Importance of Ecological Flows for Healthy Rivers

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Overview

- Flows and aquatic ecosystems
- Threats to hydrology
- Defining environmental flows
- Environmental flows in planning and management
Key factors for aquatic ecosystems

**Hydrologic Regime**
(surface flow, groundwater, surface inundation, and soil moisture regimes)

**Physical Habitat Conditions**
(woody debris, riparian canopy, geomorphology, sediment/soil regime)

**Connectivity**
(up-down gradient continuity, water-wetland-land connectivity)

**Biological Composition & Interactions**
(energy regime, feeding, 1 & 2 production, target structure & composition, competition & predation, reproduction, disease & parasitism, mutualism)

**Water Chemistry Regime**
(salinity, alkalinity, hardness, temperature, dissolved minerals, dissolved gases, turbidity, pH, ORP, radioactivity, organic compounds)
Adaptations to flow

www.dec.ny.us/website/dow/stream/empfamilies.htm
Current and body shape

- Sunfish and bullheads with broad body forms are adapted to slow current.

- Stonecats and trout with streamlined body forms are adapted to fast current.
Flow Events (lows, highs, floods)
Flow Components

Many studies have shown that altering one or more flow regime components can significantly impact biota
Proportion of U.S. Species at Risk
Fish at Risk by Ecoregion

Walsh et. al, 2009
Threats to Hydrology

- Dams
- Water withdrawals
- Land use change
- Climate change
Dams

- Barrier to movement
- Trap sediment
- Change temperature
- Change flow regime
Snail Darter – 1970s

Knoxville News Sentinel
Water withdrawals

2010 withdrawals by category, in million gallons per day:

- Public supply: 42,000
- Self-supplied domestic: 3,600
- Irrigation: 115,000
- Livestock: 2,000
- Aquaculture: 9,420
- Self-supplied industrial: 15,900
- Mining: 5,320
- Thermoelectric power: 161,000

Values do not sum to 355,000 Mgal/d because of independent rounding.

Source: USGS
Consumptive Loss

- Natural water supply (Rain/snow)
- Water import or desalination
- Water use
- Water withdrawal
- Return flow
- Consumptive loss

Adapted from: Chasing Water, Brian Richter (2014)
Land use change

Natural Ground Cover
- 25% shallow infiltration
- 25% deep infiltration
- 40% evapotranspiration
- 10% runoff

10%-20% Impervious Surface
- 21% shallow infiltration
- 21% deep infiltration
- 38% evapotranspiration
- 20% runoff

35%-50% Impervious Surface
- 20% shallow infiltration
- 15% deep infiltration
- 35% evapotranspiration
- 30% runoff

75%-100% Impervious Surface
- 10% shallow infiltration
- 5% deep infiltration
- 30% evapotranspiration
- 55% runoff
Climate Change

- Changing baselines
- More extreme weather at both ends – droughts and floods
- Impacts on infrastructure, availability, quality
Delta Smelt - today
“The full range of natural intra- and inter-annual variation in hydrologic regimes, and associated characteristics of timing, duration, frequency, and rate of change, are critical in sustaining the full native biodiversity and integrity of aquatic ecosystems.”

(Poff et al. 1997)
Environmental flows describe the quantity, timing, and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems.

Environmental flow management provides the water flows needed to sustain freshwater and estuarine ecosystems in coexistence with agriculture, industry, and cities.
Maintaining Natural Flow Patterns

1. Retain flood magnitude, to scour channel and vegetation, recharge river banks and floodplains
2. Maintain baseflow and thus aquatic habitat in dry season
3. Retain spring flushing flow as cue to life cycles
4. Vary baseflow in wet season, but with removal of some floods

From: “Rivers for Life: Managing Water for People and Nature” by Sandra Postel and Brian Richter, Island Press

Courtesy of TNC
These would flood Augusta
Environmental Flow Recommendations
Savannah River, USA (below Thurmond Dam)

