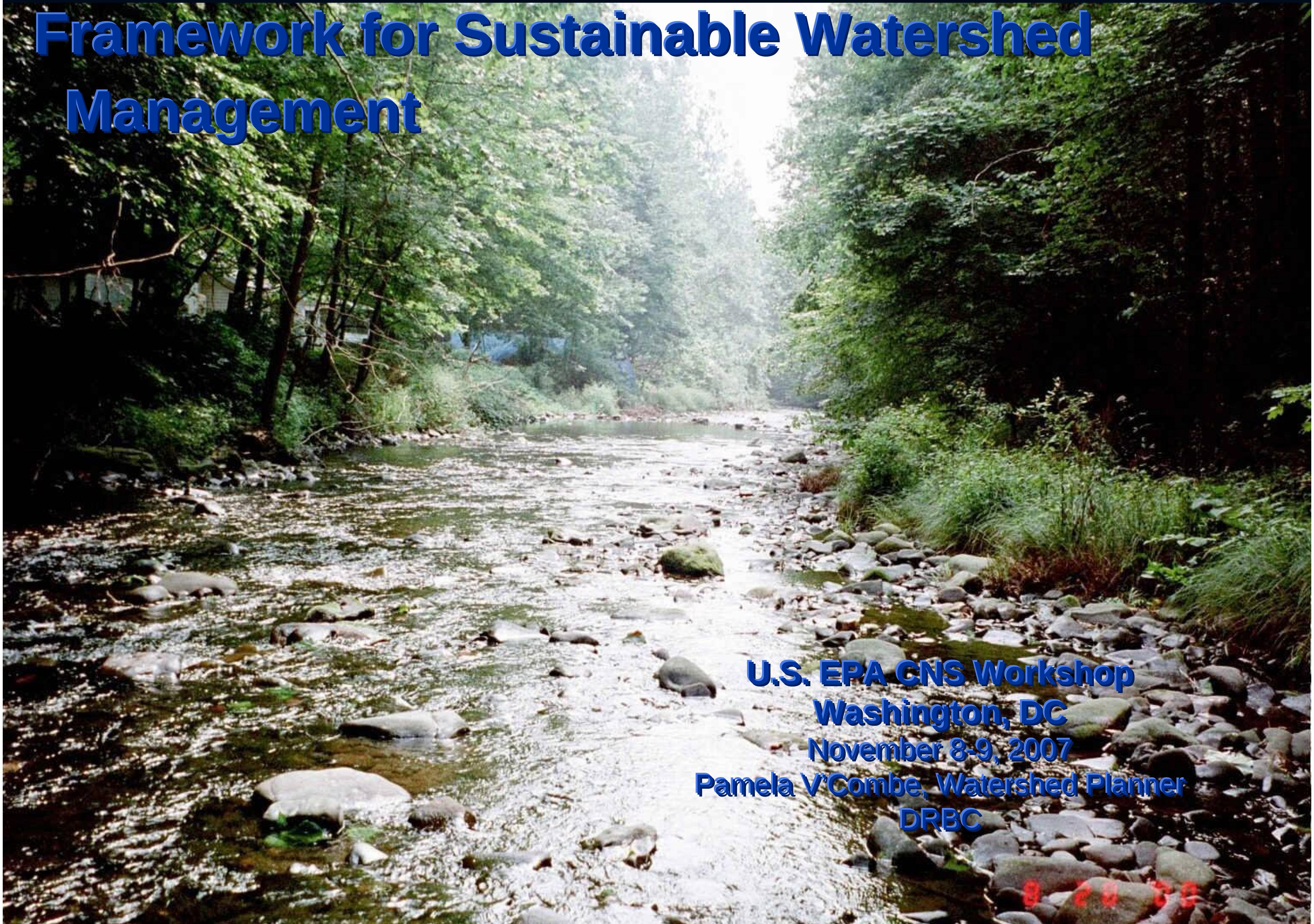
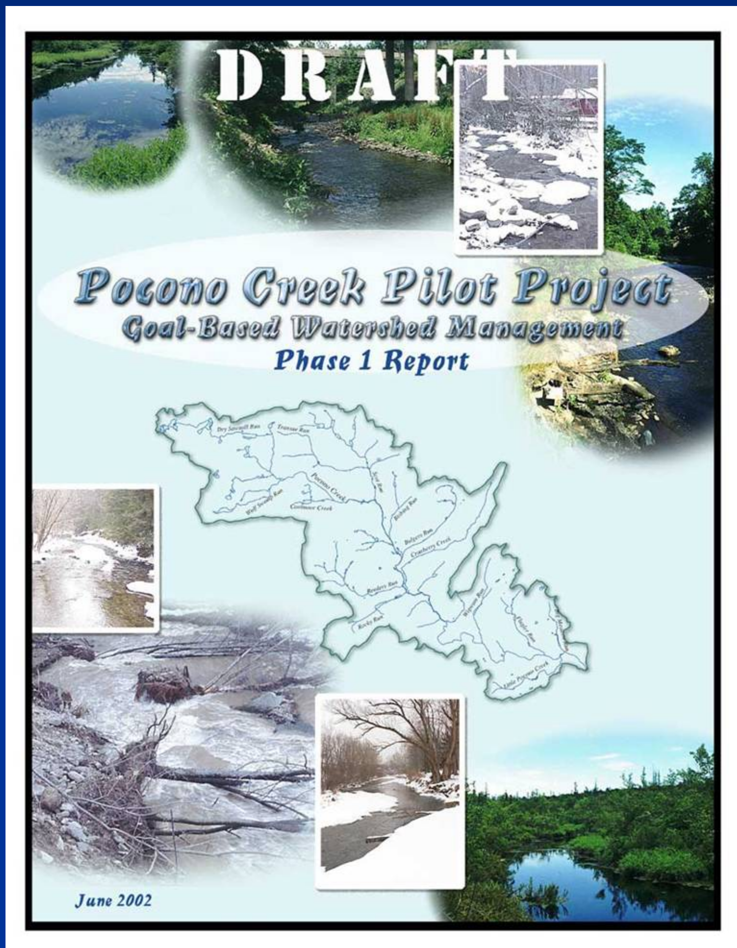
Framework for Sustainable Watershed Management



U.S. EPA CNS Workshop
Washington, DC
November 8-9, 2007
Pamela V'Combe, Watershed Planner
DRBC

Pocono Creek Pilot Study 2000-2004



Major Water Resources Issues in Pocono Creek Watershed

- 1. Stream Flow
- 2. Water Quality
- 3. Stream Channel Stability
- 4. Aquatic Ecology

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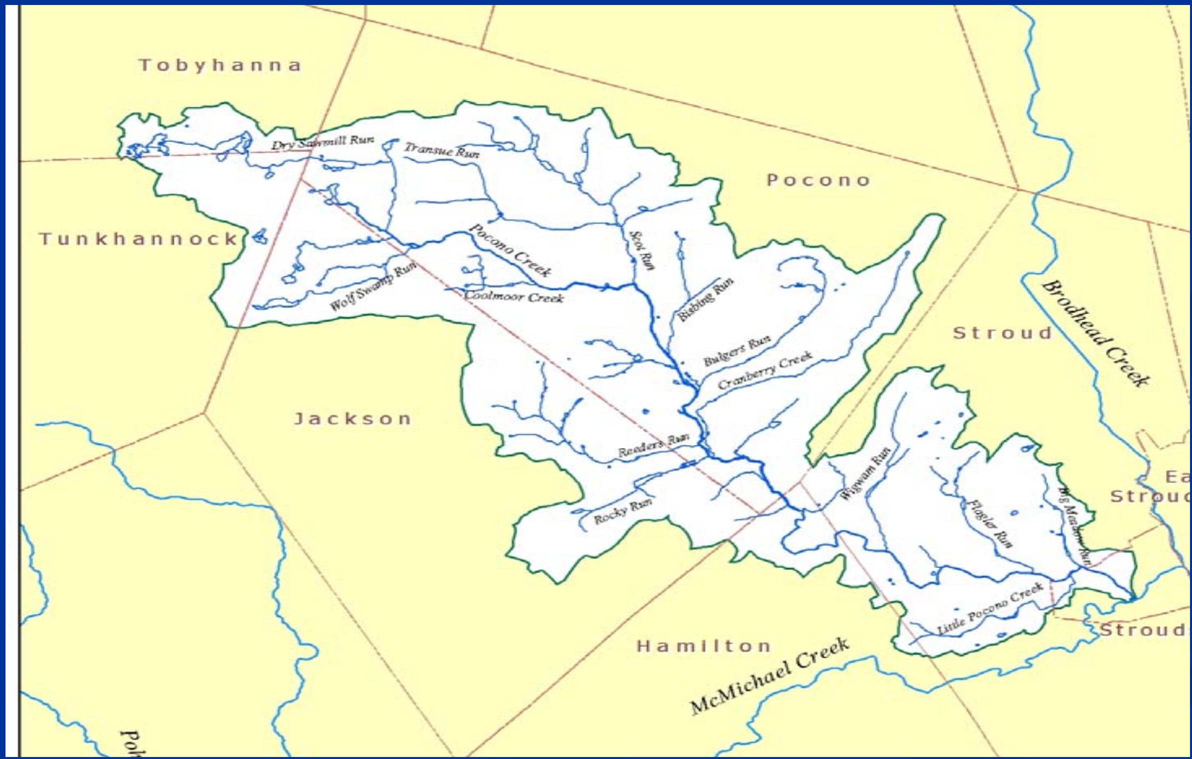
Pocono Creek Watershed

Pocono Creek is 18 Miles - Watershed 46.5 sq. mi.

