Quantified Flow–Stream Health Relationships across South Carolina

CLEMSON UNIVERSITY

SOUTH CAROLINA DEPARTMENT OF NATURAL RESOURCES

dhec

RTI INTERNATIONAL

The Nature Conservancy

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Key Messages / Proposal

1. The question of "how much water does a river need?" can be answered quantitatively and scientifically

2. It's not a matter of ability or method, it's one of data (Spoiler: We have the data)

3. The focus for today is to share the tool. The details of how it is constructed will require follow-up

4. **Proposal**: The Edisto RBC will see enough utility in this work to call for follow-up engagement, and use the results to evaluate the impact of water use scenarios on the river's health

Principles

- The amount and behavior of flow in a river or stream is a strong determinant of the biological life we find within
- If we have enough of the right data for both flow and biology, we can identify those determining relationships
- If we have those relationships, we can predict how changes in flow amount and / or behavior will change the biological health of a river or stream
- **Assumption**: We expect our rivers and streams to have some component of their natural fish and invertebrate residents to be called "healthy"

Goal of This Work:

- Determine relationships between instream flow metrics and aquatic life. We want to know:
  - What are the key relationships?
  - How strong are those relationships?
  - How do relationships differ among regions across SC?
  - Are there key thresholds?

Build a hydrologic foundation of streamflow data

- RTI International
  - WATERFALL model: Watershed Flow and ALLocation system
- Selected 24 stream metrics to evaluate
  - Minimally redundant
  - Timing, magnitude, frequency, rate of change, and duration

Code	Flow regime	Description
MA1	Magintude	Mean daily flow (cfs)
MA3	Magintude	Mean of the coefficient of variation for each year
MA41	Magintude	Annual runoff
MA42	Magintude	Variability of MA41
ML17	Magintude	Base flow index
ML18	Magintude	Variability in ML17
ML22	Magintude	Specific mean annual minimum flow
MH14	Magintude	Median of annual maximum flows (dimensionless)
MH20	Magintude	Specific mean annual maximum flow (cfs/mile)
FL1	Frequency	Low flood pulse count
FL2	Frequency	Variability in FL1
FH1	Frequency	High flood pulse count
FH2	Frequency	Variability in FH1
DL16	Duration	Low flow pulse duration (Days)
DL17	Duration	Variability in DL16
DL18	Duration	Number of zero-flow days
DH15	Duration	High flow pulse duration (Days)
DH16	Duration	Variability in DH15
TA1	Timing	Constancy
TL1	Timing	Julian date of annual minimum
TL2	Timing	Variability in TL1
TH1	Timing	Julian date of annual maximum starting at day 100
TH2	Timing	Variability in TH1
RA8	Rate	Number of reversals

