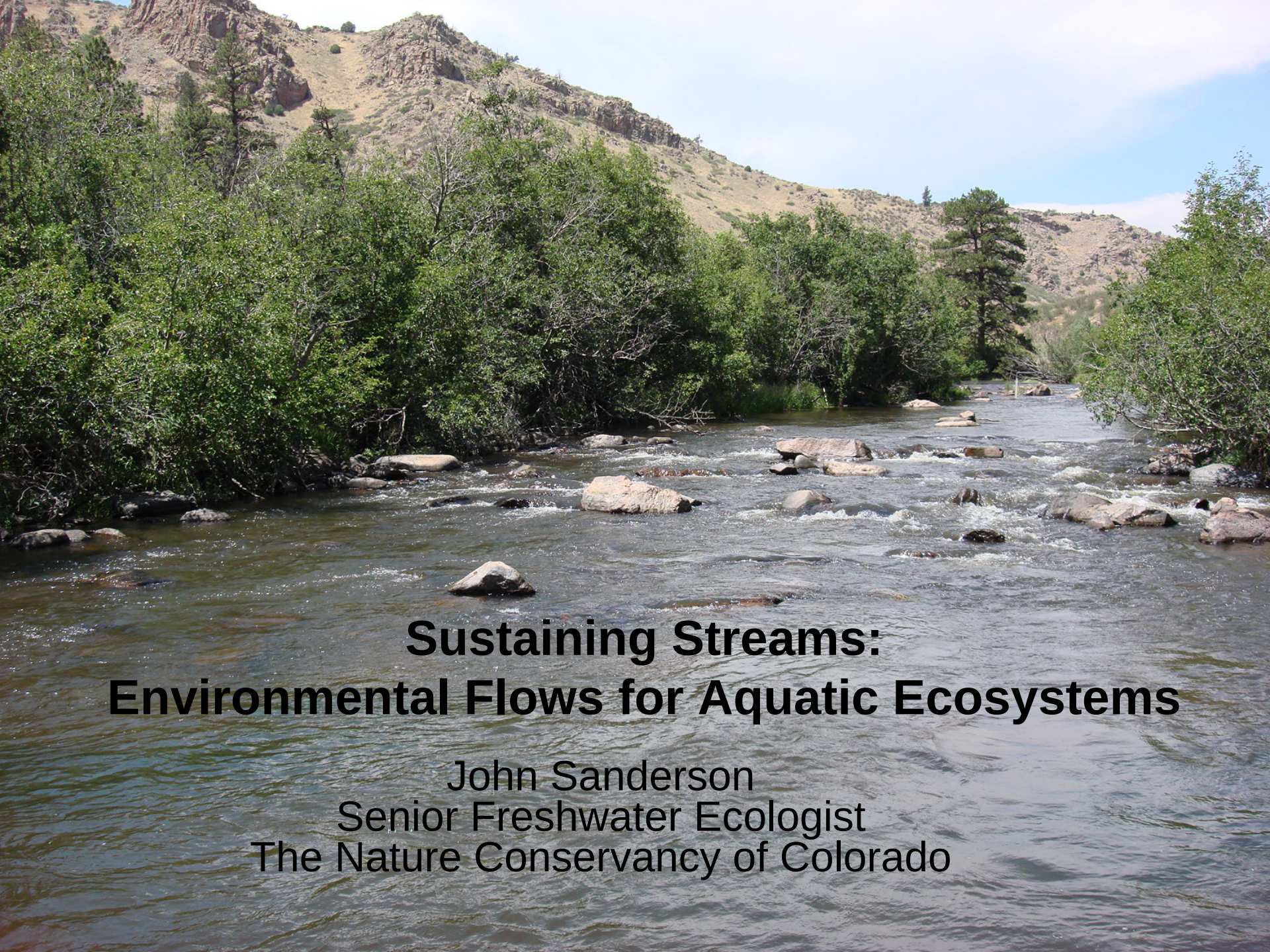
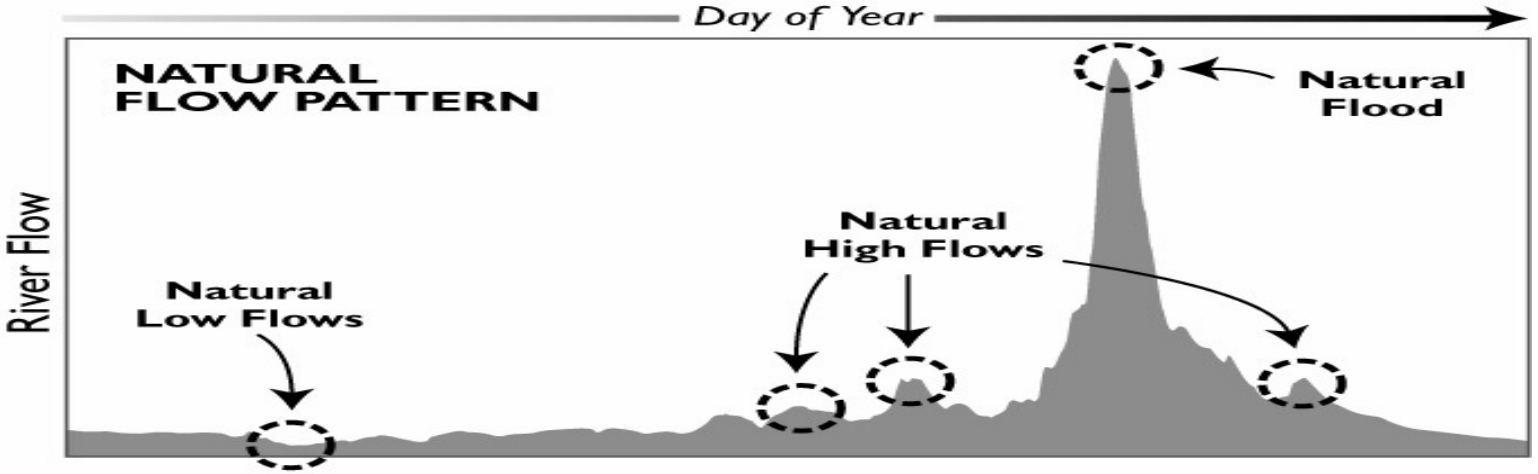


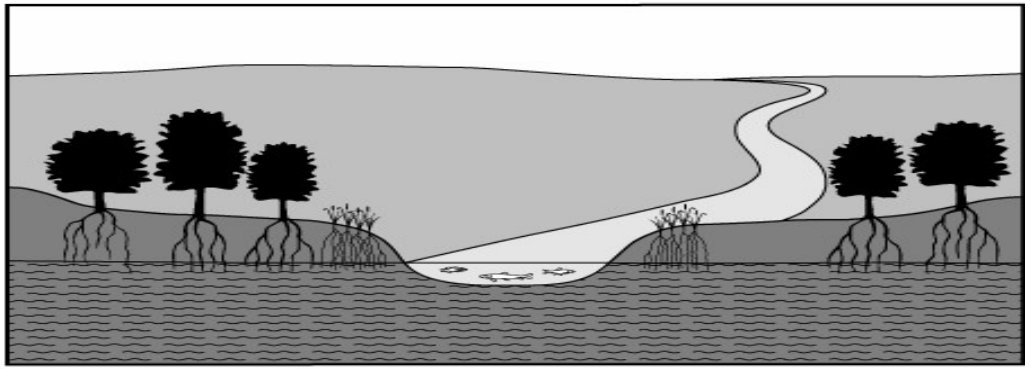
# Sustaining Streams: Environmental Flows for Aquatic Ecosystems

