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Ecological Flow Assessments in Eastern U.S. Basins

Tara Moberg

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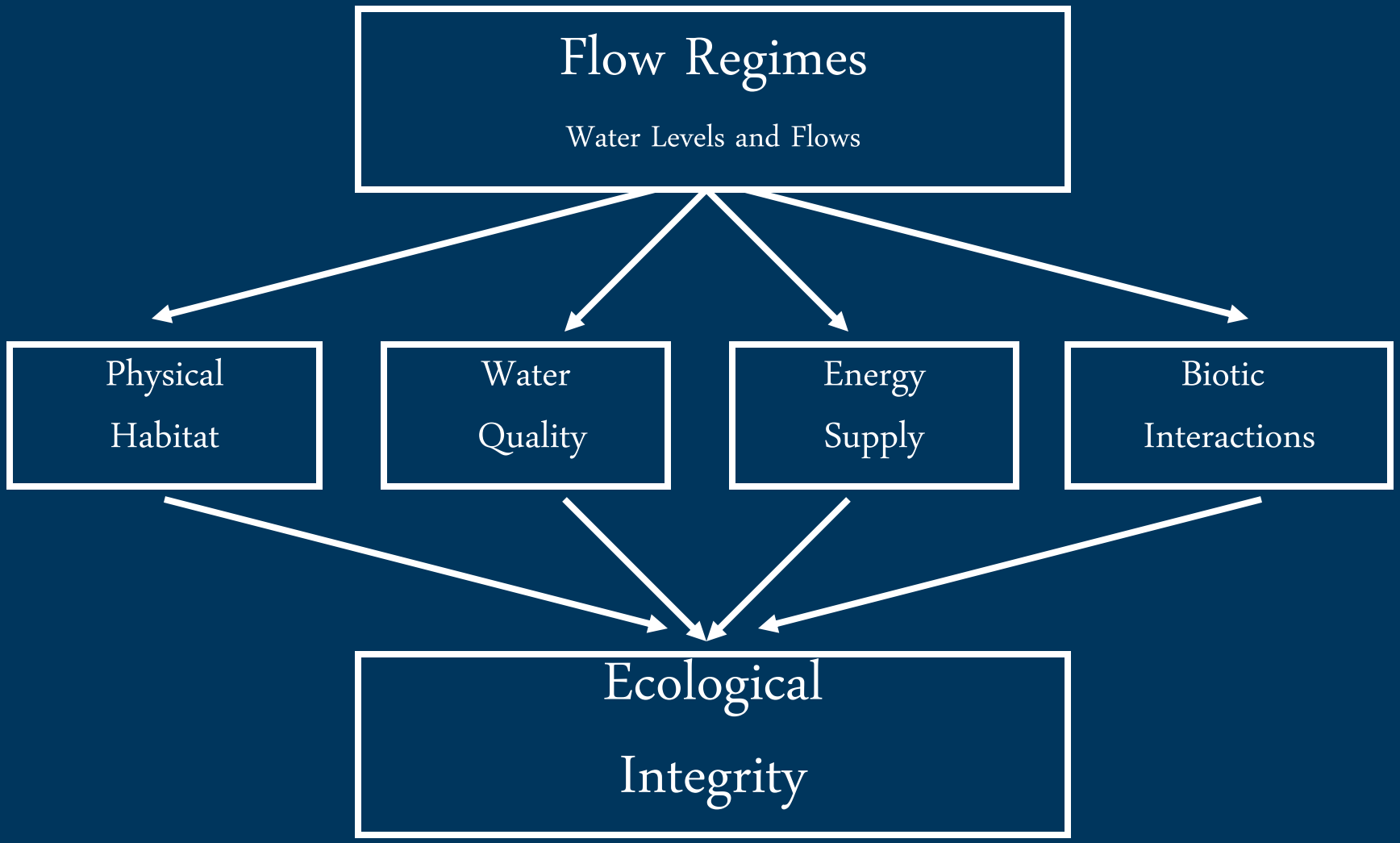
What are Ecological Flows?

The flow of water in a natural river or lake that sustains healthy ecosystems and the goods and services that humans derive from them.