A = annual flow

M = Magnitude

L = low flow

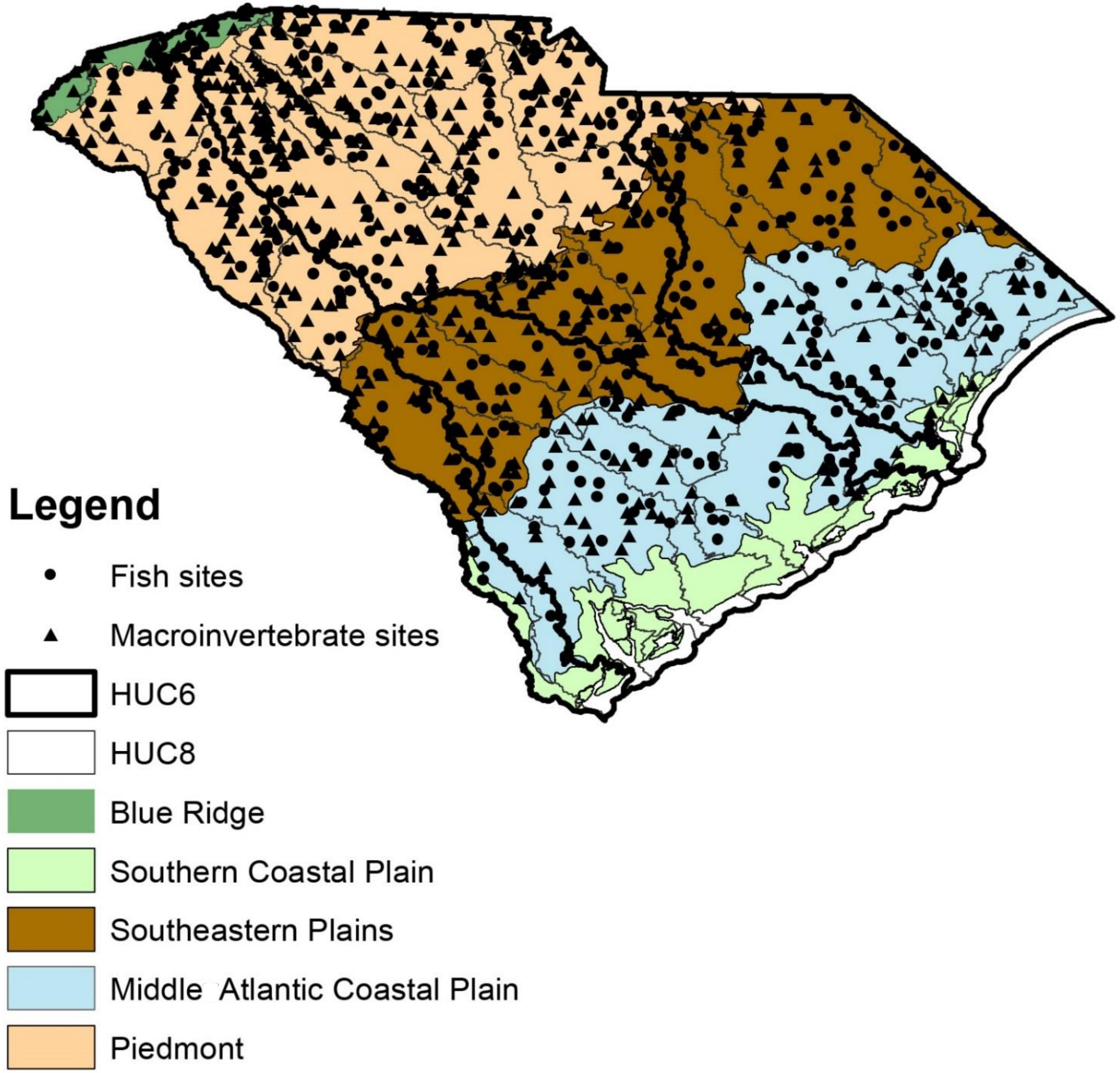
H = high flow

F = Frequency

D = Duration

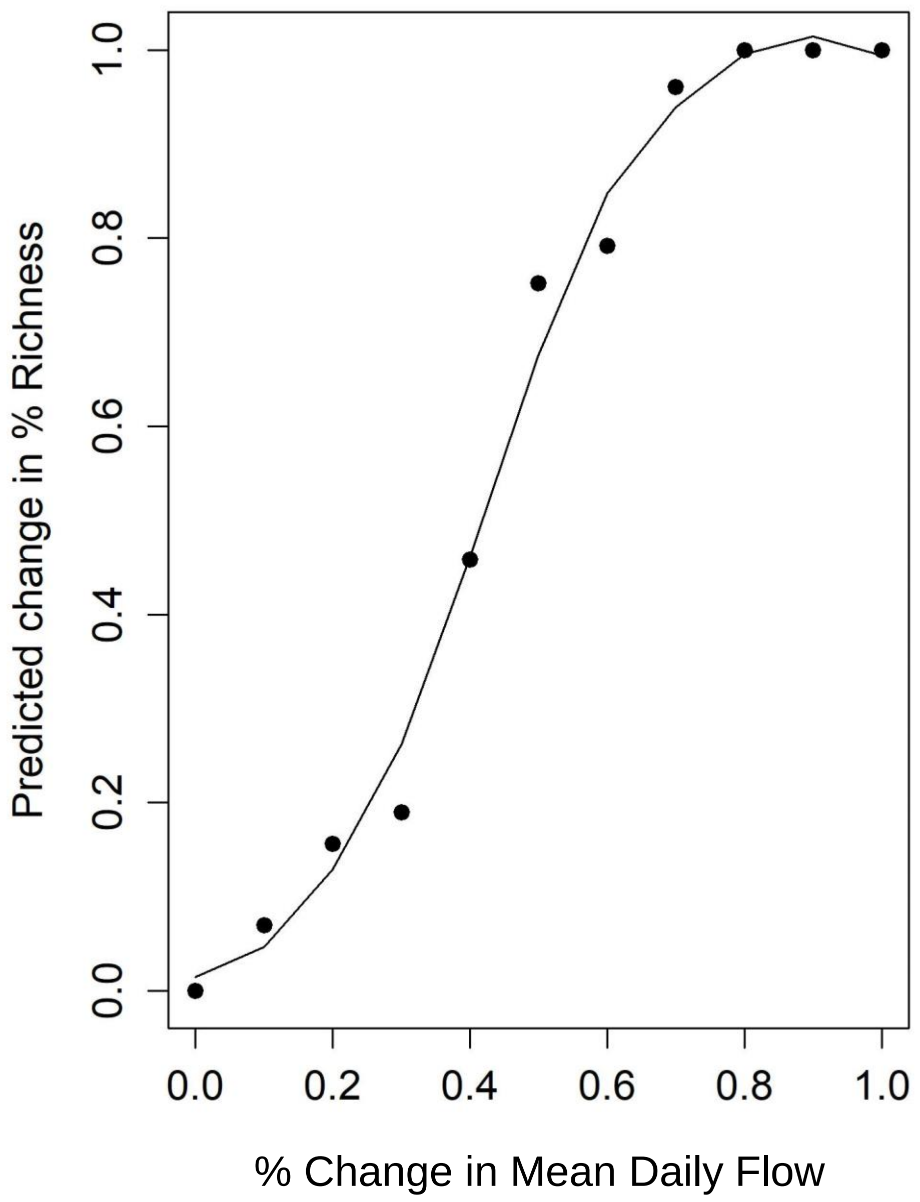