**Flooding**
- **Low Flows**
  - <5,000 cfs
    - Adequate floodplain drainage
    - Create shallow water habitat for small-bodied fish
  - 3,000 cfs; 3 successive years every 10-20 years
    - Floodplain tree recruitment

- **High Flow Pulses**
  - >8,000 cfs
    - Larval drift for pelagic spawners
  - >30,000 cfs; 5 pulses, >2 days with 2 events of 2 week duration (March and early April)
    - Maintain channel habitats
    - Create floodplain topographic relief
    - Provide fish access to the floodplain
    - Control invasive species
    - Maintain wetlands and fill oxbows and sloughs
    - Enhance nutrient cycling & improve water clarity
    - Disperse tree seeds
  - 20,000-40,000 cfs; 2-3 days, 1/month
    - Provide predator-free habitat for birds
    - Disperse tree seeds
    - Transport fish larvae
    - Flush woody debris from floodplain to channel
    - Floodplain access for fish
    - Fish passage past NSBLD
  - <13,000 cfs; 3 successive years, every 10-20 years
    - Floodplain tree recruitment

- **Floods**
  - 50,000-70,000 cfs; 2 weeks, avg every 2 yrs
    - Maintain channel habitats
    - Create floodplain topographic relief
    - Provide fish access to the floodplain
    - Control invasive species
    - Maintain wetlands and fill oxbows and sloughs
    - Enhance nutrient cycling & improve water clarity
    - Disperse tree seeds
  - >8,000 cfs
    - Larval drift for pelagic spawners
  - 8,000-12,000 cfs
    - Exchange water with oxbows
  - 20,000-40,000 cfs; 2-3 days, 1/month
    - Provide predator-free habitat for birds
    - Disperse tree seeds
    - Transport fish larvae
    - Flush woody debris from floodplain to channel
    - Floodplain access for fish
    - Fish passage past NSBLD

**Details**
- 20,000-40,000 cfs; 2-3 days, 1/month

- **Purposes**
  - Provide predator-free habitat for birds
  - Disperse tree seeds
  - Transport fish larvae
  - Flush woody debris from floodplain to channel
  - Floodplain access for fish
  - Fish passage past NSBLD

**Key**
- Wet Year
- Avg Year
- Dry Year

Source: TNC
Applying Environmental Flows in Planning and Management

Types of Ecological Flow Standards
Instream flow criteria vs withdrawal limits
Minimum flow standards

- $7Q_{10}$ – lowest flow for seven consecutive days every 10 years
- Minimum of mean annual flow – e.g. 30% MAF
- Variable mean annual flow by season
Statistically based standards

- Maintain characteristics of flow regime
  - E.g. protect certain high or low flows with certain frequency
Percent of Flow Standard

- Can only remove X% of flow going by certain point during Y period of time
  - Can vary X or Y
- “flow-by”
Presumptive Flow Standard

Richter (2011)
NC Ecological Flows Assessment

- State-driven, stakeholder process
- Adopted an “85% flow by” approach

How will DWR implement the EFSAB recommendation?

- **Planning tool**
  - Will not override existing permits, such as FERC license.
  - Will not replace site specific studies.
  - Will not change the SEPA minimum criteria – 20% 7Q10

- During the planning process if ecologic integrity is determined or projected to be adversely impacted, we will flag the river reach for additional studies.
Developing Environmental Flows

**Challenges Include:**

- identifying what components of flow are ecologically most critical in a particular river system
- quantifying those flow components to help guide water management
- incorporating new knowledge and understanding into water management over time
- achieving these tasks for all rivers within resource constraints
Developing Environmental Flows

* A Four Level Approach *

- Level I: Hydrologic Desk Top Method
- Level II: Experts Workshop
- Level III: Detailed Instream Flow Studies
- Level IV: Adaptive Refinement
Opportunities

* Hydropower relicensing
* Water withdrawal permits
* CWA standards
* Basin planning
* Voluntary processes
* Corporate replenishment
Resources

- **Southern Instream Flow Network** - http://southeastaquatics.net/sarps-programs/sifn
Thank you

www.rivernetwork.org