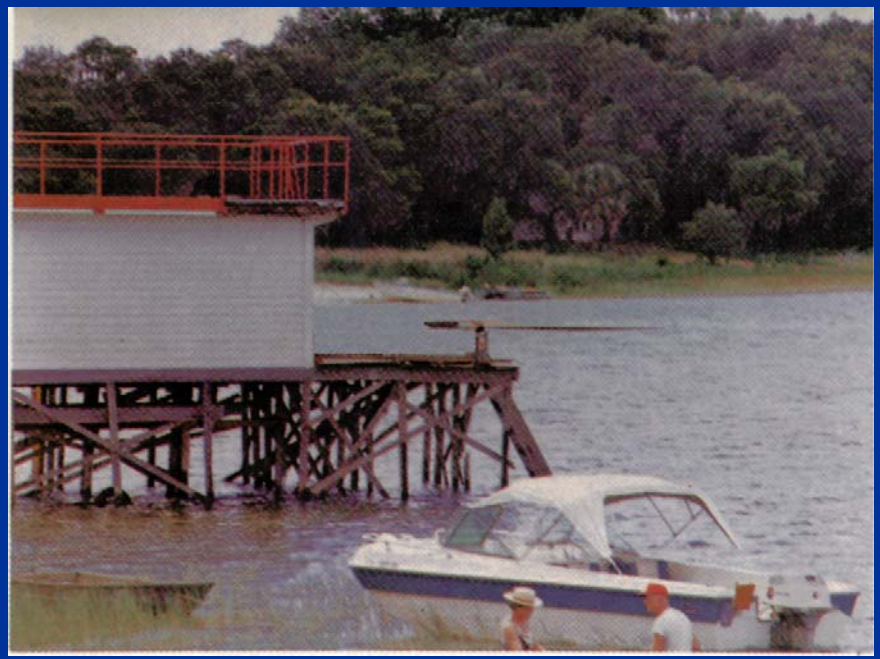
Lake or wetland impacts

An example from a Florida lake: before and after ground-water development



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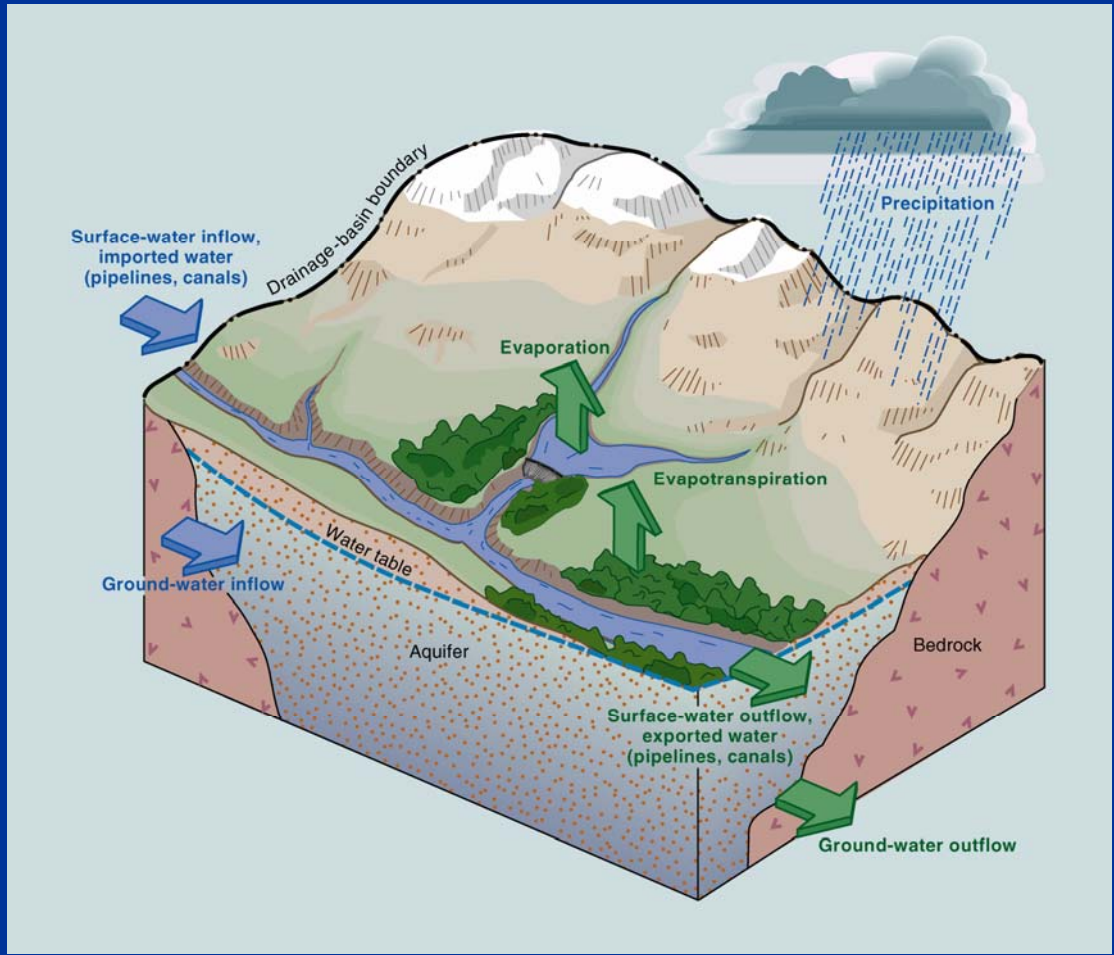
Scientific need: basin-scale coupled ground-water / surface-water models