T = Timing

R = rate

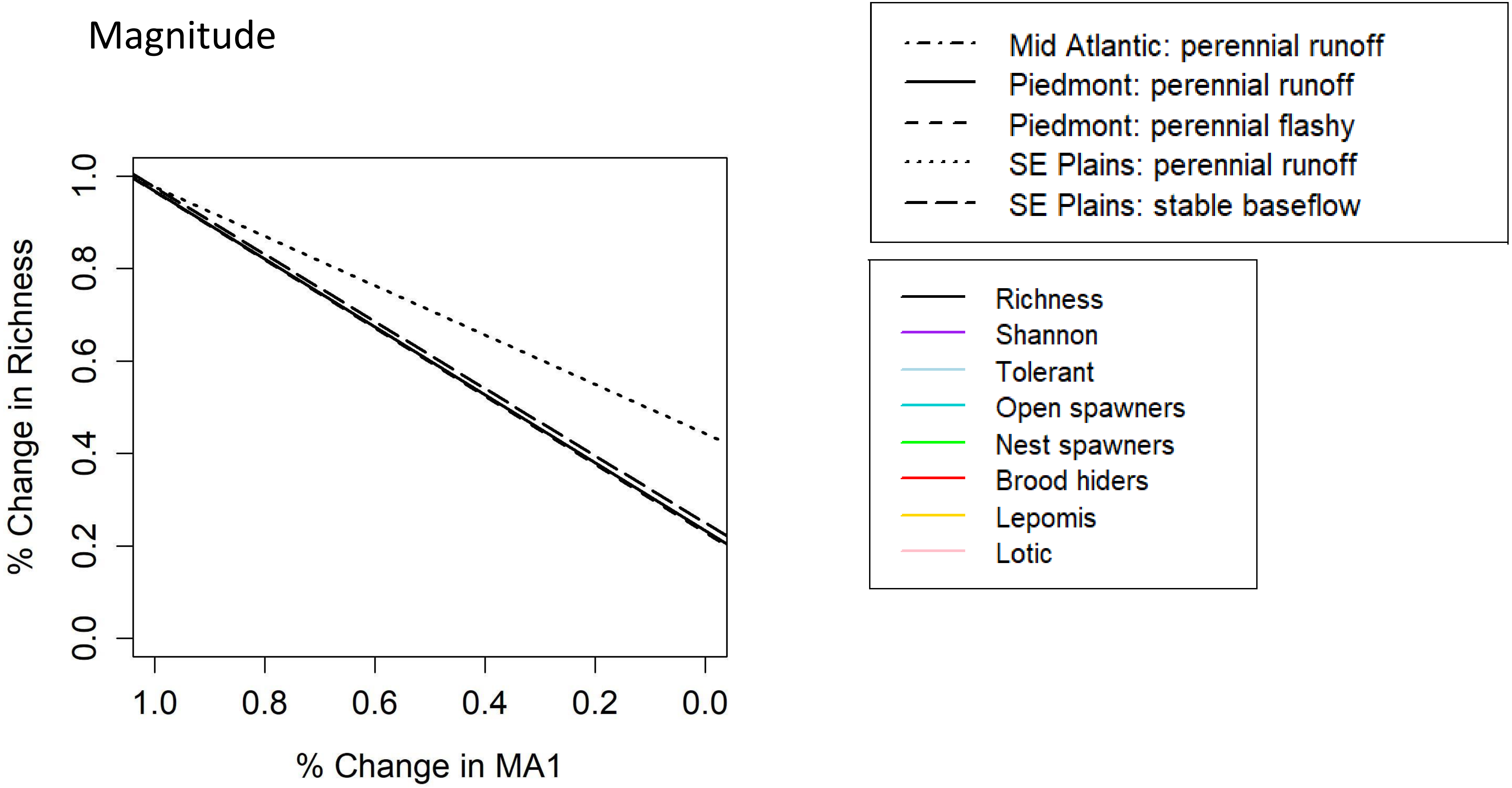


Biological Data:

- Ecoregion is important!
  - Some metrics differ across ecoregions
  - Assemblage differences
- 492 Fish sites (streams & rivers)
  - SCDNR
  - Up to ~500K watersheds
  - Stream order 7
- 530 macroinvertebrate sites
  - SCDHEC
  - Genus level
- Sites > 3 sp

