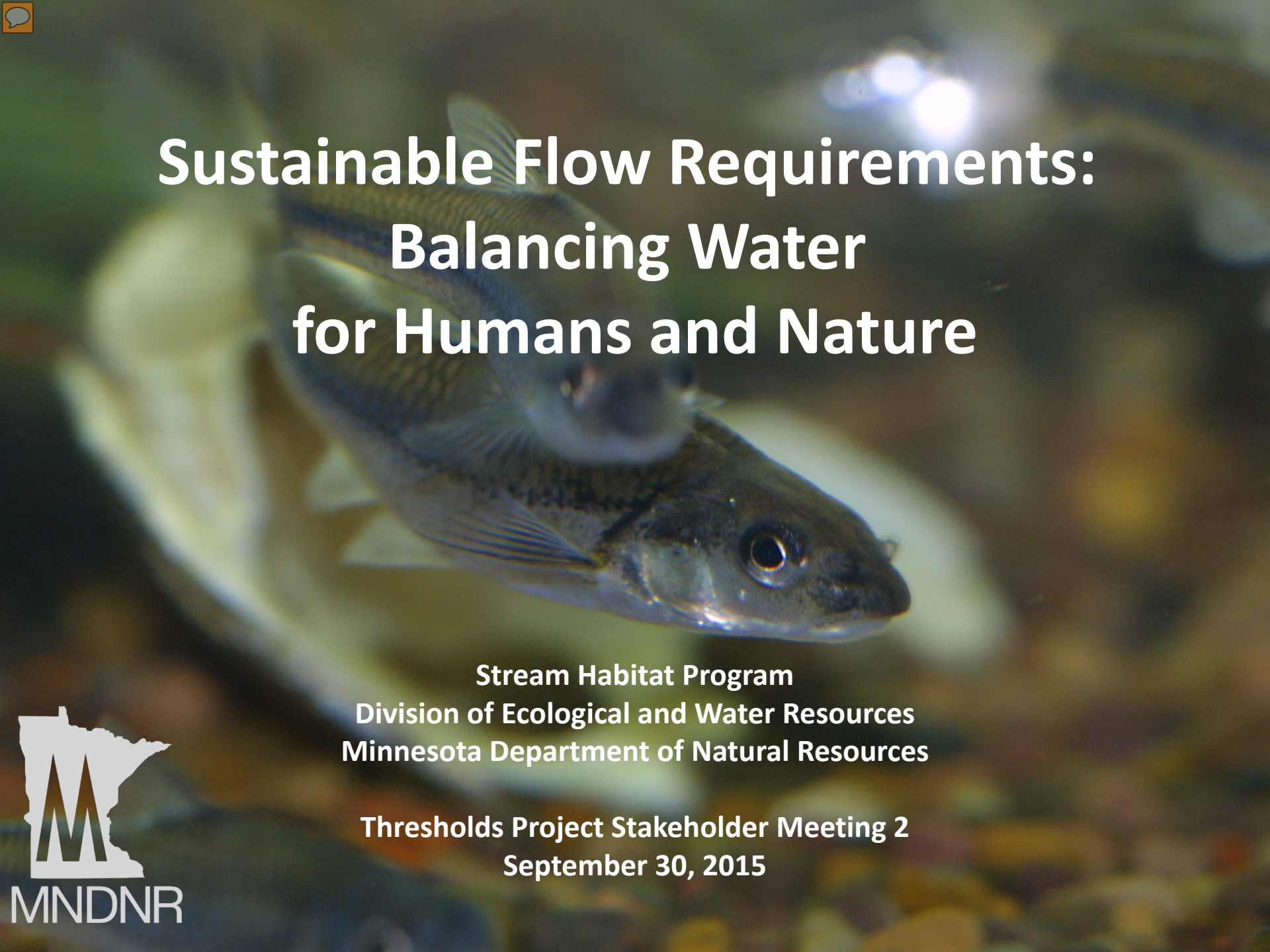


Sustainable Flow Requirements: Balancing Water for Humans and Nature

Stream Habitat Program
Division of Ecological and Water Resources
Minnesota Department of Natural Resources

Thresholds Project Stakeholder Meeting 2
September 30, 2015

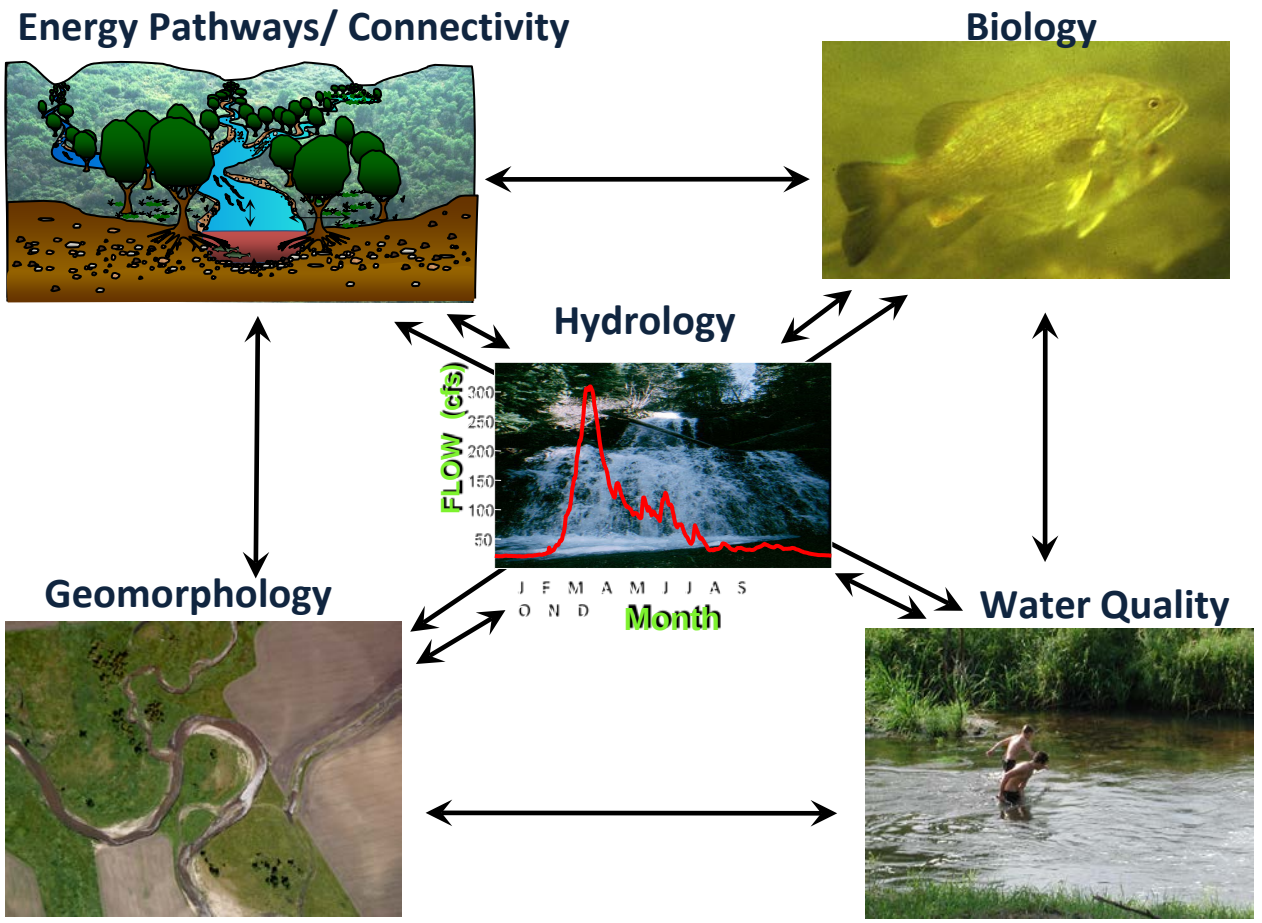
MNDNR

General Outline

- Ecological Principles (4)
- Our Charge and Rationale
- Thresholds
- Management Approach and Supporting Information

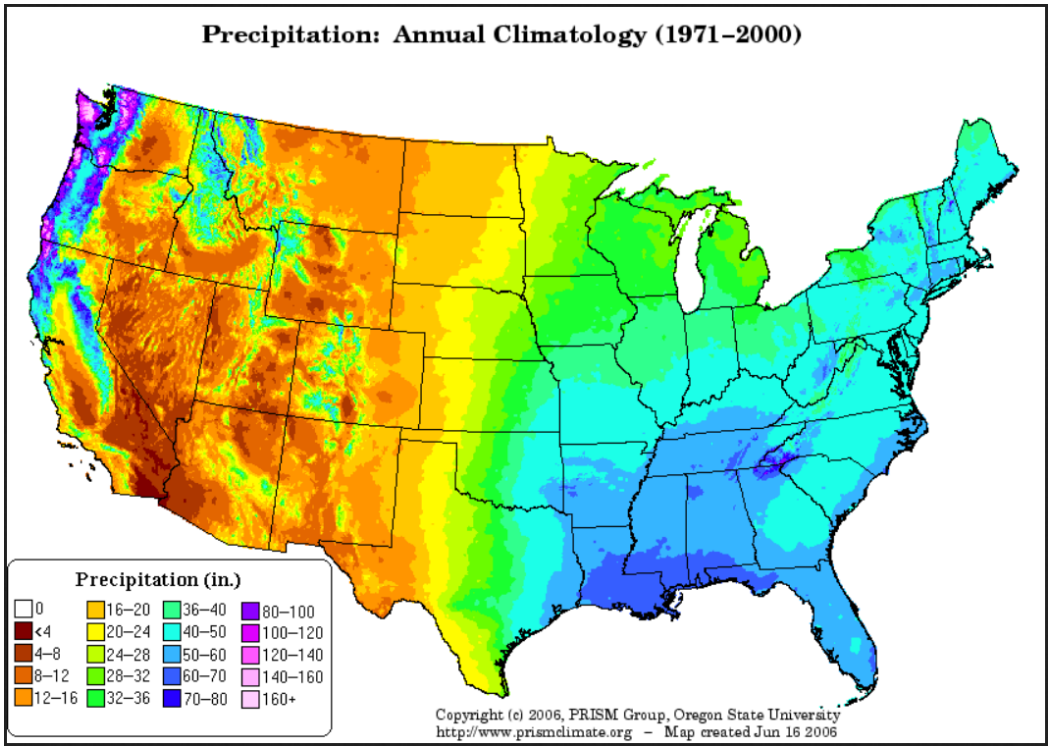
Principles:

1. Hydrology drives ecosystems;



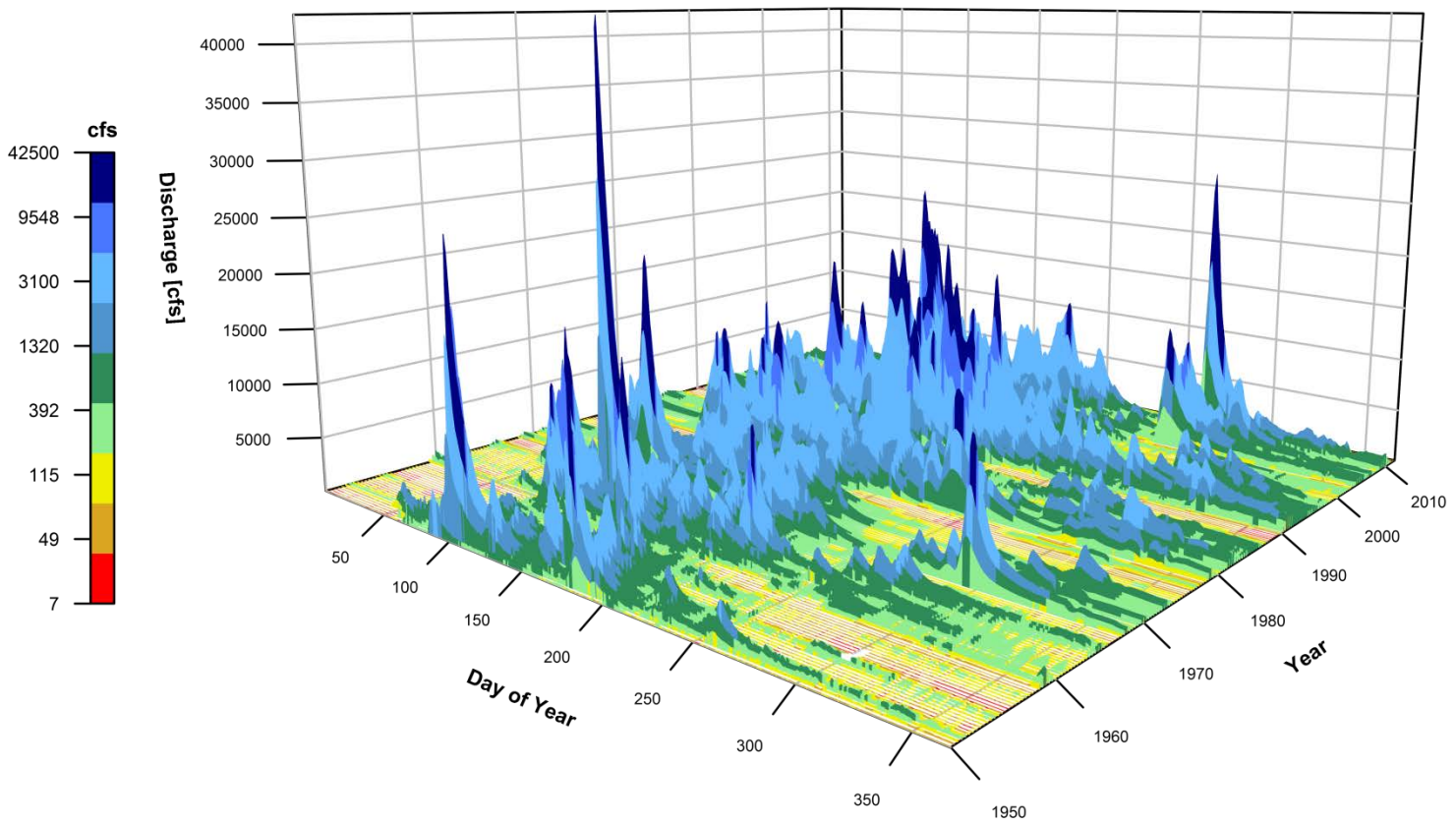
Principles:

