Review of Instream Flow Methods and Application to Baron Fork Creek

Presented to
Oklahoma Instream Flow Advisory Group

Presented by
Forrest Olson, CH2M HILL

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US Army Corps of Engineers

WRB

CH2MHILL

Oklahoma does not have a formal instream flow protection program, but the topic is considered in other processes:

Federal Processes

- Oklahoma's Interstate Stream Compacts with New Mexico, Texas, Kansas, Arkansas, and Louisiana
- Endangered Species Act
- Section 10 of Rivers and Harbors Act (navigation by the Corps of Engineers)
- Section 404 Clean Water Act: (dredge and fill by the Corps of Engineers)
- Section 401 Clean Water Act, Water Quality Certification
- Federal Power Act (Federal Energy Regulatory Commission)
- National Environmental Policy Act

State Processes

- Oklahoma Outstanding Resource Waters
- Oklahoma Scenic Rivers Act
- Oklahoma Comprehensive Water Plans
- Oklahoma domestic use set aside policy (24 acre feet per sq mi)

Methods of Quantifying Instream Flow *Needs*…. but first:

- How much water do fish *need*?
- How high is up?

Instream flow issues are matters of <u>*values*</u> *more so than science*

Principles of Stream Ecosystem Function

- The 3 master parameters:
  - Landscape
  - Flow Regime
  - Sediment Regime
- The three parameters act in dynamic equilibrium, so that if one parameter changes so do the other two
- Understanding these principles is critical in considering alternative instream flow regimes especially in regulated rivers

Environmental (ecological) Flow Regimes

- Flow conditions necessary to support a sound ecological environment
- Four Major Flow Components:
  - **Subsistence Flows** – low flow but enough to meet water quality criteria and prevent direct fish mortality (e.g. 7Q10 flow)
  - **Base Flows** – "normal" conditions between significant precipitation events. Emphasis typically in summer
  - **High-flow Pulses** – brief high flow events but within channel. Supports habitat creation and maintenance, connectivity, and fish migration
  - **Overbank Flows** – maintain riparian, transport sediment and nutrients, recharge aquifers, lateral connection to other water bodies

Major vs. Minor Projects

- In deciding what instream flow method/approach is best, must consider size/nature of the proposed water project

  - **Major** projects include those that regulate flow (storage and release) or involve the setting of basin-wide instream flow standards

  - **Minor** projects are those that don't significantly affect the annual hydrograph or are temporary in nature

Three levels of Instream Flow Consideration

- **Reconnaissance or Planning Level** – Identify instream flow concerns
- **Feasibility Level** – determine if proposed water project is compatible with instream flow resource uses
- **Operational Level** – quantify impacts, develop mitigation, negotiate operational strategies

Types of Instream Flow Methods

- **Hydrologic** – Desk-top methods based on examination of stream flow statistics. Typically based on mean annual flow (MAF) or monthly median flows. Tennant Method is most common

- **Hydraulic** – Requires site-specific data to determine hydraulic responses to flow increments. Wetted Perimeter method is most common

- **Incremental** – produces relationships between stream flow and habitat for selected fish species. The Instream Flow Incremental Methodology (IFIM) is the most used method

Important questions before applying any instream flow method:

- Do we use existing flow conditions or natural (unimpaired) flow conditions? The baseline question.
- Are we protecting existing resource conditions or attempting to restore to natural conditions?

Question of values, not science.

The Tennant Method (and modifications):

- Recommended instream flows by the Tennant Method.

Narrative description of flows	Recommended Flo (percent of mean annual flow)	
	Low Flow Period	High Flow Period
Flushing or maximum	200%	200%
Optimum range	60% – 100%	60% – 100%
Outstanding	40%	60%
Excellent	30%	50%
Good	20%	40%
Fair or degrading	10%	30%
Poor or minimum	10%	10%
Severe degradation	< 10%	< 10%

