Public Hearing on the Proposed Souhegan River Protected Instream Flows

University of New Hampshire
University of Massachusetts
Normandeau Associates, Inc.

21 March 2007

Presentation and Reports available online

- http://www.unh.edu/erg/souhegan/
- http://www.des.state.nh.us/rivers/instream/

Env-Ws 1901.01 Purpose

The purpose of these rules is to specify standards, criteria, and procedures by which a protected instream flow shall be established and enforced for each designated river segment on the Lamprey River and the Souhegan River in order to maintain water for instream public uses and to protect the resources for which the river or river segment is designated.

IPUOCR

Instream **P**ublic **U**ses,
Outstanding **C**haracteristics,
and **R**esources

= *protected entities*

Work Tasks

- 1 - Identification and Draft List of IPUOCR Entities
- 2 - Assessment of Well Withdrawal Impacts on Surface Water
- 3 - On-Stream Survey
- 4 - Report Describing IPUOCR Entities and Proposed PISF Methods
- 5 - PISF Assessments and Proposed PISF Report
- 6 - PISF Public Hearing
- 7 - PISF Final Report
- 8 - Assessment of Water Use with the Established PISF
- 9 - Development of WMP Sub-plans
- 10 - Proposed WMP
- 11 - WMP Public Hearing
- 12 - WMP for the Souhegan River Designated Reach

Task 1. Identification and Draft List of IPUOCR Entities

Flow-Dependent IPUOCR Classes

- Human
- Fish
- Rare, Threatened, and Endangered Species (RTE)