2. Water is naturally variable in space and time (& limited);



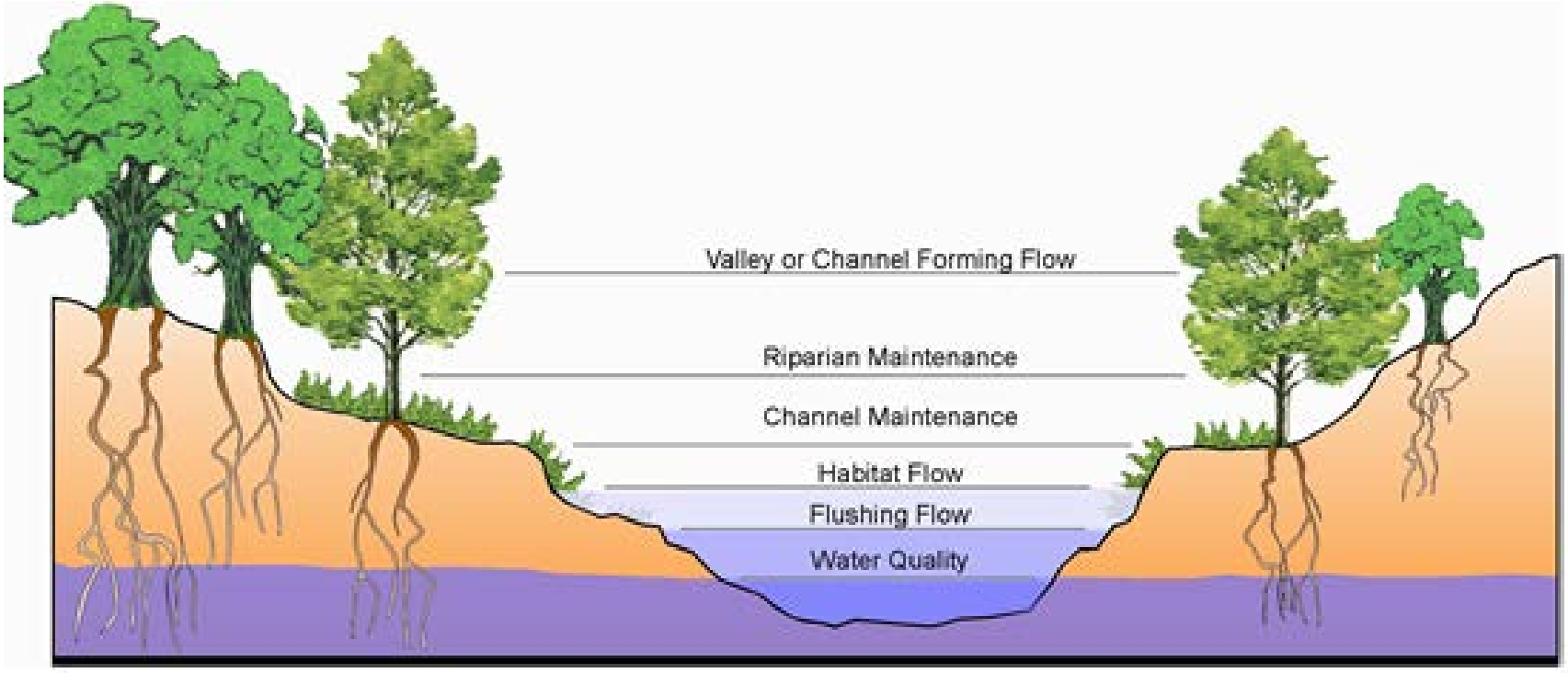
BLUE EARTH RIVER NEAR RAPIDAN, MN

Hydrology is variable within a year, and across years



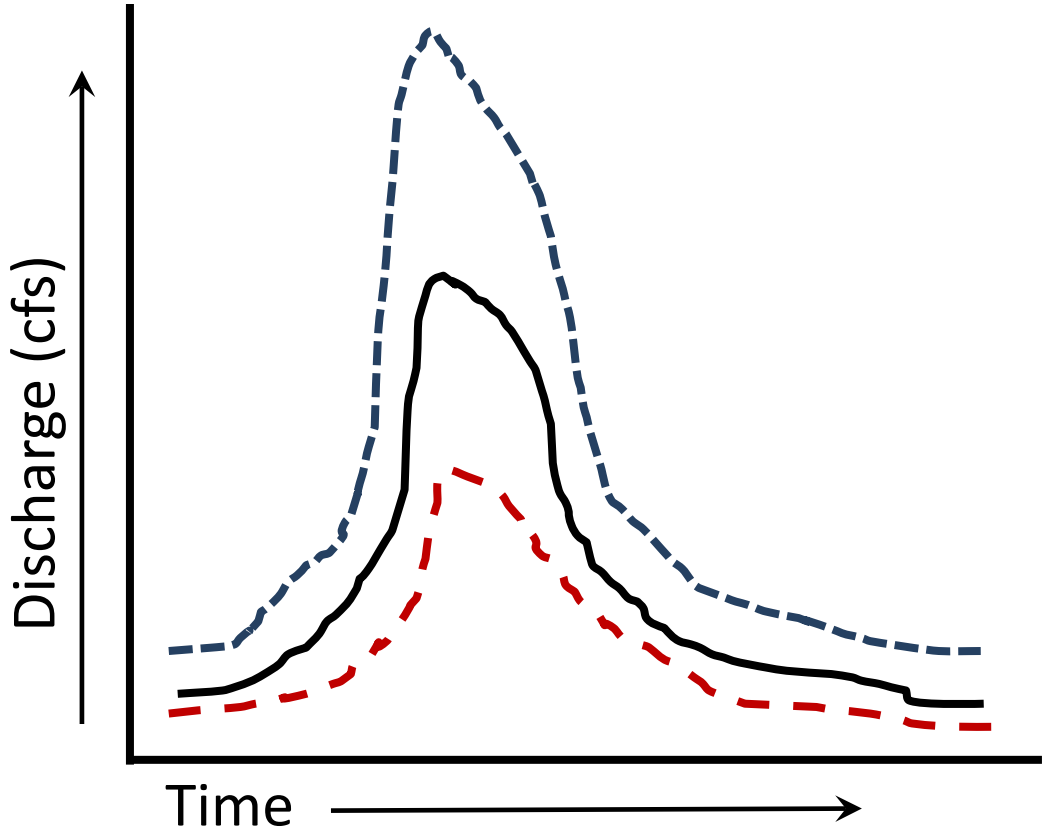
Principles:

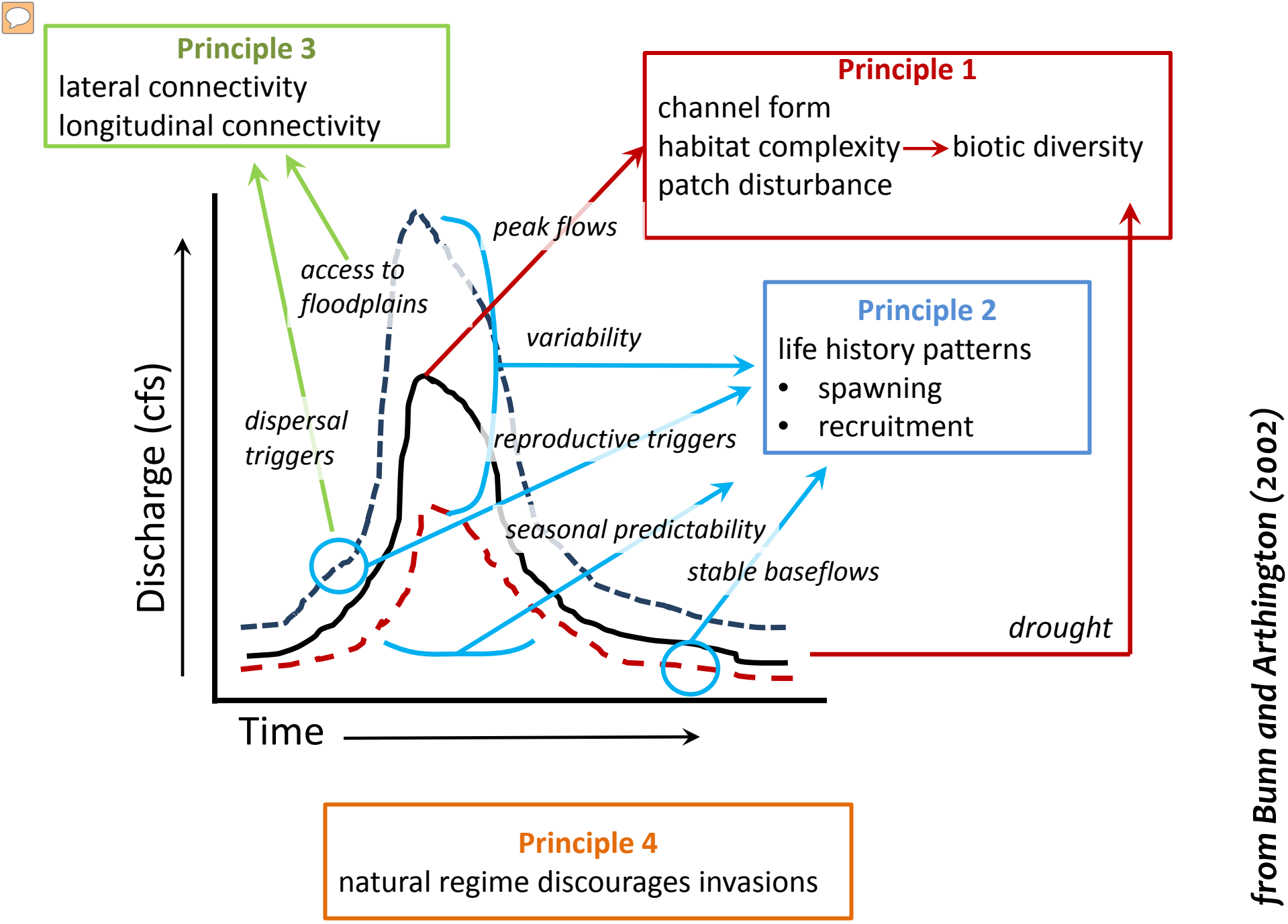
3. All parts of the hydrograph are functionally important;



Hill et al. (1995)

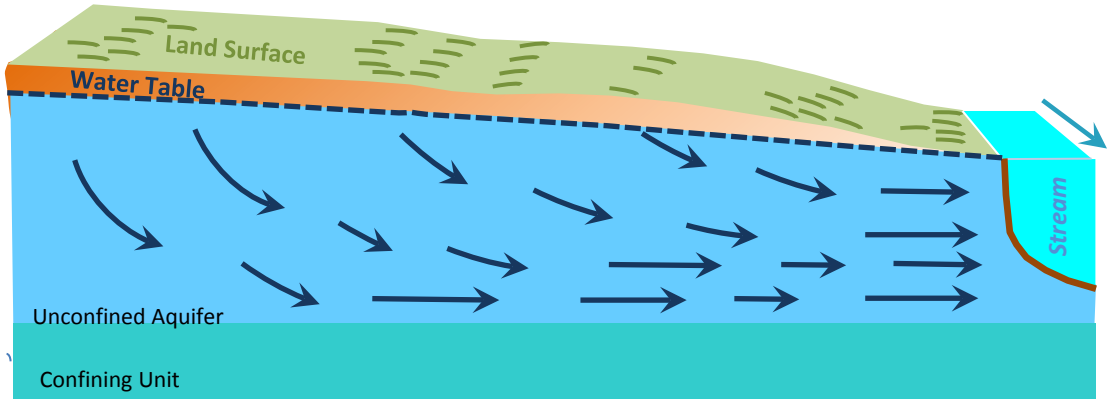
Important Links of Hydrologic Variability to Biology

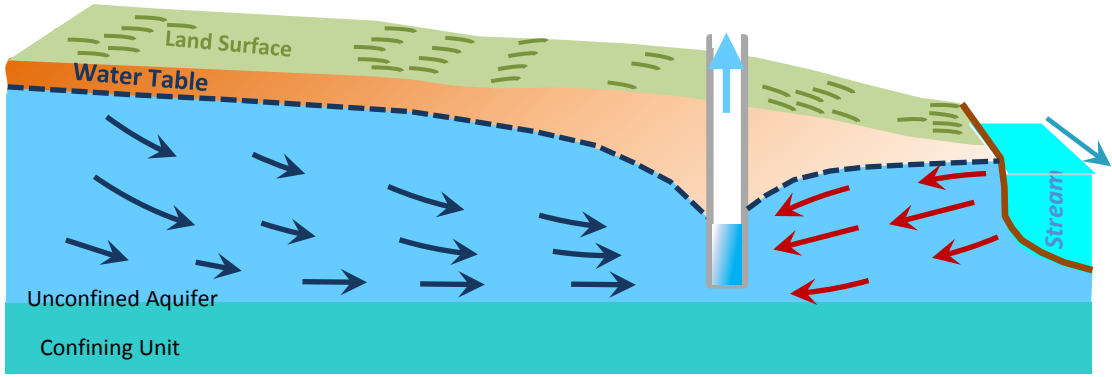



Principle 3
lateral connectivity
longitudinal connectivity
Principle 1
channel form
habitat complexity → biotic diversity
patch disturbance
Principle 2
life history patterns
• spawning
• recruitment
peak flows
access to floodplains
variability
dispersal triggers
reproductive triggers
seasonal predictability
stable baseflows
drought
Discharge (cfs)
Time
Principle 4
natural regime discourages invasions
from Bunn and Arthington (2002)

Principles:

4. Surface water and Groundwater are connected – a single resource.





Our Charge and Rationale:

1. Sustainability accounts for ecosystems and future generations,

2. Identifying a threshold for ecological health/sustainability is a key task,

3. Management prescriptions are developed to maintain the threshold and thereby, ecosystem health and sustainability.

Our Charge and Rationale:

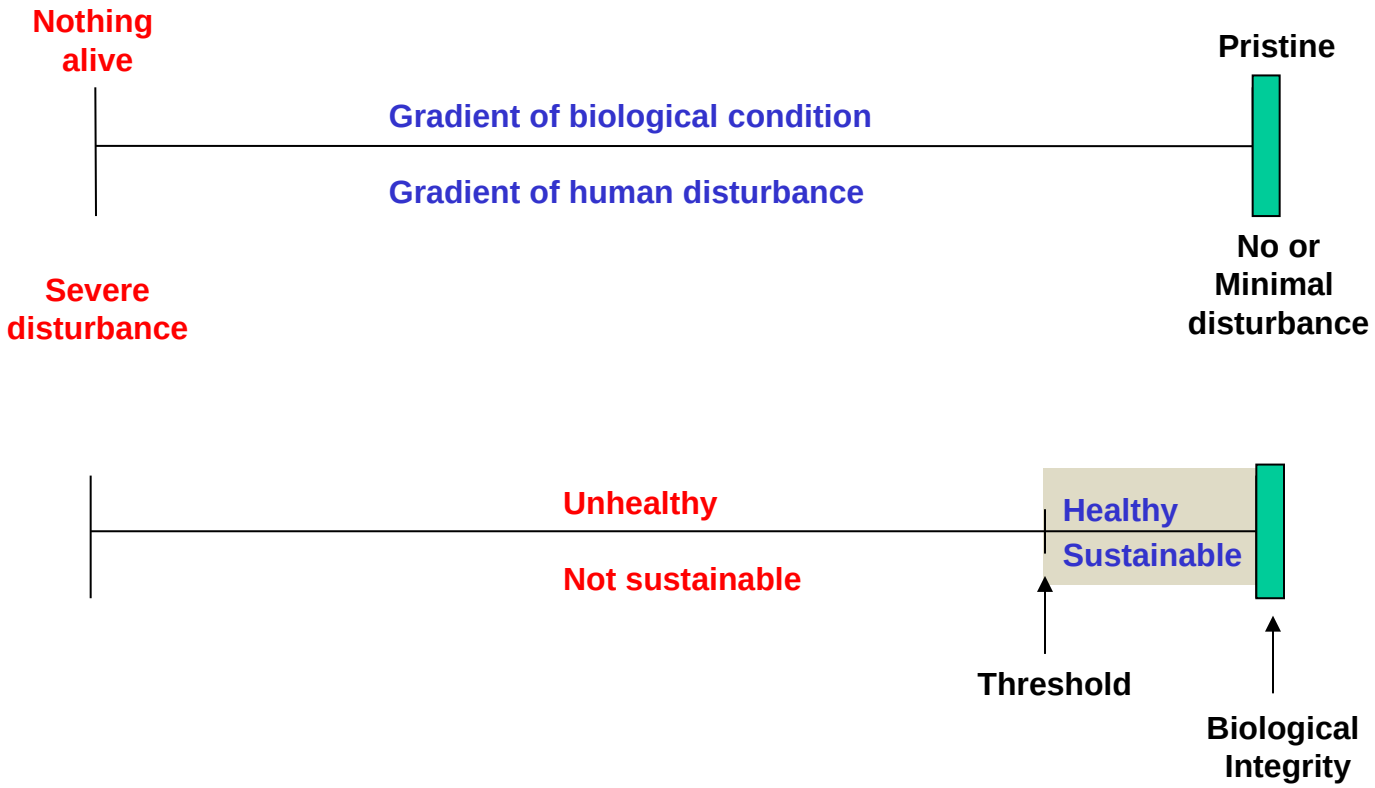
1. Sustainability accounts for ecosystems and future generations

- **Sustainability standard**: " . . . use is sustainable to **supply the needs of future generations** and the proposed use **will not harm ecosystems**, degrade water, or reduce water levels beyond the reach of public water supply and private domestic wells . . ." *MN Statute 103G.287 Subd.5.* (2014)

MN Statutes	Headnotes
116B.01 and .02.	❖ Environmental rights; no adverse impairment **1.**
103G.265. Subdivision 1.	❖ Assurance of supply; to meet long range seasonal requirements **2.**
103G.271. Subdivision 3.	❖ **No restriction of amount authorized in a permit for agricultural land**
103G.285. Subdivision 2.	❖ Surface water appropriations; limits appropriations during periods of specified low flows **3.**
103G.287. Subdivision 2.	❖ Groundwater appropriations; relationship to surface water resources **4.**
103G.287. Subdivision 3.	❖ Protection of groundwater supplies **4.**
103G.287. Subdivision 5.	❖ **Sustainability standard**

Our Charge and Rationale:

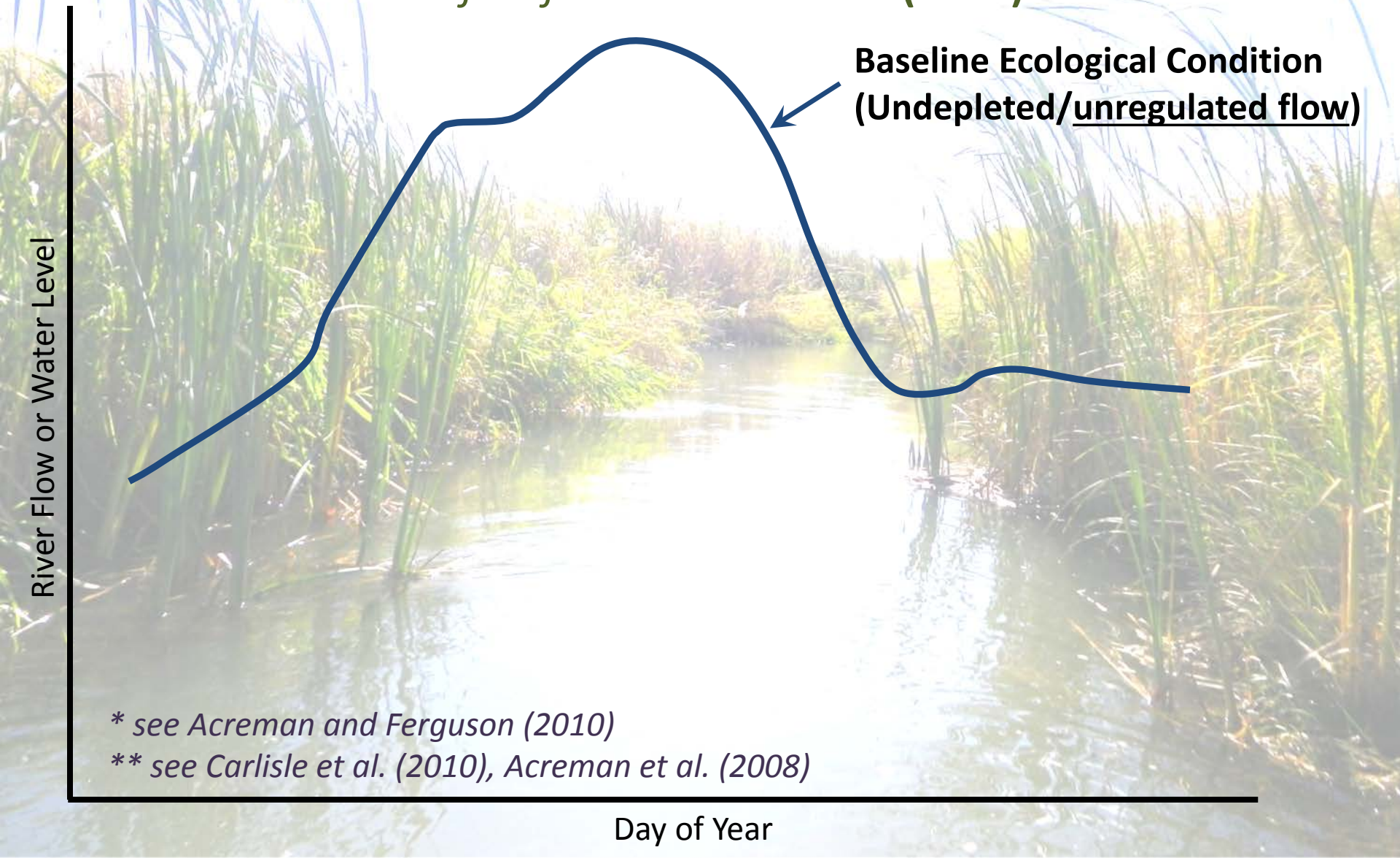
2. Identifying a **threshold for ecological health/sustainability** is a key task



(*adapted from* Karr and Chu 1999).

Illustration of the Sustainable Ecosystem Boundary and Thresholds for Depletion Limits

modified from **Richter et al. (2011)**



** see Acreman and Ferguson (2010)*

*** see Carlisle et al. (2010), Acreman et al. (2008)*

Illustration of the Sustainable Ecosystem Boundary and Thresholds for Depletion Limits

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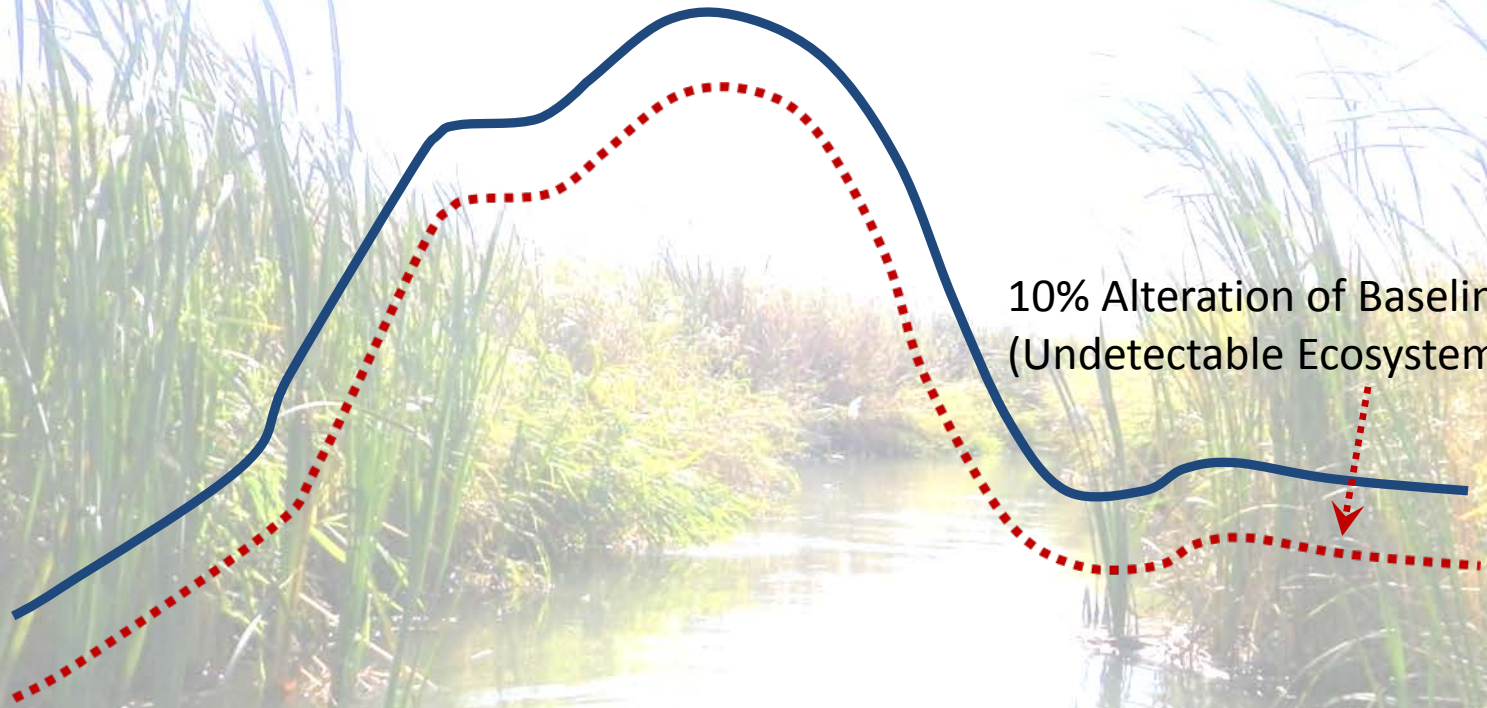