Tributaries are HQ & EV Cold Water Stream (PADEP) & Class A Wild Trout Stream (PF&BC)



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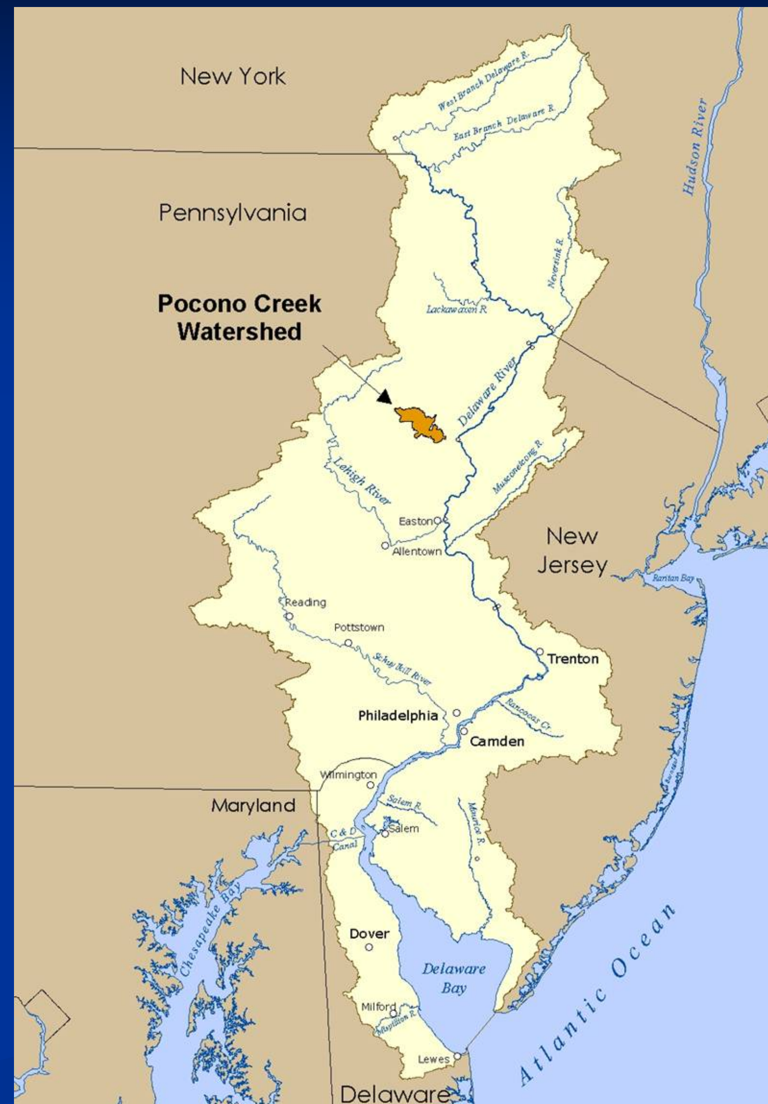
Pocono Creek Watershed

- Monroe County PA – 2nd in Growth
- Tourism Based Economy
- Population Increased > 50% in past decade
- More than 50% Undeveloped
- 90 minute Drive from Philadelphia & NYC



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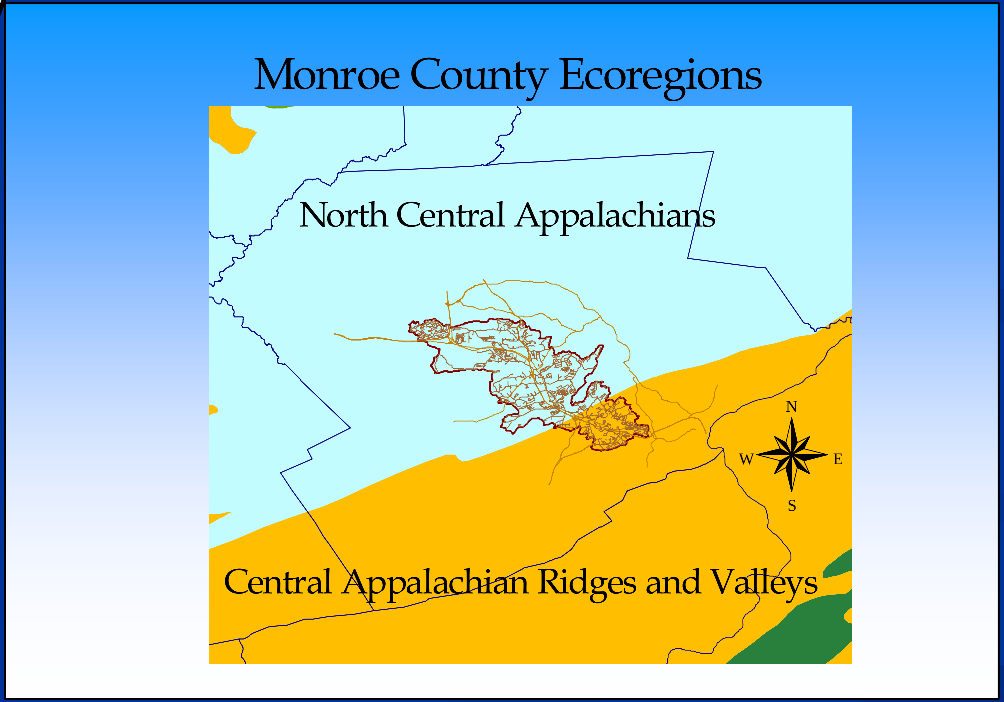
Two Ecoregions

- Appalachian Plateau
- Ridge & Valley



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Pocono Creek Watershed Goals

- **Maintain high quality water quality**
- Preserve stream corridors and floodplains
- **Coordinate watershed planning process with other levels of government**
- **Maintain existing stream flow**
- Develop using village centers and conservation design
- Establish an economy compatible with the environment
- Preserve open space

Water Quantity Goals

Maintain existing stream flows

&

Support natural ecosystems

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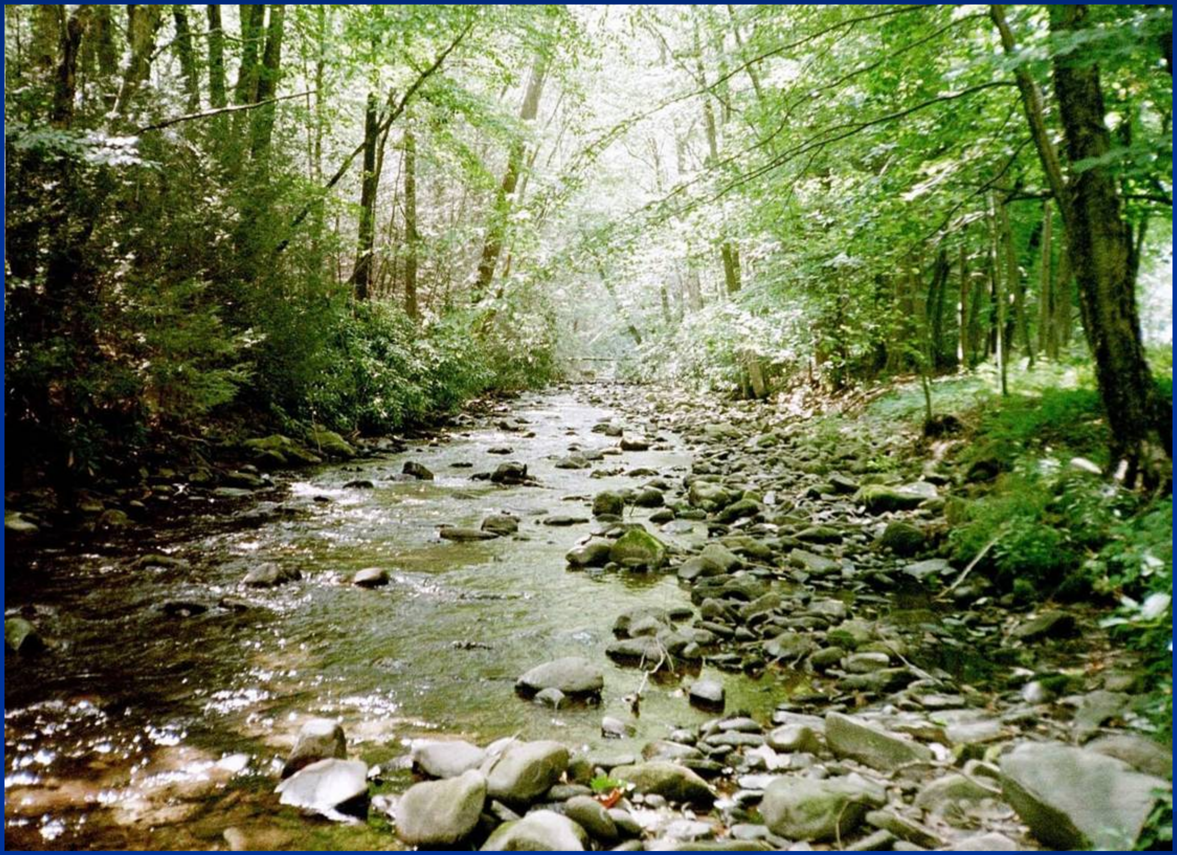
Framework for Sustainable Watershed Management

Manage the Water Resources to Meet Current and Future Needs

Sustainable Watershed Conditions

Water
Resources to
Support
Human Needs
&
Ecological
Habitat



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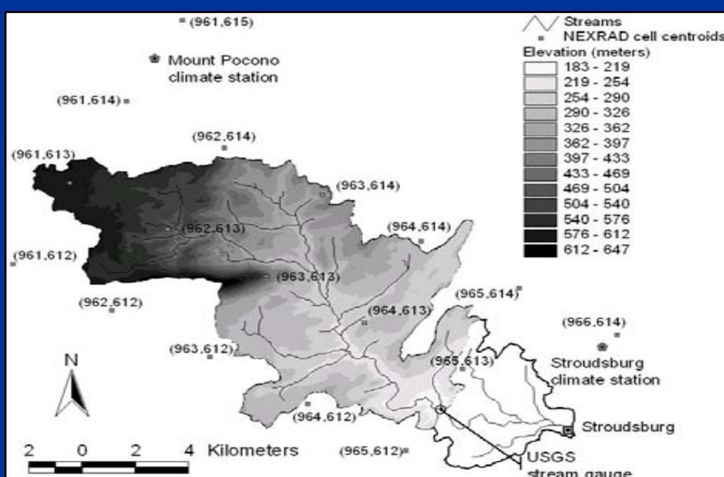
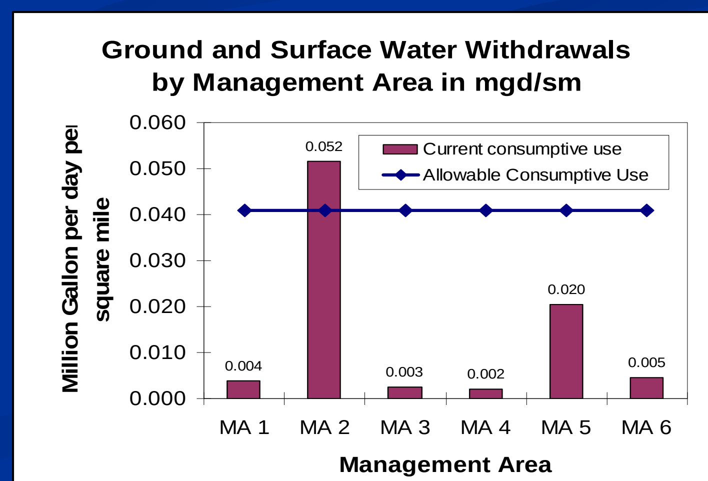
Framework for Sustainable Watershed Management

Approach: To use sound science to develop water resource management strategies and polices that local decision makers **a) adopt** and **b) implement**.