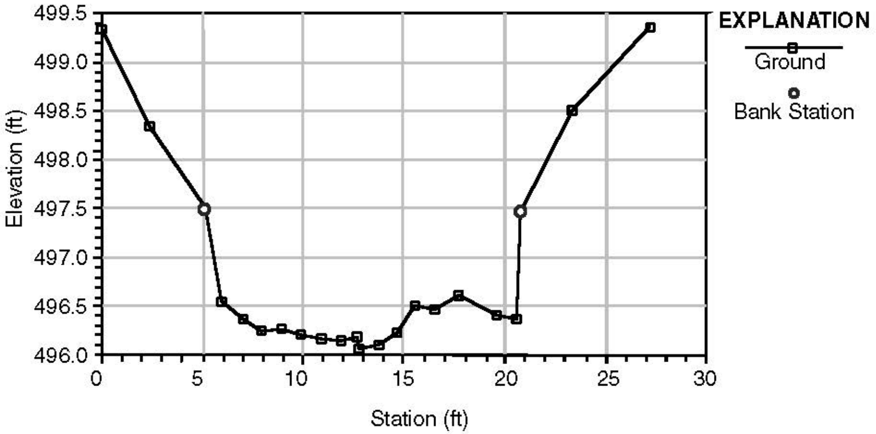
Attributes of Tennant Method

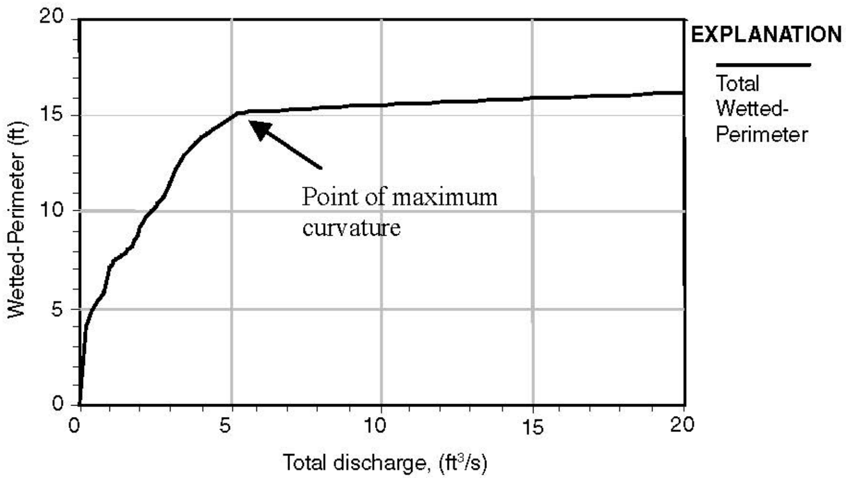
- Simple
- Flexible
- Value driven
- Affected by stream size (but method assumes not)
- Affected by year-to-year variability in MAF
- Affected by stream hydrologic type

Use of Median Monthly Flows for Determining Instream Flow Needs

- The use of monthly or seasonal median flows for recommending minimum instream flows is based on the principle that fish in a particular stream have adapted to the historic streamflow regime, which, at least for baseflows, is best defined by median rather than mean flows.

