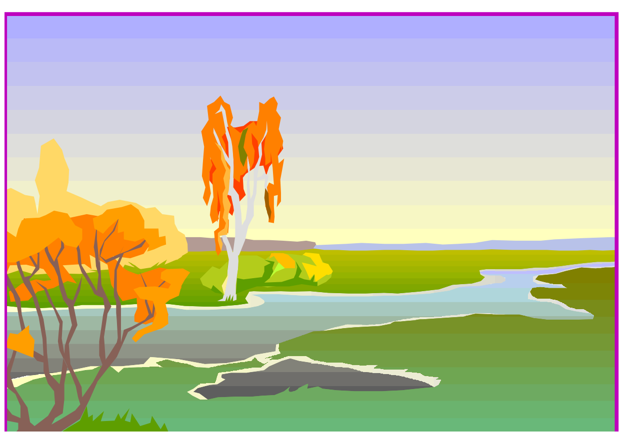
Water Allocation Program Advisory Committee (WAPAC)

Streamflow Subcommittee Final Report



February 2004

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TABLE OF CONTENTS

1. Goals and Objectives……………………………………………………………………….4

2. Guiding Principles………………………………………………………………………….4

3. Background…………………………………………………………………………………4

4. Recommendations…………………………………………………………………………..5

5. Overview of Committee Process and Summary of Technical Presentations and Findings…...8

6. Definitions…………………………………………………………………………………11

7. References…………………………………………………………………………………12

Appendix A – Draft Workplan Outline………………………………………………………..13

Appendix B – The Presentation on Review of Instream Flow Methodologies

Appendix C – The Presentation on proposed RIABF

Goals and Objectives

The goal of the subcommittee is "to develop instream flow standards, including site-specific standards that allow for maximum sustainable use of the State's waters and are protective of the biological, chemical and physical integrity of those waters."

The objectives were developed to direct the work of the subcommittee and are as follows:

- Establish an interim instream flow standard applicable to new withdrawals and for planning purposes.
- Determine acceptable methodologies for measurement and estimation of instream flows to establish site specific standards.
- Identify gaps in streamflow gaging and other data
- Establish scientific framework to create long-term watershed specific instream flow protocols.
- Identify funding needs and sources
- Develop recommendations on implementation of instream flow standards.

Guiding Principles

In addition, guiding principles were also established which facilitate the actions of the subcommittee and are as follows:

- The focus of the subcommittee will be to apply the "best science" available in developing streamflow standards which provide for maximum sustainable use and are protective of the biological, chemical and physical integrity of the State's waters.
- Development of the streamflow standard is not in itself regulatory in nature. Any future adoption of the streamflow standards in regulation will allow for full public participation and follow the Administrative Procedures Act requirements.

The goal, objectives and guiding principles were used to develop a set of work tasks for the subcommittee and can be found in "next steps" Appendix A.

Background

Hydrologists and ecologists have identified five critical components of the flow regime that regulate ecological processes in river ecosystems: the magnitude, frequency, duration, timing and rate of change of hydrologic conditions. These components influence ecological integrity both directly and indirectly, through their effects on other primary regulators of integrity. Modification of flow thus has cascading effects on the ecological integrity of rivers. (Poff et al., 1997)

Ecologically protective flows are considered to be flows that support desirable biota[1] at densities similar to those expected under natural flow conditions. It is acknowledged that natural flows may not be optimal flows and that natural variability in flow over time may adversely impact aquatic biota even in the absence of human influence. According to Armstrong et al., 2001 streams have a natural flow regime that varies within an annual cycle, between wet, dry and normal years, and from upstream to downstream. Consequently, streamflows cannot be expected to meet a minimum summertime requirement at all times or at all sites. Favorable flows for one life stage of a species are often different than those for another stage of the same species, and flow needs of different species can vary tremendously. A wide range of flow magnitudes occur naturally and human needs and actions (e.g., development, dams, withdrawals, discharges) often alter critical components of the flow regime, i.e. duration or frequency of flows. Alterations of the natural flow regime may not always be to the detriment of the biota. In the absence of site-specific data that allow a better understanding of relations between flow and biotic integrity, flows are sought that generally mimic the essential components of the natural flow regime under the assumption that ecological processes will then foster a desirable aquatic community.