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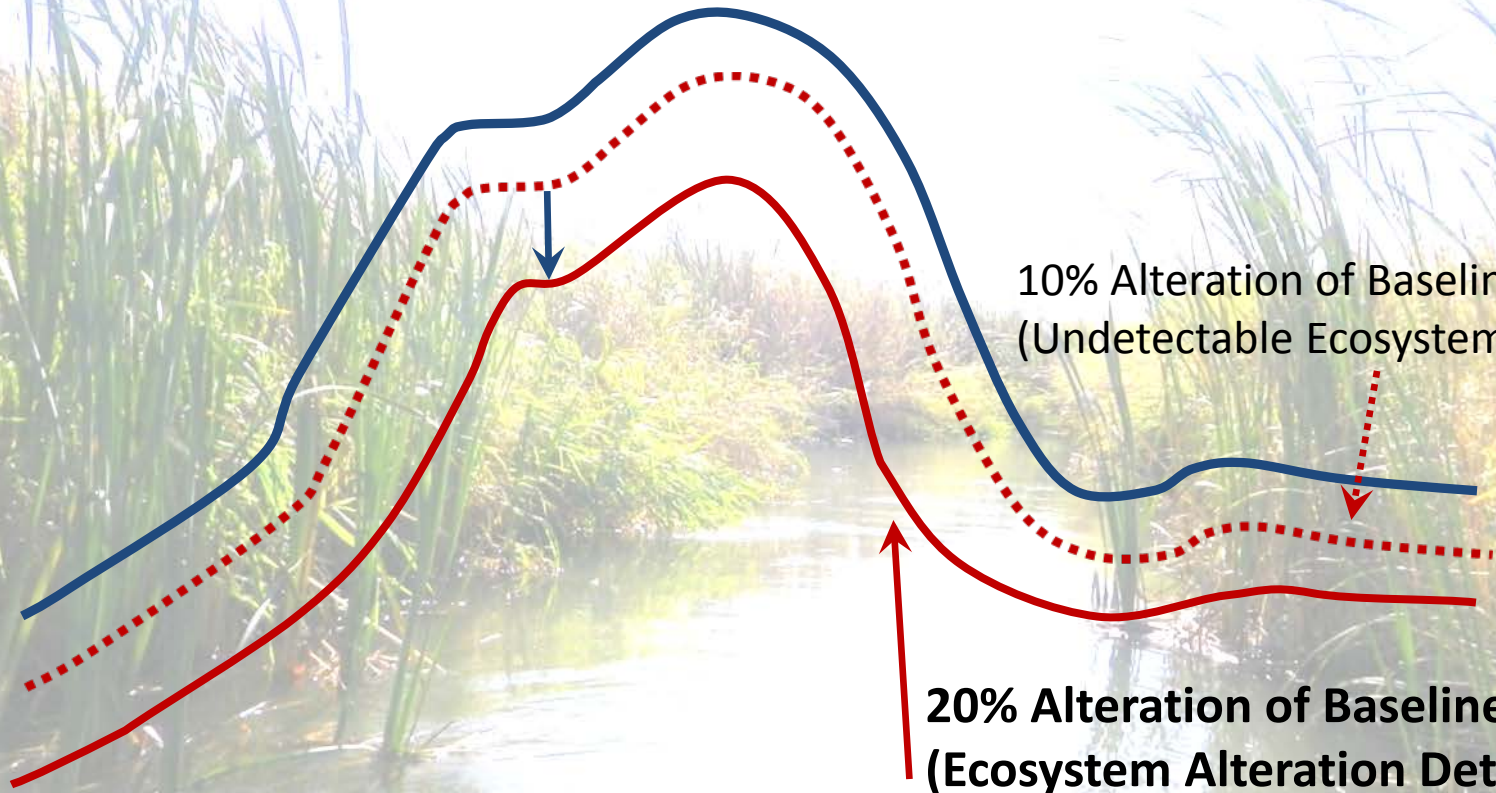

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Illustration of the Sustainable Ecosystem Boundary and Thresholds for Depletion Limits

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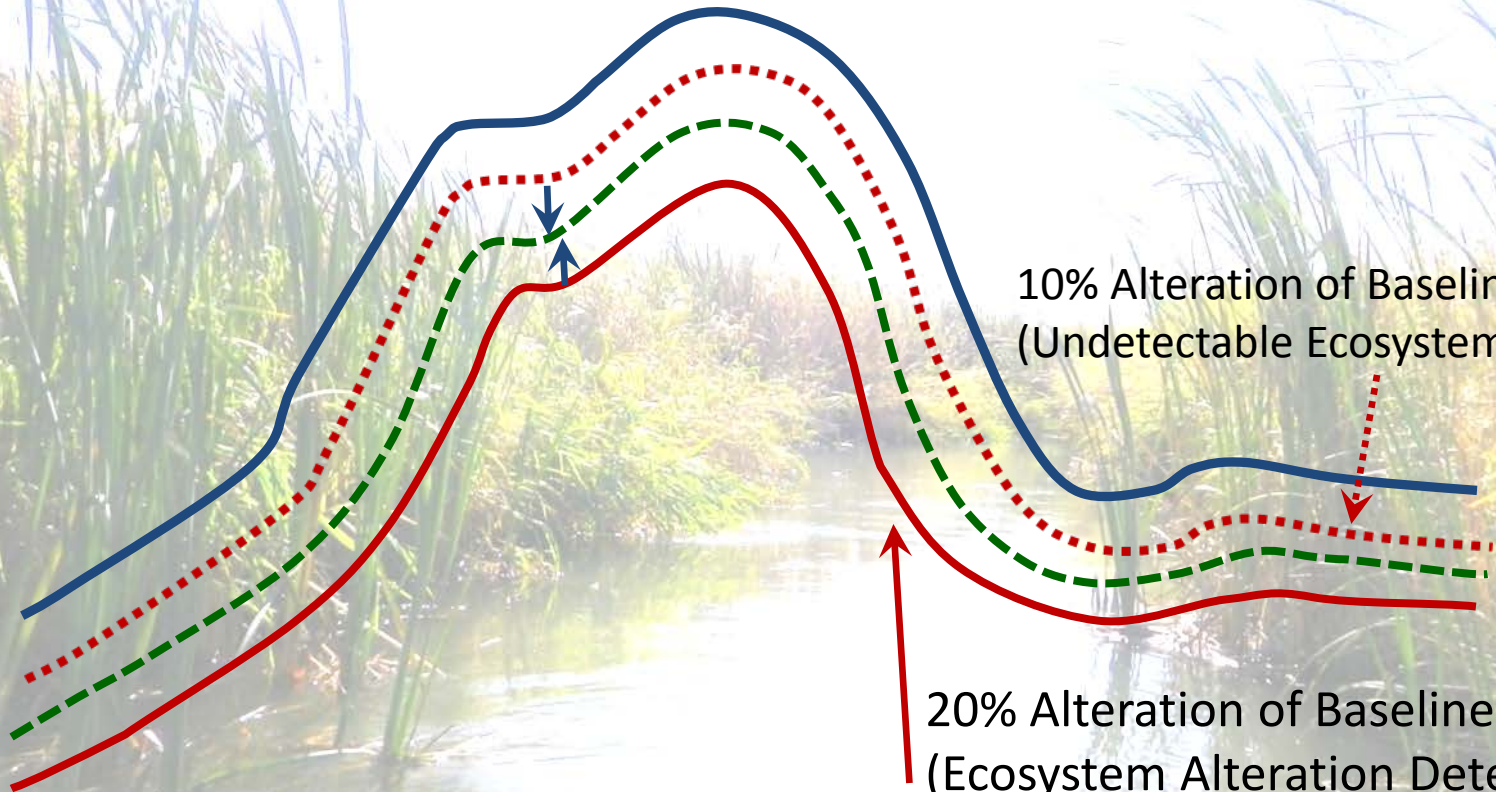


** see Acreman and Ferguson (2010)*

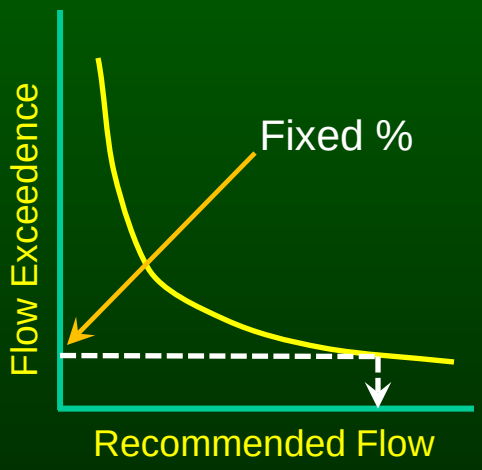
*** see Carlisle et al. (2010), Acreman et al. (2008)*

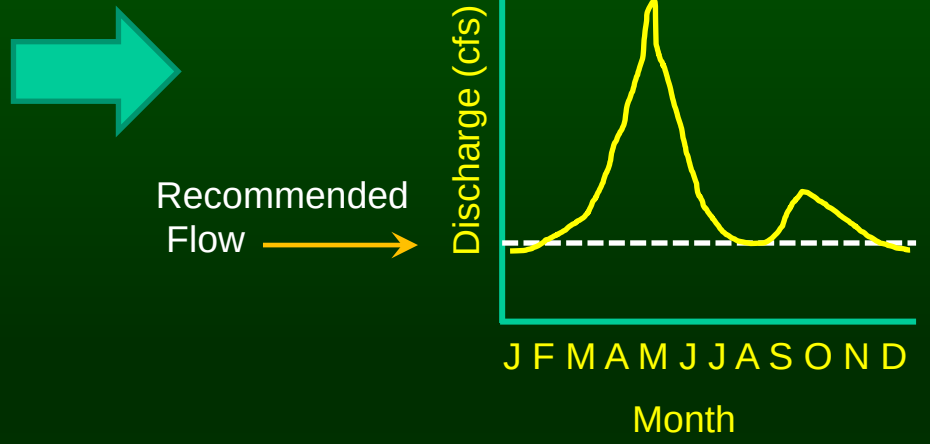
Our Charge and Rationale:

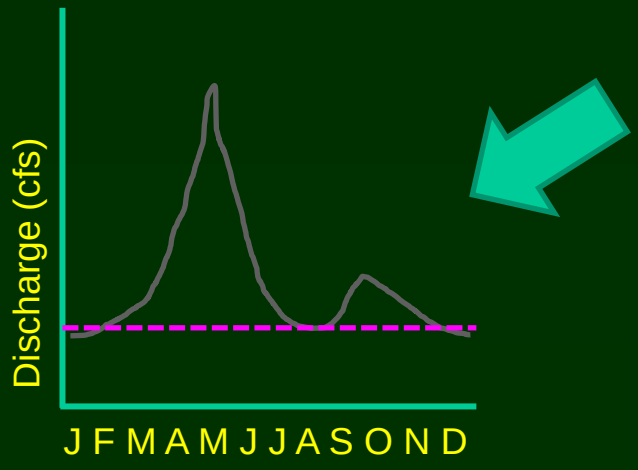
3. **Management prescriptions** are developed to maintain the threshold and thereby, ecosystem health

Management prescriptions: essentially, what hydrology will maintain the desired state of ecosystem health?