Wetted Perimeter Method

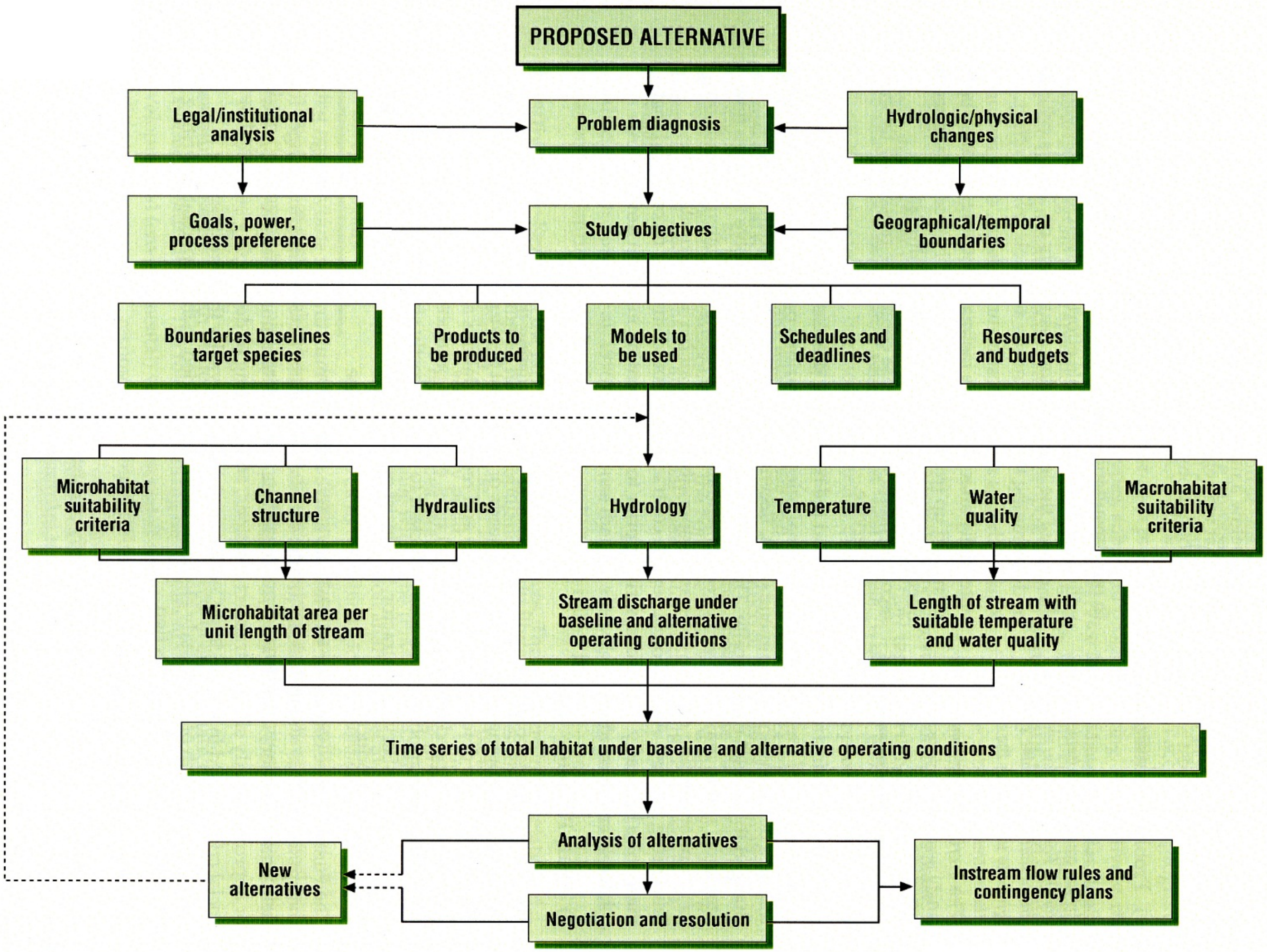




Instream Flow Incremental Methodology

- IFIM is a methodology not a method
- Does not prescribe an instream flow value
- Provides technical information to the decision making process about the affects of alternative flows
- Information subject to different interpretations based on professional opinions <u>and</u> values
- Designed to evaluate <u>alternative</u> instream flows
- Intended for a negotiated resolution