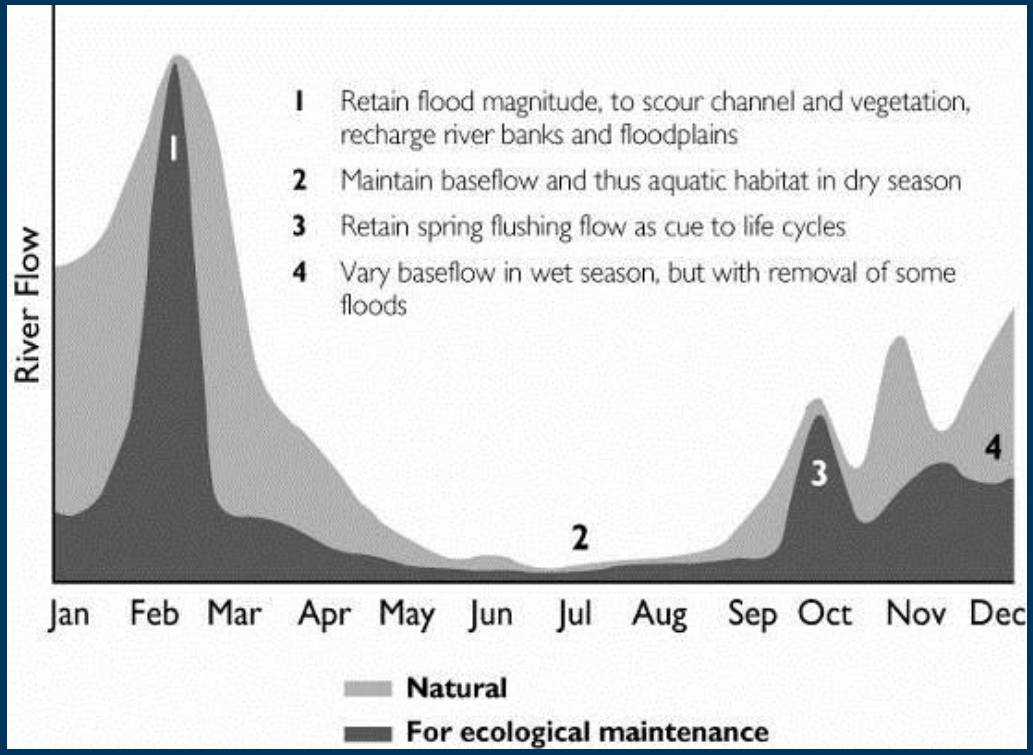
Flow: a master variable



Poff et al. 1997

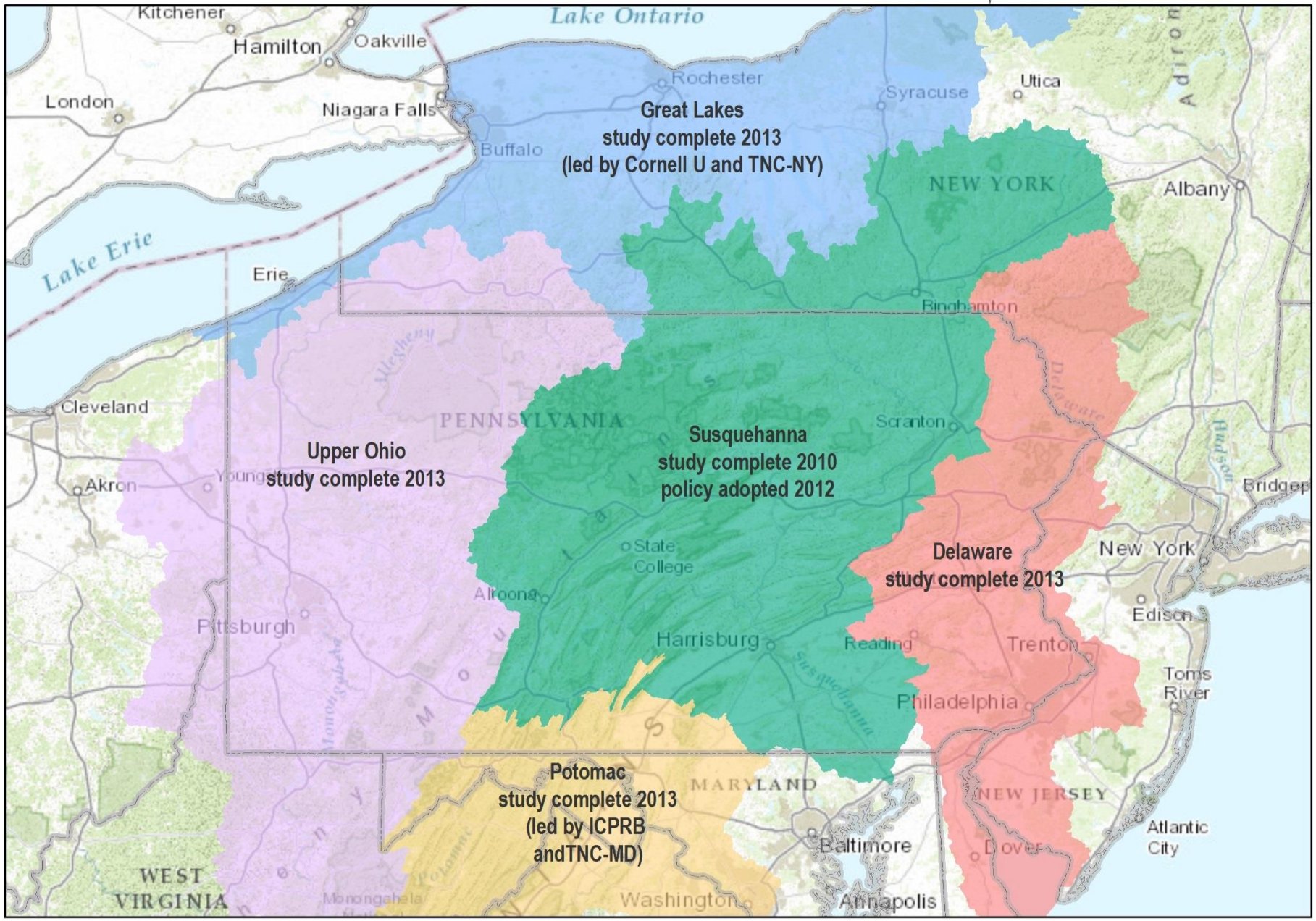
TNC Flow Principles

The goal is *not* to create optimal conditions for all species all of the time; rather, we want to create adequate conditions for all native species *enough* of the time



Postel and Richter 2003

Status of Ecological Flow Studies and Policy Implementation



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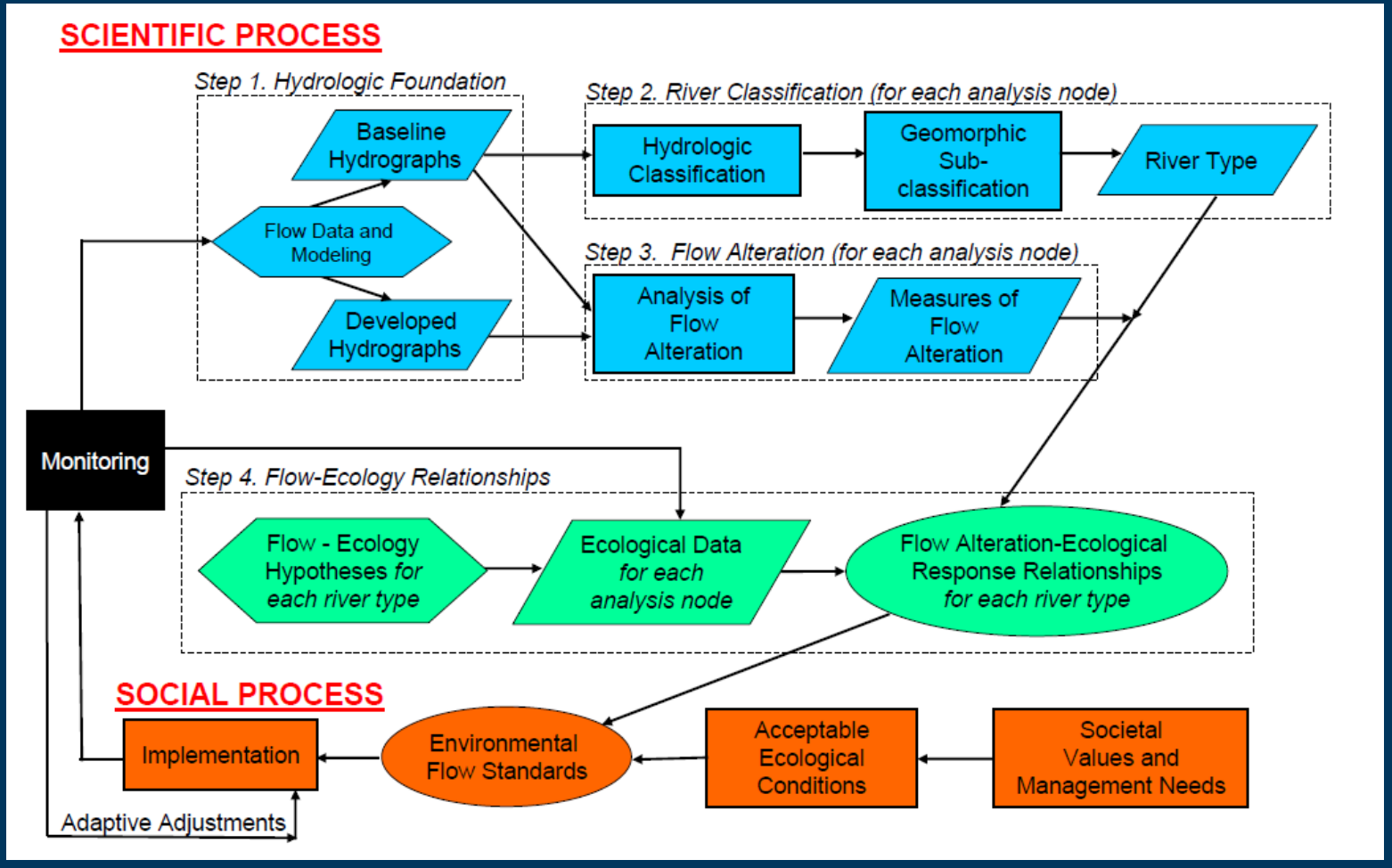
Research Approach

