SARP: River Classification Framework
NC Environmental Flow Science Advisory Board
April 16, 2013

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Southern Instream Flow Network
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Purpose - To facilitate protective instream flow policies and practices in 15 southern states by providing science-based resources and opening lines of communication.

More information at: www.southeastaquatics.net/programs/sifn/
Presentation Overview

1. Present SARP River Classification Framework for the South Atlantic Landscape Conservation Cooperative (SALCC) region

2. Review uses of classification
SARP River Classification Framework

Objectives

• Characterize streams by ecologically relevant characteristics
• Provide common terms for describing rivers across the region
• Support development of flow-ecology relationships
Ecological Limits of Hydrologic Alteration (ELOHA)

SCIENTIFIC PROCESS

Step 1. Hydrologic Foundation
- Baseline Hydrographs
- Flow Data and Modeling
- Developed Hydrographs

Step 2. River Classification (for each analysis node)
- Hydrologic Classification
- Geomorphic Sub-classification
- River Type

Step 3. Flow Alteration (for each analysis node)
- Analysis of Flow Alteration
- Measures of Flow Alteration

Step 4. Flow-Ecology Relationships
- Flow - Ecology Hypotheses for each river type
- Ecological Data for each analysis node

SOCIAL PROCESS

Implementation
- Environmental Flow Standards
- Acceptable Ecological Conditions
- Societal Values and Management Needs

Adaptive Adjustments

Monitoring

Biotic indicator

Hydrologic alteration

http://conserveonline.org/workspaces/eloha

(Poff et al. 2010)
SARP River Classification Framework
Geomorphic Sub-Classifications

Stream Gradient

Stream Temperature

Ecoregions
- EPA Level III
- Freshwater
- EDU

Size (basin area and MAF)
SARP River Classification Framework
Geomorphic Sub-Classifications (cont.)

Base Flow Index

Soils
- Available water capacity
- Soil organic carbon
- % Sand, Silt, and Clay

Bedrock Geology

Landforms

Land Uses
Ecological Limits of Hydrologic Alteration (ELOHA)

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**Adaptive Adjustments**

(Biotic indicator)

http://conserveonline.org/workspaces/eloha

(Poff et al. 2010)
SARP Hydrologic Classification Framework for SALCC region

1. **Size** –
   - Headwater,
   - Creek,
   - Small R.,
   - Medium R.,
   - Large R.,
   - Great R.

2. **Variability** – (median annual std deviation/mean flow)
   - Very low,
   - Low,
   - Medium-High
### SARP River Classification Framework

#### Stream Size Class (by basin area)

<table>
<thead>
<tr>
<th>Size Class</th>
<th>Description</th>
<th>Definition: Upstream Drainage Area (sq.mi.)</th>
<th>Definition: Upstream Drainage Area (sq.km)</th>
<th>Definition: Mean Annual Flow (cfs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Headwaters</td>
<td>0&lt;3.861</td>
<td>0&lt;10</td>
<td>&lt;= 10</td>
</tr>
<tr>
<td>1b</td>
<td>Creeks</td>
<td>&gt;=3.861&lt;38.61</td>
<td>&gt;=10 &lt; 100</td>
<td>&gt;10 - 75</td>
</tr>
<tr>
<td>2</td>
<td>Small Rivers</td>
<td>&gt;= 38.61&lt;200</td>
<td>&gt;=100 &lt; 518</td>
<td>&gt;75 - 400</td>
</tr>
<tr>
<td>3a</td>
<td>Medium Tributary Rivers</td>
<td>&gt;=200&lt;1000</td>
<td>&gt;= 518 - 2590</td>
<td>&gt;=400 - 2,000</td>
</tr>
<tr>
<td>3b</td>
<td>Medium Mainstem Rivers</td>
<td>&gt;=1000&lt;3861</td>
<td>&gt;= 2590 &lt; 10,000</td>
<td>&gt;=2,000 - 6,000</td>
</tr>
<tr>
<td>4</td>
<td>Large Rivers</td>
<td>&gt;=3861&lt;9653</td>
<td>&gt;=10,000 - 25,000</td>
<td>&gt;=6,000 - 20,000</td>
</tr>
<tr>
<td>5</td>
<td>Great Rivers</td>
<td>&gt;=9653</td>
<td>&gt;= 25,000</td>
<td>&gt;=20,000</td>
</tr>
</tbody>
</table>