John Sanderson
Senior Freshwater Ecologist
The Nature Conservancy of Colorado



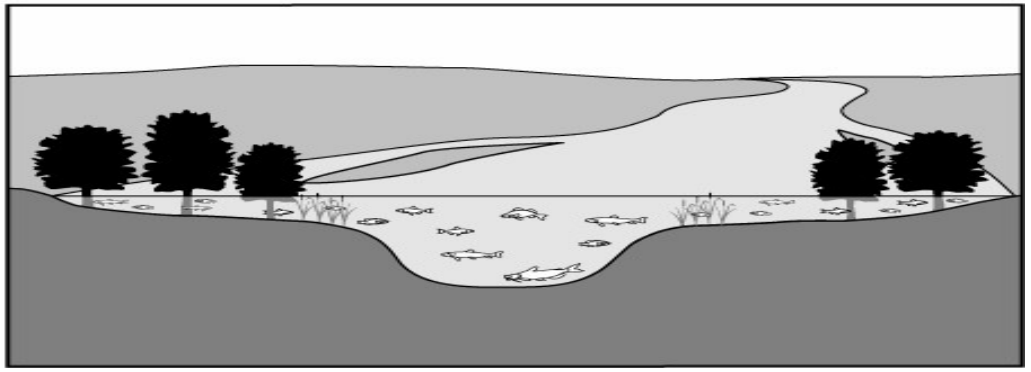

## Natural Low Flow

- Fish have adequate oxygen and can move up- or downstream to feed
- Riparian vegetation sustained by shallow ground water table
- Insects feed on organic material carried downstream
- Birds supported by healthy riparian vegetation and aquatic prey



## Natural Flood

- Fish are able to feed and spawn in floodplain areas
- Riparian plant seeds germinate on flood-deposited sediments
- Insects emerge from water to complete their lifecycle
- Wading birds and waterfowl feed on fish and plants in shallow flooded areas



| Basin | Current Estimated Irrigated Acres | Gross Diversions (AF) |
|---|---|---|
| Arkansas | 405,000 | 1,770,000 |
| Colorado | 238,000 | 1,764,000 |
| Dolores/San Juan/ San Miguel | 255,000 | 953,000 |
| Gunnison | 264,000 | 1,705,000 |
| North Platte | 116,000 | 397,000 |
| Rio Grande | 633,000 | 1,660,000 |
| South Platte | 1,027,000 | 2,606,000 |
| Yampa/White/Green | 118,000 | 642,000 |
| **TOTAL** | **3,056,000** | **11,497,000** |

Source: Colorado's Decision Support Systems and Basin Roundtable/Basin Advisor input.

Current ag diversions: 3.7 trillion gallons

Current M&I use: 389 billion gallons

Projected M&I increase by 2030:
205 billion gallons (53%)

| Basin | Estimated Water Demand In 2000 (AF) | Projected Water Demand with Level 1 Conservation in 2030 (AF) | Increase in Water Demand (AF) | Increase in Water Demand (AF) |
|---|---|---|---|---|
| Arkansas | 256,900 | 354,900 | 98,000 | 38% |
| Colorado | 74,100 | 136,000 | 61,900 | 84% |
| Dolores/San Juan/ San Miguel | 23,600 | 42,400 | 18,800 | 80% |
| Gunnison | 20,600 | 35,500 | 14,900 | 72% |
| North Platte | 500 | 600 | 100 | 20% |
| Rio Grande | 17,400 | 21,700 | 4,300 | 25% |
| South Platte | 772,400 | 1,182,100 | 409,700 | 53% |
| Yampa/White/Green | 29,400 | 51,700 | 22,300 | 76% |
| **TOTAL** | **1,194,900** | **1,824,900** | **630,000** | **53%** |