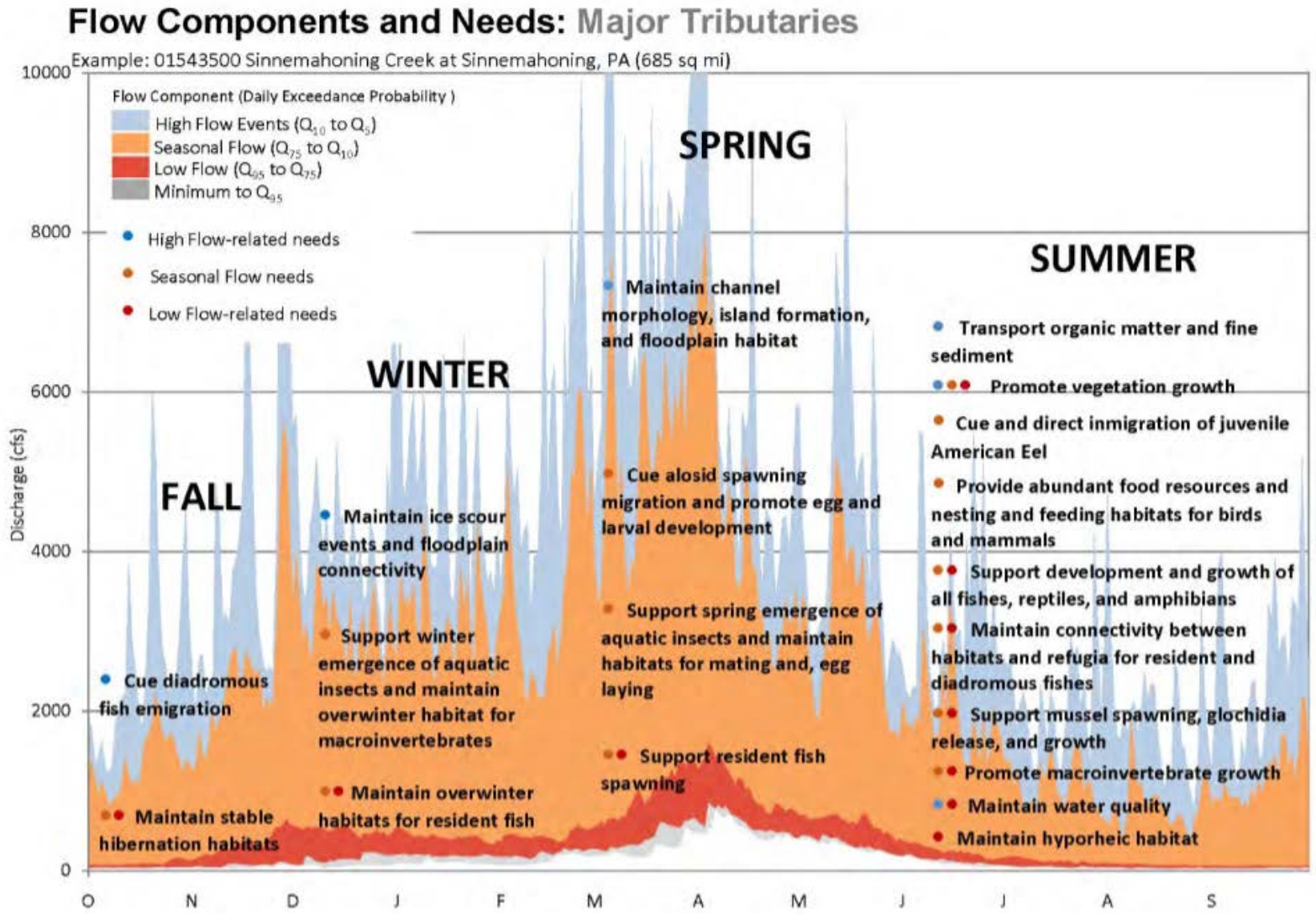
Minimum Flow Thresholds







Statistically Based Standards



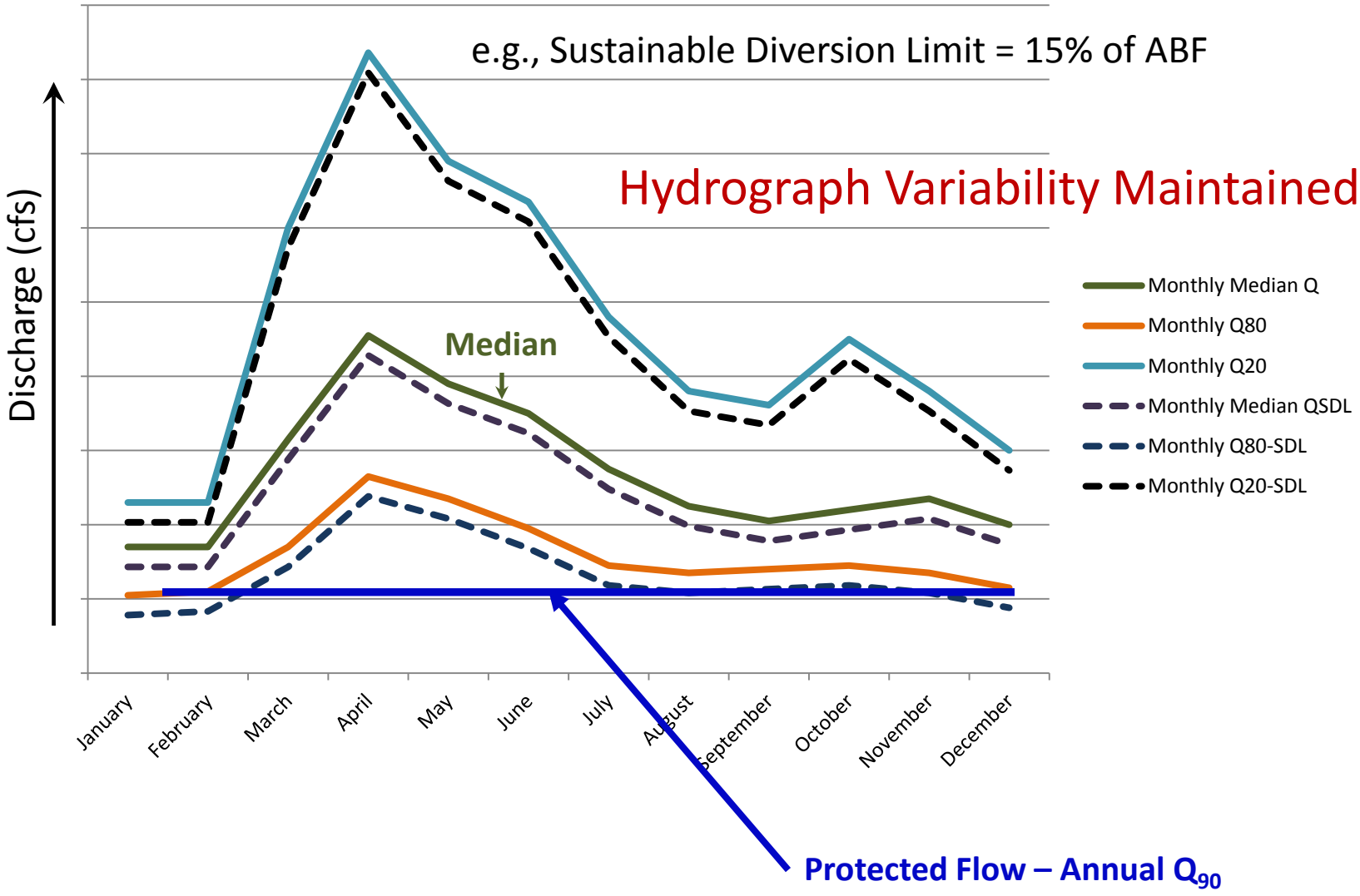
Susquehanna River Basin Ecological Flow Management Study, Phase 1: example of flow needs associated with high, seasonal, and low flows in major tributaries.

Percentage of Flow

- Conceptually simple
- Can provide a high degree of protection for natural flow variability
- Relatively simple to implement

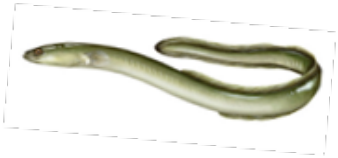
from Richter et al. (2011)

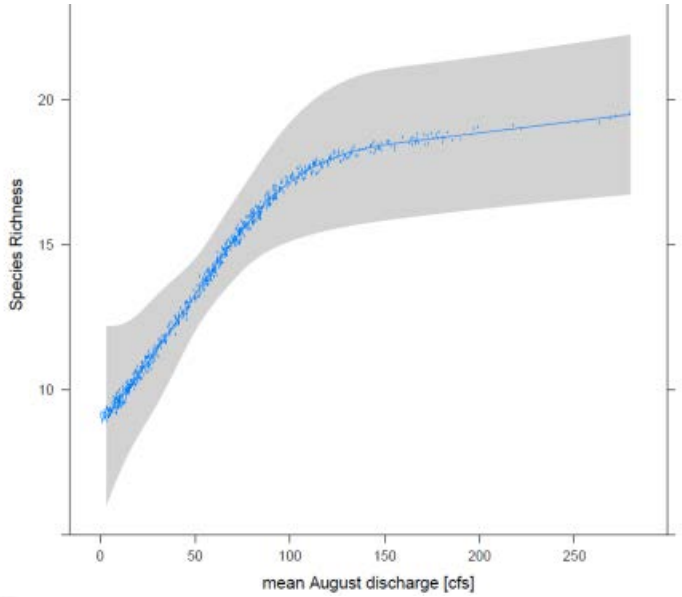
Illustration of Percentage of Flow Approach

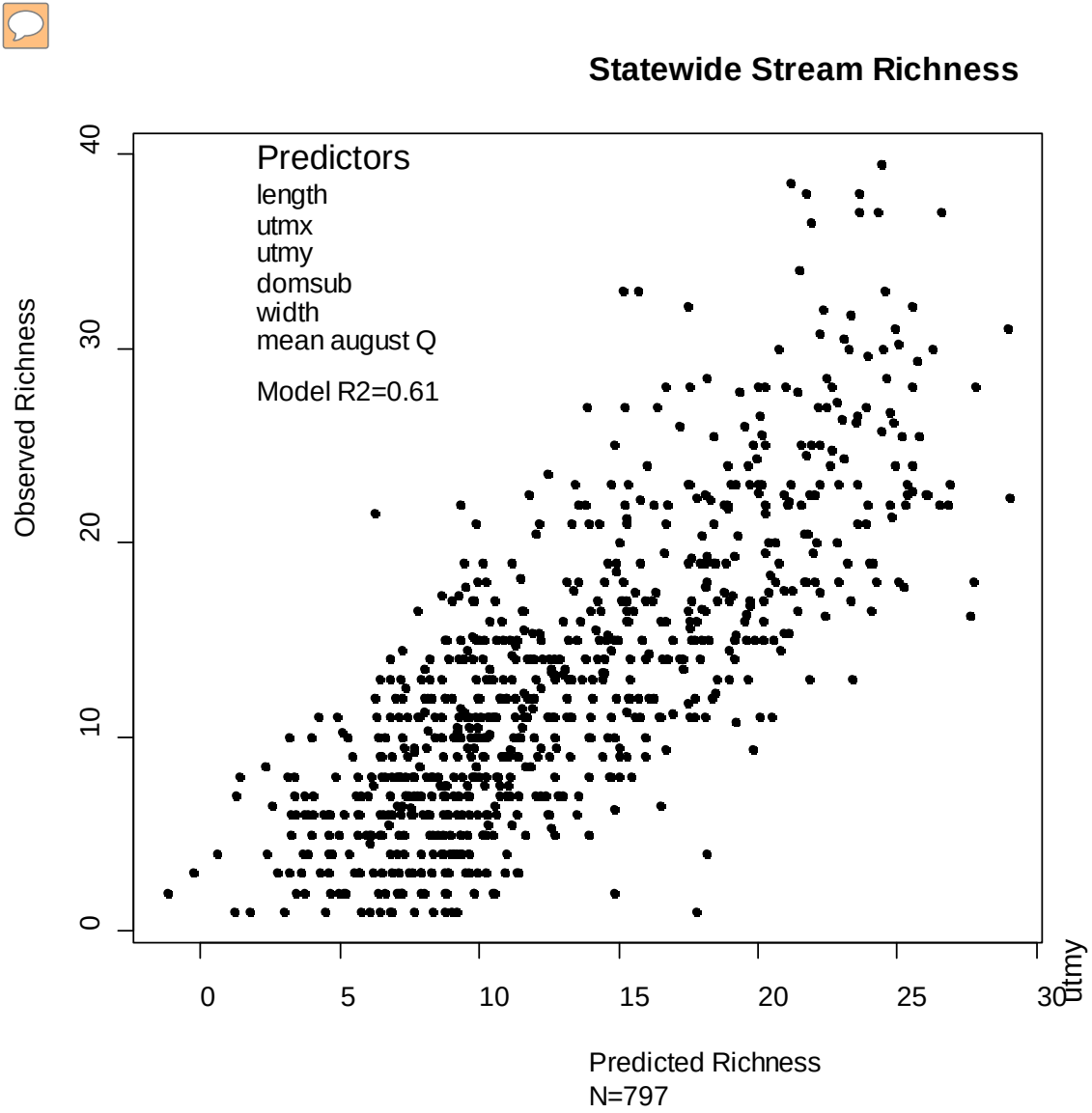


Percent of what flow? August

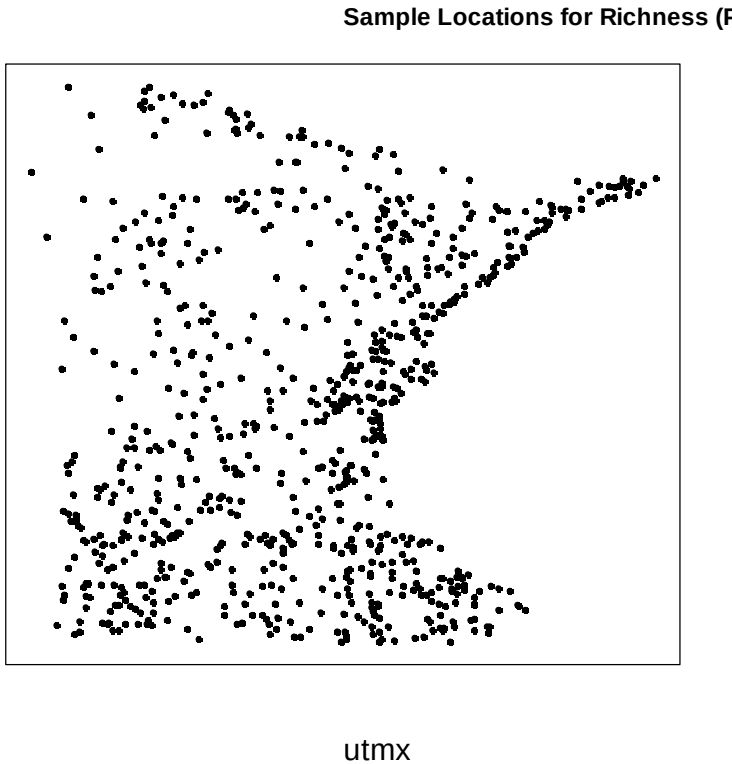
- August is a biologically critical month in Minnesota;
  - low flow month
  - part of growing season (June-Sept)
  - determinant of species richness







Richness (number) of fish species is predicted by habitat conditions and discharge.



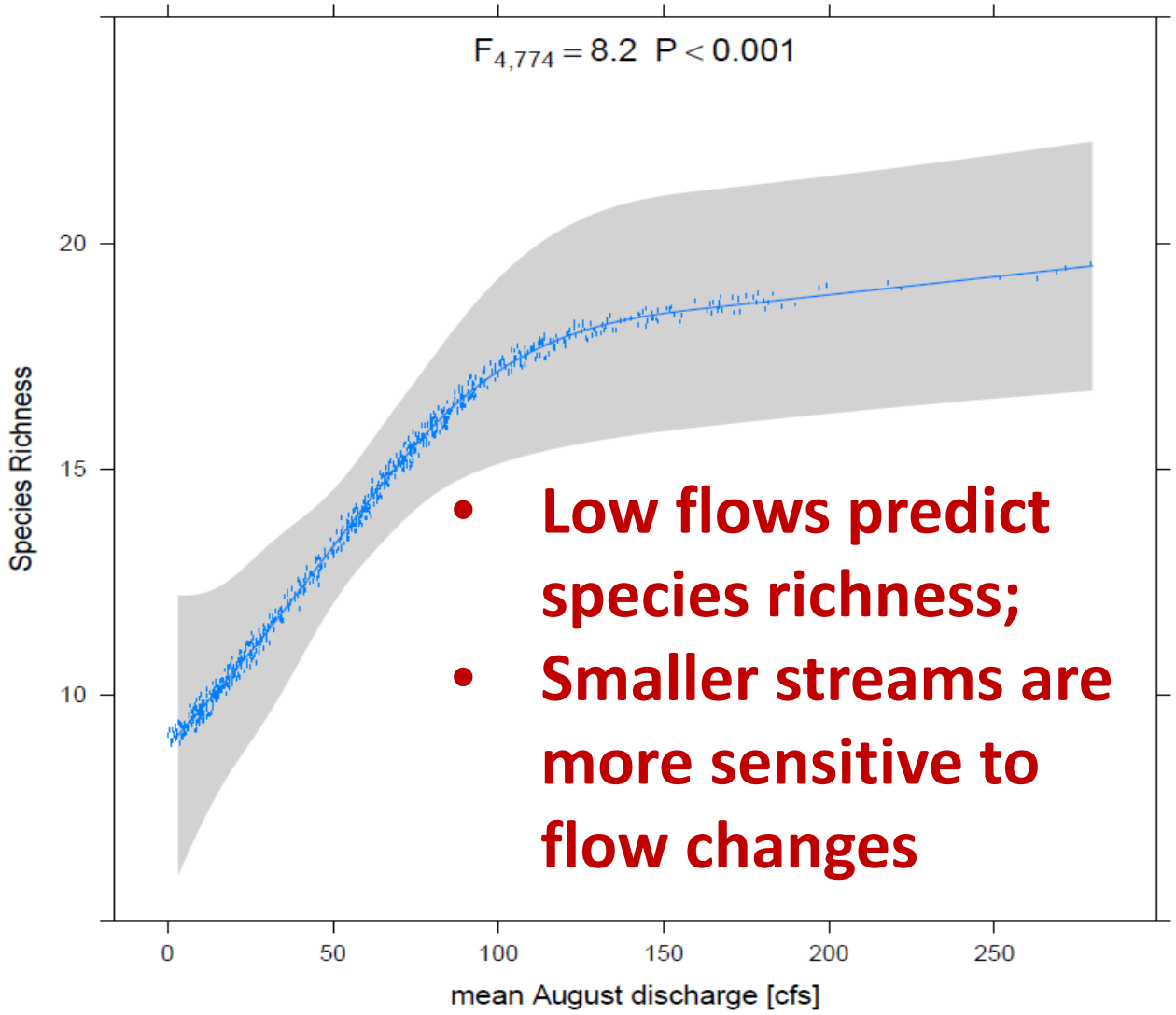


Figure 6: Effect of mean August discharge (restricted cubic spline with 5 knots) on richness estimated by the fitted model with 95% CI with other variables adjusted to their median. Blue dots represent the density of points along the x-axis. The overall F-test is provided at the top of graph.