Altered stream flows may adversely affect stream ecology. For example, there may be increased water temperatures, decreased dissolved oxygen levels and increased fine sediment deposition, which can result in a shift from cold water to warm water fish species, decreased productivity and increased fish kills, and stream bottoms rendered unsuitable for fish spawning. Low flows can also affect the ability of rivers and streams to assimilate wastewater. These effects and others are discussed more thoroughly in the Connecticut Water Allocation Task Force Report, Ecological Needs Section (MacBroom & Jacobson, 1999) and other sources (Poff et al., 1997)

The recommendations of this subcommittee include methods for estimating natural flows to aid in determining future standards that will protect the ecology of the state's rivers and streams. Flows calculated by these methods should be used to set a context for future streamflow standard regulations and allocation decision-making. Natural flow estimates may provide the basis for developing future instream ecological goals following additional evaluation of their ecological benefit and their potential impacts on water uses, particularly public water supply. These evaluations should include analysis of the following potential impacts: loss of public water supply safe yield; increased frequency of public water supply drought restrictions; and economic and social effects. The actual impact on public water supply and other water uses will depend upon the way in which the flow goals are implemented and integrated with adaptive management strategies and conservation practices to protect the river resource and use it as efficiently as possible. Prior to utilizing any method to aid in determining future stream flow standards, the relationship between flow and habitat value must be scientifically established for all months of the year.

While the ultimate allocation of the state's water resources is beyond the purview of this Subcommittee, it is important that the proposed methods be understood and applied in a balanced context that accounts for the needs of, and impacts to, all lawful water users. The recommended methods should provide policy makers and regulators with the tools necessary to work toward the goal of maintaining or restoring instream habitat without compromising the adequacy of water supplies now or in the future. Before they are applied, the recommended stream flow methods must be rigorously tested to determine their effects on industry, public utilities, water supply, public safety, agriculture, aquatic habitat and other lawful uses of water. Achieving instream ecological goals may not be feasible in some streams due to water use priorities, economic limitations, or physical or technological constraints. Other alternatives such as system interconnection should be explored if these goals are not being met.

Recommendations

On September 4, 2003 the streamflow subcommittee had consensus on six recommendations, as follows:

1. **Watershed specific instream flow protocol is the preferred approach for establishing instream flow standards in Rhode Island. The Subcommittee recognizes that this will take several years to develop and implement. Consequently, the Subcommittee recommends the use of a simplified reconnaissance level method in the interim. The interim method would only be used for new withdrawals and planning purposes.**

   There are two broad categories of instream flow assessment approaches, standard setting and incremental or site-specific. Standard setting methods are typically desktop methods and involve statistical applications of set standards to permits or reconnaissance level planning. Incremental or watershed specific methods are typically project specific, based on detailed relationships between flow and habitat, and involve a lot more expense and knowledge of the response of watershed's critical resources (including fauna and flora) to flow alterations. Specific studies done at a watershed scale entail determination of the habitat requirements necessary to sustain a watershed's critical resources and the role that flow plays in meeting these requirements.
   Recognizing the effort involved in site specific criteria development, the subcommittee recommends that a phased-in approach be used whereby a standard setting method should be used in the interim until watershed site specific instream flow standards are developed.

2. **As watershed specific standards are being developed, the subcommittee recommends use of an interim standard for new withdrawals and planning purposes. The subcommittee has considered a wide range of alternatives, and has found none substantially superior to the RIABF interim standard proposed by DEM. The subcommittee wants to further evaluate the RIABF as the interim standard.**

   The Rhode Island Aquatic Base Flow (RIABF) was proposed to the subcommittee by RIDEM and has been evaluated by technical experts throughout New England. The review process has initiated some valuable comments and as a result the RIABF is undergoing some modifications. Currently, the Department uses the New England Aquatic Base Flow (NEABF) developed by the U.S. Fish and Wildlife Service to permit water development projects. The statistics involved in setting the standard were developed from regional stream gage data collected by the USGS, mostly in northern New England. The RIDEM has taken similar methods used by the USFWS and applied it to Rhode Island data to better represent conditions found within this state. Once the RIDEM has responded to the technical comments, the subcommittee intends to further evaluate the RIABF.