IPUOCR and Flow Need

Flow dependent
versus
Non-flow dependent

Task 2. Assessment of Well Withdrawal Impacts on Surface Water

Determine the potential reduction of streamflow due to ground water withdrawals

→ induced recharge

Task 3: On-Stream Survey

Field verify IPUOCR information

Task 4. Report Describing IPUOCR Entities and Proposed PISF Methods

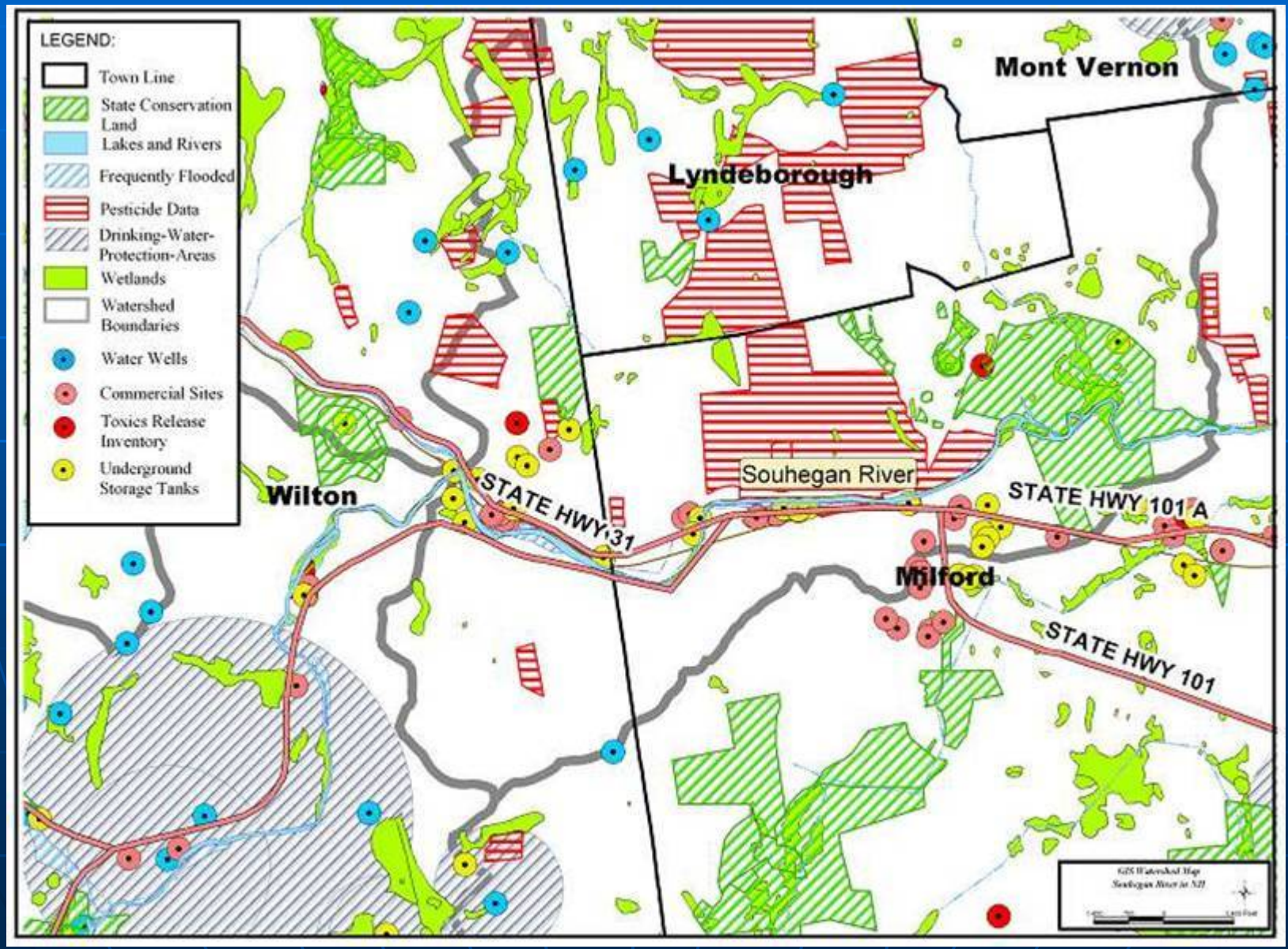
submitted October 1, 2004

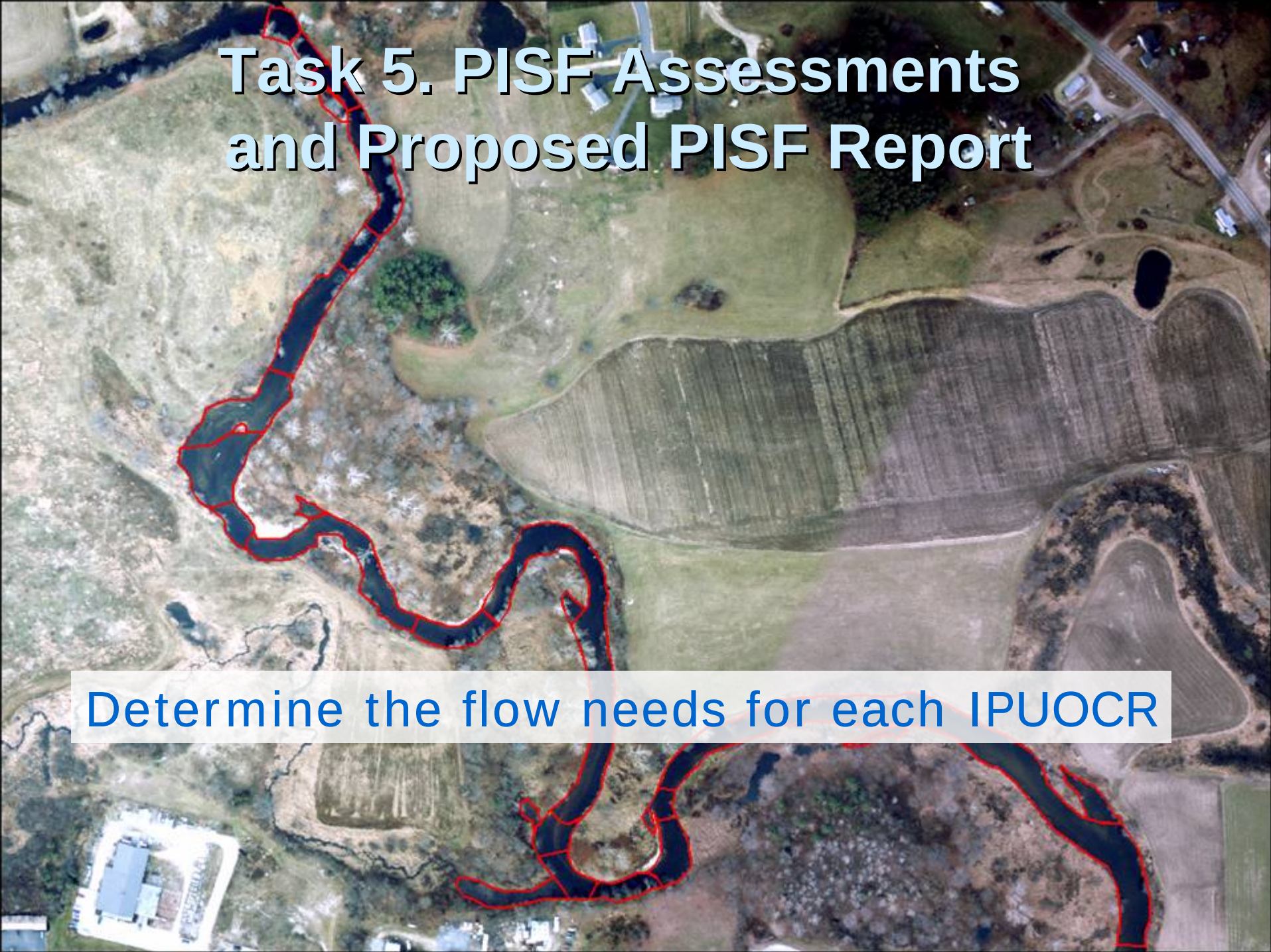
http://www.unh.edu/erg/souhegan/

Methods to Determine the IPUOCR Flow Needs

- Human – Surveys, regulations, interviews
- Fish – Field surveys, reference communities, target communities, modeling
- RTE - Field surveys, reference communities/habitat needs

Presentation of IPUOCR Findings




Task 5. PISF Assessments
and Proposed PISF Report
Determine the flow needs for each IPUOCR

Human Flow Needs

- Recreation
- Fishing
- Water Supply
- Hydropower
- Pollution Abatement

PISF for selected Human-Related IPUOCR				
IPUOCR	Reach			
	Upper Souhegan			Lower Souhegan
Recreation	150 cfs; 4.0 cfsm			Use is not dependent on Souhegan River flow.
Fishing	Use is dependent on Souhegan River flow only to the extent that it protects the fishery resource. Fish and aquatic habitat apply.			
Hydropower	~20 cfs; ~0.7 cfsm	No users	~42.2 cfs; ~0.44 cfsm	No users
Pollution Abatement	2.4 cfs; <0.1 cfsm			9.4 cfs; <0.1cfsm
Water Supply	Use is not dependent on Souhegan River flow			

Units of Flow

- Typically measured and reported at a specific location as *cubic feet per second* (cfs)
- Normally, river flow increase in the downstream direction as more tributaries and baseflow join the main stem
- To compare flows from one location along the river to another, flow is divided by the watershed area at the point of interest. Watershed area is measured in square miles.
- The units of flow divided by watershed are *cubic feet per second per square mile* (cfsm)