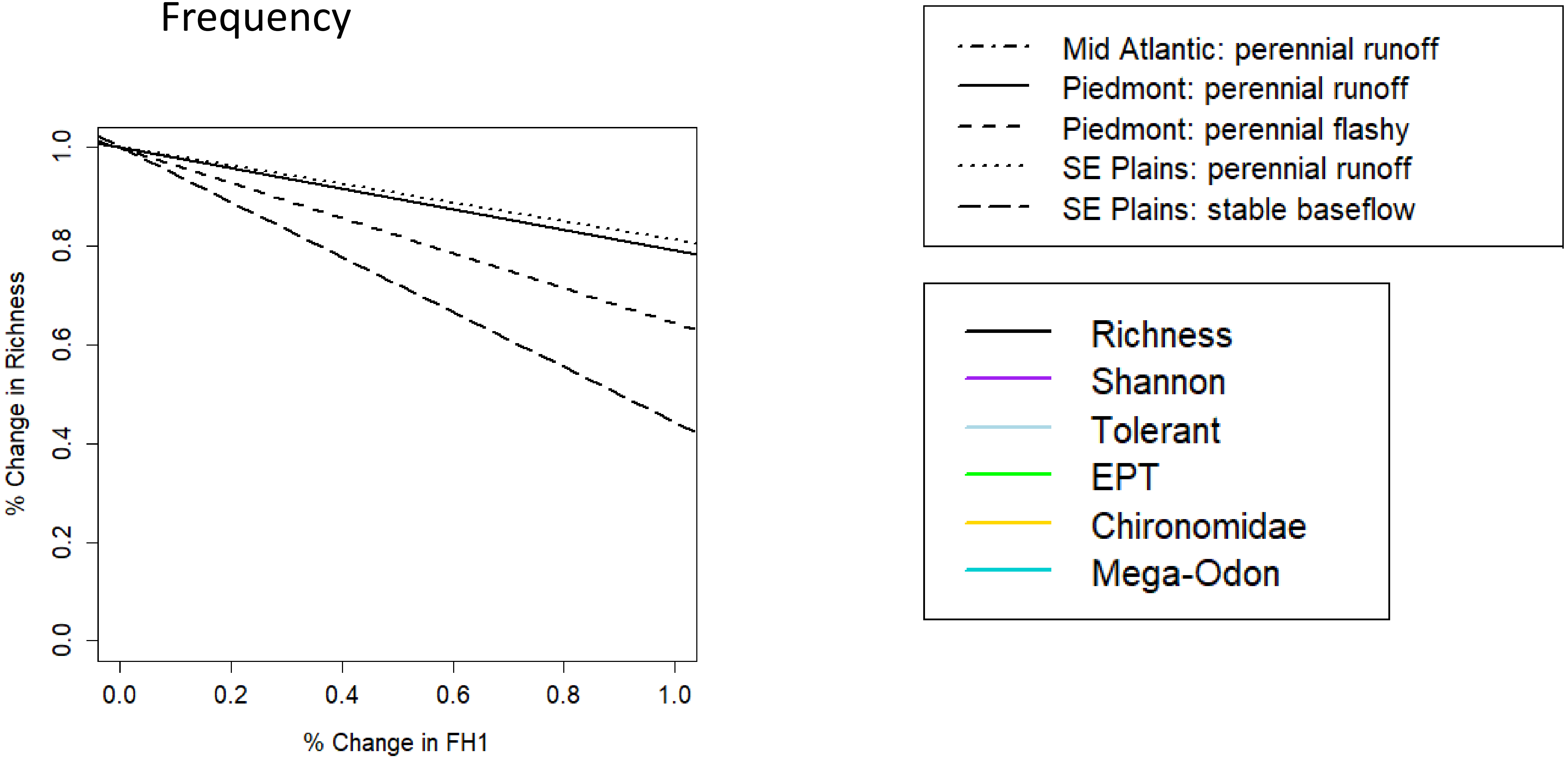

Predicted change in % Richness
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.2
0.4
0.6
0.8
1.0
% Change in Mean Daily Flow

Magnitude

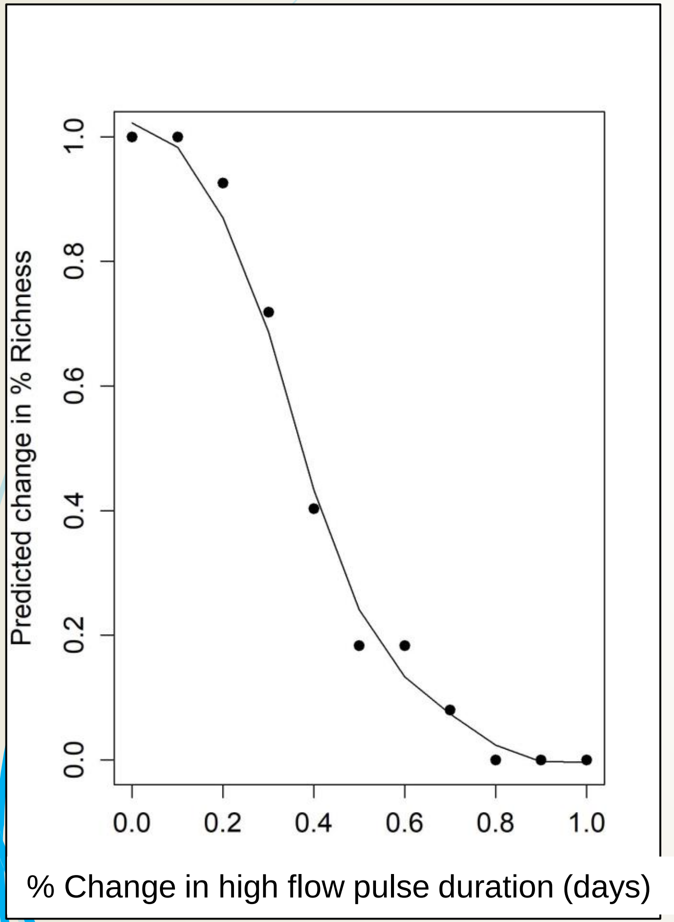


Mid Atlantic: perennial runoff
Piedmont: perennial runoff
Piedmont: perennial flashy
SE Plains: perennial runoff
SE Plains: stable baseflow
Richness
Shannon
Tolerant
Open spawners
Nest spawners
Brood hiders
Lepomis
Lotic
% Change in Richness
0.0
0.2
0.4
0.6
0.8
1.0
% Change in MA1