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GW/SW Interactions

- *Old paradigm*
  - Small areas < 1 km
  - Time scales of weeks to years
  - Effect on streamflow
- *New paradigm*
  - Tens of kilometers
  - Time scales of days to decades
  - *and* ecosystem and water quality issues

Effective water management depends on understanding these interactions

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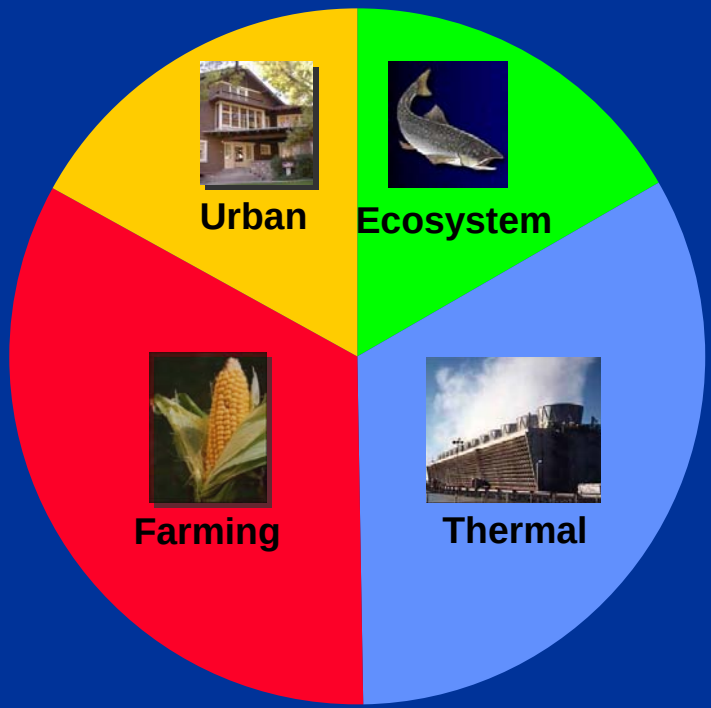
The “pie” might be shrinking because climate warming leads to less snow-pack storage



Reliable supplies depend on storage:

- **Ground water**
- **Soil water**
- **Reservoirs**
- **Snow pack**

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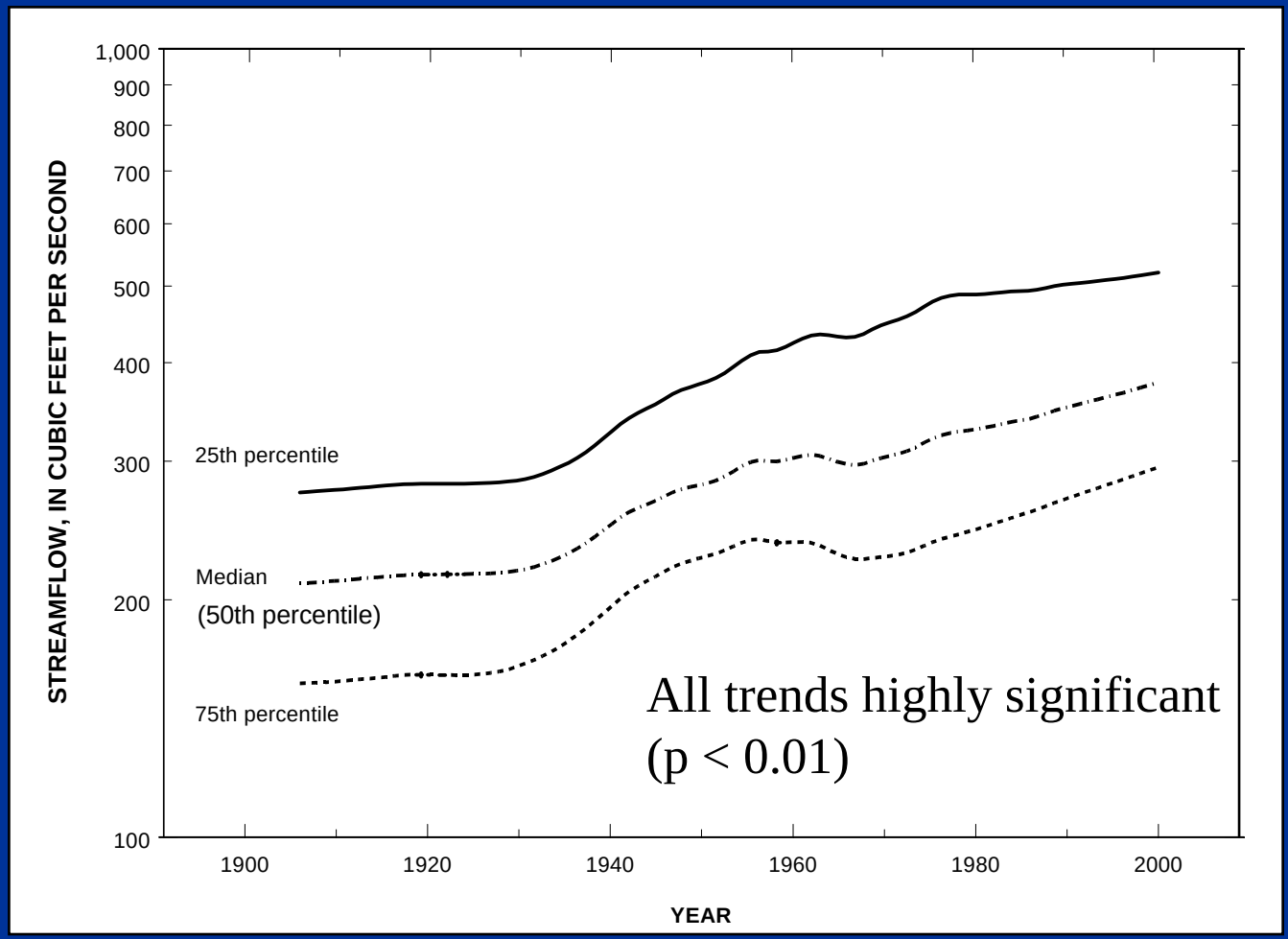
In parts of New England, February daily streamflow has increased over the past 100 years.