3. **Empirical stream flow methodologies should continue to be accepted as an alternative to the interim method. The R2 Cross and Wetted Stream Perimeter Methods appear to be acceptable methodologies however, the subcommittee recommends the establishment of guidance in application of these methodologies**.

   As described later in this report the R2Cross and Wetted Stream Perimeter Methods are called midrange techniques because they require more field effort than standard setting methods but less than site specific methods. They are not as extensive as some techniques;

they apply more to summer flows and do not provide flow requirements for the entire year. They do offer advantages over the RIABF or USFWS ABF in that they require site-specific evaluations of hydraulic characteristics at critical areas in order to determine the relation between habitat and stream flow. The establishment of guidance is recommended because USGS has made several improvements to the initial protocol.

4. **The Subcommittee recommends development of watershed specific standards that quantify the relation of instream flow to critical stream resources and acknowledges existing uses. The subcommittee recognizes that these recommendations are costly and recommends that funding should be made available for this process**.

   Several steps are required to develop watershed specific standards. First, watershed specific methods such as the Physical Habitat Simulation System (PHABSIM), MesoHABSIM and the Instream Flow Incremental Methodology (IFIM) are applied in order to characterize the relation of flow to the availability of stream habitat throughout the watershed. Once the watershed specific flow requirements are determined, it is possible to input this information, along with information on the current and future demand for water into surface and groundwater models to evaluate the relations of water withdrawals and other hydrologic modifications to flow, and subsequently, habitat availability. Utilizing optimization modeling techniques, it is possible to evaluate alternative management scenarios to allow for maximum sustainable water use while protecting the physical, chemical, and biological integrity of the resource. Priority should be given to watersheds that are approaching safe yield.

5. **The subcommittee recognizes that the stream gaging network needs to be improved and that stream gaging is a vital part of managing streamflow. The subcommittee recommends a statewide stream gaging network that has at least one continuous gage for each USGS 12-digit HUC delineation to acquire long-term data.**

   Stream gages provide basic information on hydrology and are important to evaluate trends and assess instream flow needs. Gage records are important to quantify and monitor instream flow and water availability. Information may be obtained regarding the annual hydrographs of stream and lakes, water budgets, annual and seasonal flow variations, flow response to precipitation or snow melt (IFC 2002). Information from gaged streams may be transferable to streams with similar characteristics. However, the greater the geographic separation and the more different the watershed characteristics, the less applicable data from another stream gage become (Lowham 1988). Therefore, the subcommittee recommends at least one continuous gage for each of the 57 *subwatersheds* (as delineated by NRCS/USGS 12-digit HUC's) to acquire long-term data. The state should maintain the 20 existing stream gages and current groundwater observation wells and develop a priority protocol to establish additional stations.

6. **The subcommittee recommends that during periods of drought or water emergency, use of water, normally within protected minimum flows or levels, be allowed as necessary to protect public health and safety and to prevent widespread economic harm, provided every precaution has been taken to prevent permanent impairment of the biological, chemical, or physical integrity of the water source**.

   This language was derived primarily from the Model Riparian Code in an effort to recognize that during periods of drought or water emergency, all beneficiaries of water are affected. This subcommittee recognizes that droughts will occur and therefore it is imperative that the

State undertakes comprehensive planning and demand management in order to mitigate impacts of drought. When droughts occur all users and uses should share the burden .

Overview of Committee Process and Summary of Technical Presentations and Findings

On **November 19, 2002,** the Office of Water Resources gave a power point presentation of their idea of how to establish an interim streamflow standard for Rhode Island. A copy of the presentation and handout were distributed. The proposed interim standard is available in Appendix C of this document and presents this idea of an interim standard in more detail. The subcommittee was also given a table which outlines the Ecological Responses to alterations of components of flow, the Rhode Island Water Works Association Flow Allocation Policy Position, the Regulated Riparian Model Code – part of chapter 1, and other miscellaneous documents not directly related to this issue. Discussion ensued about how to apply an interim standard and DEM replied that it would be applied to new withdrawals and for planning purposes.
There was also discussion on the purpose and objectives covering a range of perspectives. Agricultural interests stated that that basin specific flow standards were necessary and that the subcommittee's goal ought to be to find the money to support the necessary research.

