Role of NHD/NHDPlus for environmental-flow based legislation in Michigan and environmental-flow framework for the US Great Lakes Basin

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Overview

- Great Lakes-St. Lawrence River Basin Water Resources Compact
  - Interstate Compact
    - Companion International Agreement
  - Implemented by each state
  - Regional goals for water conservation and efficiency
  - Prevent adverse resource impact from new or increased water withdrawals

Michigan Water Withdrawal Assessment

- Streamflow data
- Fish presence and abundance
- Stream temperature
- Aquifer distribution and characteristics

Steinman and others, 2011.
Role of NHD and NHDPlus

- NHD connectivity and catchment information:
  - Streamflow estimates
  - Stream temperature modeling
  - Fish presence and abundance modeling
  - Streamflow classification
  - Withdrawal accounting for cumulative impact assessment
Stream Classification and Ecological Response

- Classification based on drainage area, stream temperature, and fish community
- Represents diversity in settings across the state
- Used to estimate impacts of withdrawal on fish communities
- Allows setting of thresholds
  - Thresholds are different for different settings
  - Set through legislative process
- *Preserve the geography of flow*
Ecological Response Curves

**Basic Data**
- Fish surveys for 60+ species from 1,720 sites, 1980-2006
- July mean water temp (JMT) (estimated by regional kriging and linear regression)
- Baseflow (median August) yield (BFY) (estimated by linear regression of catchment attributes)
- Catchment area (CA; GIS)
- Surficial geology (GIS)

**Models**
- Fish assemblage model
  - Method described herein
  - Clustering of river reaches plus expert refinement
  - Multivariate regression tree analysis plus expert refinement
  - River segment delineation
    - ~9,000 segments statewide
  - River segment classification
    - 11 stream types

**Outputs**
- Predicted fish assemblage metrics per segment, as a function of CA and initial BFY and JMT values
- Run fish assemblage model per ~20 representative segments per each river type
- Predicted response in fish assemblage metrics as function of % BFY reduction
- Results averaged within river types
- Fish metric response curves for each river type; river types assigned to all segments statewide.

Zorn and others, 2012
SIZE CLASSES

STREAM

SMALL RIVER

LARGE RIVER

EXPLANATION
- Thriving Fish Species
- Characteristic Fish Species
- A-Line
- B-Line
- C-Line

FRACTION OF INITIAL POPULATION METRIC

FRACTION OF INDEX FLOW REMOVED
Screening Tool: Identify withdrawals less likely to cause adverse resource impacts

- Recognize and allow withdrawals that will likely not have adverse impacts.
- Register the use.
- Increase efficiency and limit regulatory oversight.
- Make system more user driven.
- Withdrawals that do not pass screening may be submitted for site-specific review.

http://www.deq.state.mi.us/wwat/
Great Lakes Basin

- Given science components of Michigan implementation of the Compact – can we provide same information regionally?
- Great Lakes Restoration Initiative
Role of NHD and NHDPlus

- Streamflow estimates: need stream network and catchments to get landscape information for unaged stream estimates (Luukkanen and others, 2014)
- Stream temperature modeling
- Fish presence and abundance
- Streamflow classification
AFINCH

- Analysis of Flows in Network of Channels
- Constrained regression technique
  - Linear regression to estimate yield from catchments
  - Yield * area = incremental flow from catchment
  - Sum incremental flow down the network -> streamflow
  - Estimates are corrected by adjusting incremental yields upstream of observed flows at streamgages
    - Resulting estimated monthly flows match observed at active gages used in the regression step
Ecoflows Flow-Response Curves - Provisional

- Period of Record 1979-2011 August median yield (cfs/mi$^2$).
- Cumulative Catch-per-unit-effort versus yield is graphed
  - Look for areas of rapid change: population sensitive to yield
- Response curves show reductions in suitable habitat with changes in flow.
Provisional: for illustration only

Brook Trout - Applied to all streams & small rivers. Based on the slopes of abundance trendlines. Note that the slope curves have different shapes for different size-temperature classes.
Resources