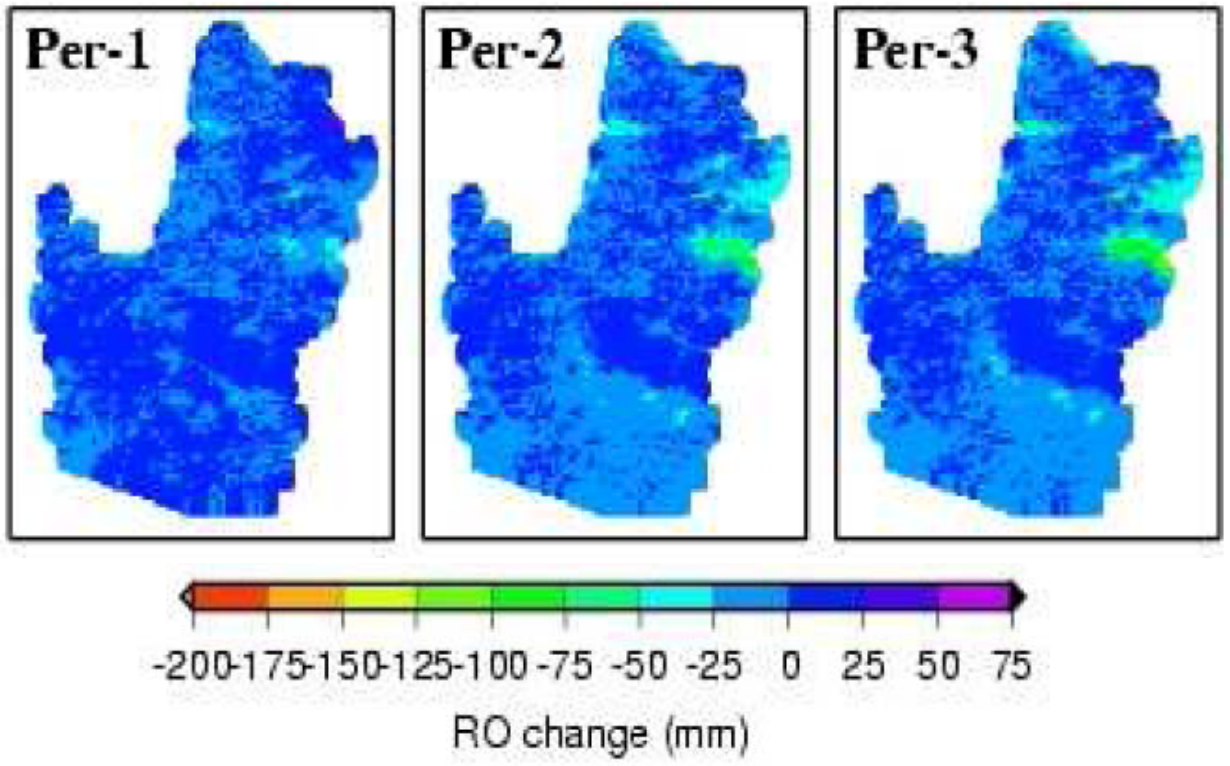
AF = Acre-Feet

*Municipal & Industrial Gross Water Demand in 2000 and 2030*

# Effects of climate change on runoff in the Colorado River basin

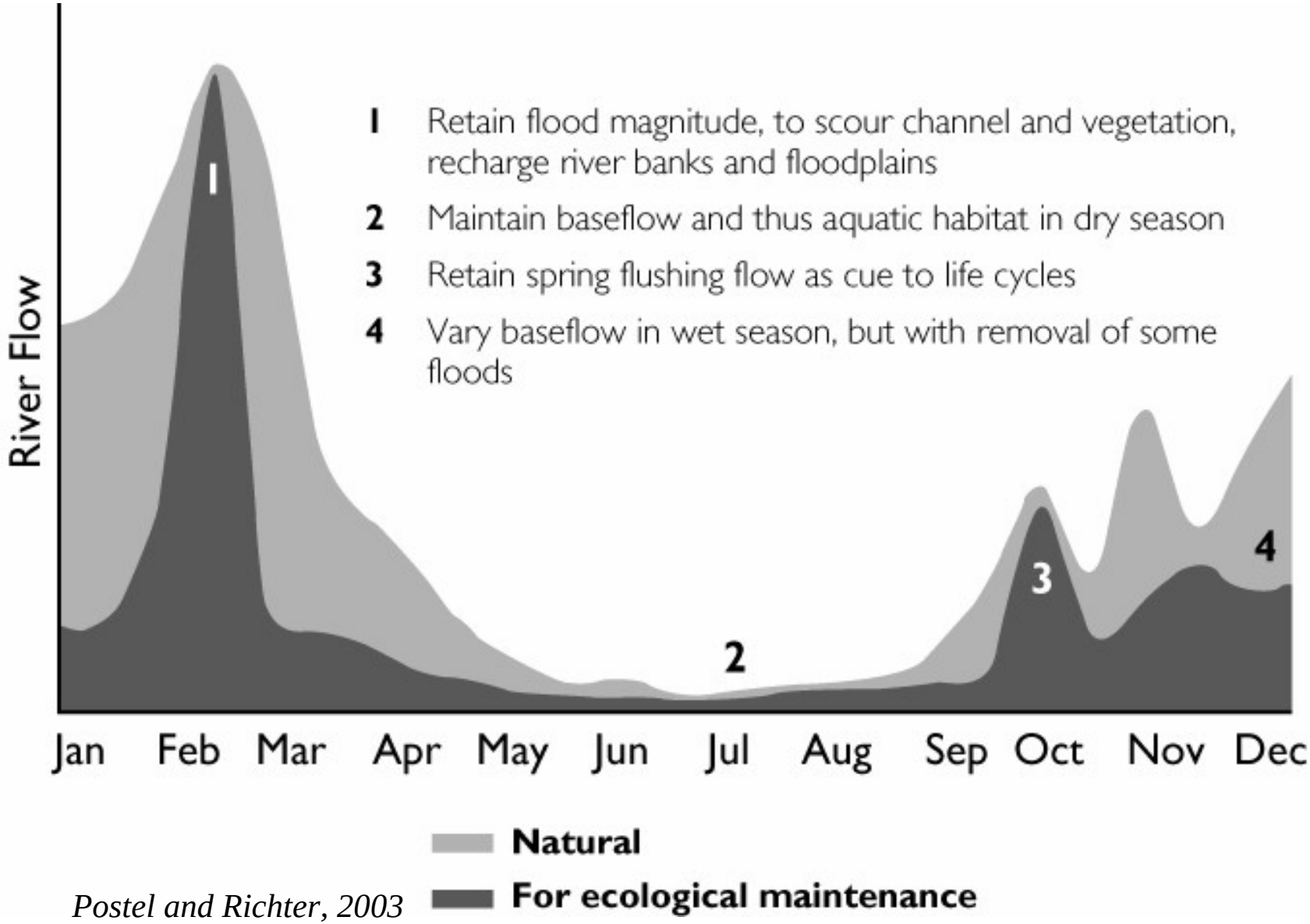
**HIST - B1 Scenario**
**Average Annual**
**B1 Runoff Relative to 1950-1999 HIST**

**Period 1: 100%**
**Period 2: 93%**
**Period 3: 92%**




Source: Christensen and Lettenmaier 2007)

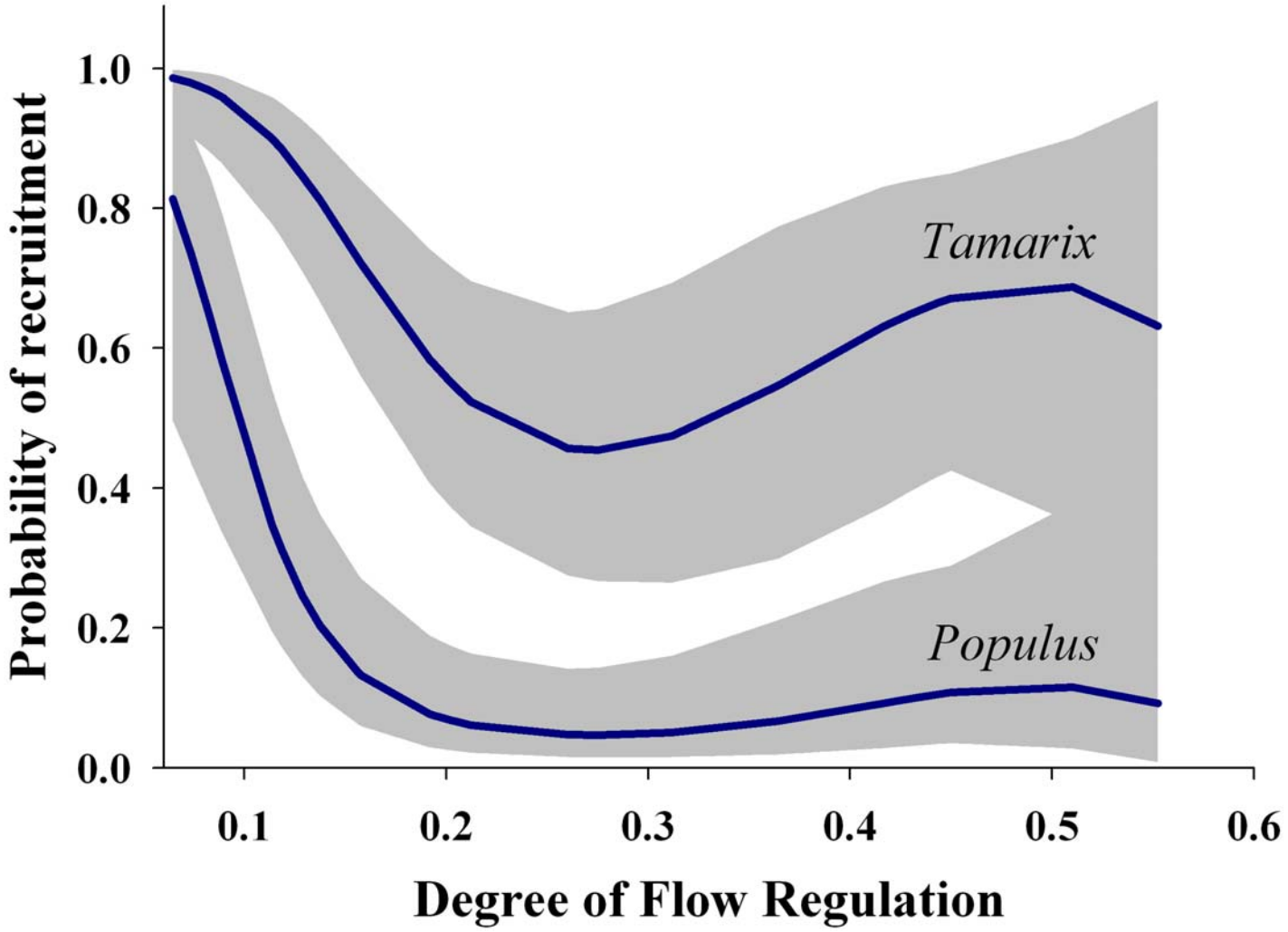
# Managing for Natural Variability




*Postel and Richter, 2003*

# Flow-ecology response curve

*Tamarix* and *Populus* recruitment *vs.* flow regulation

# Freshwater conservation

- ***What to protect?***
- ***Where to work?***
- ***How much water and when?***

- Identify targets and goals.
  - What do we want to protect?