On **December 10, 2002**, Ralph Abele of the USEPA gave a presentation about the effort of other New England States in setting streamflow requirements and registration programs. The group agreed that the final goal of basin specific standards is the way to go. Agriculture interests are concerned that an interim standard will be applied to existing users and also that it will become a final standard due to the lack of funds to perform basin specific studies. DEM explained that an interim standard is needed for new applications and for planning purposes. Existing users would be evaluated by the basin specific standards.

On **January 14, 2003**, OWR staff responded to questions by Committee members on the proposed interim standard.

On **February 12, 2003,** at the prompting of the WAPAC, the subcommittee developed their work tasks to accomplish the subcommittee's objectives. The work tasks are outlined at the end of this report in the "Next Steps" section.

On **March 17, 2003** a brief overview of the development of the RI ABF was given. A copy of that presentation was available as an attachment to the minutes. The presentation and accompanying discussion resulted in some interesting questions, which will be presented to the TAC for further consideration as part of their review (Attachment B). The group also decided to begin developing site-specific guidance for use in RI. It was decided that the subcommittee should solicit presentations of the various flow-setting and management methodologies from individuals who have applied them in the field. This educational process would provide the group with a good foundation for making decisions on what site-specific methodologies and approaches are appropriate for use in RI.

On **April 30, 2003** Dave Armstrong of the USGS gave a presentation to the streamflow subcommittee on the R2Cross, wetted perimeter, RVA, Tennant, and ABF methods and how they have been applied in New England. In this presentation he laid out that there are different classes of instream flow setting techniques:

- standard setting: desktop, rule-of-thumb methods; uses predefined formulas and existing information; assumes certain flow is generally protective of all habitats; conservative

- mid-range: same as standard setting but requires some field work, usually hydraulic data
- monitoring/diagnostic: assesses conditions and how they change over time; field work requirements vary; assumes certain stream flow is protective of habitat in general
- incremental: analyzes variables to assess different flow management alternatives; targets specific species and determines flow necessary to protect those species

Dave Armstrong gave a brief review of the methods used in studies on Queen/Usquepaug, Ipswich and selected sites on the Charles and Assabet Rivers, as follows:

R2-Cross method, developed in Colorado, is a mid-range standard setting method. The method assumes that if riffles, which are important habitats for macroinvertebrates and reproduction for some fish, are maintained then there will also be good habitat elsewhere in the stream. The streamflow required to protect the riffles is determined from flows that meet mean depth, % of wetted perimeter and mean stream velocity at stream width. However, this method only addresses summer minimum flows to maintain riffles. The natural hydrograph for the remainder of the year is not taken into account.

Stream Bankfull width (ft)	Mean Depth (ft)	% of bankfull wetted perimeter	Mean Velocity (ft/s)
1-20	0.2	50	1.0
21-40	0.2 - 0.4	50	1.0
41-60	0.4 - 0.6	50 – 60	1.0
61-100	0.6 - 1.0	$\geq$ 70	1.0

Wetted perimeter, a mid-range standard setting method, requires field work to gather hydraulic data. This method is based on the same assumption as for R2CROSS. Wetted perimeter is the width of the streambed and banks in contact with water at a particular cross section. The method determines the flow needed to maintain the riffles as the breakpoint in the wetted perimeter vs. discharge curve. The weakness of the method is that the breakpoint in the curve is affected by the channel characteristic; shape, presence of rocks and sandbars, altered or constructed banks and backwater effects from downstream. In addition because this method produces flows necessary to maintain the riffles, it only addresses summer minimum flows. The natural hydrograph for the remainder of the year is not taken into account.

On **May 12, 2003,** Ralph Abele of the USEPA gave an Overview of the Connecticut Interim and Long-Term Streamflow Approaches. Copies of the proposed long-term approach for Connecticut in which they recommended a framework for quantifying the relationship between instream flow and habitat suitability was distributed at the meeting. Also Mr. Phil Zariello presented an overview of the Ipswich River HSPF Model. He discussed the management strategies investigated for the Ipswich to meet water demand and maintain adequate flow.

On **June 2, 2003**, the technical advisory committee met to discuss the RIABF. As of this date the Office of Water Resources is still responding to the discussions and questions raised during the meeting and to the written submittals.