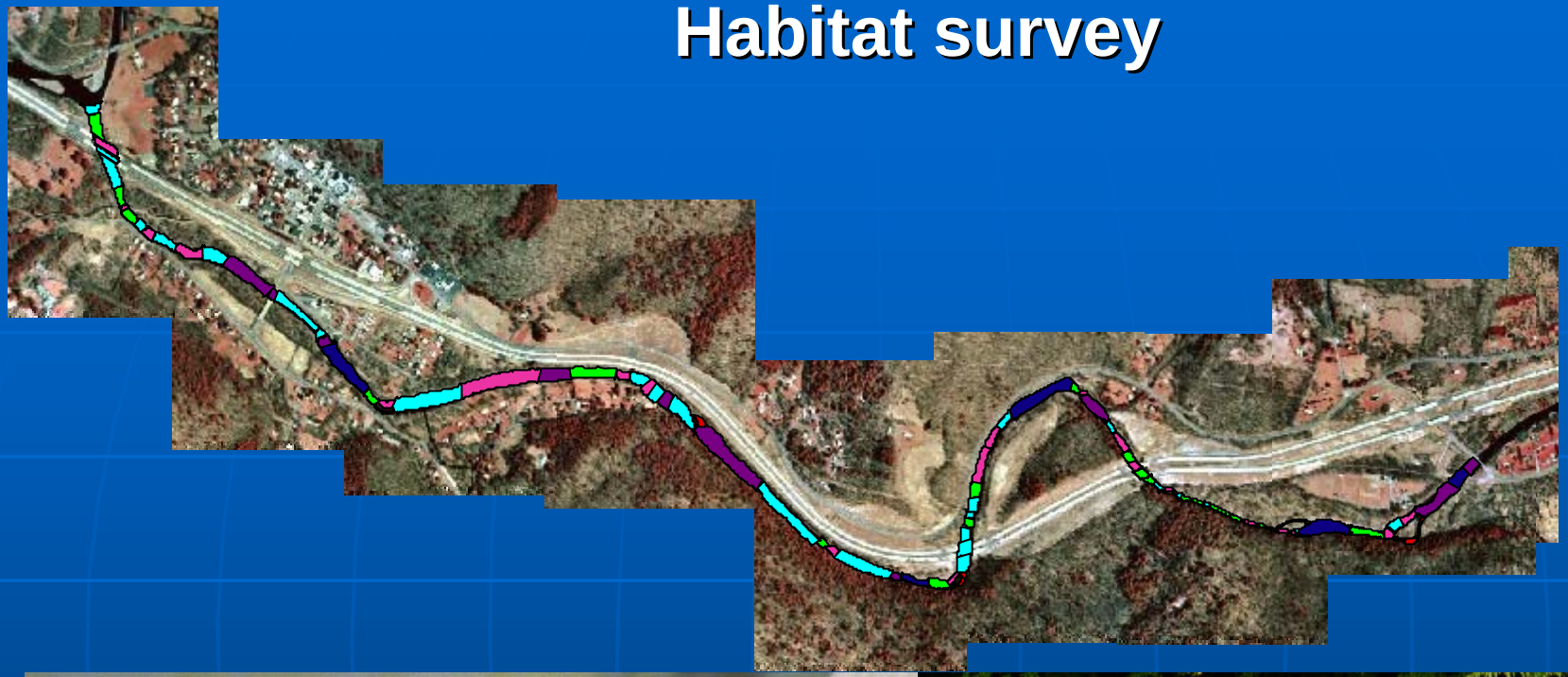
Human ISF

- Hydropower – 0.7 cfsm (Upper Souhegan)
- Recreation – 4 cfsm (Upper Souhegan)
- Pollution Abatement – 0.1 cfsm

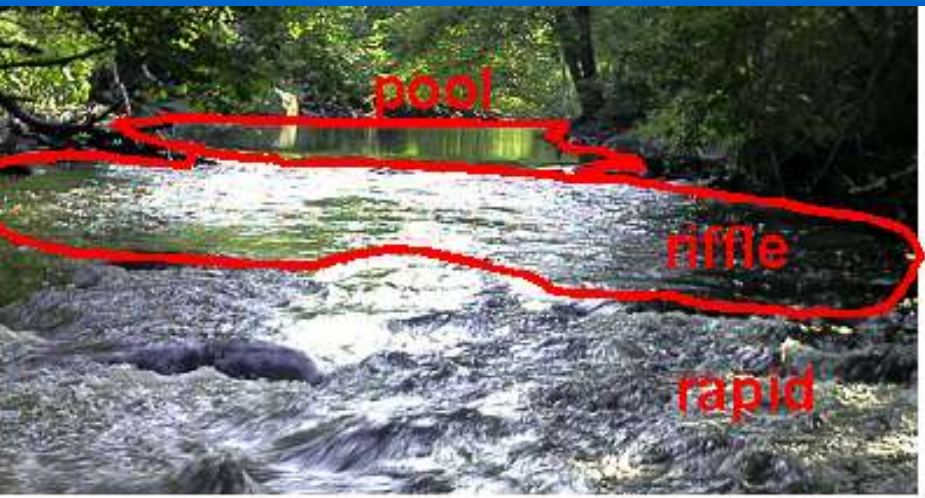
Fish Flow Needs

- Identify the target species
- Identify habitat characteristics and relate habitat to flow need