[Map of the United States with river classification areas highlighted]
SARP River Classification Framework
Flow Variability Class (Median daily variability)

Predict Flow Variability Class for Ungaged Locations

The modeling work consisted of four major steps.
1. Compile set of gages, assign hydrologic class, and link them to the appropriate NHDPlusreach
2. Attribute each stream reach and gage with GIS predictor variables
3. Build random forest (RF) classification models using the randomForest package in R
4. Apply the best RF model to each stream reach and map each stream reach according to the “highest probability” class.

Of 75 predictor variables, the most important variables were:
- mean baseflow index
- stream size
- cumulative drainage area and
- run-off coefficient.
SARP River Classification Framework
Flow Variability Class (Median % variability)
Use of the SARP River Classification Framework

River Class: EPA Level III Ecoregion
Use of the SARP River Classification Framework

River Class: Size within EPA Level III Ecoregion
Use of the SARP River Classification Framework

River Class: Flow Variability by Size within EPA Level III Ecoregion
Presentation Overview

1. Present SARP River Classification Framework for the South Atlantic Landscape Conservation Cooperative region

2. Review uses of classification –

   When do you classify?
   – Michigan
   – Potomac River Commission
Ecological Limits of Hydrologic Alteration (ELOHA)

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**Before analyses?**

(Poff et al. 2010)

http://conserveonline.org/workspaces/eloha
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Before analyses? Or to inform the analyses?

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Michigan Instream Flow Standard Setting Process

- Used fish assemblage temperature preferences to classify
Michigan’s Instream Flow Standards by Class

Proportion of initial fish population metric

Cold

Cold Trans.

Cool

Warm

Streams

Small Rivers

Large Rivers

Proportion of index flow removed
Middle Potomac Watershed Assessment: Environmental Flows

- Follows ELOHA framework
- Multistate watershed
- www.potomacriver.org

Slides courtesy of Carlton Haywood, PRC
Hydrologic Data

- Simulated daily flow time series for a current conditions scenario and for a baseline scenario
  - Current conditions:
    - 2000 land use
    - 2005 withdrawals, discharges, and impoundment volume
    - 1984-2005 hydrology
  - Baseline:
    - Land use modified to 78% forest, 0.35% impervious surface, other land uses adjusted proportionally,
    - Discharges and withdrawals set to zero.
    - No impoundments
- Flows simulated for 747 watersheds
Middle Potomac – Biological Data

1) Benthic macroinvertebrate data
   a) Only bio data set sufficiently rich for this basinwide, interstate, assessment
   b) Samples rarified to common basis and metrics calculated to family level for consistency

2) Collected in years 2000 – 2008

3) 1,313 samples at 869 locations for 747 watersheds
Flow-Ecology Relationships

Mean daily fall rate (RAFT) vs BIBI

Median annual flow vs BIBI

Flood Free Season vs BIBI

Mean of Jul-Oct monthly Q85 flow vs BIBI
Classification

Some biological metrics appear not to need classification....

Family-Level Taxa Richness

Watershed Size
Season
"Bioregion"
Classification

...while others may need classification

<table>
<thead>
<tr>
<th>%Shredders</th>
<th>%Net Caddisfly</th>
<th>%Chironomidae</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Watershed Size</th>
<th>Season</th>
<th>“Bioregion”</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st, 2nd, 3rd, 4th, 5th, 6th+</td>
<td>Spring, Summer, Fall, Winter</td>
<td>Coastal Plain, Piedmont, Ridges, Valleys</td>
</tr>
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**Biotic indicator**

**Or to inform the analyses?**

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**Or to inform the analyses?**

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(Poff et al. 2010)
When to classify for flow-ecology relationships?

The answer for when to classify seems to depend:
• Complexity of the system
• Parameters being analyses
• ???

Since the answer is not clear, a safe approach is to allow for exploration of both approaches and let the rivers direct the results.