On **July 23, 2003,** a presentation of MesoHABSIM was given by Piotr Parasiewicz of Cornell University. MesoHABSIM is a further development of PHABSIM (physical habitat simulation), which describes the distribution of the physical parameters that are relevant to fish; flow, depth, velocity, substrate and cover. At the scale of hydromorphologic units of riffles, pools and runs, MesoHABSIM takes this model further by predicting the biology, based on the broad range of physical parameters. In addition, it has been adapted to be applied more broadly spatially, over an entire river or watershed instead of being limited to a portion of a river.

At the **August 18, 2003** meeting, it was questioned how standards would be applied, specifically during times of water shortages. The discussion revolved around the model riparian code language. Committee members were referred to page 46, Item 2 of the code refers to actions taken during water “emergencies”. It was noted that the term “emergencies” should not be equated with “shortages”.

Subsequent meetings to the August 18th meeting were used to discuss and finalize the recommendations from the subcommittee and this report. Meetings were held on **September 4, 2003, September 24, 2003, October 8, 2003, October 15, 2003, November 11, 2003 and December 10, 2003.**

During the **December 10, 2003** meeting the subcommittee prioritized the next steps necessary for accomplishing a streamflow standard. These next steps are:

1. To maintain existing gages,
2. To evaluate and modify the proposed Rhode Island Aquatic Base Flow (RIABF),
3. To prioritize new gages with a recommended phase in schedule,
4. To develop a framework for the watershed specific standards.

Definitions

1. Desirable Biota - Robust riverine communities reflective of native stocks.

2. Natural Flow- A flow regime that is consistent with seasonal and annual variations for analogous Rhode Island streams with no anthropogenic flow regulation. The meaning of the word "natural" is not limited to only those conditions that would exist in water draining from pristine land. Conditions that exist in the water, in part due to normal uses of the land, may be considered natural.

3. Regulated Flow- The natural flow of a stream that has been artificially modified by reservoirs, diversions, or other works of humans to achieve a specified purpose or objective. (From IFC 2002)

References

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New England Water Works Association (NEWWA), December 2002. *Recommendations Regarding Water Allocation Policies as They Affect Public Water Systems in New England* .

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RIDEM, Office of Water Resources. *A Presumptive Interim Instream Flow Standard for Rhode Island.* May 2003

Stalnaker C., et al. 1995 *The Instream Flow Incremental Methodology: A Primer for IFIM*

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Appendix A

DRAFT WORKPLAN OUTLINE
Work Plan

The objectives as laid out in the charge of the subcommittee are as follows:

1. Establish an interim instream flow standard applicable to new withdrawals and for planning purposes.
2. Determine acceptable methodologies for measurement and estimation of instream flows to establish site specific standards.
3. Identify data gaps in streamflow gaging and other data.
4. Establish scientific framework to create long-term watershed specific instream flow protocols.
5. Identify funding needs and sources.
6. Develop recommendations on implementation of instream flow standards.

The tasks listed in the attached chart are geared toward meeting the objectives. Each task is given a priority (or timeframe) and an associated agency responsible for completing or overseeing the task.

TASKS	TIMEFRAME	AGENCY
1. Establish an interim instream flow standard applicable to new withdrawals and for planning purposes.		
Respond to questions raised by Streamflow Subcommittee including: • Define “naturally occurring” • Study flow duration curves associated with proposed standard		DEM/OWR
Complete white paper on development of interim instream flow standard		DEM/OWR
Coordinate review by TAC and Streamflow Subcommittee of the white paper		DEM/OWR
2. Determine acceptable methodologies for measurement and estimation of instream flows to establish site specific standards.		
Review and make determinations through the TAC for methodologies (including biological and hydrologic techniques) which will be acceptable for use in RI to develop site-specific standards		
Test methodologies to specific basins to present to the public		
Specifically identify data gaps needed to provide the best outcomes of this task		
Coordinate a public workshop for tasks 1 and 2		
3. Identify data gaps in streamflow gaging		
Identify management objectives to be addressed with expanded flow gaging network		
Present recommendations for adequate flow gaging in RI to subcommittee		

TASKS	TIMEFRAME	AGENCY

Develop plan for attaining adequate flow gaging in RI based on previous task output to include:

- Identification of data gaps to estimate flow on ungaged streams
- Where should partial and continuous gages be located