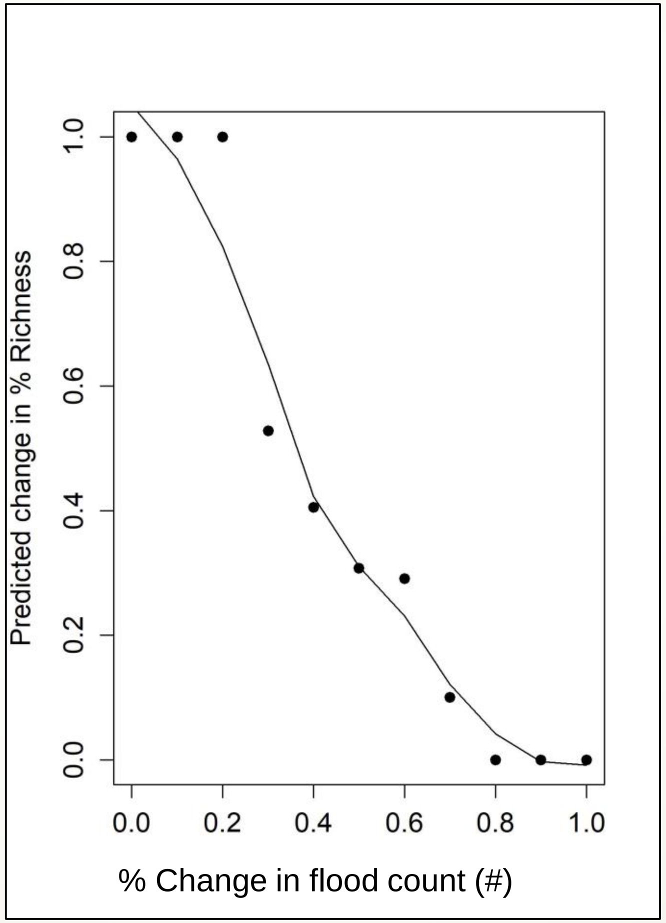
Frequency



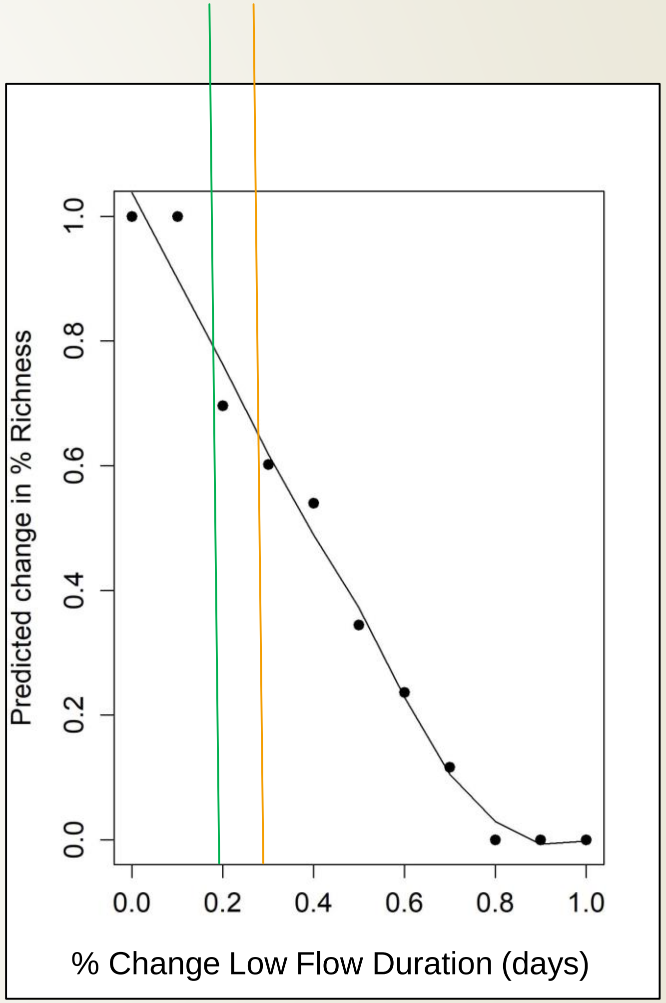
% Change in Richness
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
% Change in FH1
Mid Atlantic: perennial runoff
Piedmont: perennial runoff
Piedmont: perennial flashy
SE Plains: perennial runoff
SE Plains: stable baseflow
Richness
Shannon
Tolerant
EPT
Chironomidae
Mega-Odon



Piedmont



Piedmont



SE Plains

Next Steps

- The completion and publication of these flow-ecology relationships is slated for June 2021

- Team will identify and recommend a set of relationships for use as water management metrics (begin Mar-Apr 2021?)

- Questions?