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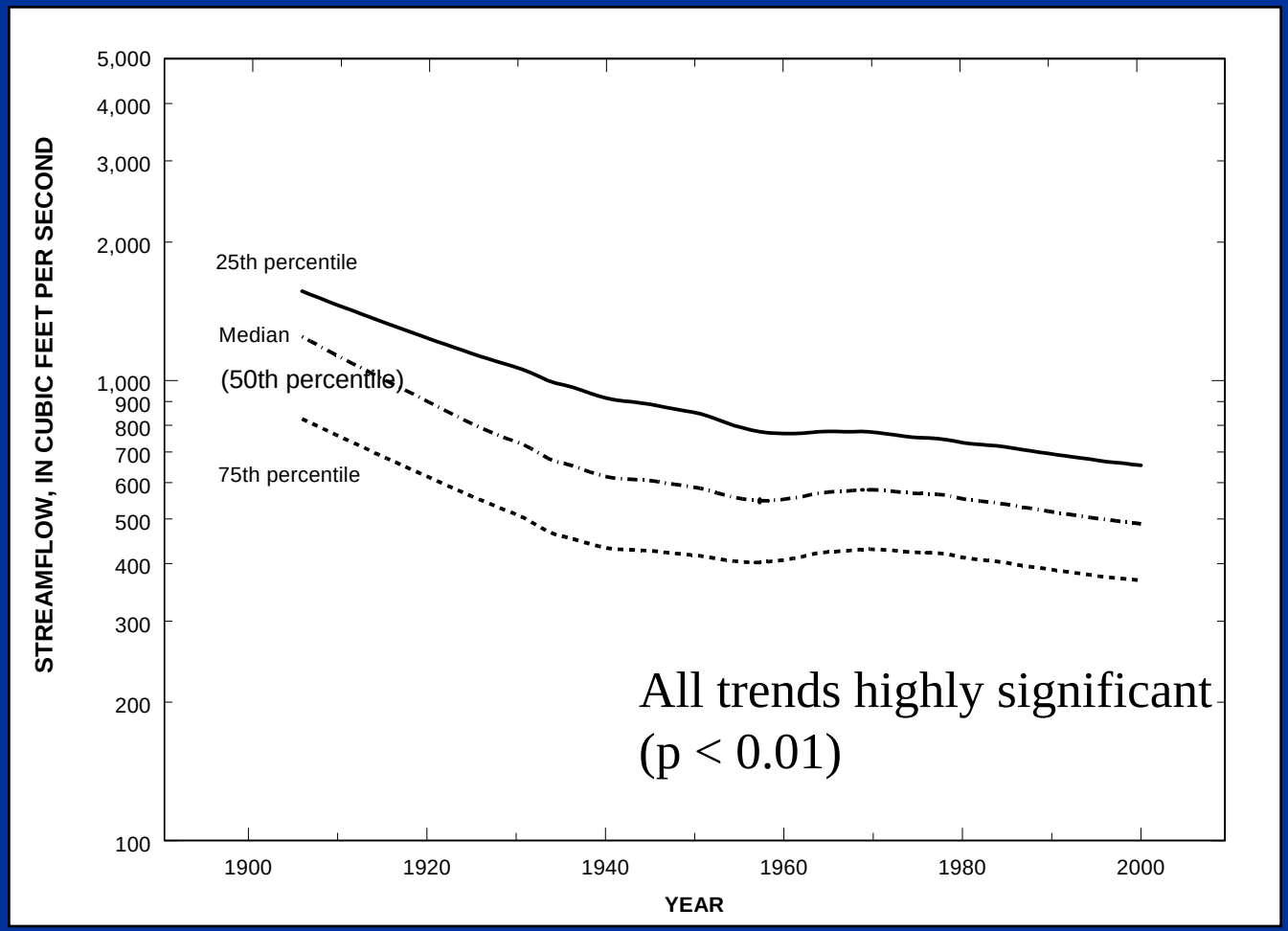
Narraguagus River, Maine