Ecological Limits of Hydrologic Alteration – Poff et al. 2010



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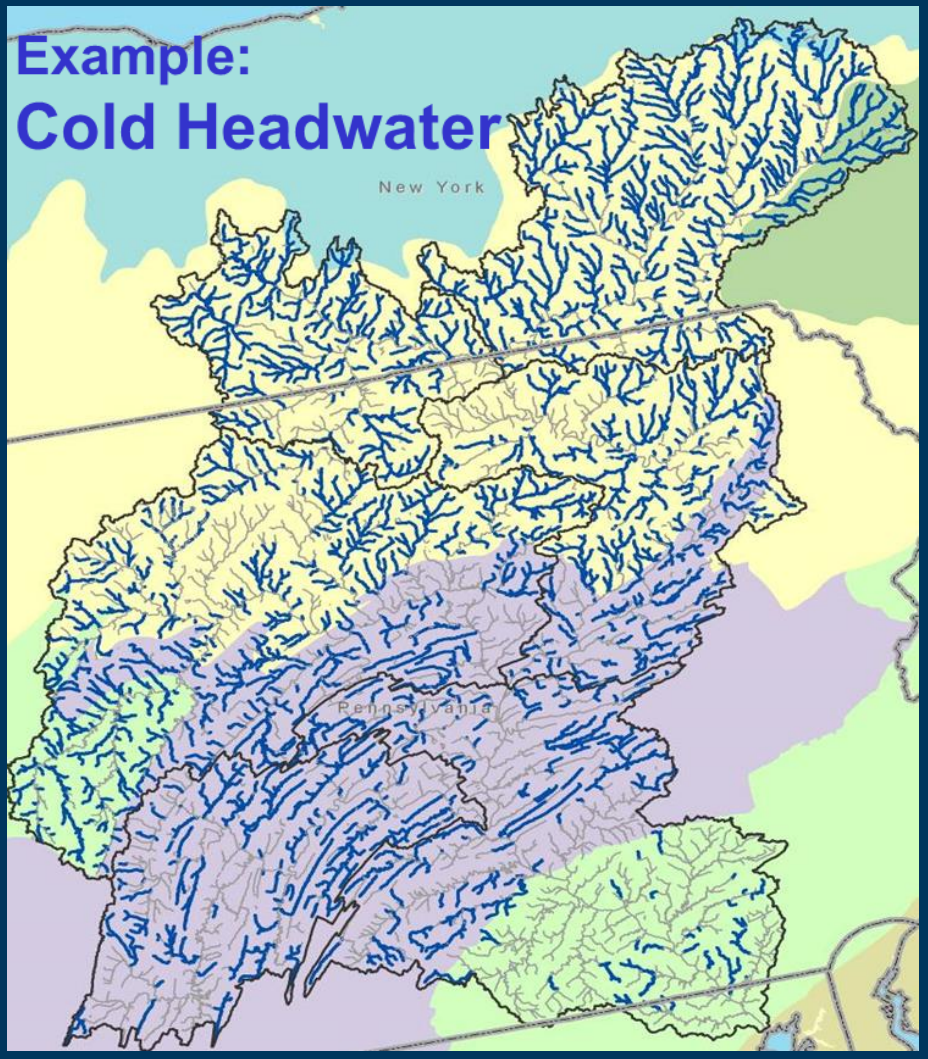
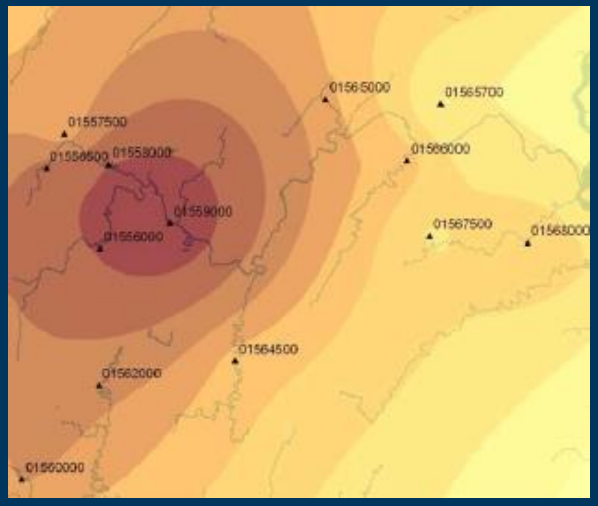