**APPENDIX E. Priority List of Species Targets of the Central Shortgrass Prairie**

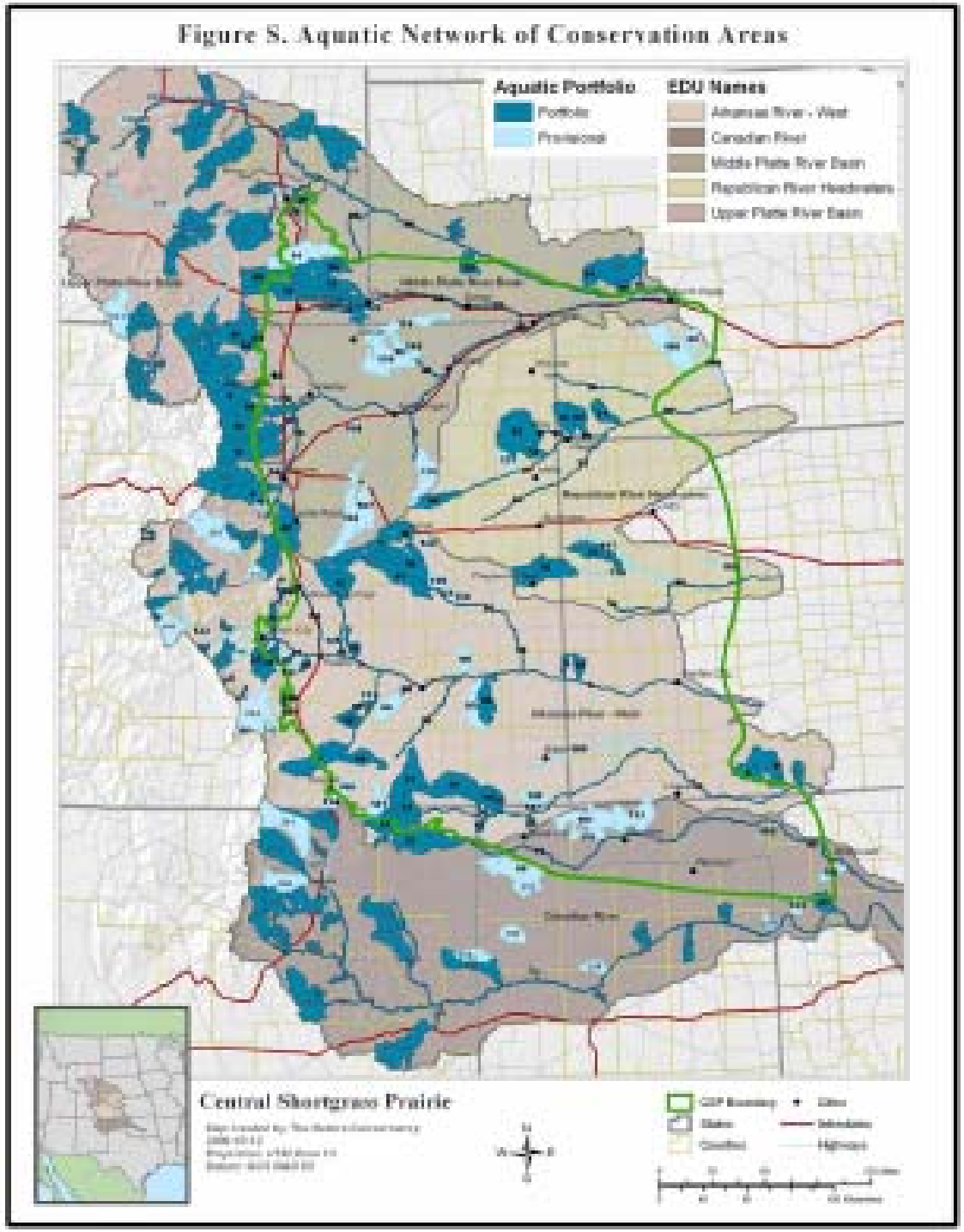
| TAXONOMIC GROUP | COMMON NAME | SCIENTIFIC NAME | GLOBAL RANK |
|---|---|---|---|
| **G1: Critically Imperiled Globally** | | | |
| Fish | Peppered Chub | *Macrohybopsis aestivalis tetranemus* | G1 |
| Invertebrates | Scott Riffle Beetle | *Optioservus phaeus* | G1 |
| Mammals | Black-footed Ferret | *Mustela nigripes* | G1 |
| | Botta's Pocket Gopher subspecies | *Thomomys bottae rubidus* | G5T1 |
| Plants | Wyoming Dodder | *Cuscuta plattensis* | G1Q |
| | Wild Buckwheat | *Eriogonum jamesii* var *simplex* | G5T1? |
| **G2: Imperiled Globally** | | | |
| Birds | Mountain Plover | *Charadrius montanus* | G2 |
| Fish | Arkansas River Shiner | *Notropis girardi* | G2 |
| | Greenback Cutthroat Trout | *Oncorhynchus clarkii stomias* | G4T2T3 |
| | Topeka Shiner | *Notropis topeka* | G2 |

Also,

- Habitats (e.g., cottonwood forests)
- Aquatic ecosystems (e.g., steep gradient, high elevation, headwater streams)

# Developing a Freshwater Portfolio

- Select species (fine filter) and system (coarse filter) goals
- Identify locations based on:
  - goals and priorities
  - condition
  - cost
  - connectivity/adjacency
  - opportunity, etc.
- Identify flow/habitat restoration needs