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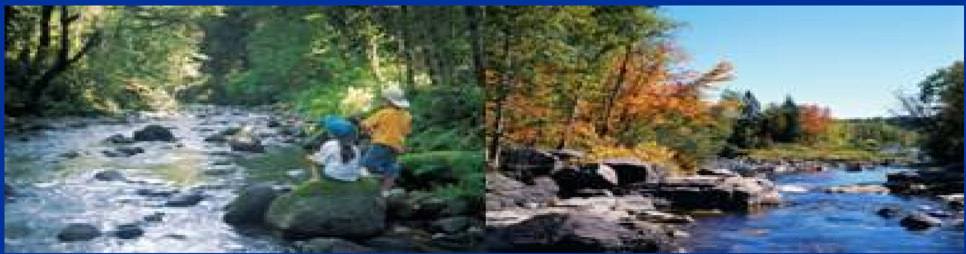
Framework for Sustainable Watershed Management

- Stage 1 – Technical & Scientific Research
- Stage 2 – Development of Management Strategies & Planning Tools
- Stage 3 – Innovative Watershed Community Event



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The Framework for Sustainable Watershed Management

1. Technical Process

Establish Baseline Information
(Gwater Model, Water Budget, etc.)

Establish HIP Stream Classification

Determine Effects of Land Use on:
- Ground Water Withdrawals
- Recharge
- Stream Ecology

Determine Thresholds for:
- Groundwater Withdrawals
- Minimum Recharge

2. Planning Method

Based on Community-driven Watershed Goals

from Pilot Project

DEVELOP WATER RESOURCE MANAGEMENT PRACTICES FROM SCIENCE

Assess Needs & Implementation at:
- Local
- Regional/State
- Developers
- Utilities

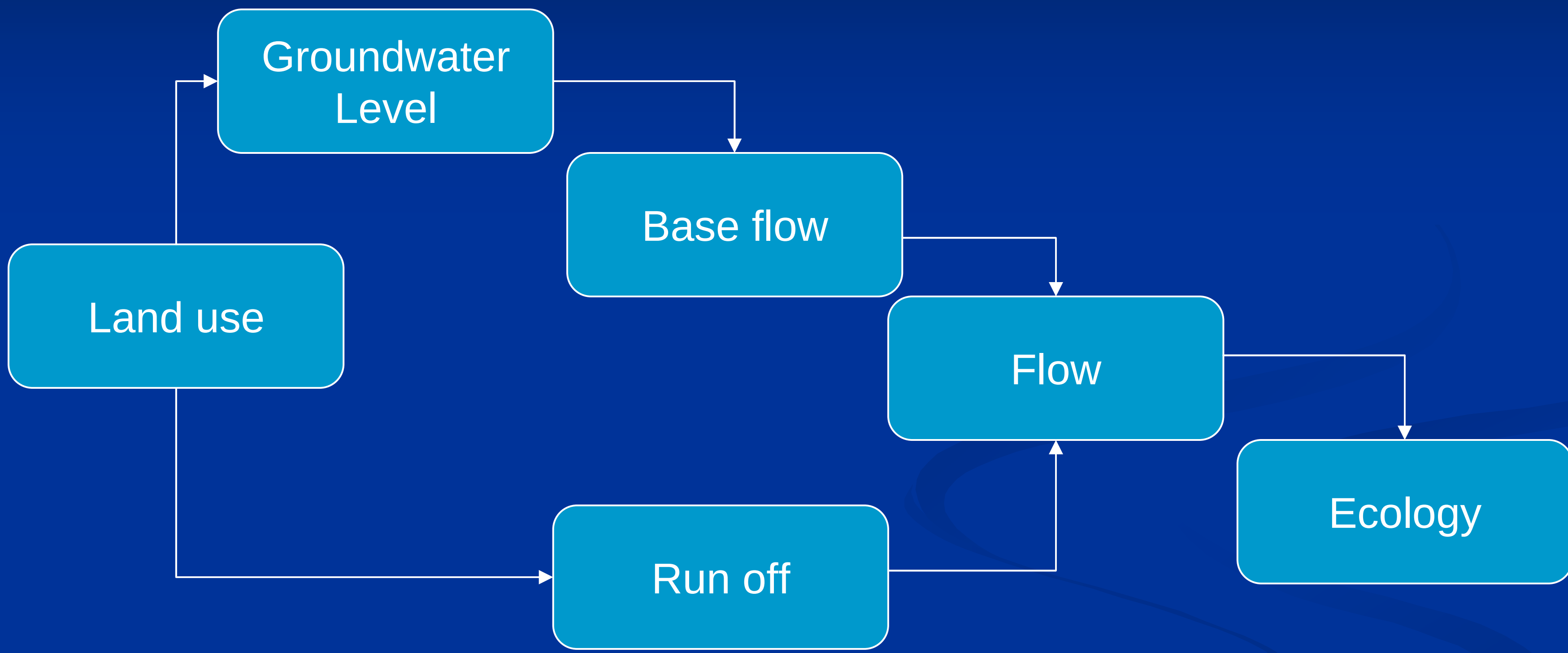
3. Watershed Outreach

INFLUENCE DEVELOPMENT SO THAT IT PROTECTS THE ENVIRONMENT

SOCIAL MARKETING EFFORT
"Sustain Development – Save a Trout"
&
WATERSHED EVENT

PHASE 2 – IMPLEMENTATION

Models and HIP Process



Technical Stage

- Completed Baseline Studies for:

Existing Water Budget
Ground Water/Surface Water Interface
Streamflow Statistics
Hydrologic Conditions
Existing Water Demands

Characterize hydrologic relationships between baseflows and withdrawals

- Identify stressors for existing habitat
- Determine necessary conditions to maintain sustainable flows in Pocono Creek Watershed

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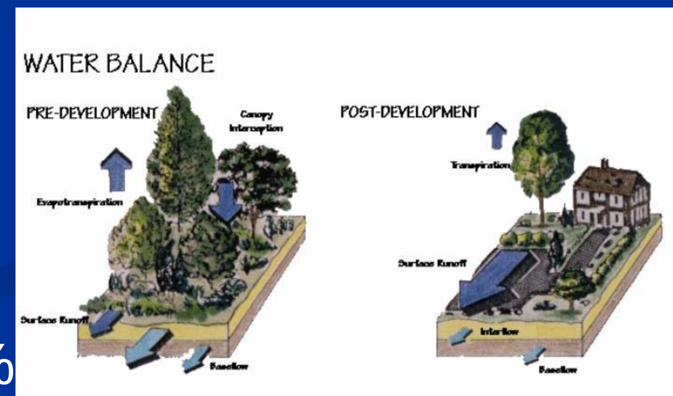
EPA HYDROLOGY MODEL STUDY

RESULTS Based on Projected Build Out -

Recharge reduced in 26 out of 29 recharge areas

Daily Base Flow < 31%
Low Flow 7Q10 < 11%,
Monthly Median Daily Flow < 10%



Monthly Peak of Daily Flows > by 21%
Annual Maximum of Daily Flow > 19%

Watershed-averaged Groundwater Recharge < 31%

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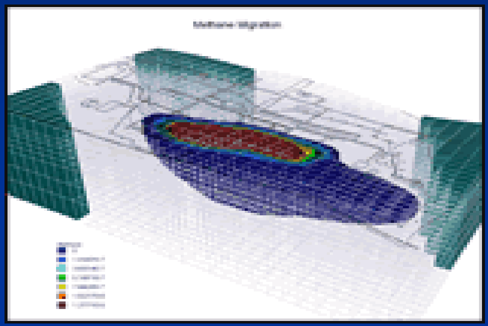
USGS MODFLOW-2000 Groundwater Flow Model

Measured Effects on Base Flow from



Ground-Water Withdrawals

&

Reduced Recharge from Land Use Change

- Three-dimensional model
- Entire Pocono Creek watershed
- Used EPA-ORD hydrology model recharge values for 2000 land use & 2020 land use.

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USGS MODFLOW-2000 Groundwater Flow Model

2020 Build-out:

- Effects of withdrawals are related to drainage area
- Base flows < 38 to 100%
- Groundwater withdrawals and surface water withdrawals equally affect stream flow

In 2007 -

We Got HIP -

The Pocono Creek
Hydroecological
Integrity Assessment Process

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and….

We Got HAT -

The Pocono Creek

Hydroecological Assessment Tool

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Purpose of HIP

Links Streamflow and Stream Health in order to maintain healthy aquatic ecosystems

- sustain or restore stream communities
- sustain or restore stream integrity

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Purpose of HAT

Establishes a hydrologic baseline to:

- Determine environmental flow standards, and
- Assess alternate (future) conditions

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Fundamental Scientific Principle

- Ecological integrity of river ecosystems depends on their natural dynamic character (Poff and others 1997).

- Altering flow regimes affects stream biota in relation to the degree of alteration (Bunn and Arthington 2002).