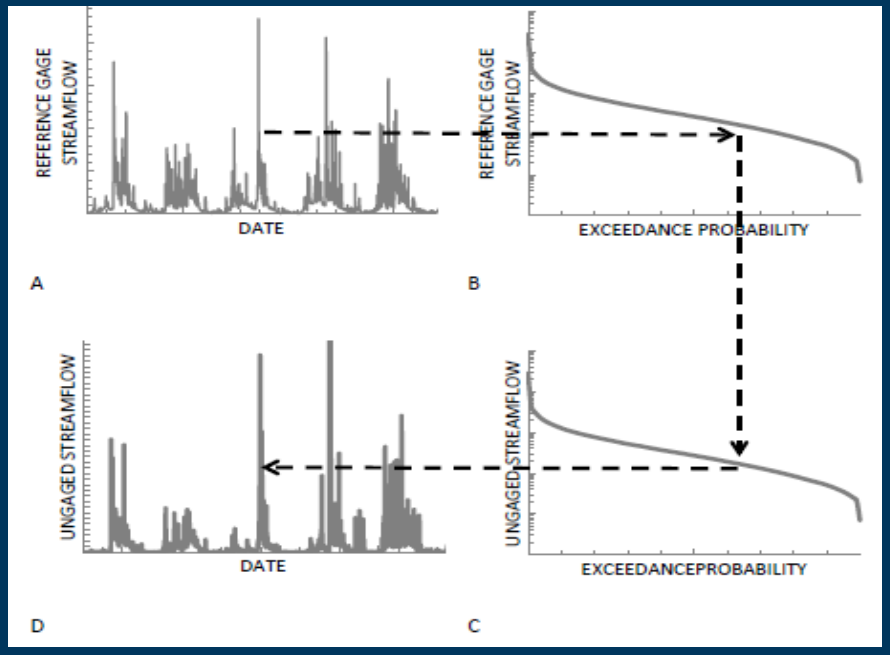
What are the variety of hydro-ecological settings?

Within each setting (type), how do flow conditions affect species and ecological processes throughout the year?

What range of flows would protect these species and ecological processes?

Characterizing hydro-ecological settings





- Minimally altered stream gages
- USGS BaSE tool to estimate daily streamflow at ungaged locations
- TNC's Indicators of Hydrologic Alteration software
  - interannual, annual and monthly statistics
  - magnitude, frequency and duration

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How does the ecosystem depend on flow?

- Represent communities characteristic of basin stream types
- Group species with shared flow-dependencies
- Capture range of traits
  - distribution
  - mobility
  - habitat associations
  - feeding and spawning habits
  - longevity

Snuffbox and host fish (log perch), Chris Barnhart

Eastern Hellbender, The Nature Conservancy

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Flow-sensitive species and processes

Fishes
Cold headwater
Slow spring fed
Riffle-obligates
Riffle-spawners
Nest builders
Potadromous
Great river

Mussels
Mod gradient, small river
Moderate to swift
Slow, low gradient
Great rivers (mainstem)

Reptiles and Amphibians
Aquatic lotic
Semi-aquatic lotic
Riparian and floodplain habitat spp.

Aquatic Insects and Crayfish
Habitat associations
Trophic traits
Species assemblages

Birds and Mammals
Rely on stream-derived food and habitat

Floodplain and Aquatic Vegetation
Submerged and emergent beds
Riparian forest and shrub
Low scour floodplain
Scour-dependent floodplain

Water Quality

Floodplain and Channel Maintenance

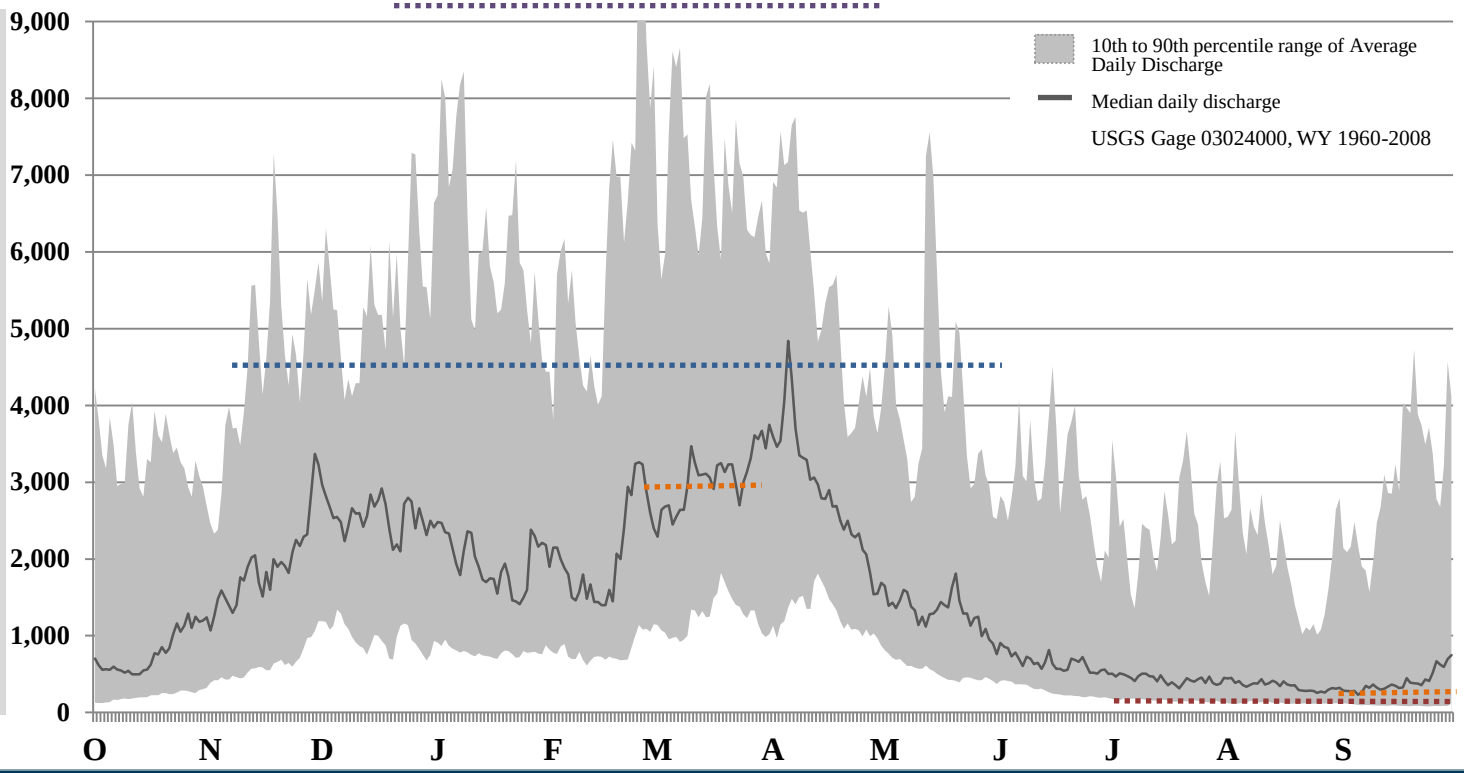
Tributary, warm, glaciated: French Creek at Utica (1,028 sq mi)