4. Establish scientific framework to create long-term watershed specific instream flow protocols.

Evaluate available methodologies for developing long-term watershed specific instream flow standards - review approaches taken by other states (CT, MA, PA and NH)

Create protocols for acceptable methodologies for developing long-term watershed specific instream flow standards

Specifically identify data gaps needed to provide the best outcomes of this task

Public Workshop – if needed

5. Identify funding needs and sources

Develop funding needs in order to carry out objectives

Identify funding sources for funding needs – and coordinate with the funding subcommittee

TASKS	TIMEFRAME	AGENCY

6. Develop recommendations on implementation of instream flow standards.

Determine how a flow standard would be applied in normal and "below normal" times

Coordinate with other agencies that may assist in implementation

Implementation strategy for task 4

- Test interim standard and site-specific methodologies on the Blackstone and/or the Pawcatuck Watershed

A Review of Instream Flow Assessment Methodologies

Available Practices and Techniques

Ecosystem Components to be Addressed

- Hydrology (magnitude, frequency, duration, timing, rate of change)
- Geomorphology (channel process, sediment transport)
- Biology (habitat, living space, population relationships, sustenance and perpetuation of indigenous diverse aquatic fauna)
- Water Quality (temperature, dissolved oxygen, contaminants, etc)
- Connectivity (pathways for water, organisms, energy)

(*Instream Flow Council 2001)*

Types of Instream Flow Assessment Tools

Tool	Description	Examples
Baseline	Establishes environmental or reference conditions	RVA IBI, IHA
Standard-setting	Sets limits or rules to define a flow regime	Tennant ABF, Wetted Perimeter R2-Cross
Incremental	Analyzes single or multiple variables to enable assessment of different flow management alternatives	IFIM, PHABSIM RCHARC, SNTEMP Demonstration Flow Assessment
Monitoring / Diagnostic	Assesses conditions and how they change over time	IBI, HQI, IHA

Selected Instream Flow Methods

R2CROSS, Wetted Perimeter, ABF, IFIM, Tennant, IHA

New England Aquatic Base Flow (ABF)

For free flowing unregulated rivers, the ABF is derived from the median of the monthly means. The ABF Method establishes summer streamflow requirements from the August Median Flow. August Median is assumed to represent the month of greatest stress for aquatic organisms because of low flows and high temperatures. There is also a minimum flow during spring and fall for spawning and incubation which is higher than the summer flow.

New England Aquatic Base Flow (ABF) Method

Season (months)	Period	Streamflow
Summer(Jun to Sept)	Low flow	0.5 $(ft^3/s)/mi^2$
Fall/Winter(Sept to Feb)	Spawning and incubation	1.0 $(ft^3/s)/mi^2$
Spring(Mar-May)	Spawning and incubation	4.0 $(ft^3/s)/mi^2$

New England Aquatic Base Flow

PROS

- Used by USFWS on FERC and Army Corps permits
- Incorporates temperature
- Has been defended in court
- Has a default flow for small streams
- Has seasonal considerations in an attempt to mimic the natural flow regime (i.e. magnitude, frequency, timing, duration, and rate of change)

CONS

- Primarily designed for flow releases
- For 50sq. Mi or greater it requires unregulated long term gaging station
- Spring Default value is difficult to attain naturally in south-eastern New England where we do not have significant snow melt
- Difficult to apply to consumptive uses because flow is not naturally met for 1/2 of August and 1/2 of September

R2Cross Method

The R2Cross method requires selection of critical area of the stream, a riffle, and assumes that a discharge chosen to maintain habitat in the riffle is sufficient to maintain fish habitat in the entire stream. Maintaining a riffle includes meeting criteria for 3 parameters which change based upon stream width. They are: mean depth, bankfull wetted perimeter (%) and average velocity

R2CROSS Method

PROS

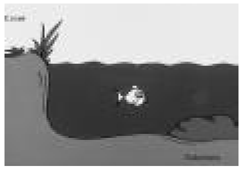
- Don't need gaged data to apply this method
- site-specific habitat assessment produces similar results at some sites to IFIM