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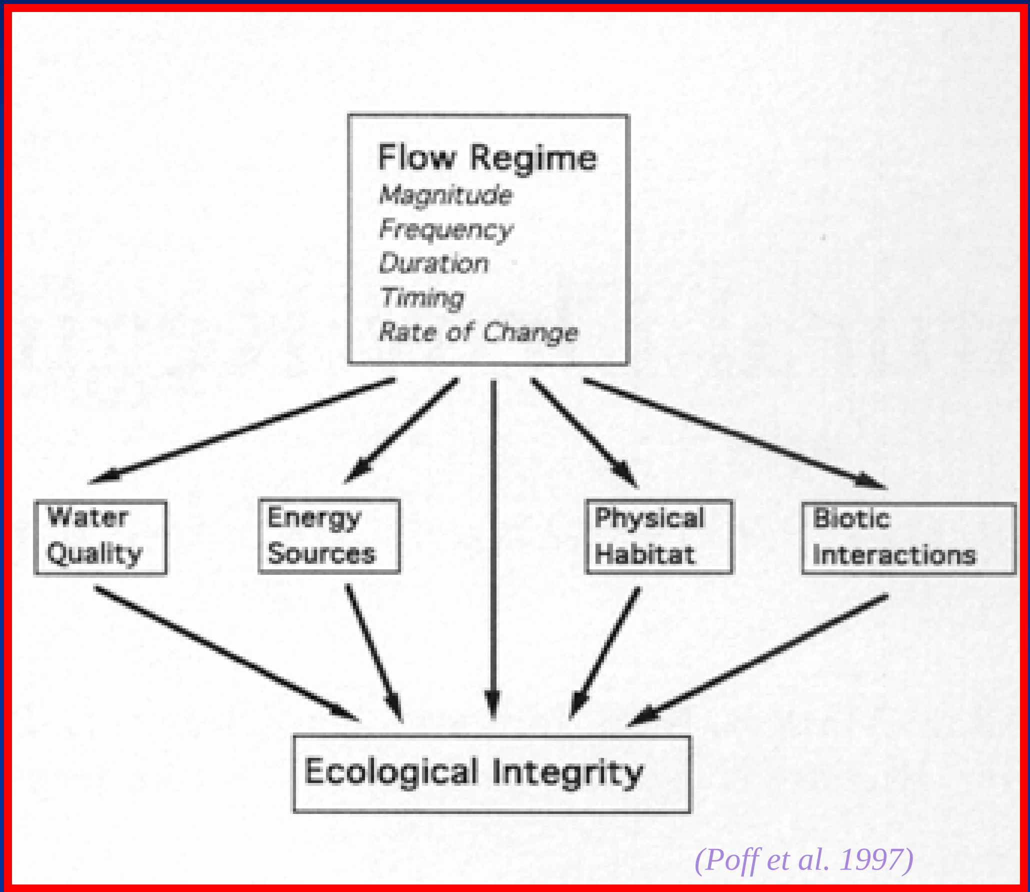
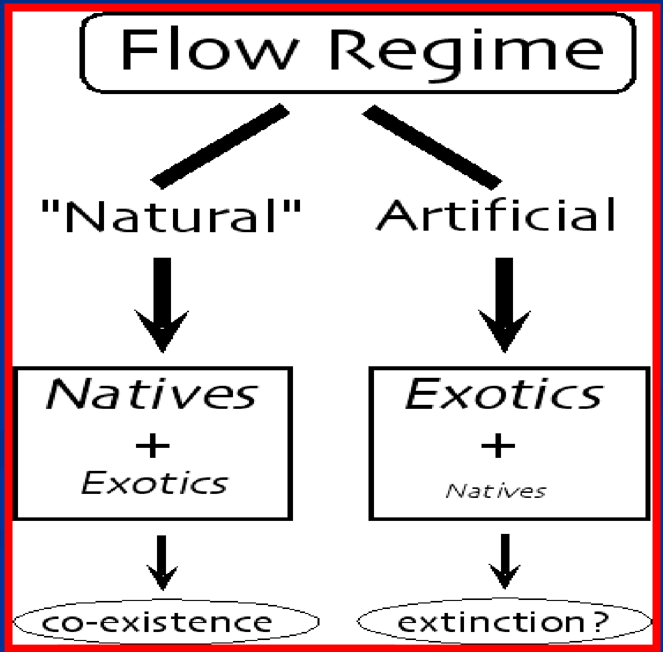
Flow – "Master Variable"



Perspective



Implication

Dynamic Variables

9 FLOW COMPONENTS

Flow Conditions:	Ave., Low and High
Frequency of Flow Events:	Low Flow Events High Flow Events
Duration of Flow Events:	Low Flow Conditions High Flow Conditions
Timing	
Rate of Change in Flow Events	

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"Table 3." Statistically Significant Stream Type Specific Indices (171)

	Stream Classification				
Perennial	Flashy/Runoff	Snow & Rain	Snowmelt	Stable GW	All Streams
Magnitude of flow events Average flow conditions	M_A18, M_A39, M_A26, M_A37	M_A9, M_A15, M_A33, M_A32	M_A24, M_A11, M_A43, M_A40, M_A45	M_A39, M_A13, M_A44, M_A40, M_A9	M_A20, M_A37, M_A34, M_A40
Low flow conditions	M_L6, M_L13, M_L13, M_L16	M_L20, M_L4, M_L21, M_L16	M_L3, M_L19, M_L20, M_L3, M_L13	M_L20, M_L20, M_L13, M_L15, M_L21	M_L8, M_L19, M_L13, M_L15
High flow conditions	M_H5, M_H16, M_H20, M_H18	M_H24, M_H4, M_H18, M_H26	M_H14, M_H17, M_H12, M_H13, M_H16	M_H16, M_H2, M_H21, M_H3, M_H1	M_H20, M_H3, M_H20, M_H23
Frequency of flow events Low flow conditions	F_L3, F_L3, F_L1, F_L1	F_L3, F_L2, F_L1, F_L1	F_L1, F_L3, F_L3, F_L2, F_L3	F_L3, F_L1, F_L1, F_L2, F_L3	F_L3, F_L3, F_L1, F_L2
High flow conditions	F_H4, F_H3, F_H1, F_H9	F_H4, F_H10, F_H1, F_H10	F_H7, F_H3, F_H3, F_H4, F_H11	F_H3, F_H9, F_H5, F_H10, F_H11	F_H7, F_H3, F_H9. F_H2
Duration of flow events Low flow conditions	D_L4, D_L12, D_L16, D_L6	D_L15, D_L1, D_L16, D_L12	D_L16, D_L14, D_L5, D_L9, D_L17	D_L4, D_L16, D_L16, D_L11, D_L7	D_L3, D_L12, D_L16, D_L6
High flow conditions	D_H2, D_H13, D_H20, D_H8	D_H12, D_H2, D_H20, D_H24	D_H11, D_H14, D_H1, D_H9, D_H23	D_H14, D_H2, D_H17, D_H12, D_H23	D_H11, D_H2, D_H15, D_H8
Timing of flow events	T_A1, T_A1, T_L1, T_A3	T_A1, T_H2, T_L2, T_H3	T_H3, T_A1, T_L2, T_L1, T_A3	T_A1, T_H3, T_H2, T_A1, T_A2	TA1, TH2, TL3, TA1
Rate of change in flow events	R_A3, R_A7, R_A8, R_A5	R_A7, R_A1, R_A6, R_A2	R_A6, R_A3, R_A1, R_A2, R_A4	R_A7, R_A3, R_A8, R_A1, R_A6	R_A6, R_A3, R_A8, R_A2

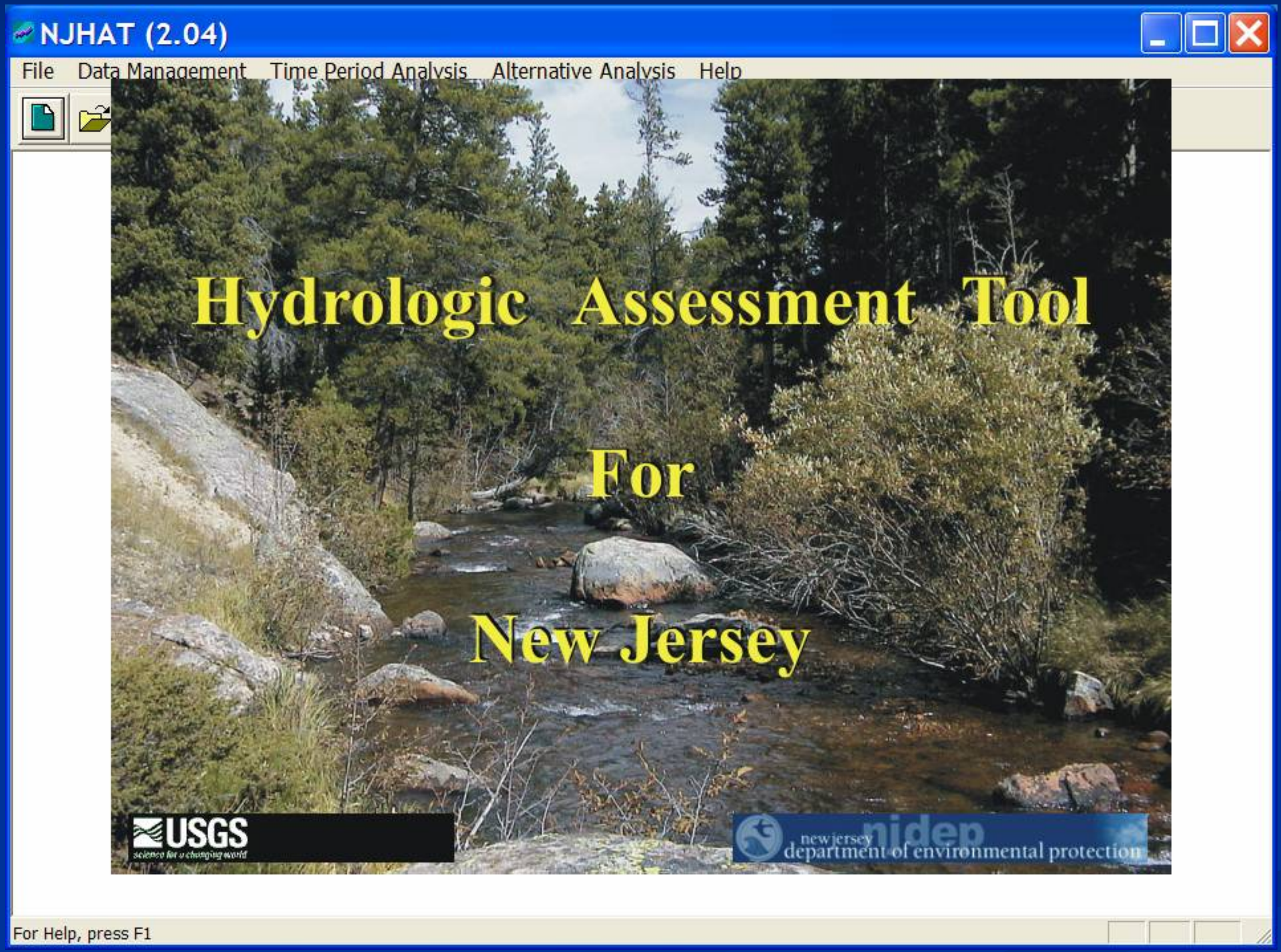
From Olden & Poff 2003

Pocono Creek HIP

USGS Task A –

1) Classify streams – hydrologically & develop flow standards – (NJSCT?)
2) Characterize hydrologic alteration – 2000 baseline & 2020 'build out' – (NJHAT or NATHAT?)

All Ready Done in NJ!