Flood (2 yr rec)
12,200 cfs

High Pulse (≥ Q10)
≥ 4,520 cfs

Seasonality (monthly median)
March: 2,890 cfs
Sept: 293 cfs

Low Pulse (≤ Q90)



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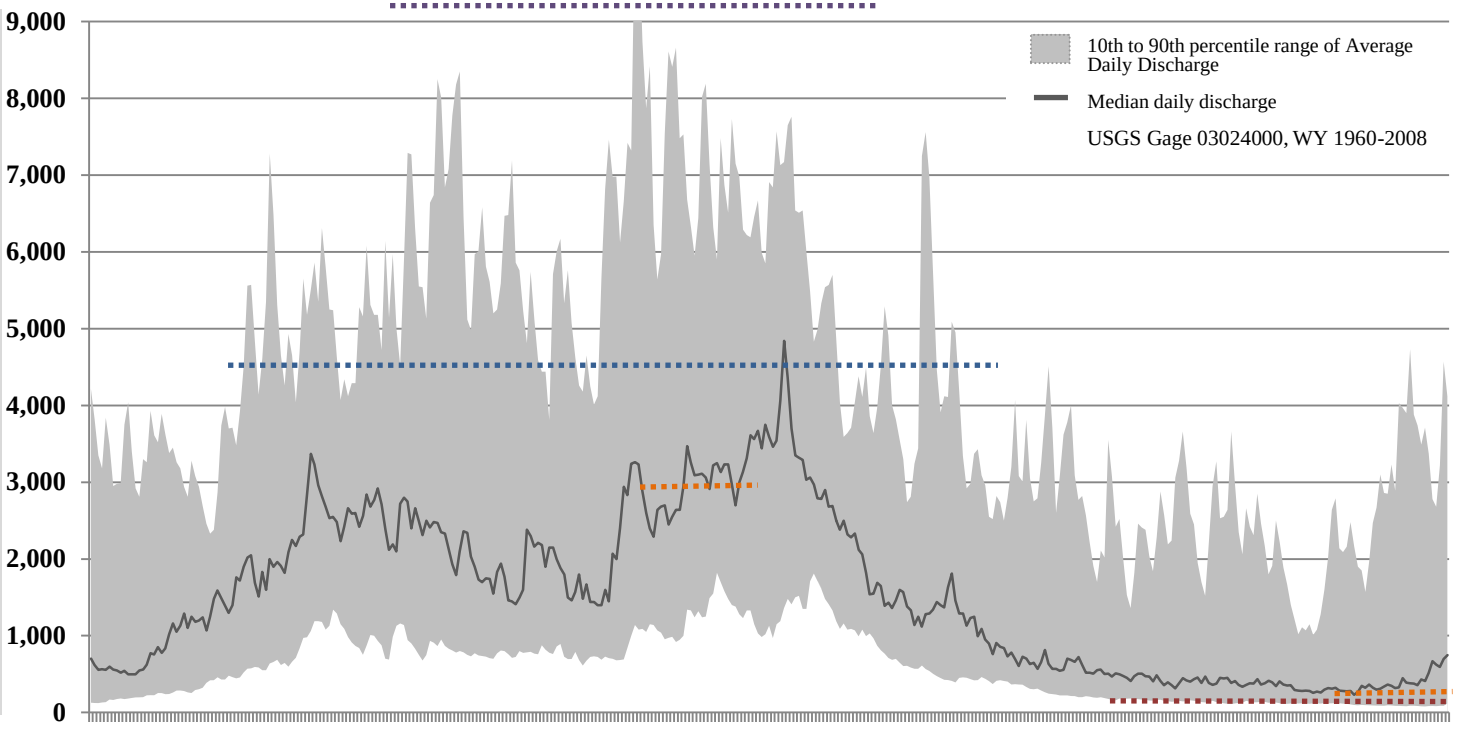
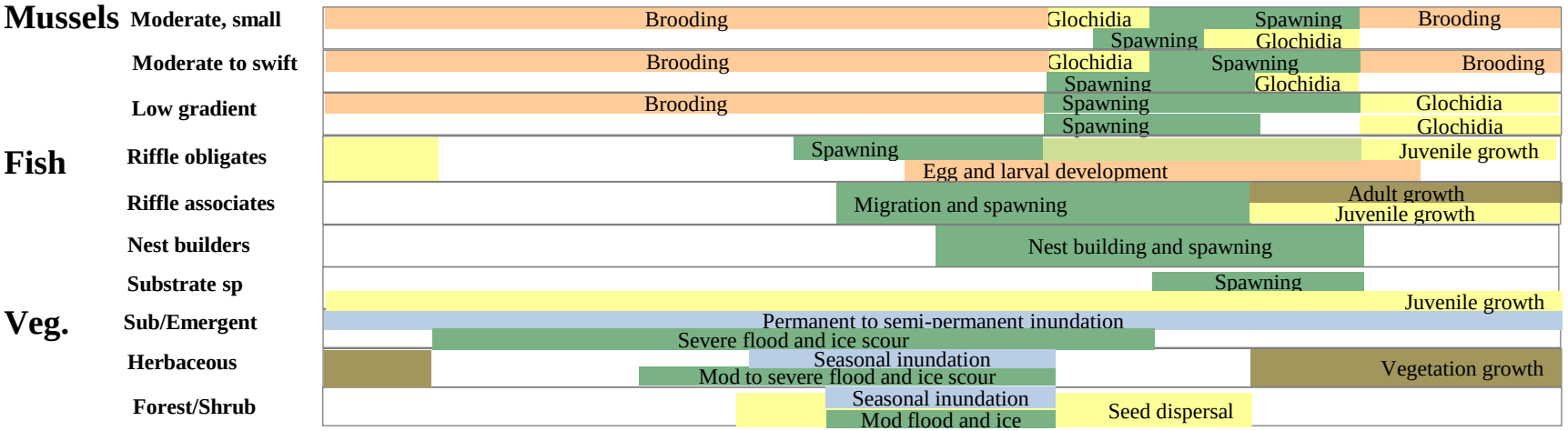
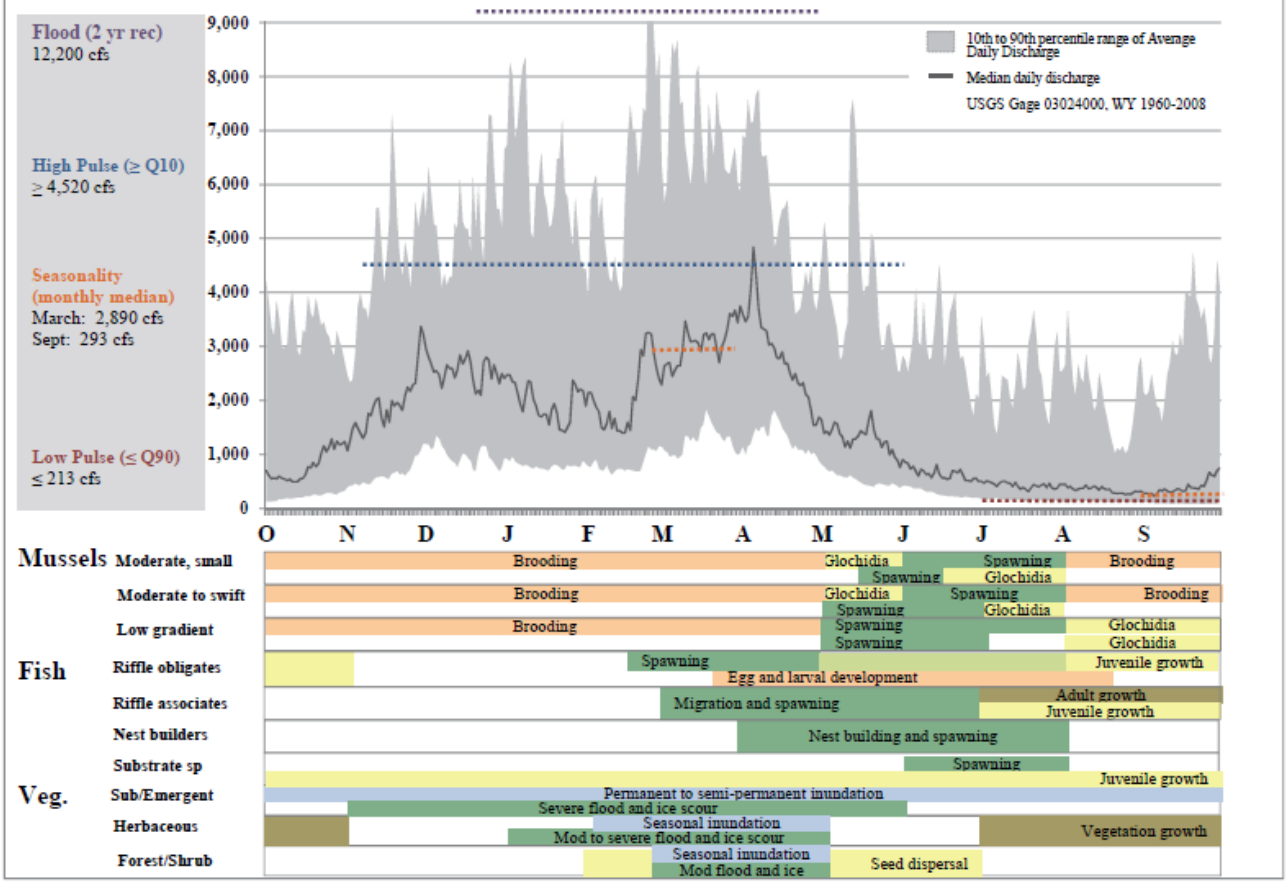