While May daily streamflow has decreased



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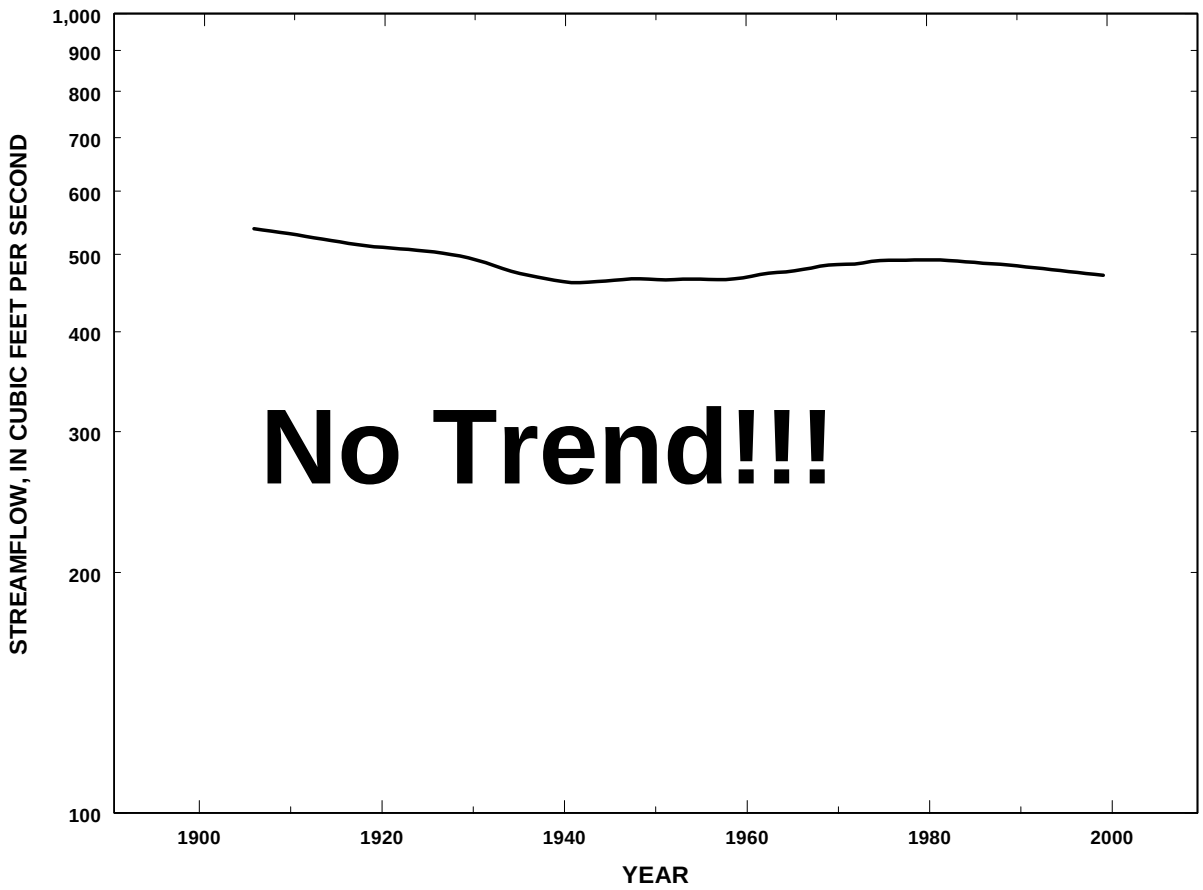
Narraguagus River, Maine

And yet: mean annual streamflow shows



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Understanding snow pack dynamics and climate is crucial to water planning in many areas. This requires long data sets on precipitation, snow pack and streamflow.