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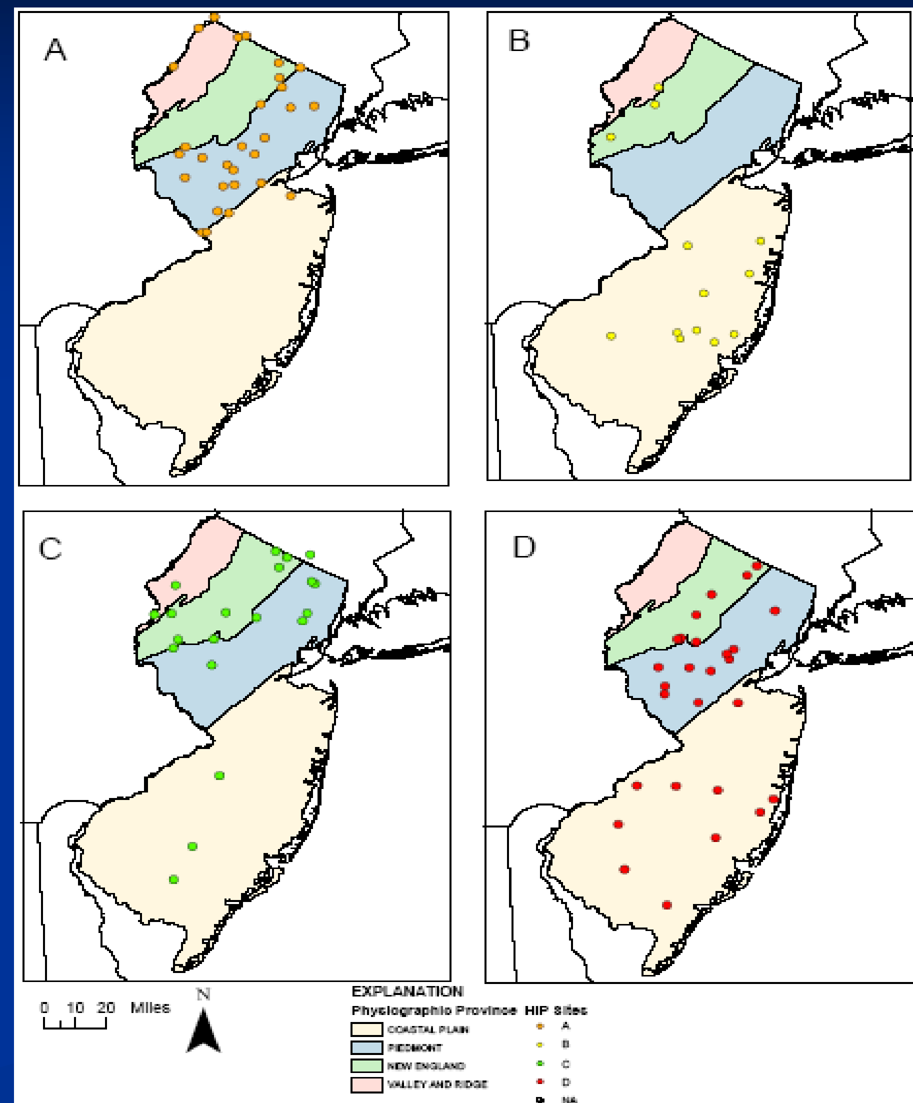
Distribution of Four NJ Stream Types

- All perennial
- Group B – GW influenced High base flow, low variability daily flow
- Group D – small DA, low base flow, highly variable daily flow (flashy)
- Groups A & C – intermediate B/D, low to moderate daily flow variability, moderate baseflow, A - small flood



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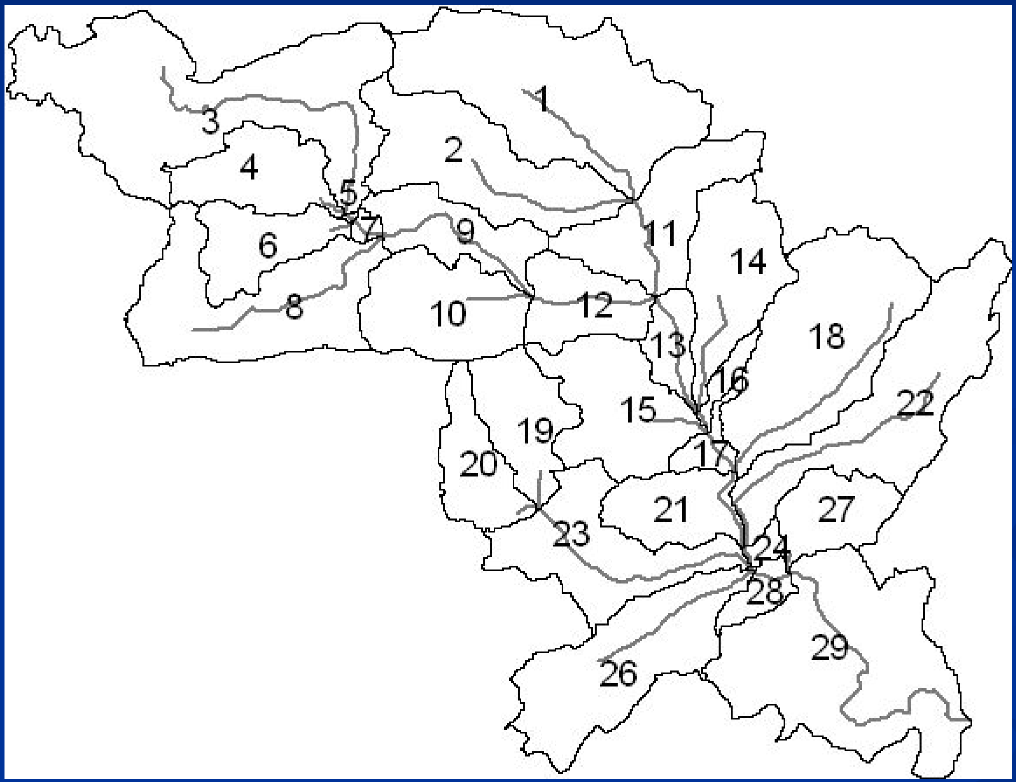
Hydrological Model's Sub – Basins Used



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Task A: Objective (1) – Classify streams hydrologically

Used NJ Stream classification tool

NJ Stream Type	Pocono Sub Basins	Percent
A	6, 20	7
B	3, 18	7
C	5, 7, 9, 11, 12, 13, 15, 16, 17, 21, 24, 25, 28, 29	48
D	1, 2, 4, 8, 10, 14, 19, 22, 23, 26, 27	38

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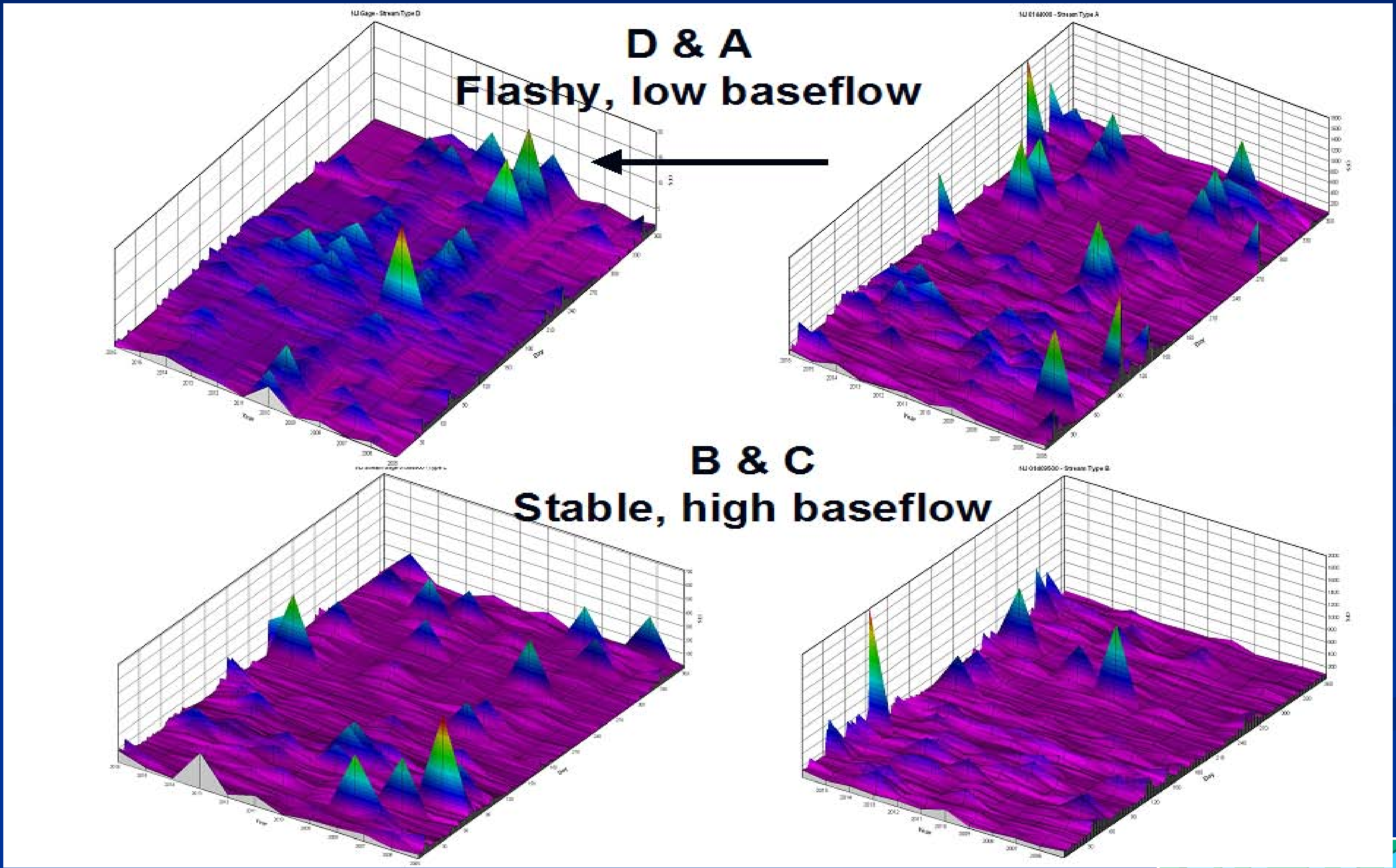
NJ Stream Classifications – "Bad Fit"