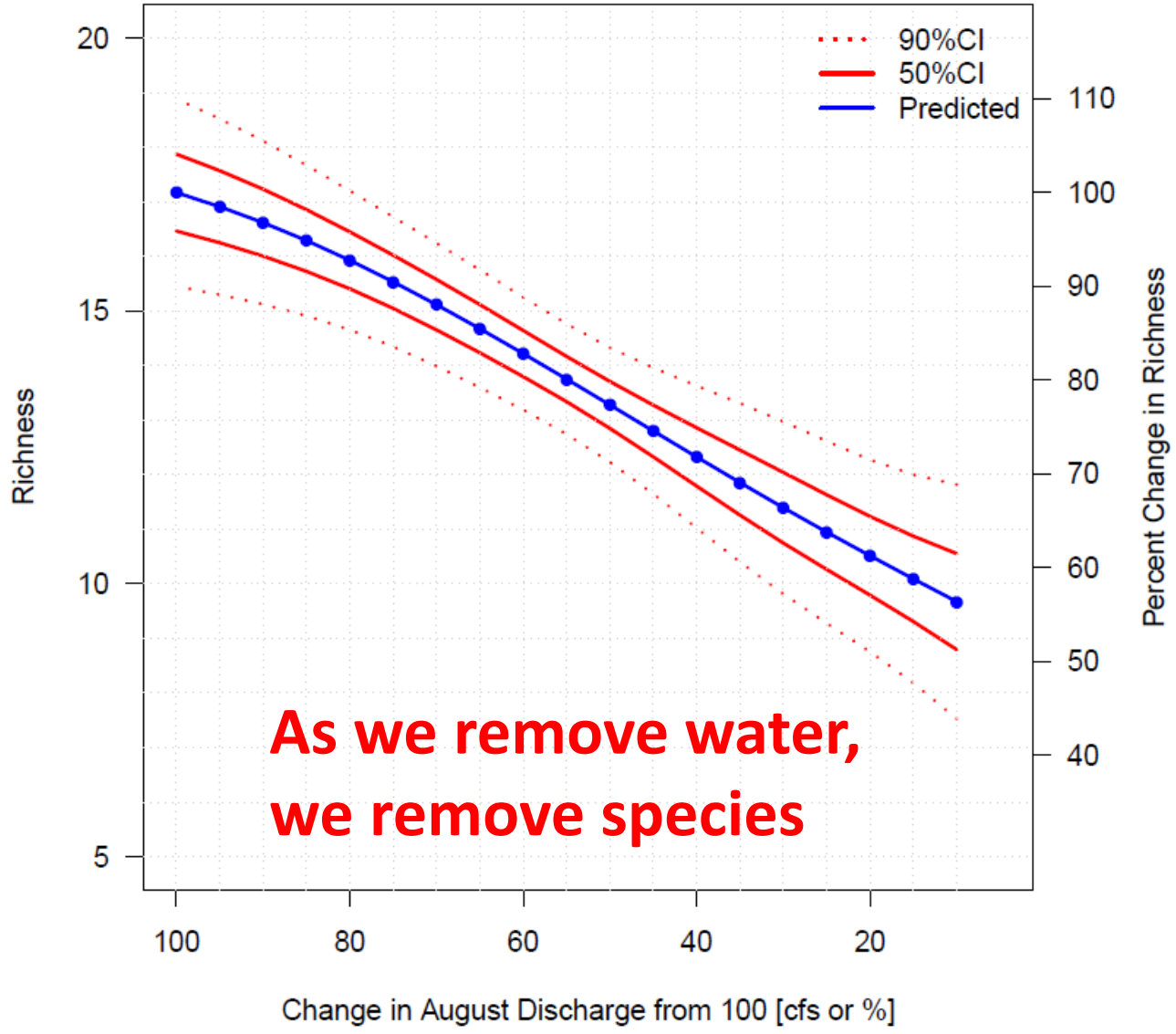
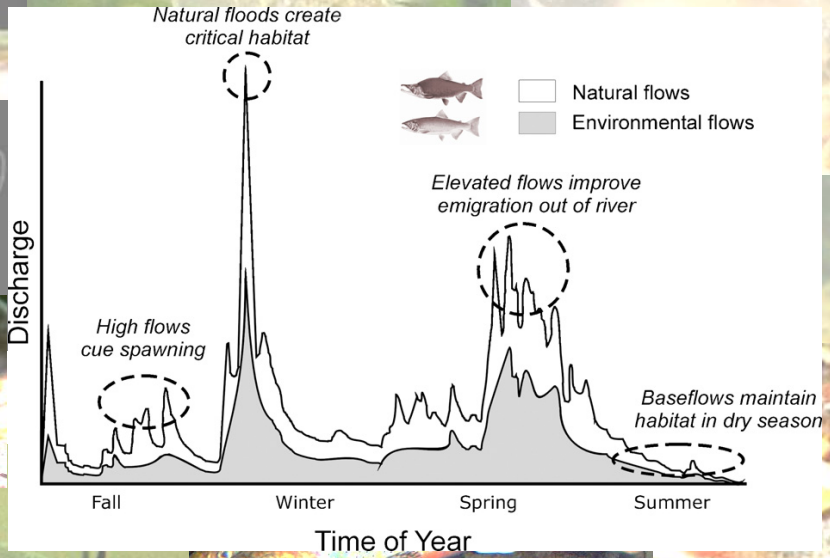
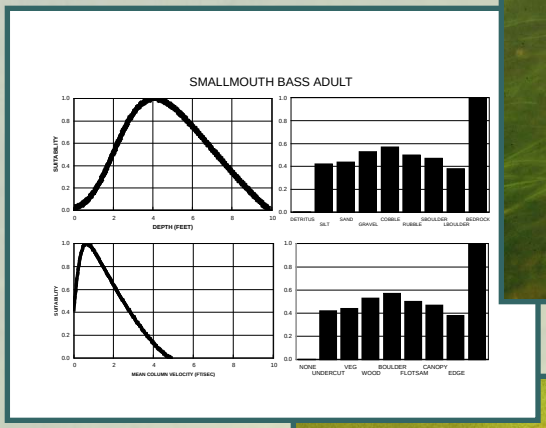


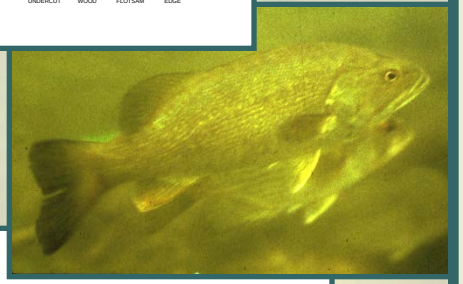
Figure 2: Change in predicted richness with decreasing discharge starting with 100 cfs while holding other predictor variables at their median.

Why use fish data to determine ecological impact?

- We have information on them, across the state
- Fish are used as surrogates for sustaining the ecosystem
  - Sustain fish, sustain opportunities for future users

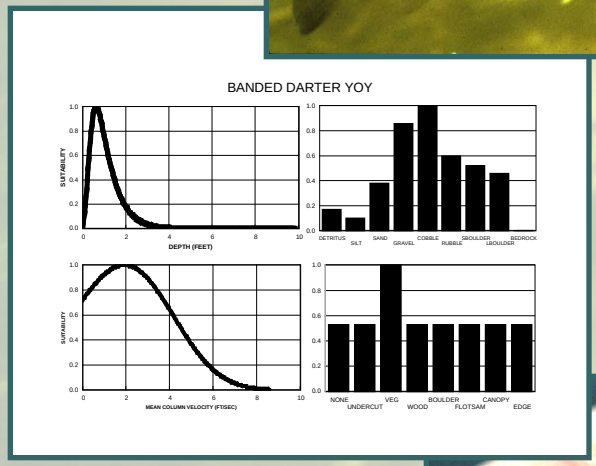




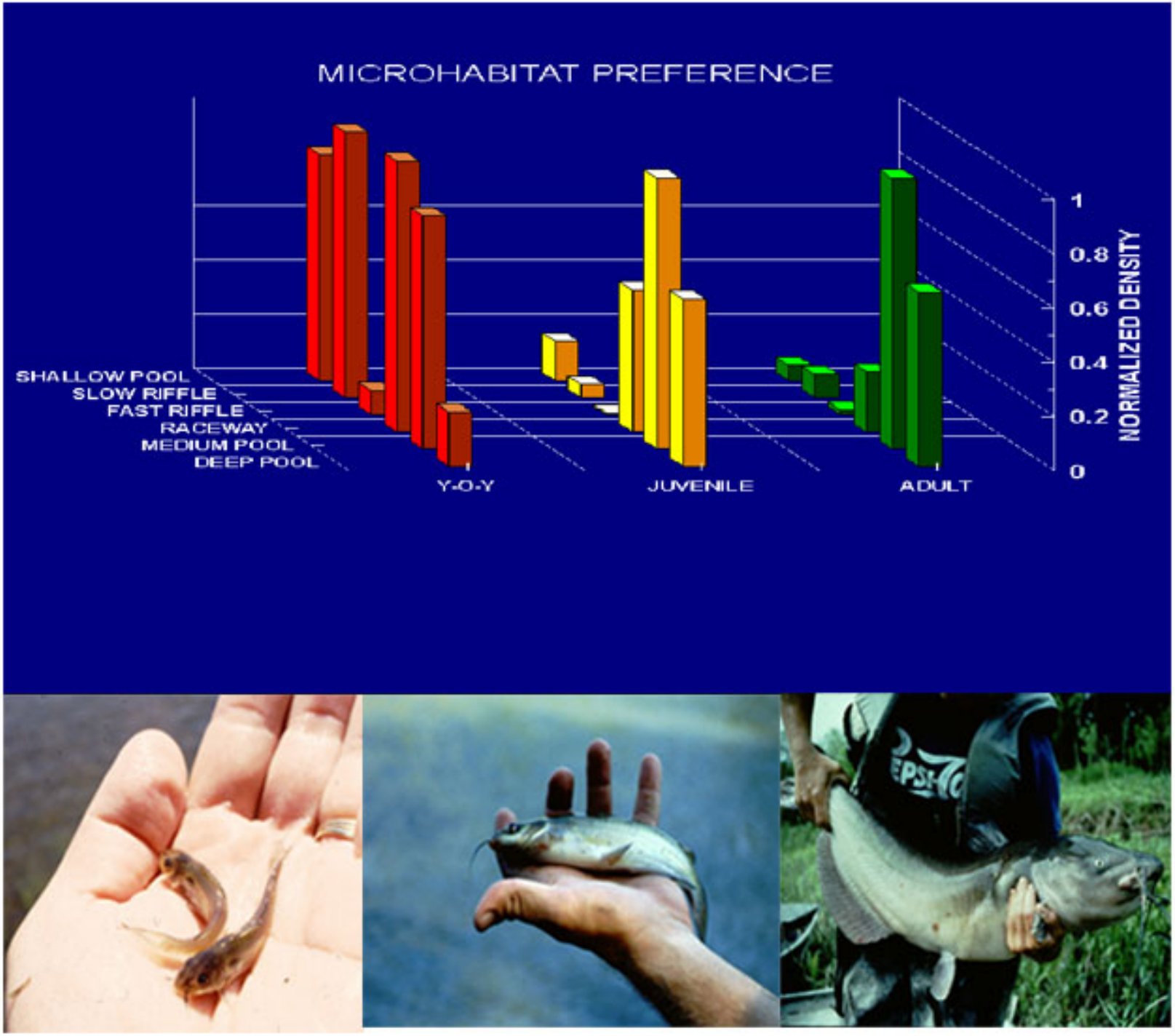


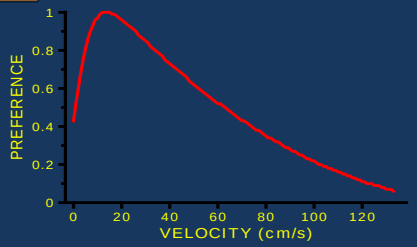
MNDNR STREAM HABITAT PROGRAM HABITAT PREFERENCE CURVES

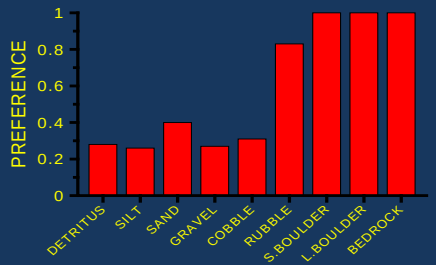
49 rivers/147 survey sites/ 9607 samples
>223,000 fish observations
129 species / 345 species-life stages
> 500 mussel observations
150 fish species-life stage habitat preference curves
9 mussel species habitat preference curves