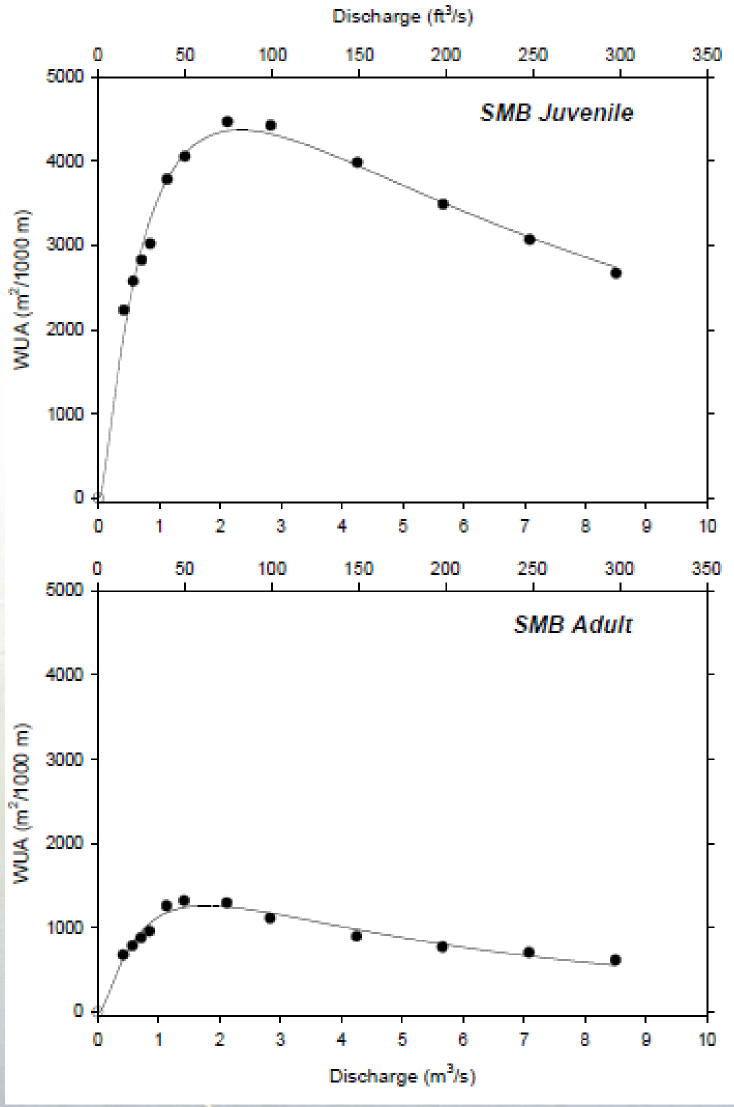
IFIM Activities and Information Flow



Source: Bovee et al., 1988

Activities and Information Flow Involved in an IFIM Study

Physical Habitat Simulation Model (PHABSIM) is the primary technical tool of IFIM



PHABSIM Results for Baron Fork, Layher 1998 Based on <u>one</u> cross section

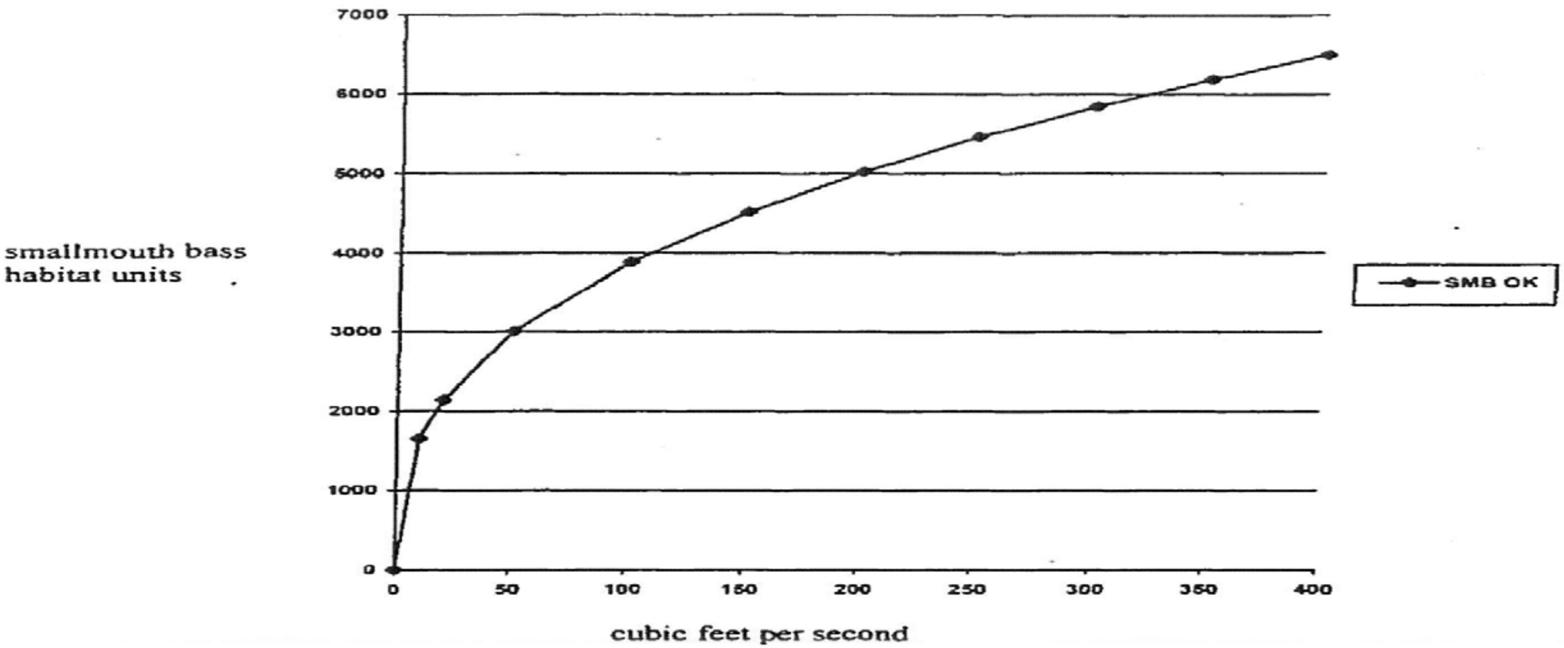


Figure 1

Smallmouth bass habitat units at various flows for the Eldon, Oklahoma stream gauge