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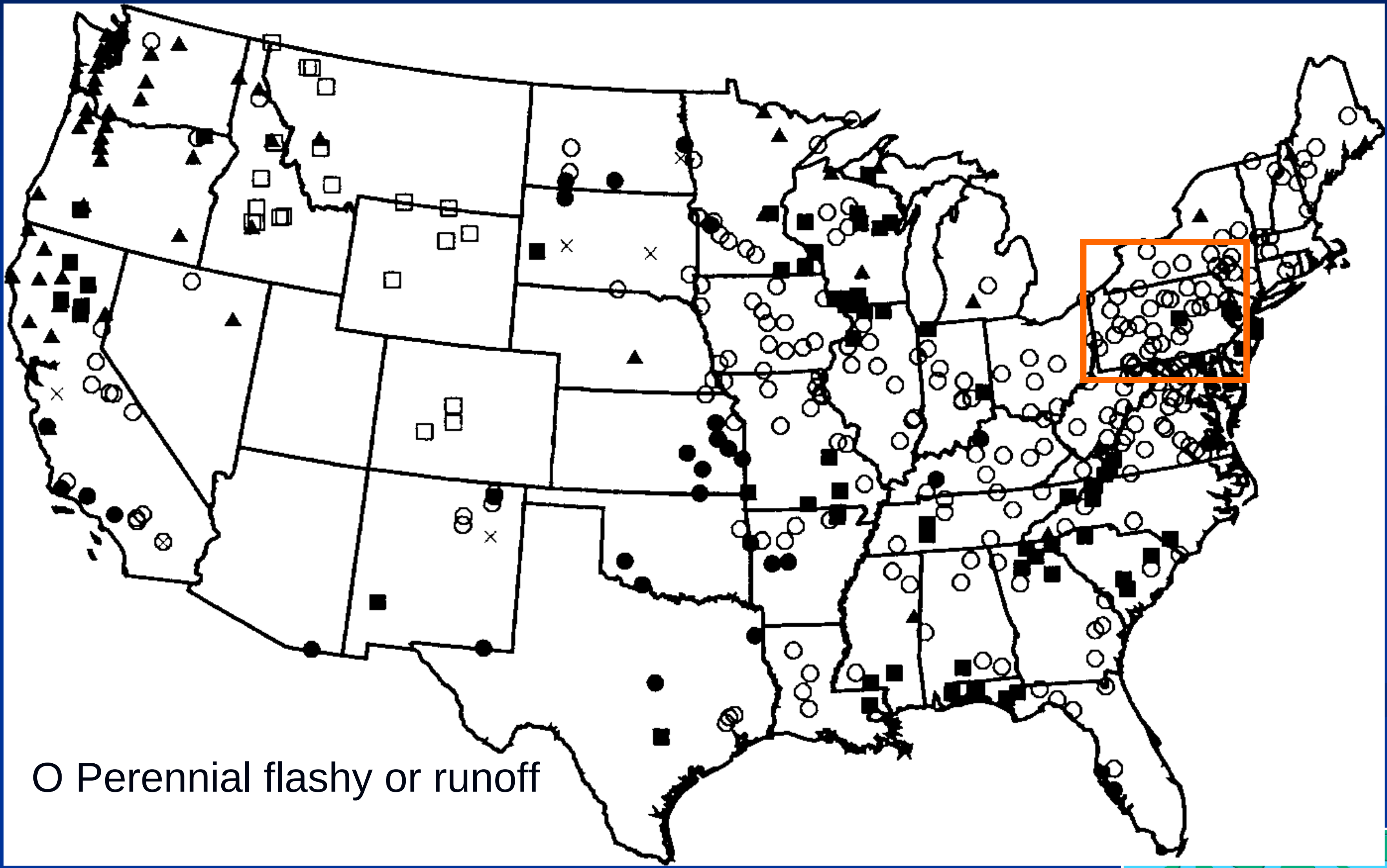
Start Again.....

Returned to National Classifications……

Olden & Poff National Classification



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National Classifications

Poff 1996 – *Freshwater Biology*

- Unregulated gages – 806 & 420 "best" Nat, 35 PA.
- 11 indices, 10 stream types Nationally, 2 PA.
- 34 Perennial runoff – low flood seasonality, high seasonality of low flow.

Olden & Poff 2006 – *River Research & Applications*

- 420 "best" unregulated, 24 PA.
- 171 indices, Six stream types Nationally, 2 PA.
- 23 of 25 Perennial flashy or runoff – low flood. seasonality, high seasonality of low flow.

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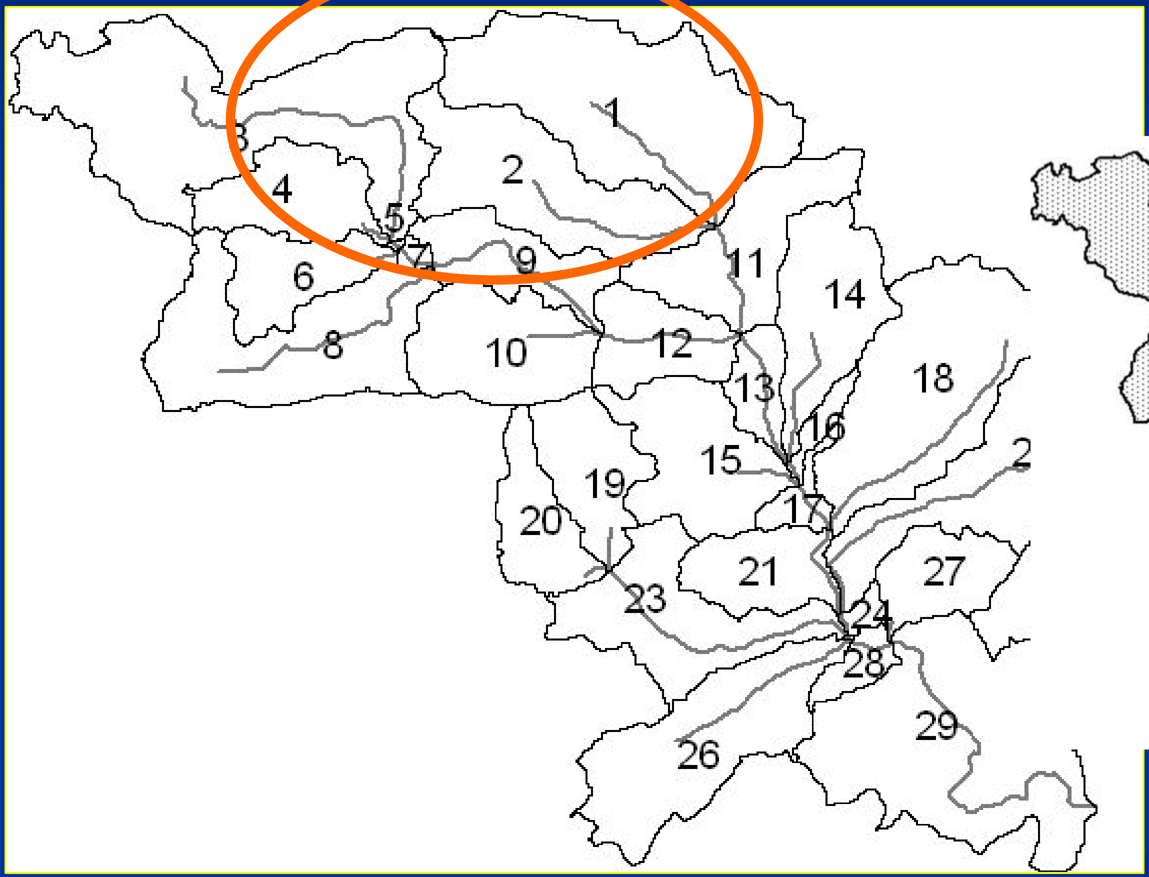
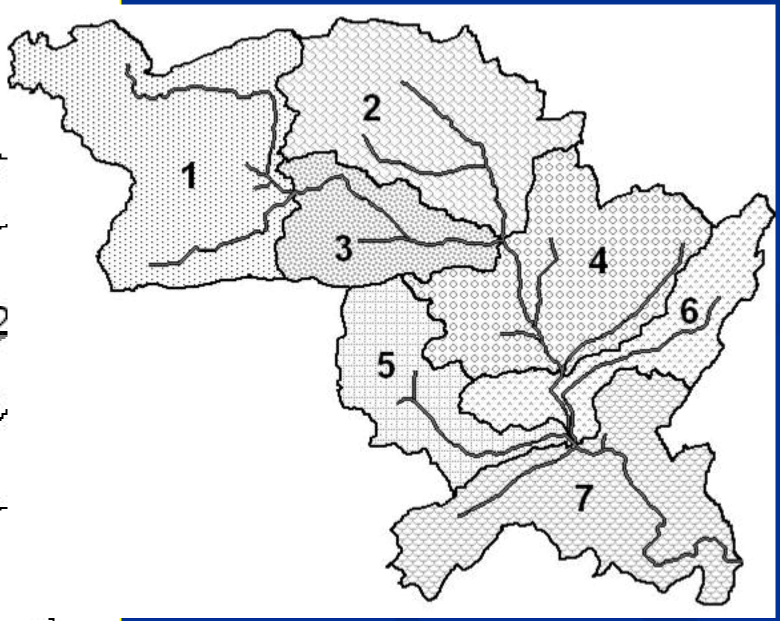
29 Sub Basins = 7 Clustered





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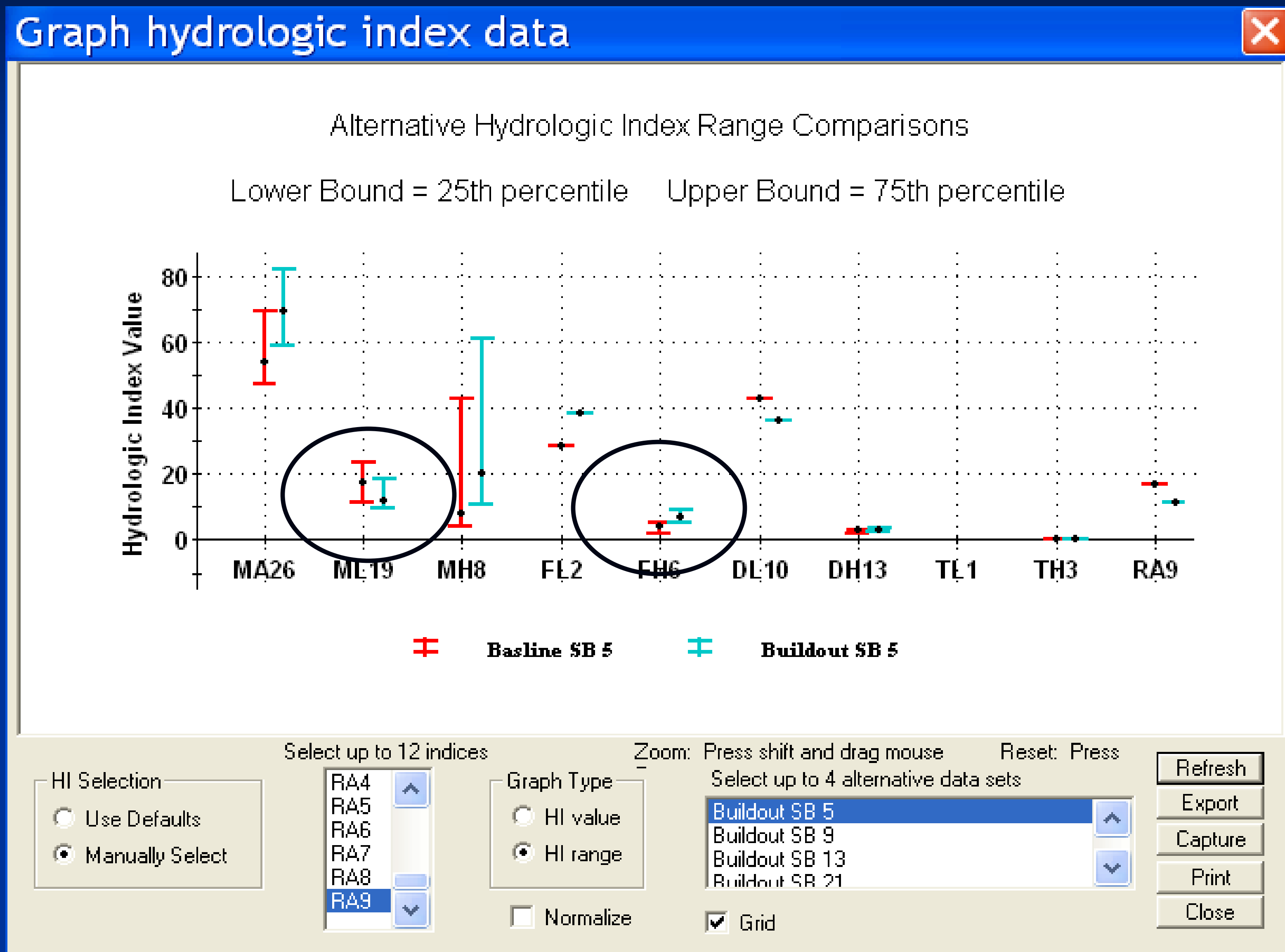
Flow Standards & Alteration Baseline vs. Build out SB 5