CONS

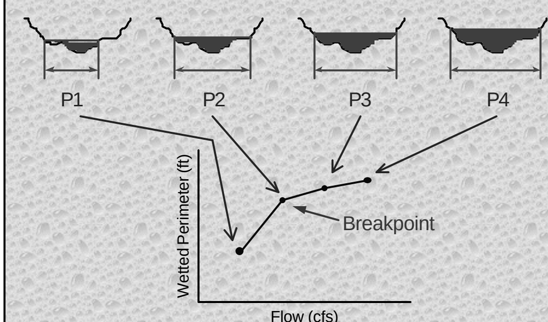
- It was developed in Colorado and requires a 1 ft/sec velocity, some modification would be required for use in RI
- Field intensive
- Does not consider temperature

Wetted Perimeter

This method assumes that the carrying capacity of the stream is proportional to fish-food producing areas and that wetted perimeter in riffles is an index of this relation. Calculations are required to determine the flow that maintains the riffle and fills the "toe of the bank"



Wetted Perimeter Method



(Stalnaker et al. 1995)

Wetted Perimeter Method

PROS

- Don't need gaged data
- Site-specific habitat assessment
- Theories and science are well accepted

CONS

- The "toe of the bank" is subject to interpretation
- Field intensive
- Does not consider temperature
- May not provide adequate depth

Tennant Method

The Tennant Method bases its streamflow requirements on the observation that aquatic habitat conditions are similar in streams carrying the same portion of mean annual flow. Minimum streamflows are considered to be the 40-, 30-, and 10- percent of the mean annual flow which represents good, fair, and poor habitat conditions.

Tennant Method

PROS

- Simple to apply when you have unregulated gaged data
- Works for all stream sizes
- Has a seasonal component

CONS

- Need unregulated streams with 30 or more years of record, or partial record sites correlated to long-term sites
- Influenced by current diversions

Indicators of Hydraulic Alteration (IHA)

A method for assessing the degree of hydraulic alteration attributable to human influence within an ecosystem. The method uses 32 statistical analysis to look at pre- and post- dam construction or groundwater withdrawal to determine if the river systems have been altered.

IHA

PROS

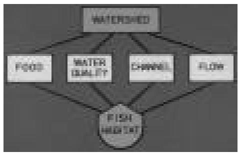
- Can measure if a groundwater withdrawal or an impoundment is causing an impact
- Measures all ranges of flows

CONS

- Must have long-term gaging data before and after event
- Changes must be discrete (e.g. dam or specific withdrawal)

In-stream Flow Incremental Methodology (IFIM)

The methodology is designed to consider each topic listed to the right and in turn, force a decision as to the importance of that topic or variable to the resource being managed and then determine the flow needed by the limiting factor. IFIM is a problem solving methodology utilizing a general problem-solving approach employing a systems analysis techniques.



IFIM

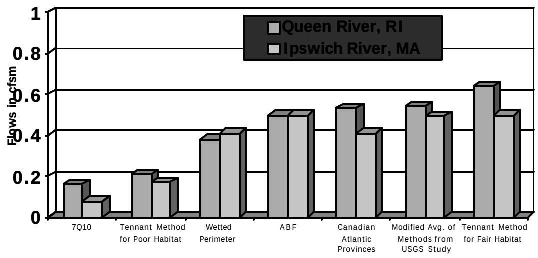
PROS

- Includes all of the major factors for determining minimum flow
- Yield highly detailed site-specific results

CONS

- Extremely field intensive
- Requires computer modeling effort
- This process is a combination of science, art, and experience

How do the methods compare?



A Presumptive Interim Streamflow Standard for Rhode Island

StreamFlow Standard Goals:

- Allow for optimum use and encourage sound management practices
- Be ecologically sustainable
- Be flexible - provide a statewide standard while allowing for site-specific studies
- Not be influenced by current pumping
- Be simple to apply
- Be influenced by site-specific hydrologic factors

Current RI Flow Standards:
Water Quality Regulations

- WQ standards provide water quality and quantity for the protection of the aquatic environment.
- Water Quality Regulations apply to activities that cause or contribute to flow alterations.
- Projects involving flow alterations require a Water Quality Certification.

Current RI Flow Standards:
Freshwater Wetlands Regulations

- Freshwater Wetlands Regulations require approval for activities that may alter the flow into or out of freshwater wetlands.
- RIDEM must find that proposed projects will not result in a significant reduction in: overall wildlife production and/or diversity, suitability for use by wildlife species, or water quality functions and values by modifying or changing water elevations, volumes, velocity of flow regimes, etc.