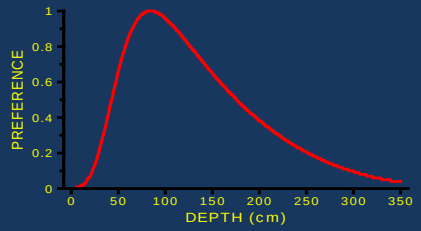


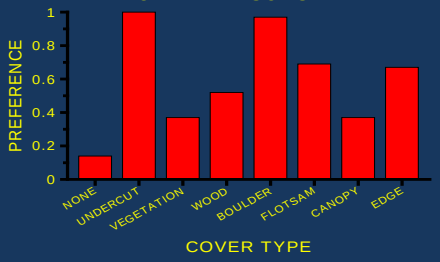
For more information contact:
Stream Habitat Program
MN DNR
500 Lafayette Rd
St. Paul, MN 55155
651.259.5113
Email: ann.kuitunen@state.mn.us


MICROHABITAT PREFERENCE
SHALLOW POOL
SLOW RIFFLE
FAST RIFFLE
RACEWAY
MEDIUM POOL
DEEP POOL
Y-O-Y
JUVENILE
ADULT
1
0.8
0.6
0.4
0.2
0
NORMALIZED DENSITY


PREFERENCE
VELOCITY (cm/s)

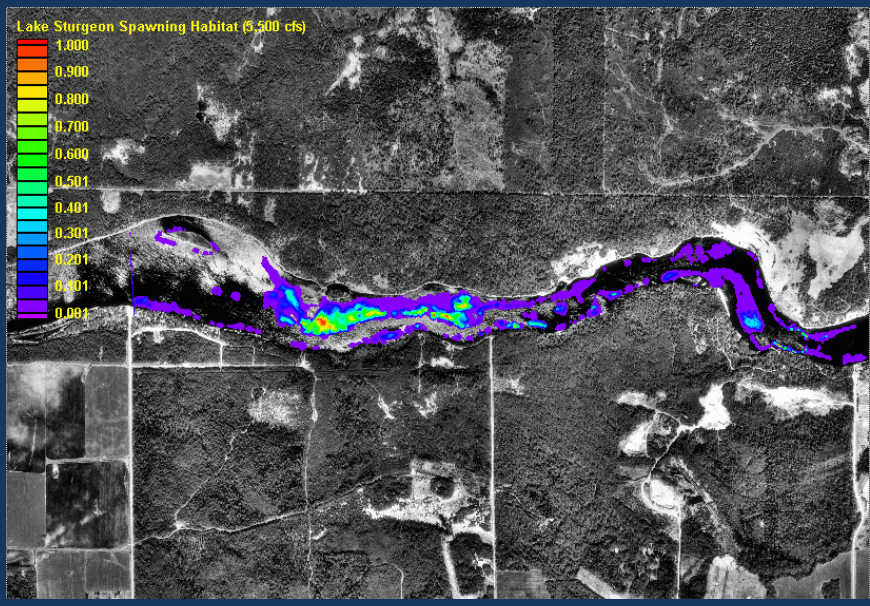

PREFERENCE
DETRITUS
SILT
SAND
GRAVEL
COBBLE
RUBBLE
S.BOULDER
L.BOULDER
BEDROCK
DOMINANT SUBSTRATE

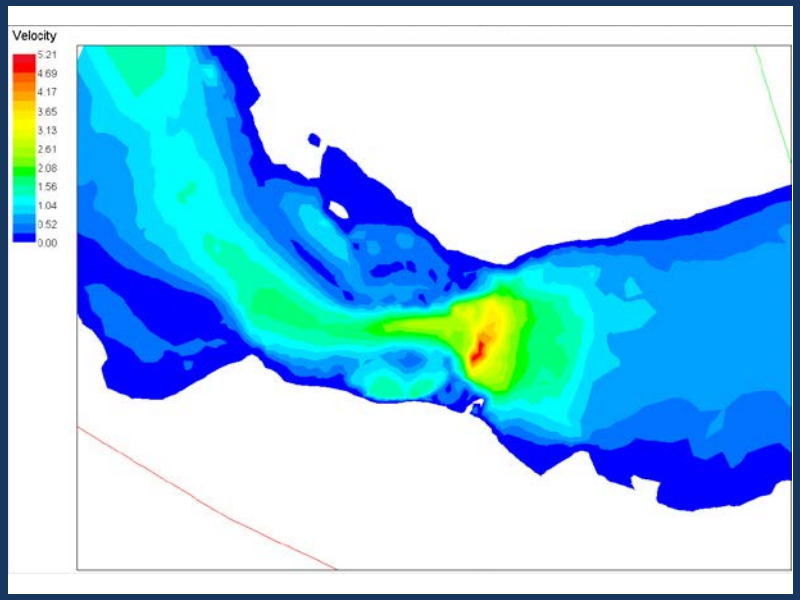

PREFERENCE
DEPTH (cm)

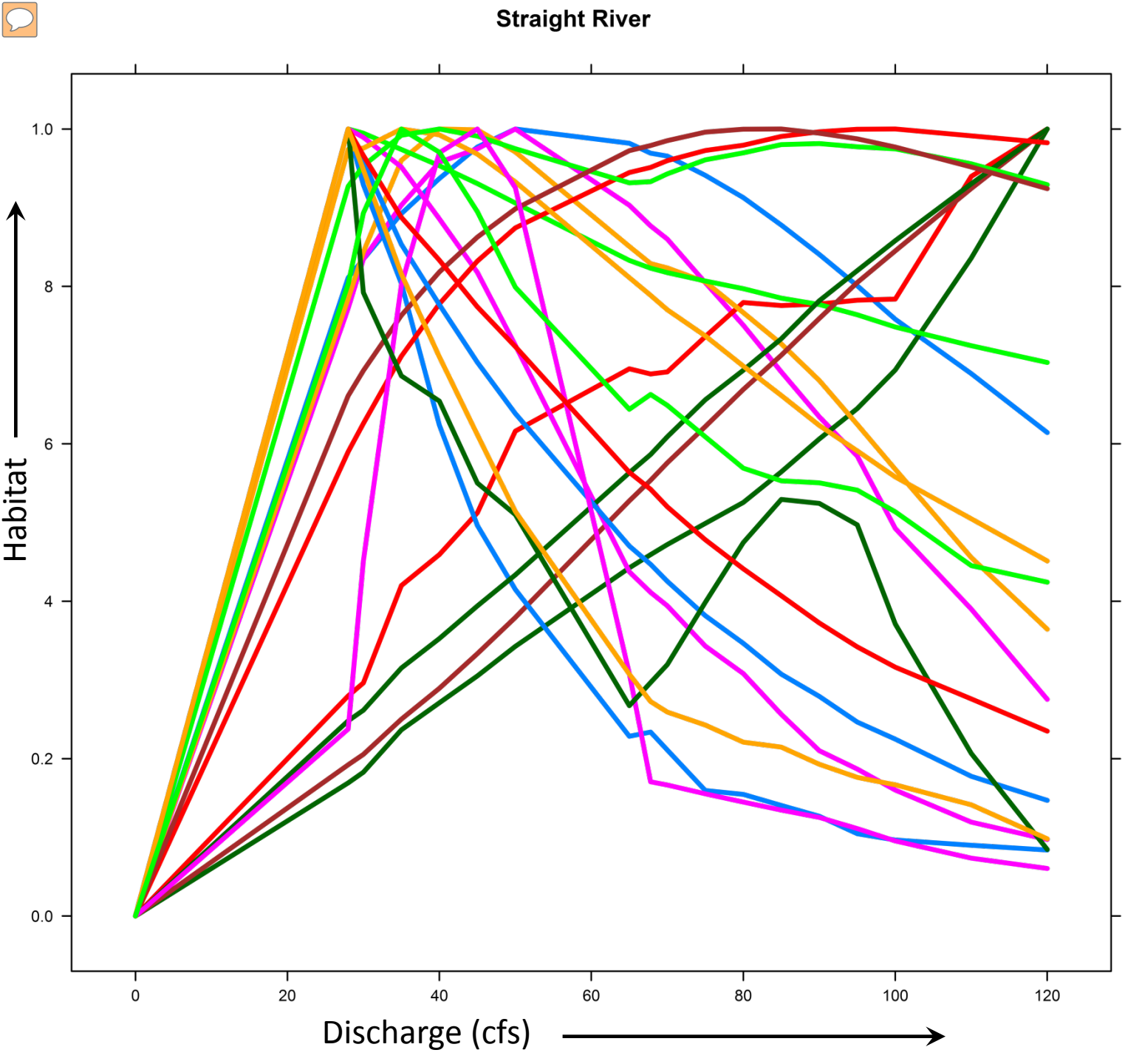

PREFERENCE
NONE
UNDERCUT
VEGETATION
WOOD
BOULDER
FLOTSAM
CANOPY
EDGE
COVER TYPE

+

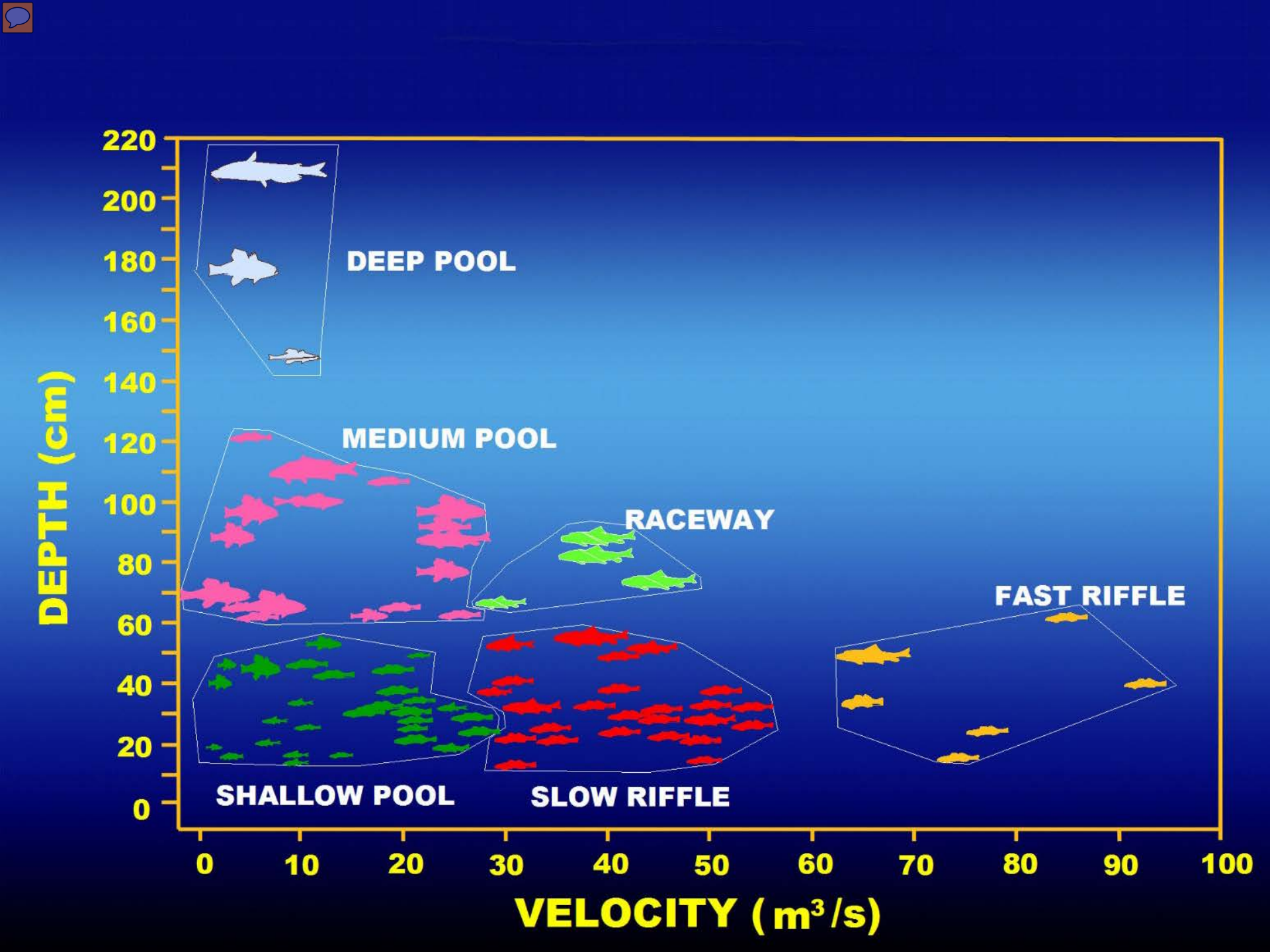
=


Lake Sturgeon Spawning Habitat (3,500 cfs)
1.000
0.900
0.800
0.700
0.600
0.501
0.401
0.301
0.201
0.101
0.001

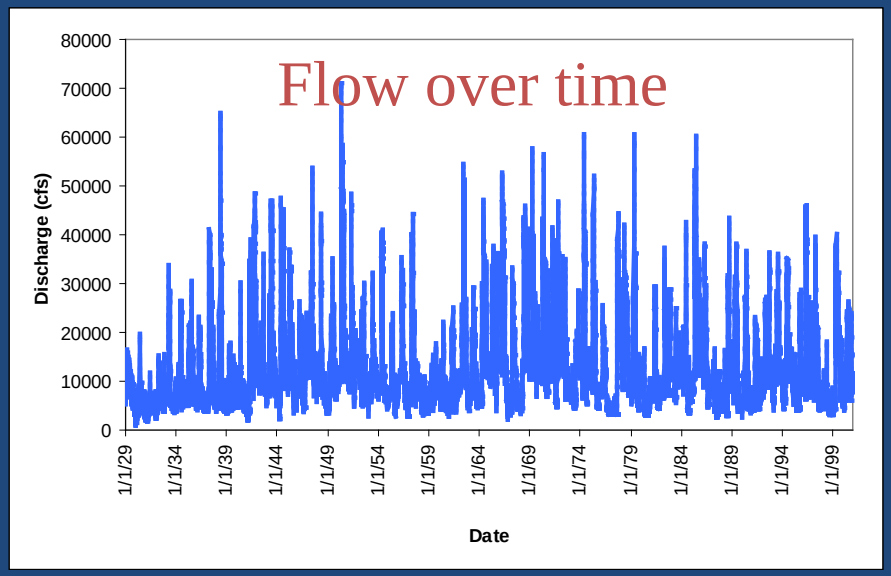

Velocity
5.21
4.69
4.17
3.65
3.13
2.61
2.08
1.56
1.04
0.52
0.00



Habitat/flow relationships for 20 species-life stages (8 species) in the Straight River, a trout stream in north-central Minnesota.