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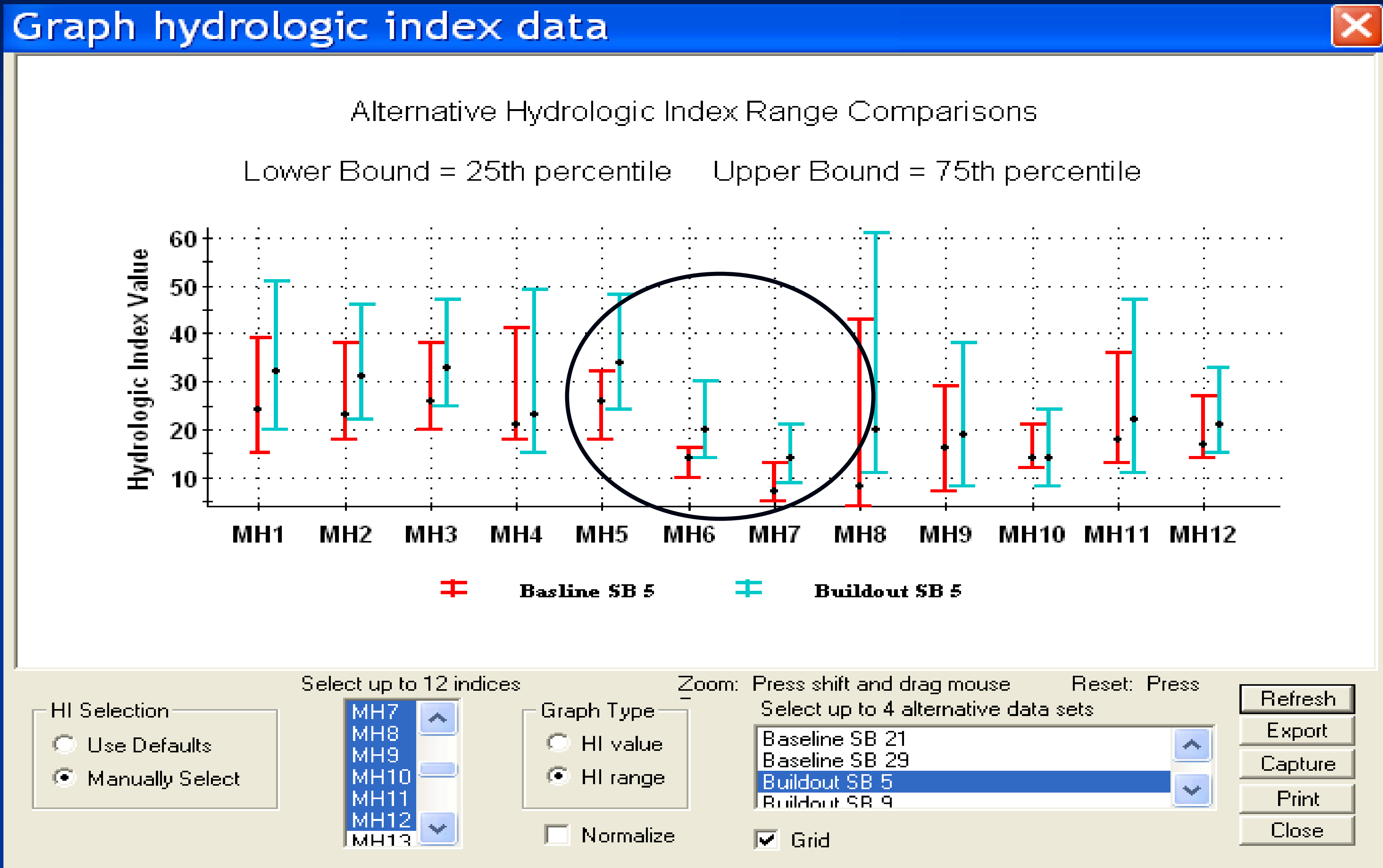
Median Monthly Maximum Flow



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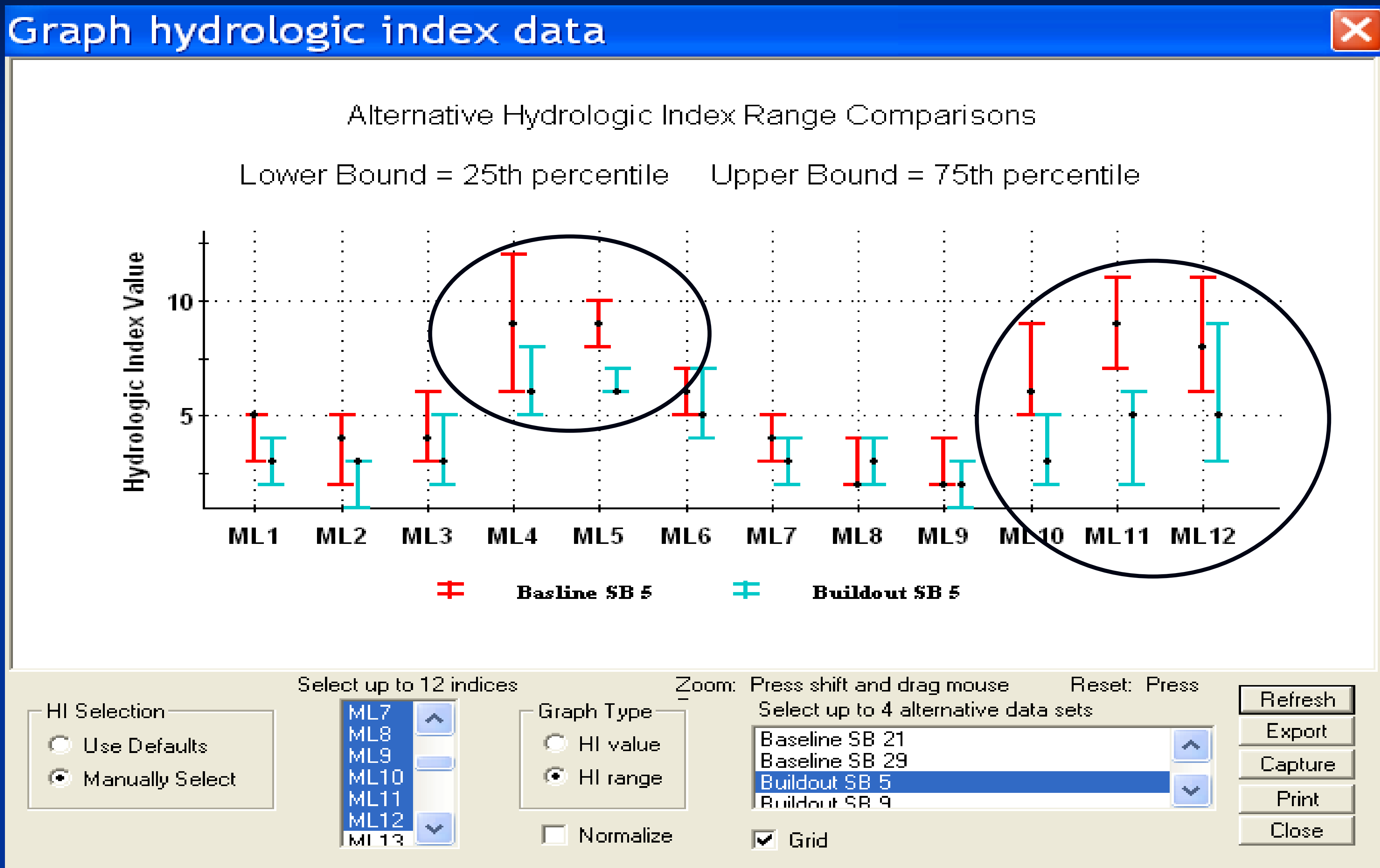
Median Monthly Minimum Flow



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Conclusions…………………in part

Index	Units	SB 5	SB 9	SB 13
ML1-12	Median monthly minimum % - # of months	16-50 ↓ 11	14-57 ↓ 11	17-42 ↓ 10
FL1	<25%t - events/yr %	7 ↑ 175 ↑	4 ↑ 57 ↑	4 ↑ 44 ↑
DL16	Mean days/yr %	10 ↓ 57 ↓	3 ↓ 26 ↓	3 ↓ 33 ↓
MH1-12	Median monthly maximum % - # of months	9-150 ↑ 11	14-90 ↑ 11	-4 ↓-90 ↑ 12
FH5	>25%t - events/yr %	5 ↑ 46 ↑	4 ↑ 31 ↑	6 ↑ 40 ↑
DH15	Mean days/yr %	3 ↓ 35 ↓	2 ↓ 25 ↓	1 ↓ 20 ↓

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Pocono Creek HIP

Task B objectives –

- If …"Flow/trout data suitable for developing testable hypotheses for flow/trout relationship?
- Test hypotheses.
- Results?
- Develop flow standards