Eighty (80) **FLOW-ECOLOGY HYPOTHESES** describe *who* (species or guild) is affected by *what* (flow component), *when* (month or season), *where* (habitat), and *how* (hypothesized ecological response).



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EXAMPLE FISH HYPOTHESES

H1 • A decrease in seasonal flow magnitude may result in loss of persistent habitats and a shift in fish assemblage.

H2 • A decrease in low flows may reduce access to and abundance of food, including algae and benthic macroinvertebrates, impacting individual growth

Eighty (80) **FLOW-ECOLOGY HYPOTHESES** describe *who* (species or guild) is affected by *what* (flow component), *when* (month or season), *where* (habitat), and *how* (hypothesized ecological response).

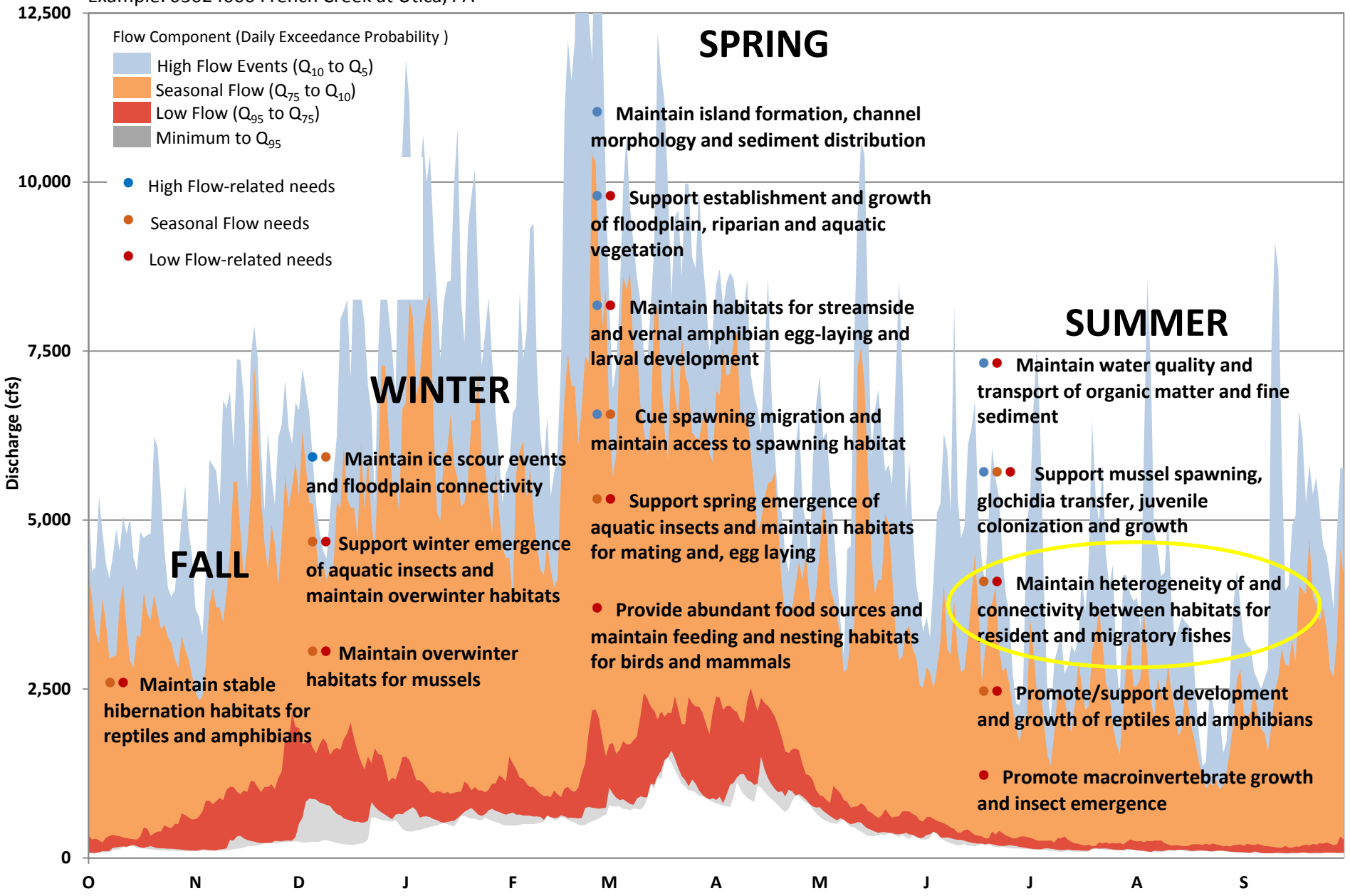
Hypotheses are consolidated into **FLOW NEEDS** (20) and qualitative support for needs is assessed through Weight-of-Evidence.