"One-size-fits-all" dilemma with hydrologic-based standard setting methods

- Different stream sizes
- Different hydrologic regimes
- Wet year dry year variability
- Regulated *vs*. unregulated streams
- Watershed or stream goals (values)
- Degree of physical/hydrologic alteration

The "one-size-fits-all" dilemma can be addressed by categorizing streams based on above criteria and establishing different instream flow standards or methods for each category.

Can get complicated though.

Baron Fork Creek

Baron Fork Stream Flow Statistics July –November

Discharge for the Summer and Autumn Low-Flow Months in Baron Fork Creek at Eldon (1948–1999)					
Statistic (condition)	Discharge (cfs)				
	July	August	September	October	November
25th percentile (dry)	40	24	19	23	40
Median (normal)	71	44	36	50	79
75th percentile (wet)	130	75	71	99	259
Monthly mean	155	76	129	178	311

Results of Various Instream Flow Methods Applied to Baron Fork Creek

Methods	Resulting Minimum Flow in Baron Fork (cfs)
State Standard Setting:	
Arkansas—100% of median flow (July–October), or 50% of mean monthly flow (July–October)	**50** cfs / **67** cfs
Kansas—Generally 80% of monthly median (some streams are set at 90%)	**40** cfs
Texas (Lyons Method: small diversions)— 60% of monthly median flow (March–September), 40% of monthly median flow (October–February), or 7Q2 flow if higher	**30** cfs (July–September)
Georgia (modified Tennant Method)—30% mean annual flow	**100** cfs
South Carolina (modified Tennant Method)—20% mean annual flow (July–November)	**66** cfs
Orth and Maughan (1981) modified Tennant for OK—10% mean annual flow (July–December)	**33** cfs
Other Methods	
Wetted perimeter	**~50** cfs
PHABSIM shallow-fast habitat guild	**50** cfs (peak of habitat curve), **30** cfs (80% peak of curve)
PHABSIM smallmouth bass	**50–75** cfs (peak of curve), ~ **30** cfs (80% peak of curve)
Oklahoma domestic use set aside	**10** cfs (at Eldon)