# How much water and when?

## Example: North Fork Cache la Poudre River

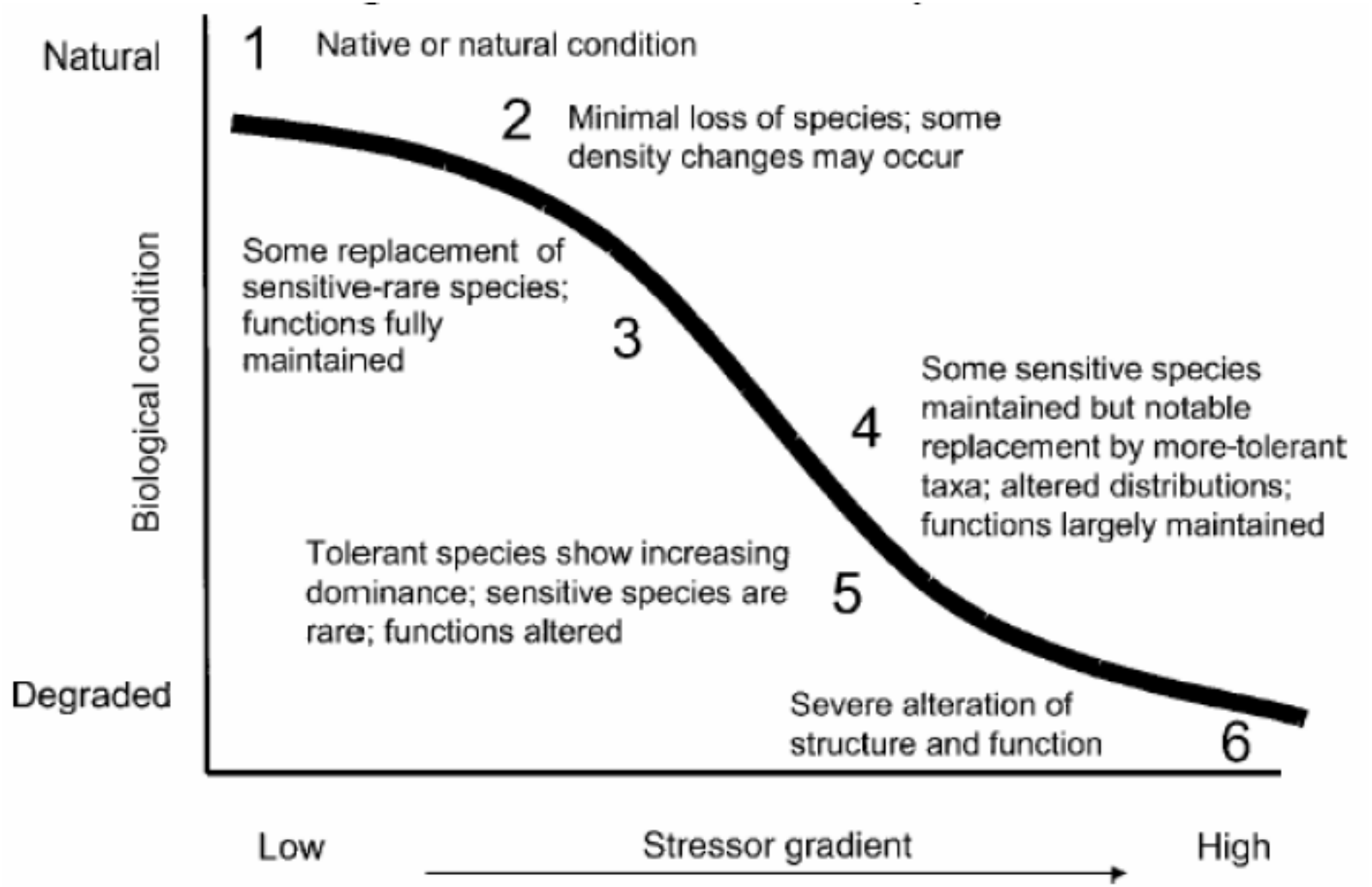
Native fish
- Cutthroat trout
- Longnose dace
- Fathead minnow
- Johnny darter

Riparian vegetation
- Willow shrublands
- Herbaceous wetland plants

Riparian animals
- Preble’s meadow jumping mouse

Aquatic macroinvertebrates

# Ecological status as a function of flow




*Source: Davies and Jackson 2006*

**Table 1. Biological targets and their flow needs.**

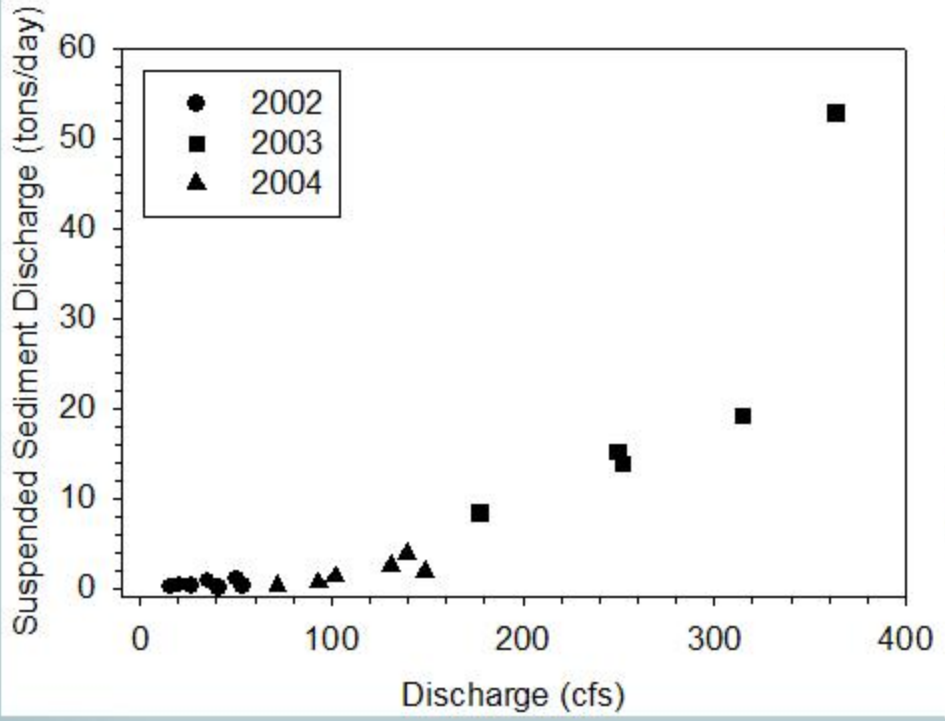
| Target | Dependence flow events |
|---|---|
| Fish:<br>• Cutthroat Trout (or 'cutbows' as surrogate)<br>• Longnose Dace<br>• Fathead Minnow<br>• Johnny Darter<br>• Iowa Darter | Large floods:<br>• Mobilize bed material to scour bed and removes aquatic vegetation (vascular plants and algae).<br>• Maintain channel width and complexity (e.g., undercut banks, coarse woody debris, off-channel pools).<br><br>High flows and small floods<br>• Mobilize interstitial sediment that clogs spawning beds.<br><br>Extreme low flows:<br>• Reduce total available habitat, and dictate minimum wetted area/habitat.<br>• Provide connectivity during driest periods.<br>• Provide over-wintering habitat.<br>• Affect water quality, with temperature and oxygen being key components<br><br>Comments:<br>• Greenback cutthroat were naturally found throughout this watershed.<br>• Large floods may reduce current year recruitment for some species. |