How have Current RI Flow Standards been Implemented?

- US Fish and Wildlife Service (USFWS) ABF method
  - Median of monthly means from historic records
  - or default values
    - 0.5 cfsm summer
    - 1.0 cfsm fall/winter
    - 4.0 cfsm spring
- Historic releases where critical fisheries and information were present
- Site-Specific based upon biologists assessment for minimum streamflow

New England Aquatic Base Flow

PROS

- Used by USF&W on FERC and Army Corps permits
- Incorporates temperature
- Has been defended in court
- Has a default flow for small streams
- Has seasonal considerations to mimic the natural flow regime(i.e.magnitude, frequency, timing, duration, rate of change)

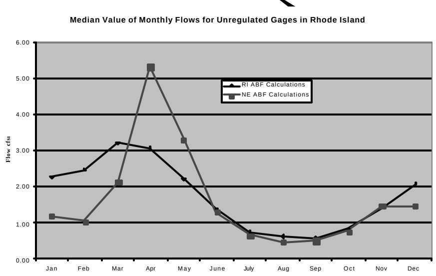
CONS

- Primarily designed for flow releases
- For 50sq. Mi or greater it requires unregulated long term gaging station
- Spring Default value is difficult to attain naturally in south-eastern New England where we do not have significant snow meltr

RI Proposed Modifications to USFWS ABF

- Use 14 RI gages
- Use statistics that better represents RI watersheds
- Use a monthly standard rather than three seasonal standards to better represent natural flow regime
- Adjust for physiographic regions

Comparison of ABF RI Gages vs NE Gages (USFWS)



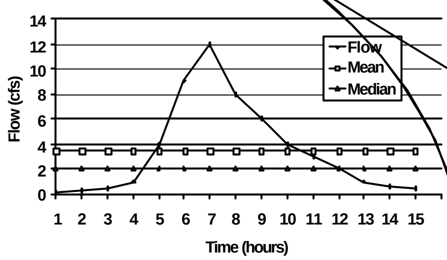
Modifications to USFWS Statistics

- Used RI gage data and calculated the median of the monthly medians rather than the median of the monthly means

Why?

- Median of monthly means can be skewed upward by large storms
- USFWS chose streams with large watersheds (>50mi^2) to ensure that a branching drainage pattern was included to smooth out the effects of localized storms and reduce flow variability
- The majority of the streams in RI have watersheds < 50 mi^2

Can Be Skewed Upward by Large Storms

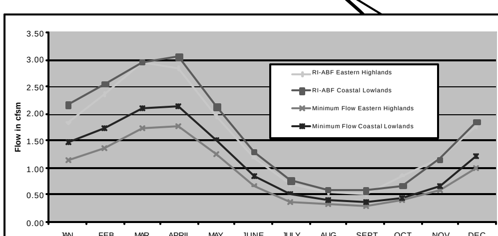


Physiographic Regions

- Studies from Patton, 1988, showed that RI has 2 distinct physiographic regions:
  - Eastern Highlands have shallow alluvial channels before reaching bedrock which yield lower quantities of water
  - Coastal Lowlands have deeper alluvial pockets which yield higher quantities of water

Where are they?

Rhode Island Presumptive Interim Instream Flow Standard



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What Duration and Frequency are Acceptable

- EPA recognizes 4B3 flow as a biologically based flow that protects aquatic habitat from chronic toxicity
- 4 day flow(duration) that occurs once every 3 years(frequency)
  - excursions of stress every 3 years provides an appropriate period of time for aquatic community to recover and function normally until the next excursion
  - if the 4 day average level of a pollutant does not exceed the chronic level once every 3 years the aquatic habitat should not be adversely affected
- Low flows create stresses such as increased temperature and reduced dissolved oxygen

How can 4B3 flow be maintained?

- If the stream is allowed to reach the 4B3 level every year then the principle of the 4B3 is not met
- Therefore, a buffer is needed
- Modeling from the Ipswich River showed that once withdrawals are shut off, the river recovers and mimics a natural flow regime over time
- Using the 4B2 as a minimum should allow the 4B3 to be maintained

Presumptive Interim Instream Flow Standard for Rhode Island

- RI ABF flow
- Minimum flow of 4B2
- Site-specific evaluations as necessary