EXAMPLE FLOW NEED FOR FISH

- ***Maintain heterogeneity of and connectivity between habitats for resident and migratory fishes***

Flow Components and Needs: Glaciated Tributary

Example: 03024000 French Creek at Utica, PA



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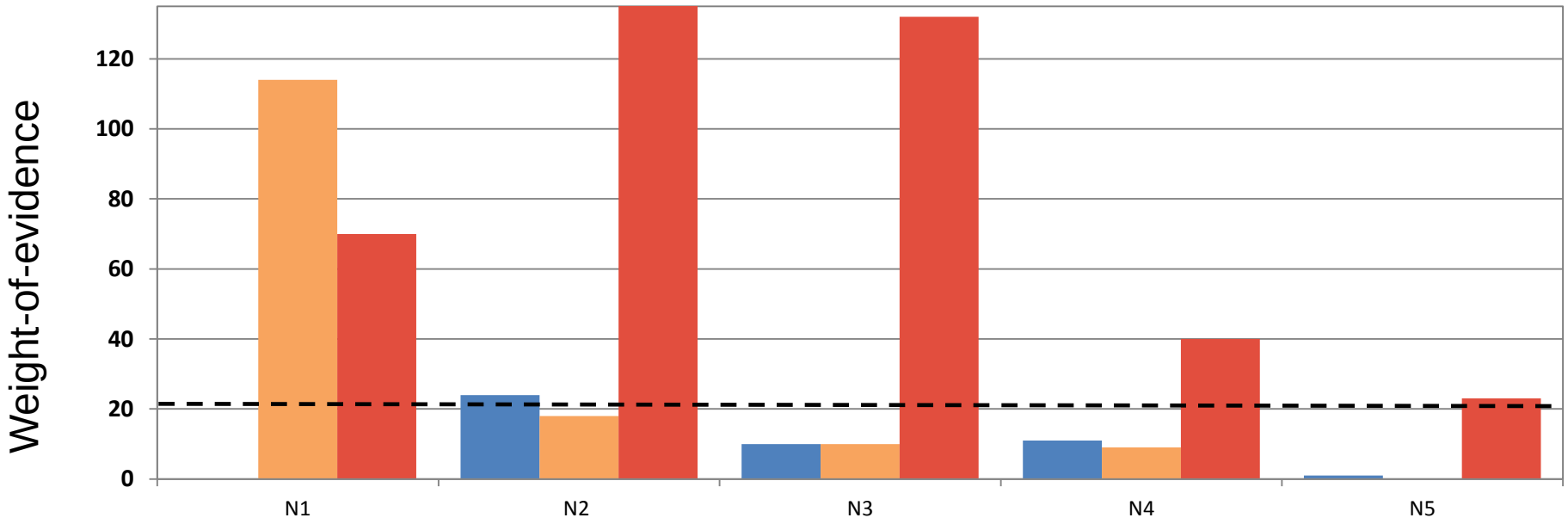
FLOW RECOMMENDATIONS to support FLOW NEEDS defined by:

- **Qualitative and quantitative support assessed with Weight-of-Evidence.**
- **Hydrologic characterization**
- **Expert review and confirmation**

Seasonal flows	• Less than X% change to seasonal flow range **(monthly Q10 to Q50)** • Y% change to **monthly median**; • Z% change to seasonal flow range **(monthly Q50-Q75)**
Low flows	• X% change to **monthly Q75;** and • Y% change to **low flow range (monthly Q75 to Q99)**

Example: Literature Support for Flow Recommendations



N1	N2	N3	N4	N5
Maintain heterogeneity and connectivity of fish habitats	Support mussel spawning, glochidia transfer, juvenile colonization and growth	Promote macroinvertebrate diversity, growth, abundance and emergence	Maintain temperature and water quality	Support development and growth of reptiles and amphibians