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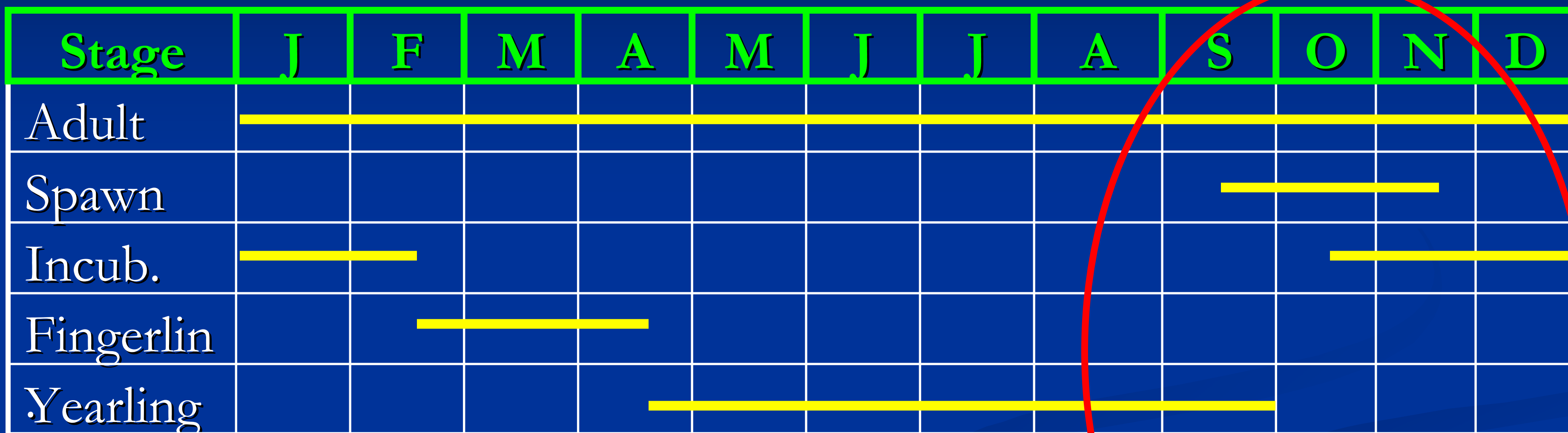
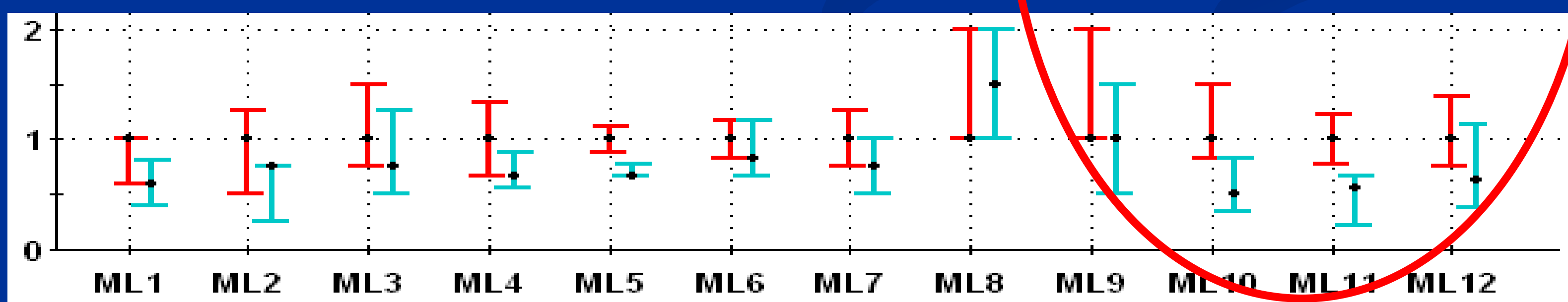
General Periodicity Chart
Brook and Brown Trout





Median Monthly Minimum Flow

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October 31, 2007 Discussion

- Which sub basins? All 29 or 7?
- Establish environmental standards and document 'violations' or…
- Test flow/'trout' (change in abundance) relationship.
- Or both?
- Time frame?

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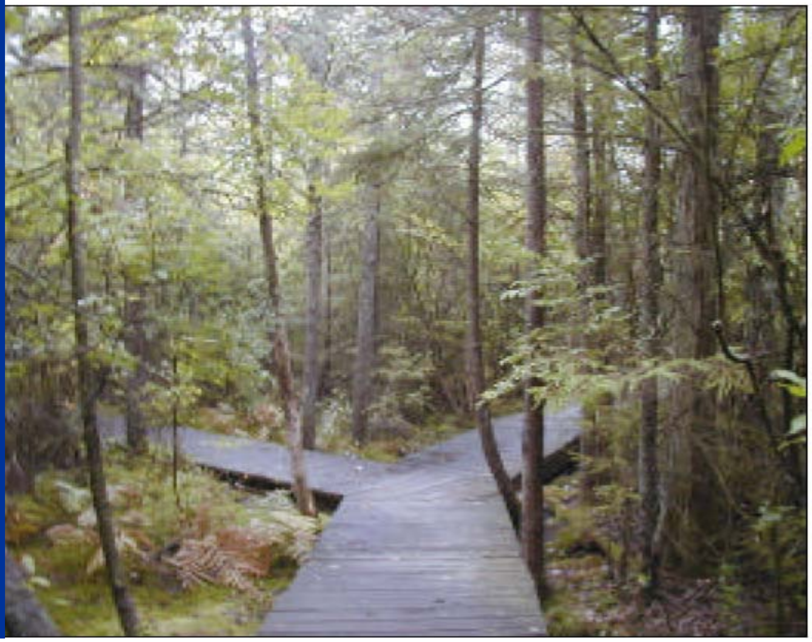
Next Steps…..

By May 2007

- Management Strategies
- Watershed Community Event

Phase II

- Local Adoption
- Local Implementation
- State Policy Revised



IMMEDIATE FUTURE DIRECTION

Through the "Seven Doors" Social Marketing

adapted from Les Robinson, Social Change Media.

- 1. Knowledge/awareness - Planning
- 2. Vision - Creates Desire
- 3. Skills – Make it Easy
- 4. Optimism Promote Benefits of Alternatives
- 5. Facilitation – Implementation
- 6. Stimulation – Watershed Community shares event => Galvanizes action
- 7. Feedback and reinforcement

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COLLABORATIVE INNOVATIVE WATERSHED COMMUNITY EVENT

"Both science and art
have the capacity to help
us see much further
than our everyday economy
requires."

(Holmes Rolston III, Philosophy Gone Wild).

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November 14, 2007

"DEVELOP RIGHT- SAVE A TROUT!"

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Linking Sustainability Message to Watershed Community

New Watershed Partners!

- Chamber of Commerce
- Corporations
- Arts League
- University
- Media
- Local Officials
- Residents
- Tourists

sanofi pasteur
The vaccines business of sanofi-aventis Group

EAST STROUDSBURG UNIVERSITY

Pocono Mountains Chamber of Commerce
Promoting Prosperity

POCONO RECORD
News & Information from Northeast Pennsylvania

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PHASE II

FUTURE DIRECTIONS:

A. Local Protection Measures

- Developed
- Adopted
- Implemented

B. Watershed Sustainability Indicators

- Developed
- Promoted
- Adopted

C. Economic Future Alternatives Analysis

D. State Water Resources Protection Measures Influenced

EPA TRUE PARTNER

This research is funded by
U.S. EPA - Science To Achieve Results (STAR) Program
Grant #

GOAL MADE POSSIBLE:
To Establish a Collaborative Community Process to Develop Sustainable Watershed Practices Based on Sound Science.

EPA Funded Project: USGS and DRBC

EPA – ORD Edison NJ and Cincinnati OH: Developed tools that will be useful in other watersheds; Provided training, equipment, and technical support.

EPA – ORD, EPA Region 3 and EPA – ORD CNS: Excellent support and collaboration, No-Cost Extension, networking opportunities, patience and good humor.

New Linkages with **PA DEP, USGS** Science Center, Ft. Collins CO

Delaware River Basin Commission

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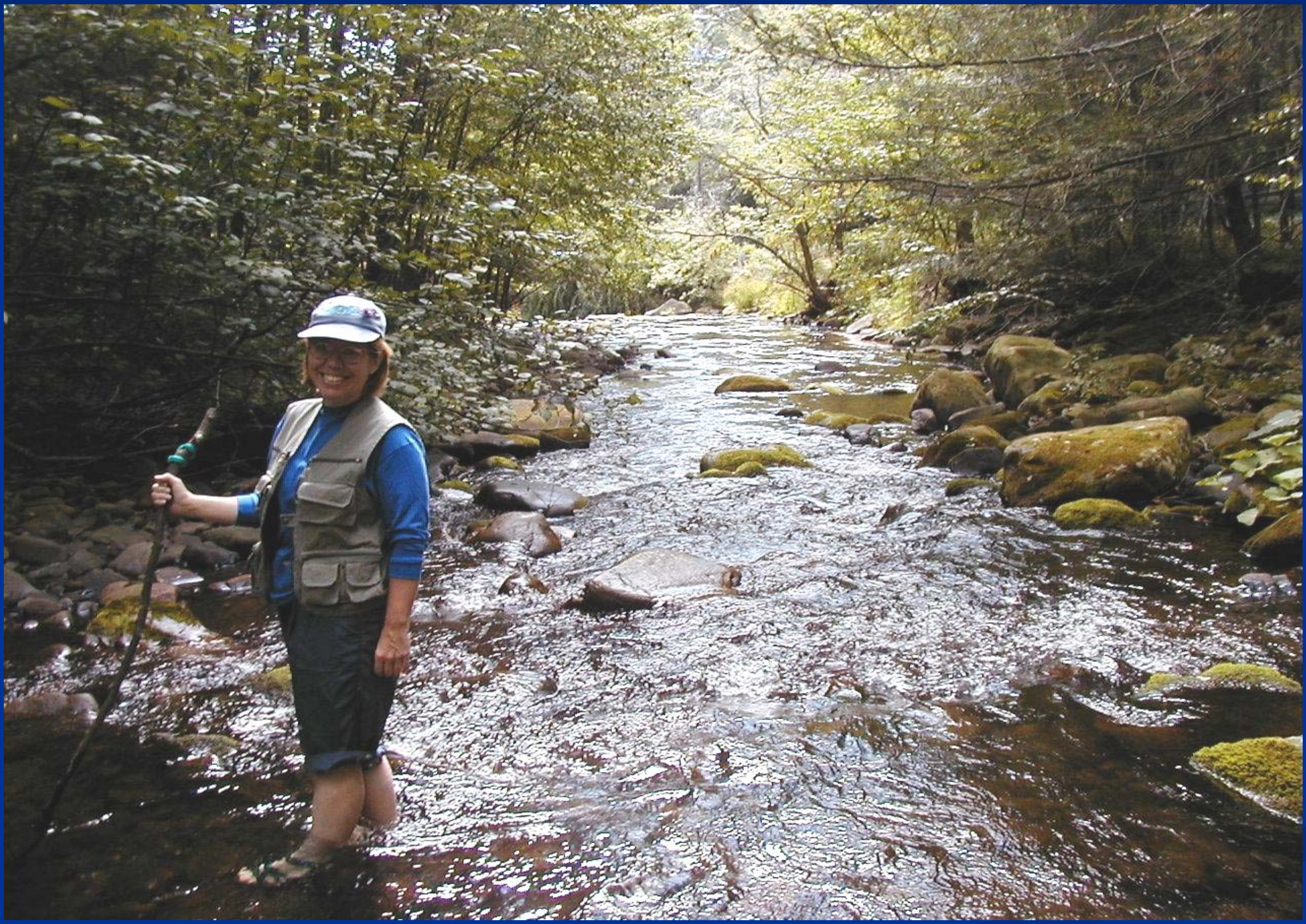

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