Baron Fork PHABSIM Results for Habitat Guilds

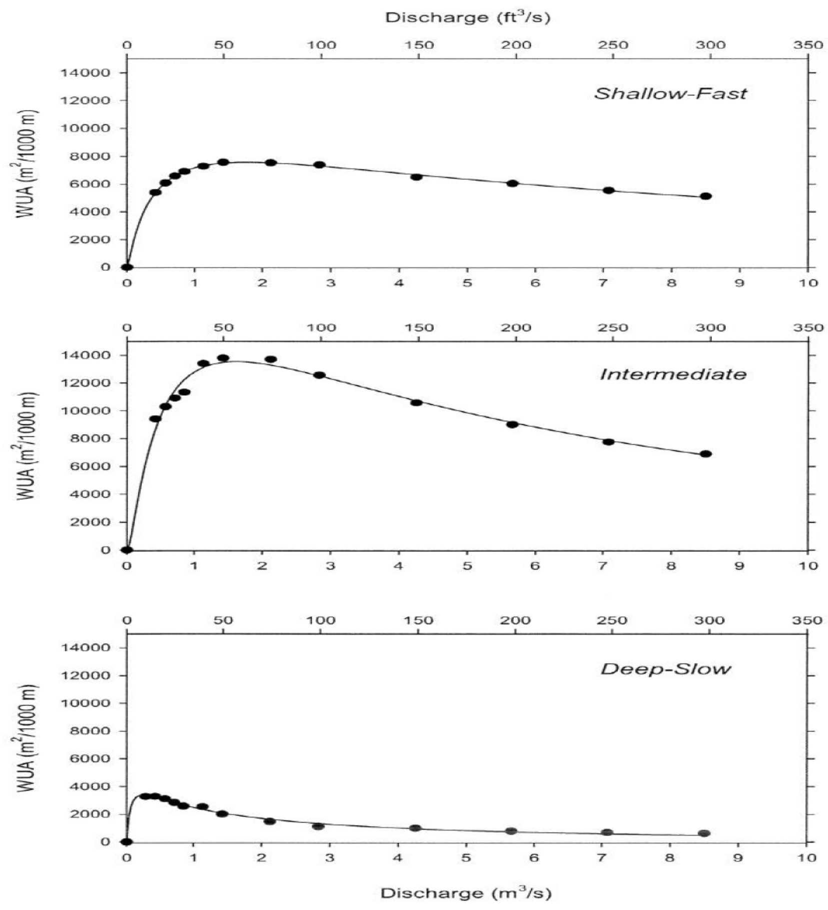
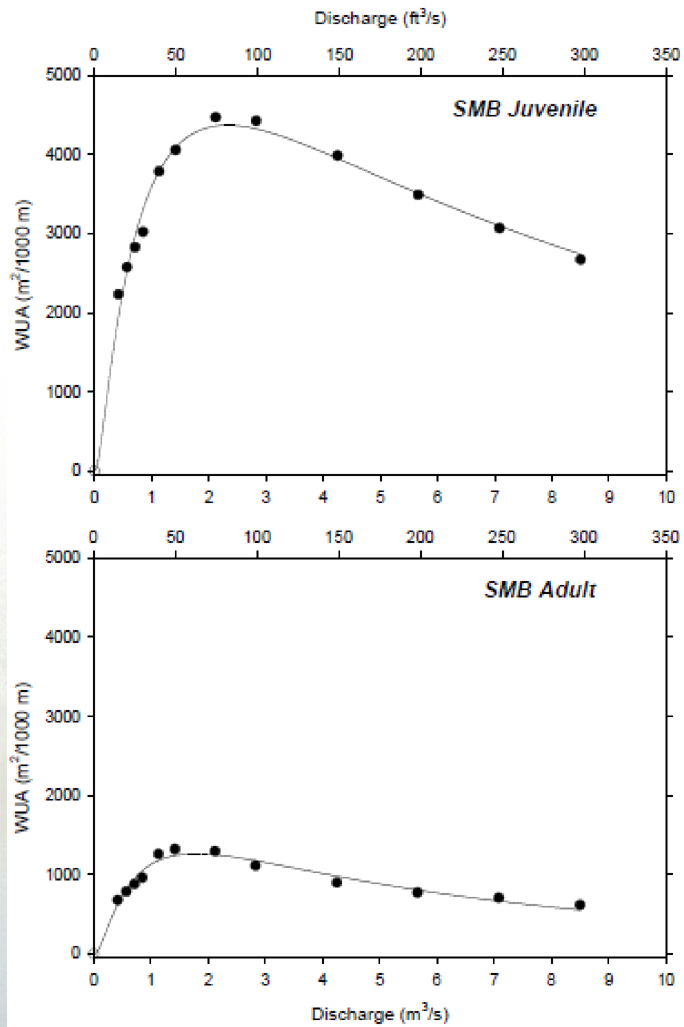


Figure 11.--Relationship between weighted usable area (WUA) and discharge for shallow-fast, intermediate, and deep-slow habitat-use fish assemblages in Baron Fork, Oklahoma.

Baron Fork PHABSIM Results for Smallmth Bass



Domestic Use Set Aside

- Domestic Use Set Aside water for Baron Fork at Eldon equates to a flow of 10 cfs
- This flow is considerably less than what other ISF methods recommend and is only 20% of the existing minimum instream flow

Conclusions

- Instream flow issues are as much about values as science.
- Acknowledging that ISF recommendations from desk-top methods are ‘preliminary’ or ‘planning level’ helps make their use more acceptable.
- When deciding on an ISF method/approach, a regulatory agency must balance the need to be uniform and consistent with the reality that each stream, proposal, and circumstance is different.
- Most IFS methods suffer from the one-size-fits-all dilemma.
- Applying different ISF methods or standards to different categories of stream types or project types can help address the one-size-fits-all dilemma.

Conclusions (continued)

- Instream flow recommendations for the Baron Fork using six hydrologic-based methods range from 30 cfs to 100 cfs. The wide range reflects differences in the level of stream protection (a value) implicit in each method.
- The IFIM study of the Baron Fork yielded results that would support a summer minimum flow ranging from 30 cfs to 75 cfs depending on how the results are interpreted (technical) and the level of protection desired (policy).
- The domestic use set aside for the Baron Fork is 10 cfs, which is only 20% of the established minimum flow.

Questions