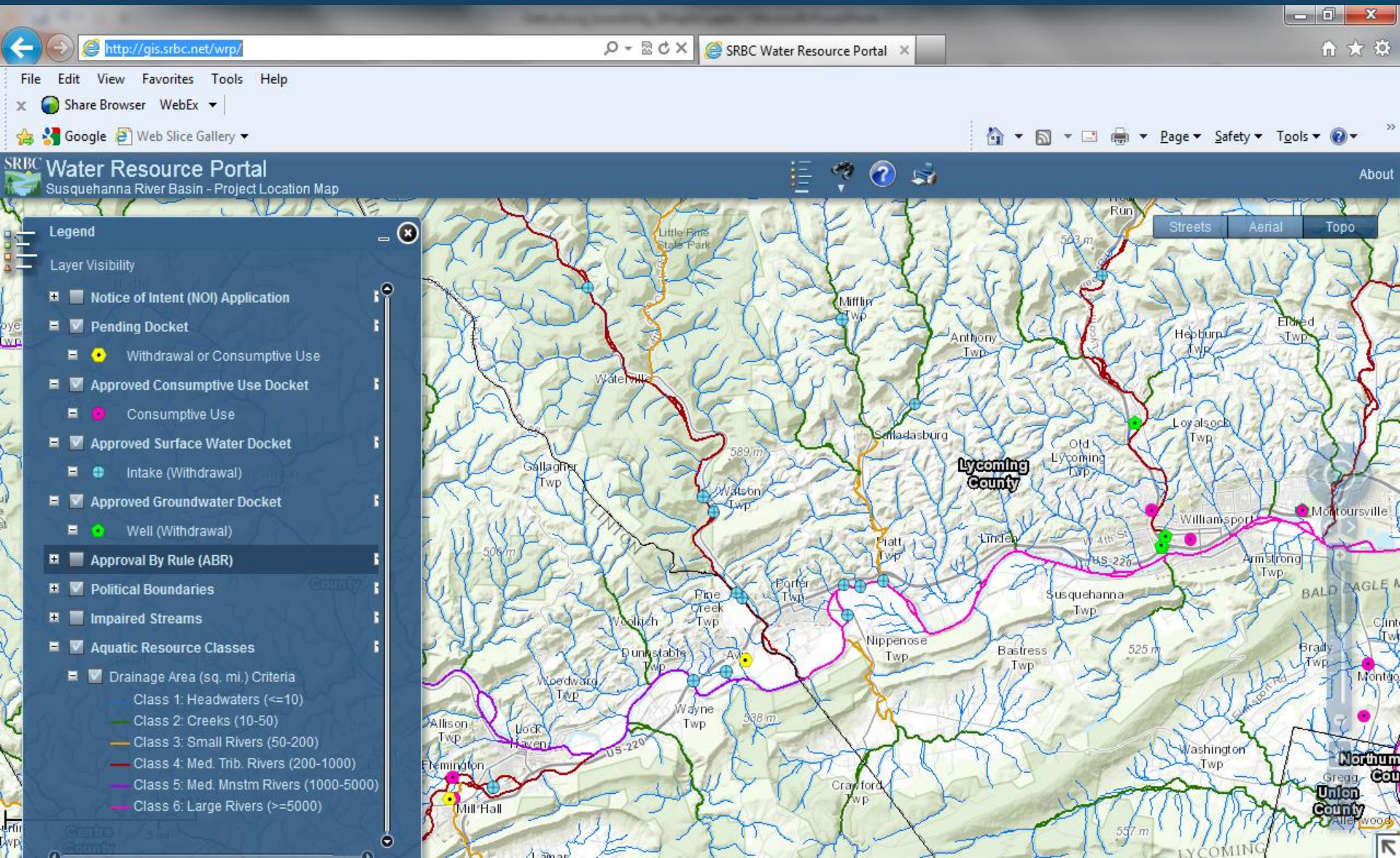
Summer and Fall

Example: Ecosystem Flow Recommendations for the Upper Ohio River Basin

Summary of Flow Recommendations for all Habitat Types – Upper Ohio River Basin

		Summer	Fall	Winter	Spring
High flows	**All habitat types**	Maintain magnitude and frequency of 20-year (large) flood Maintain magnitude and frequency of 5-year (small) flood Maintain magnitude and frequency of bankfull (1 to 2-year) high flow event			
	All habitat types	< 10% change to magnitude of **monthly Q10**			
			Maintain **frequency of high flow pulses > Q10** during fall		Maintain **frequency of high flow pulses** > Q10 during spring
Seasonal flows	**All habitat types**	Less than 20% change to **seasonal flow range (monthly Q10 to Q50)**			
	Headwaters and Creeks	No change to **monthly median** No change to **seasonal flow range (monthly Q50-Q75)**			
	Small Rivers	Less than 10% change to **monthly median** Less than 10% change to **seasonal flow range (monthly Q50-Q75)**			
	Medium Tributaries and Large Rivers	Less than 15% change to **monthly median** Less than 15% change to seasonal **flow range (monthly Q50-Q75)**			
Low flows	Headwaters and Creeks	No change to **monthly Q75** No change to **low flow range (monthly Q75 to Q99)**			
	Small Rivers	Less than 10% change to **low flow range (monthly Q75 to Q99)**			
	and Medium Tributaries and Large Rivers	*Summer and Fall* No change to **monthly Q90**		*Winter and Spring* Less than 10% change to **monthly Q90**	

Support development of an online tool that helps implement the new policy



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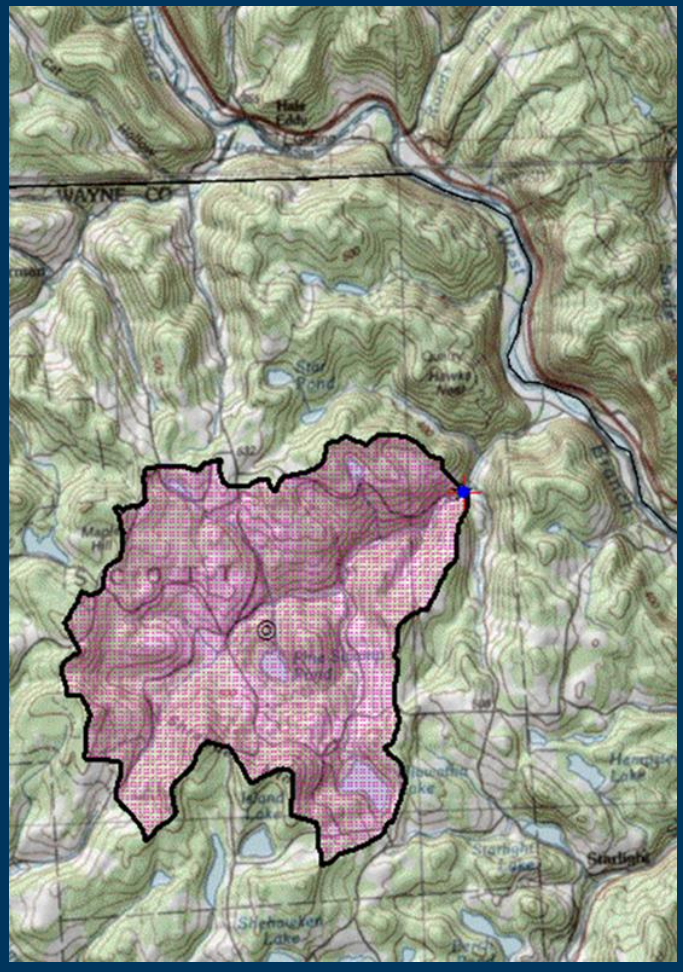
Ongoing Work

- Water withdrawal permitting and reservoir release policies
- SRBC collecting daily use and biological data
- Accounting for limitations in predicting water availability
- Updating Decision Support Tools



Pennsylvania Stream Stats: Watershed boundaries for Ball Creek upstream of simulated withdrawal point (9 sq mi)

Acknowledgements

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National Academy of Sciences

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Thank you

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