# Key flow parameters for the North Fork Cache la Poudre River

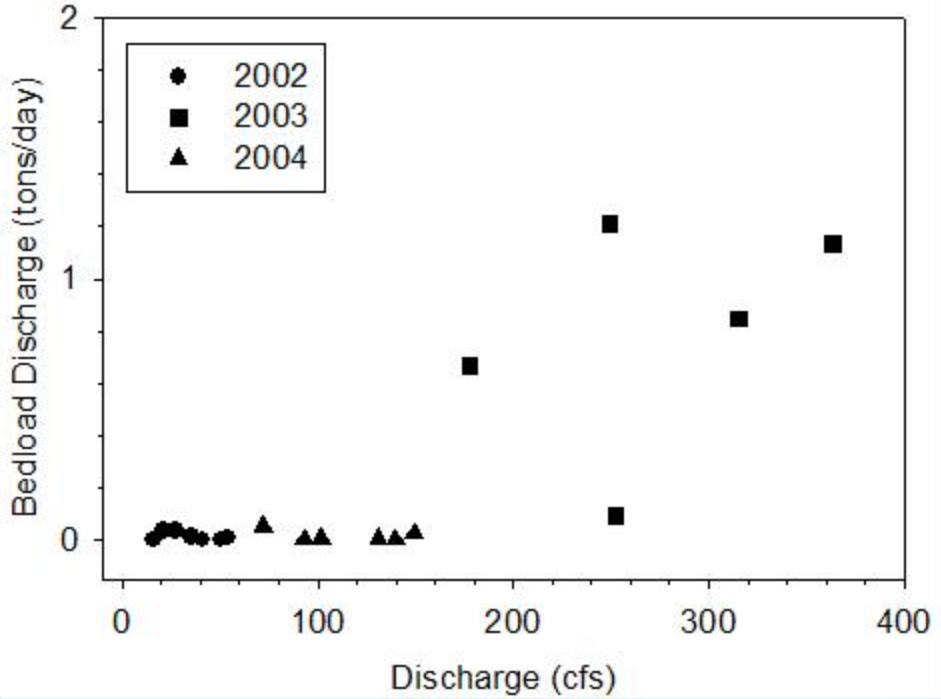
| Flow parameter |
| --- |
| Daily minimum/maximum flows |
| Timing of small floods |
| Small flood magnitude, duration, and frequency |
| Large flood magnitude and frequency |
| Very large flood magnitude and frequency |
| Rise and fall rates |
| Mean daily flow for each month |