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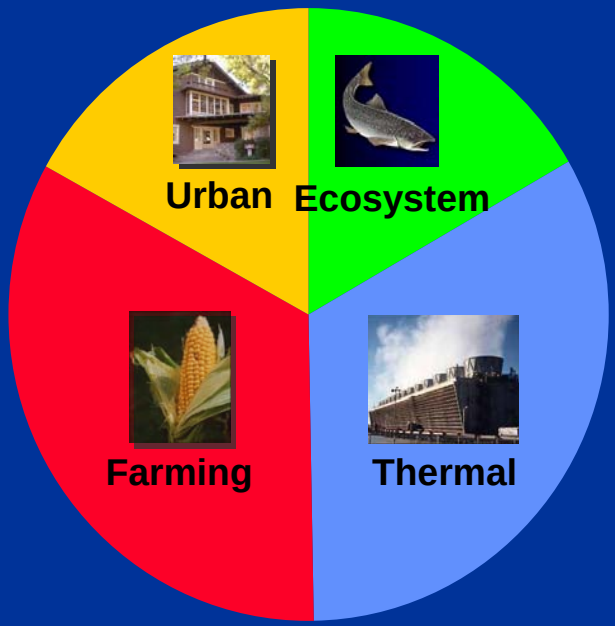
The “pie” might be able to grow if technology provides for an enhanced supply



aquifer storage & recovery

water reuse

desalinization

phreatophyte control

water use technologies

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There are *science* issues related to these *technologies*

- Geochemistry
- Hydraulics
- Botany and biophysics
- Microbiology
- Wastewater contaminants
  (transport, reaction, effects)
- Brine disposal (trace elements)

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Science and Technology provide the basis for effective management in the face of increasing competition

- Science provides the context: status and trends of the resource
- Technology can enhance supplies and efficiency of use
- Science can provide the basis for smarter decisions through prediction of outcomes (hours to generations into the future)

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“National water availability and use has not been comprehensively assessed in 25 years.” GAO, 2003

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At the request of Congress the USGS has initiated a pilot effort to test concepts for a National Assessment of Water Availability and Use.

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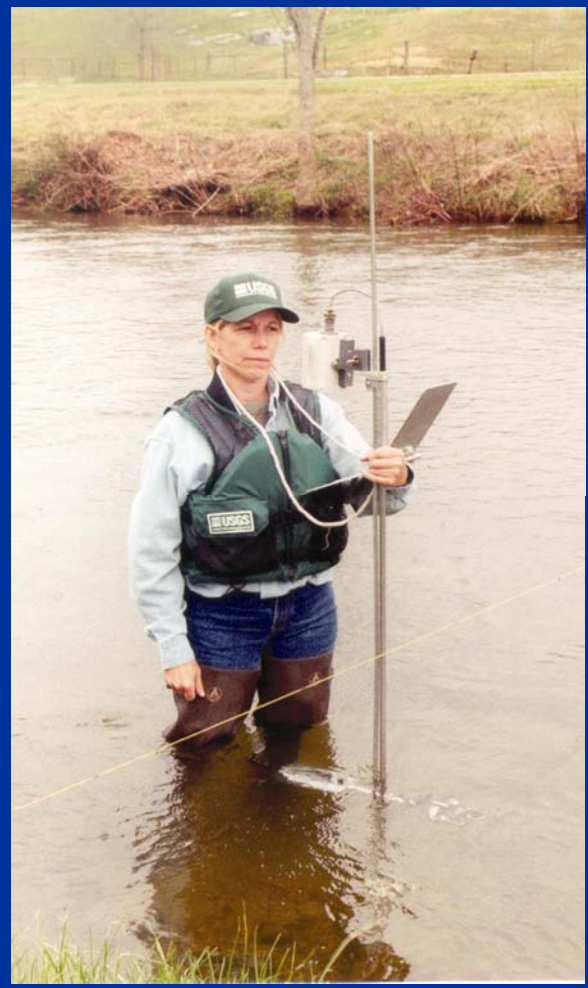
USGS looks forward to working with you on these issues

- Water Availability and Use Program
- Cooperative Water Program
- National Streamflow Information Program
- Ground Water Resources Program



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