DEPTH (cm)
220
200
180
160
140
120
100
80
60
40
20
0
DEEP POOL
MEDIUM POOL
RACEWAY
FAST RIFFLE
SHALLOW POOL
SLOW RIFFLE
0
10
20
30
40
50
60
70
80
90
100
VELOCITY (m³ /s)

Habitat Time Series



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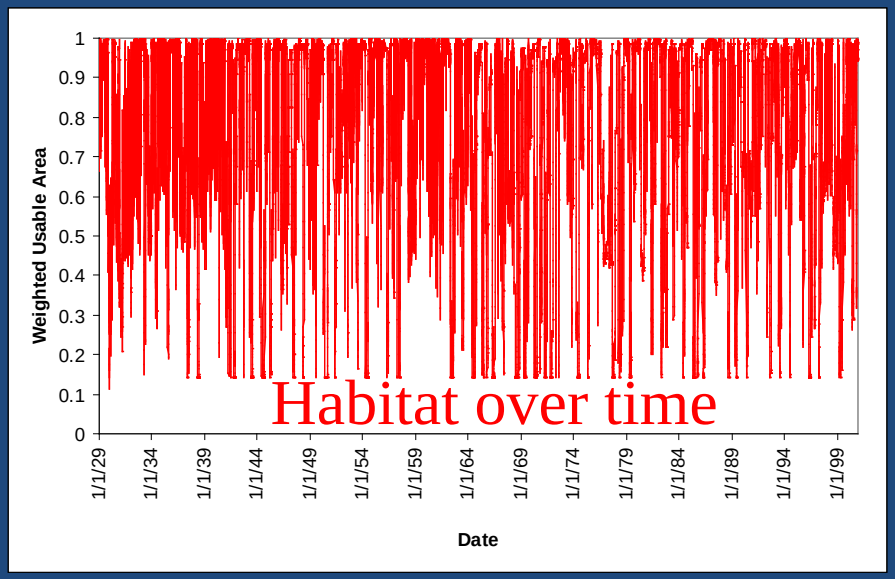
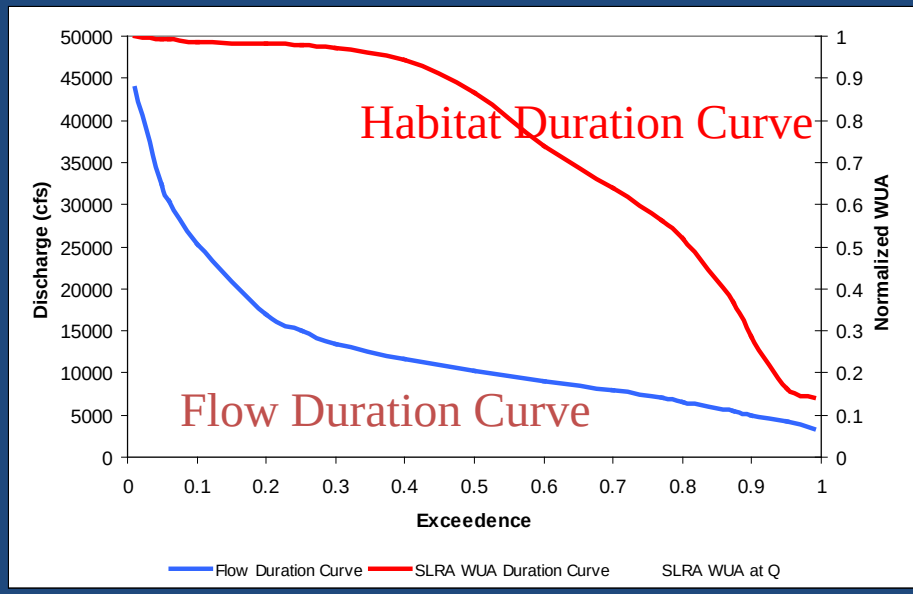
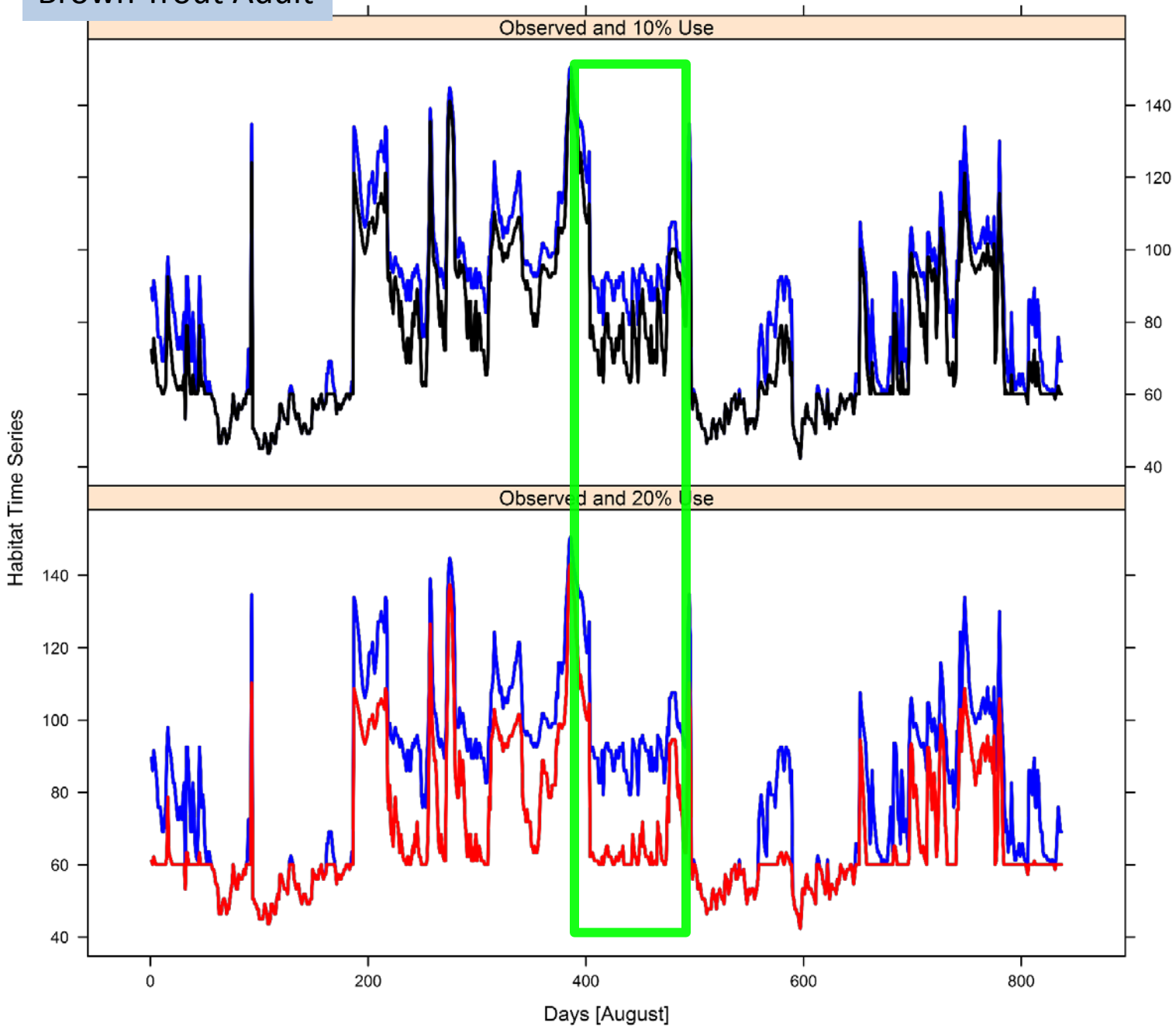


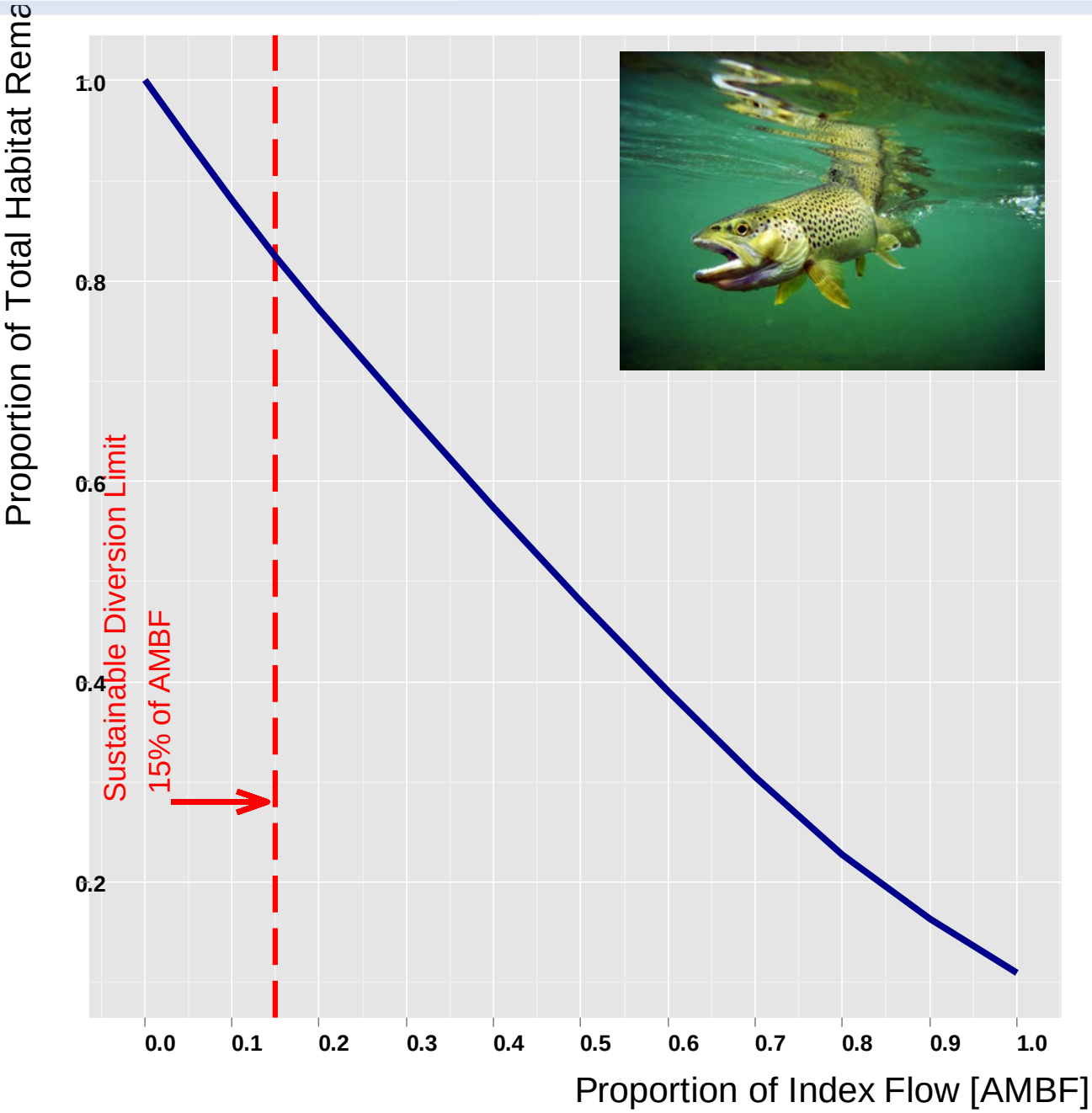


Brown Trout Adult



The effect of a 10% (top) and 20% stream flow loss on brown trout adults in the Straight River in August.

Relation of Habitat to Flow Depletion



Location	Ecological Goal	Cumulative allowable depletion	Considerations	Decision process
Florida (SWFWMD)	Avoid significant ecological harm (maximum 15% habitat loss)	8-19% of daily flows	Seasonally variable extraction limit; 'hands-off' flow (no withdrawals below)	Scientific peer review of site-specific studies
Michigan	Maintain baseline or existing condition	6-15% of August median flow	Single extraction limit for all flow levels	Stakeholders with scientific support
Maine	Protect class AA: 'outstanding natural resources'	10% of daily flow	Single extraction limit for all flow levels above a 'hands-off' flow level	Expert derived
Massachusetts	Sustainable management of water resources that balance human and ecological needs	Basin safe yield: 55% of annualized Q90 For sub-basins, maximum level of August median streamflow alteration ranges from 3-10% for Categories 1 and 2 for each season.	Seasonal extraction limit based on category	Expert, scientific support
Rhode Island	Maintain habitat conditions essential to a healthy aquatic ecosystem	6 Bioperiods and 5 classes Summer Period Class 1-3 streams can deplete 10, 20, and 30% of the 7Q10, respectively	Allocation limited by cumulative streamflow depletion Identify allowable depletion limit even during dry conditions	Scientific support, stakeholders, public process
European Union	Maintain good ecological condition	7.5-20% of daily flow 20-35% of daily flow	Lower flow; warmer months; 'hands-off' flow Higher flow;cooler months	Expert derived

Examples of the **percent of flow approach actively being used for water management** (*from* Richter et al. 2011, with additions). These examples restrict both ground and surface water allocation.

Management Prescription Proposed for Minnesota streams:

15% August Median low flow & Q_{90} Protected Flow . . .

Are There Any Questions?