# Sediment Transport

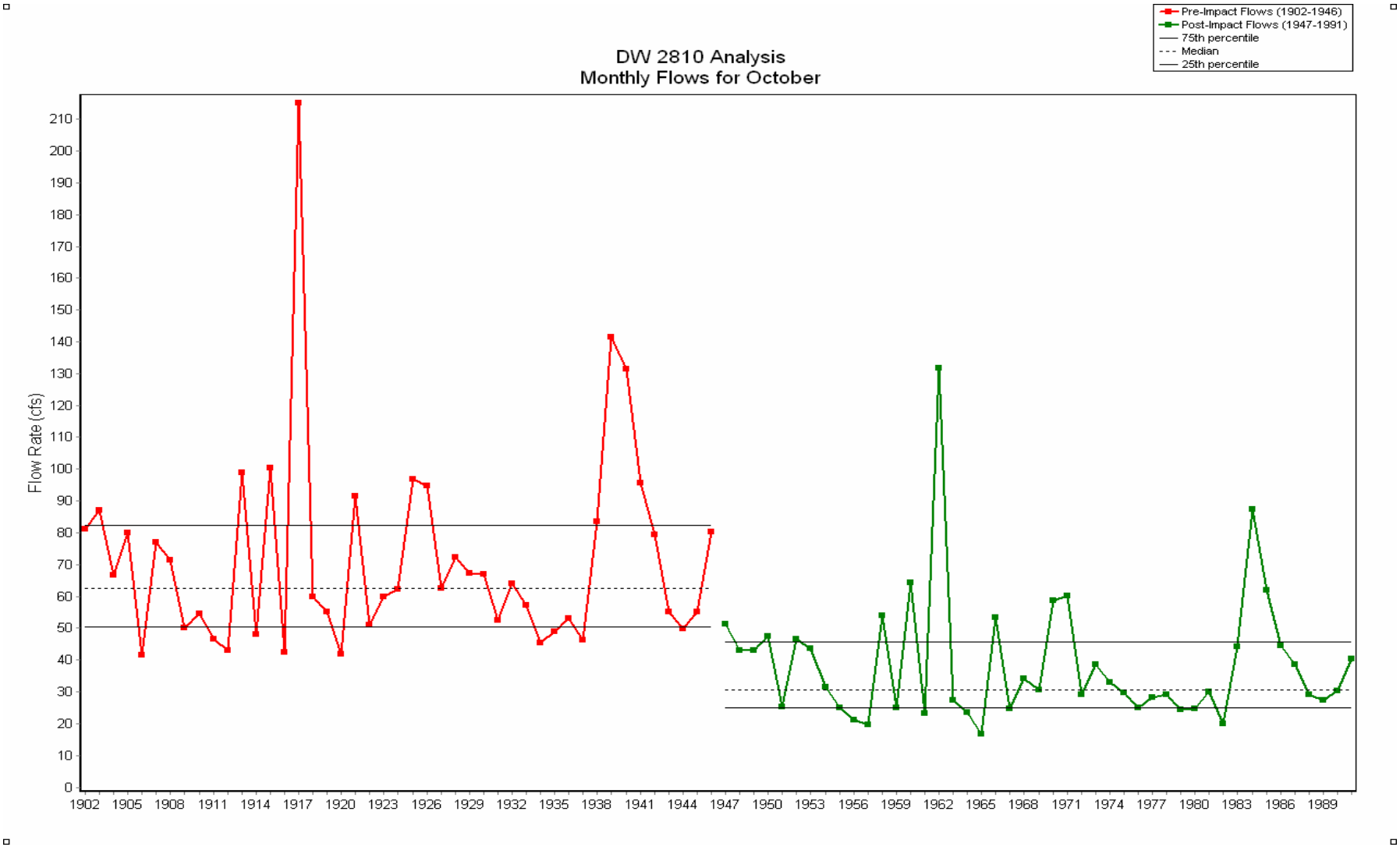
$Q_s$




$Q_b$

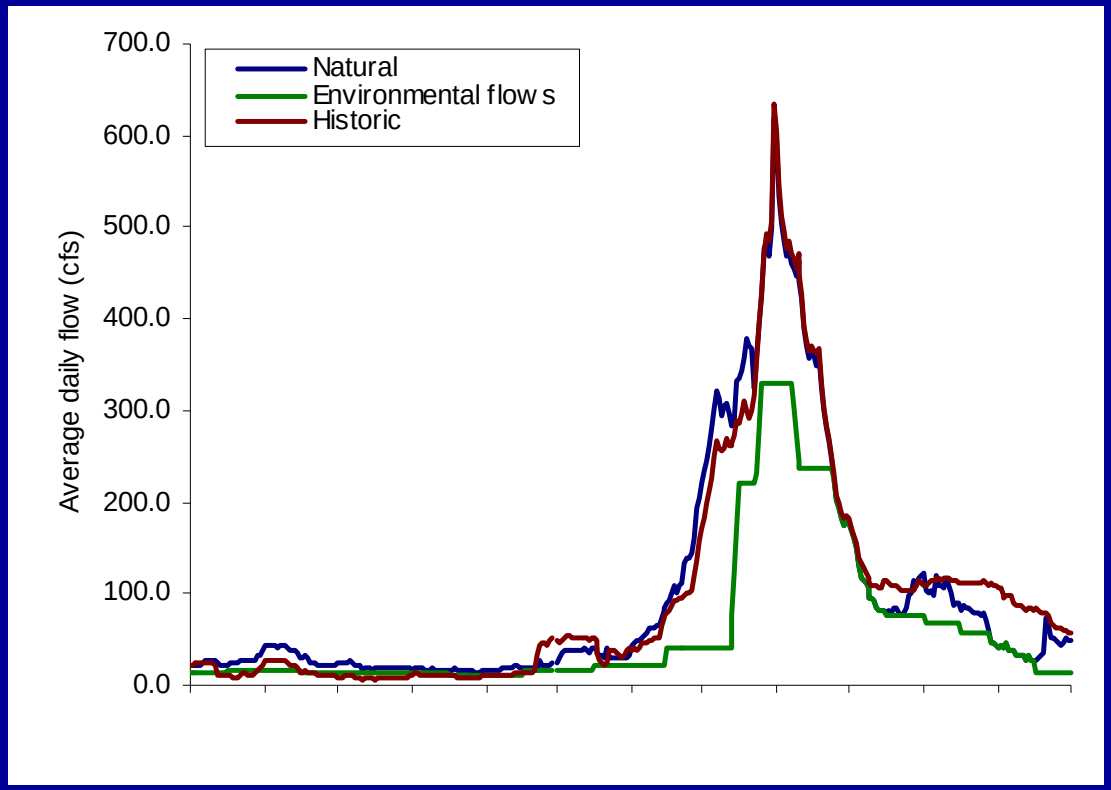


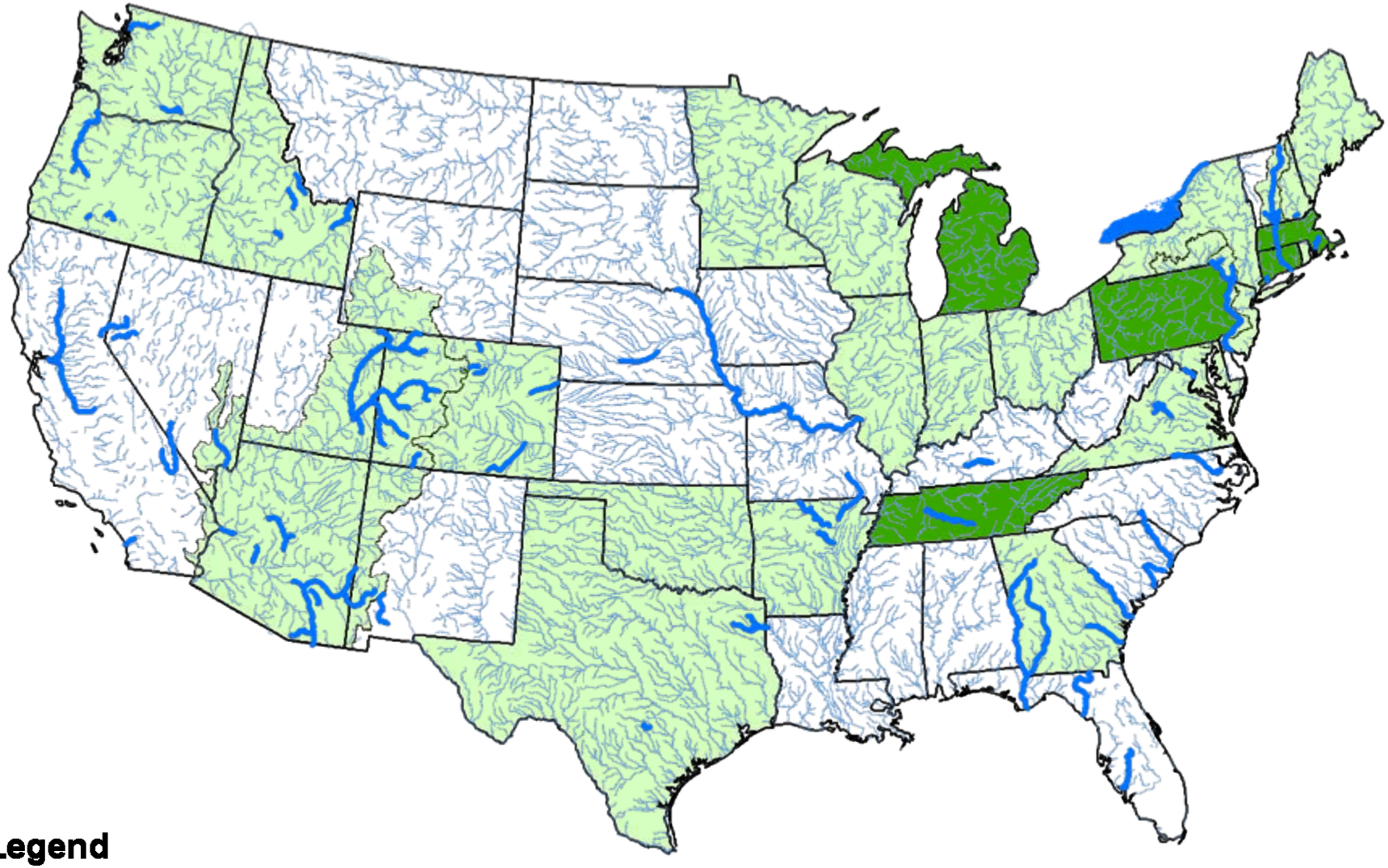
# Indicators of Hydrologic Alteration (IHA): October mean flows



# North Fork of the Poudre

## Environmental Flow Hydrographs



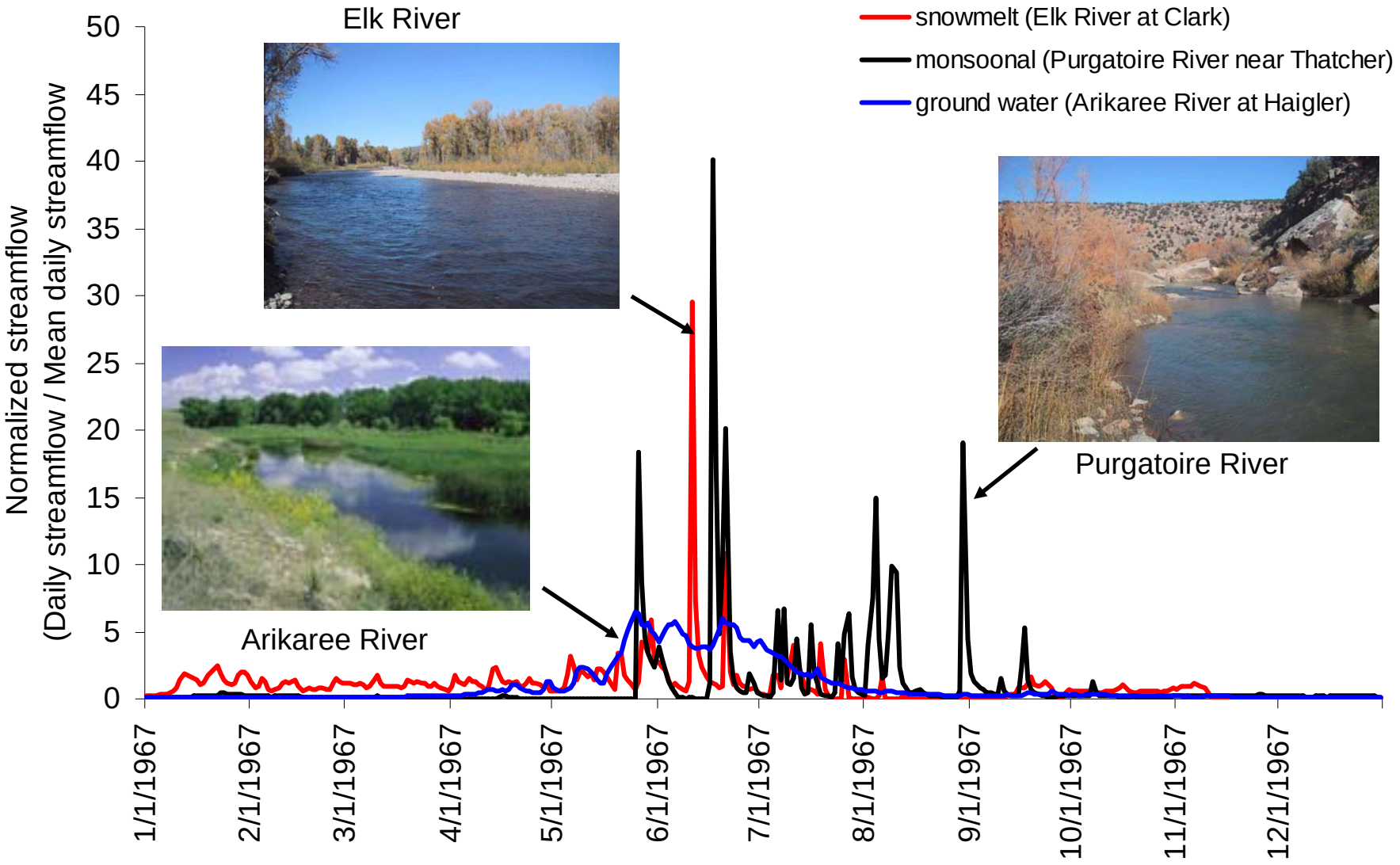



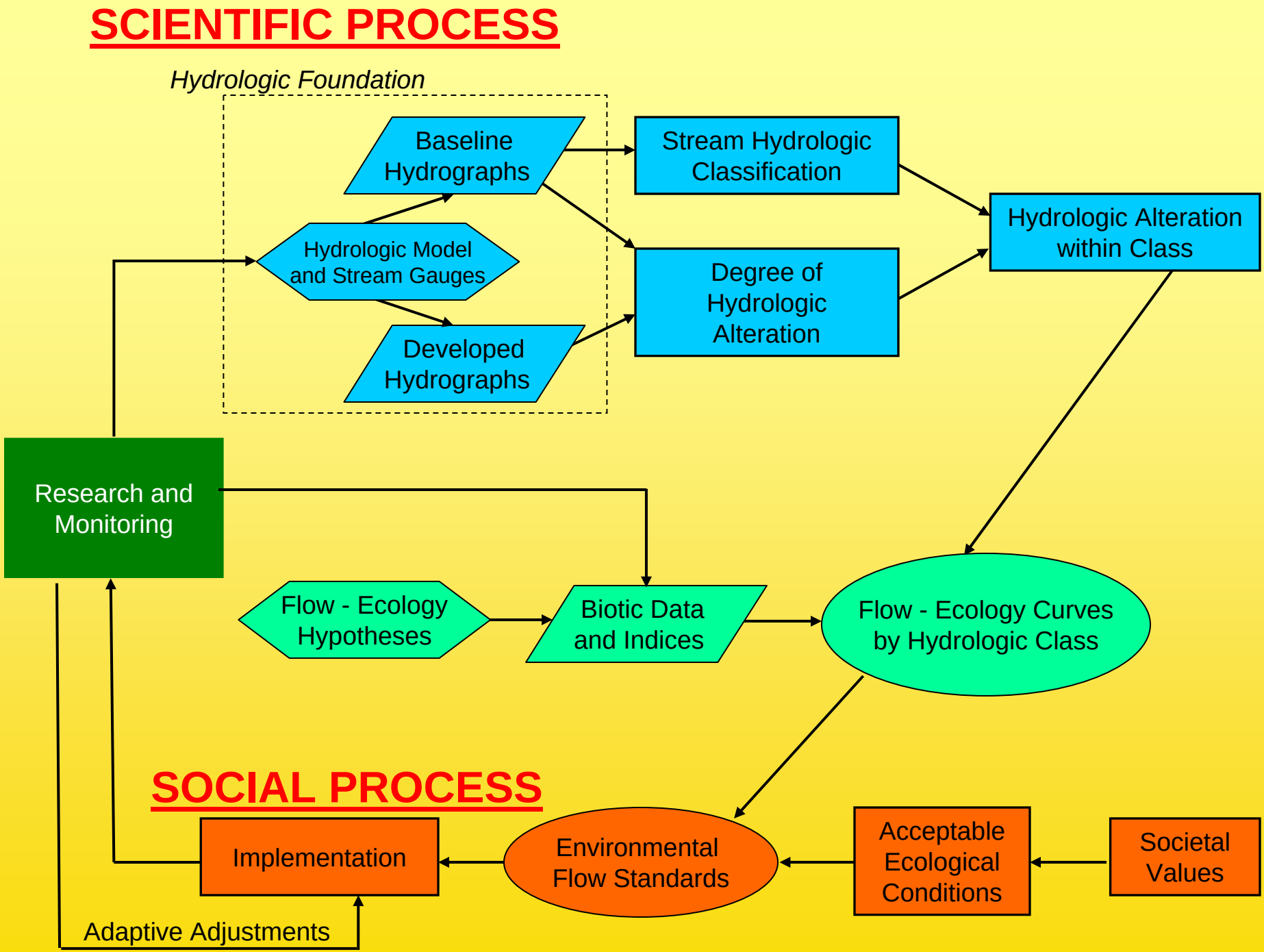
**Legend**

- Rivers for which environmental flows have been prescribed
- Active LOHA projects
- States or basins where opportunities for LOHA exist

# Representative streamflow for three hydrologic regimes

(data are from 1967)




SCIENTIFIC PROCESS
Hydrologic Foundation
Baseline Hydrographs
Stream Hydrologic Classification
Hydrologic Alteration within Class
Hydrologic Model and Stream Gauges
Degree of Hydrologic Alteration
Developed Hydrographs
Research and Monitoring
Flow - Ecology Hypotheses
Biotic Data and Indices
Flow - Ecology Curves by Hydrologic Class
SOCIAL PROCESS
Implementation
Environmental Flow Standards
Acceptable Ecological Conditions
Societal Values
Adaptive Adjustments

# What can you do?

- As an agency employee . . .
  - Raise awareness about the need for multi-faceted instream flows.
  - Identify stream-related needs and set appropriate flow standards.
  - Bring your expertise to water planning processes:
    - ✓ Colorado non-consumptive needs assessment
    - ✓ Other?
  - Research flow:ecology relationships

# What can you do?

- As an individual . . .
  - Consider what you use:
    - ✓ Per capita daily water use in Brisbane, Australia is 67 gallons;
    - ✓ in Denver, Colorado, it is 137 gallons.
  - Participate in water planning processes:
    - ✓ Municipal discussions, EIS, etc.
    - ✓ Colorado non-consumptive needs assessment