Habitat survey

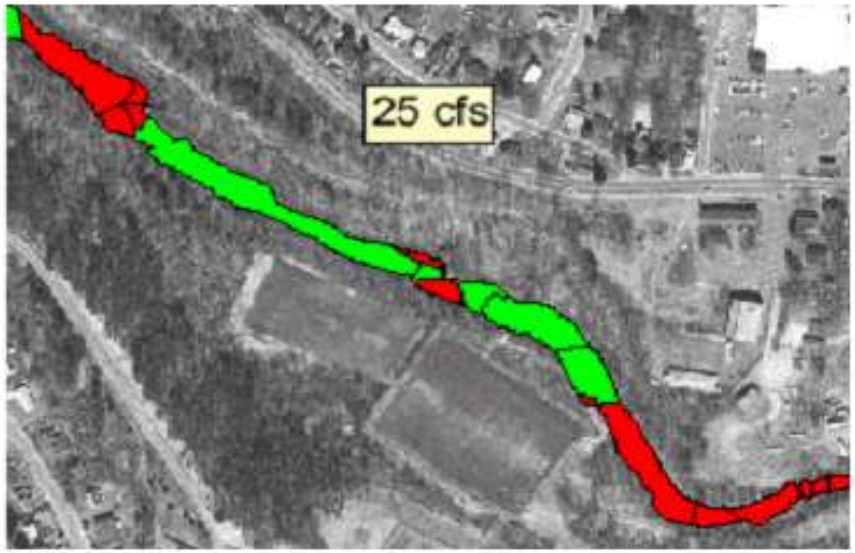


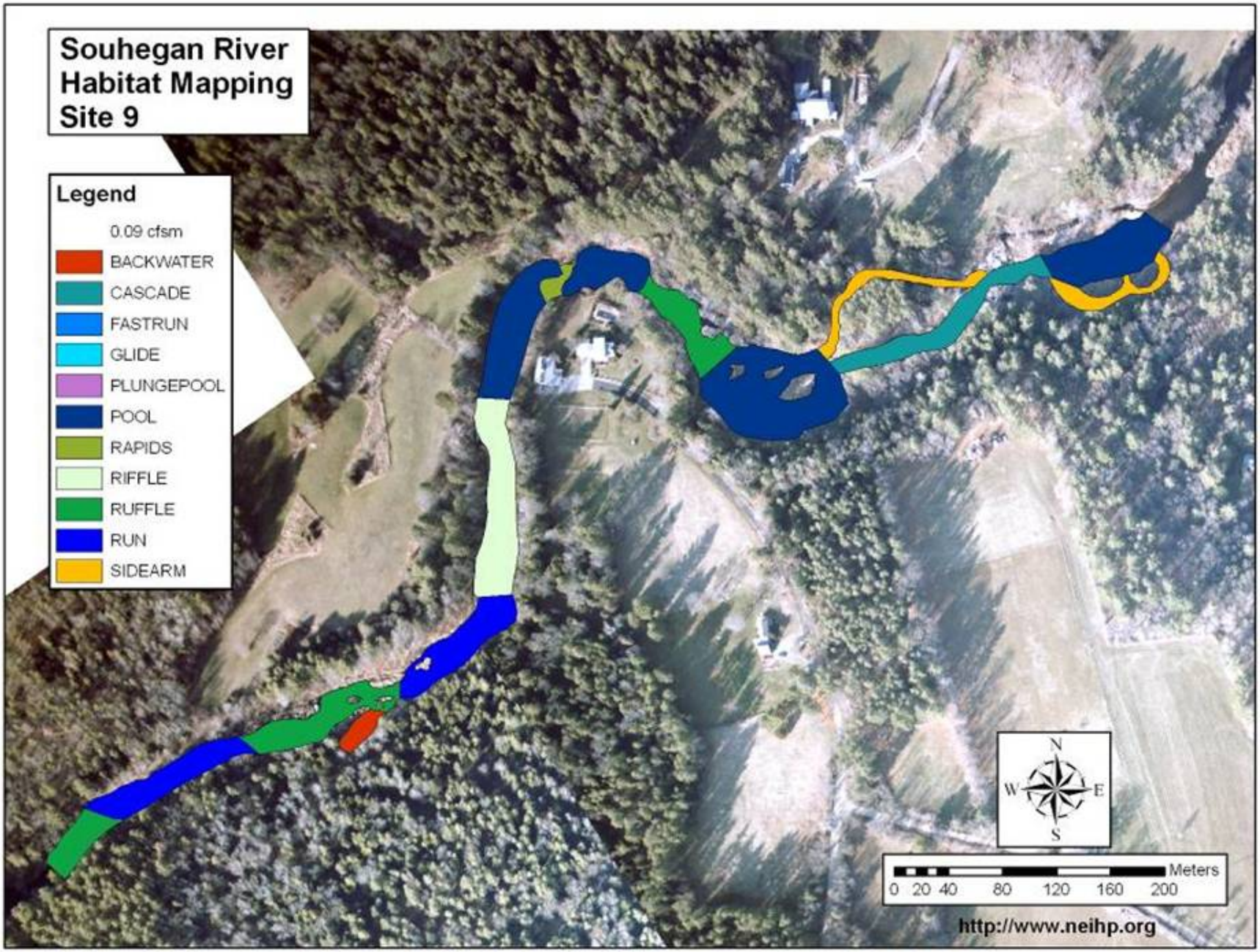
MesoHABSIM

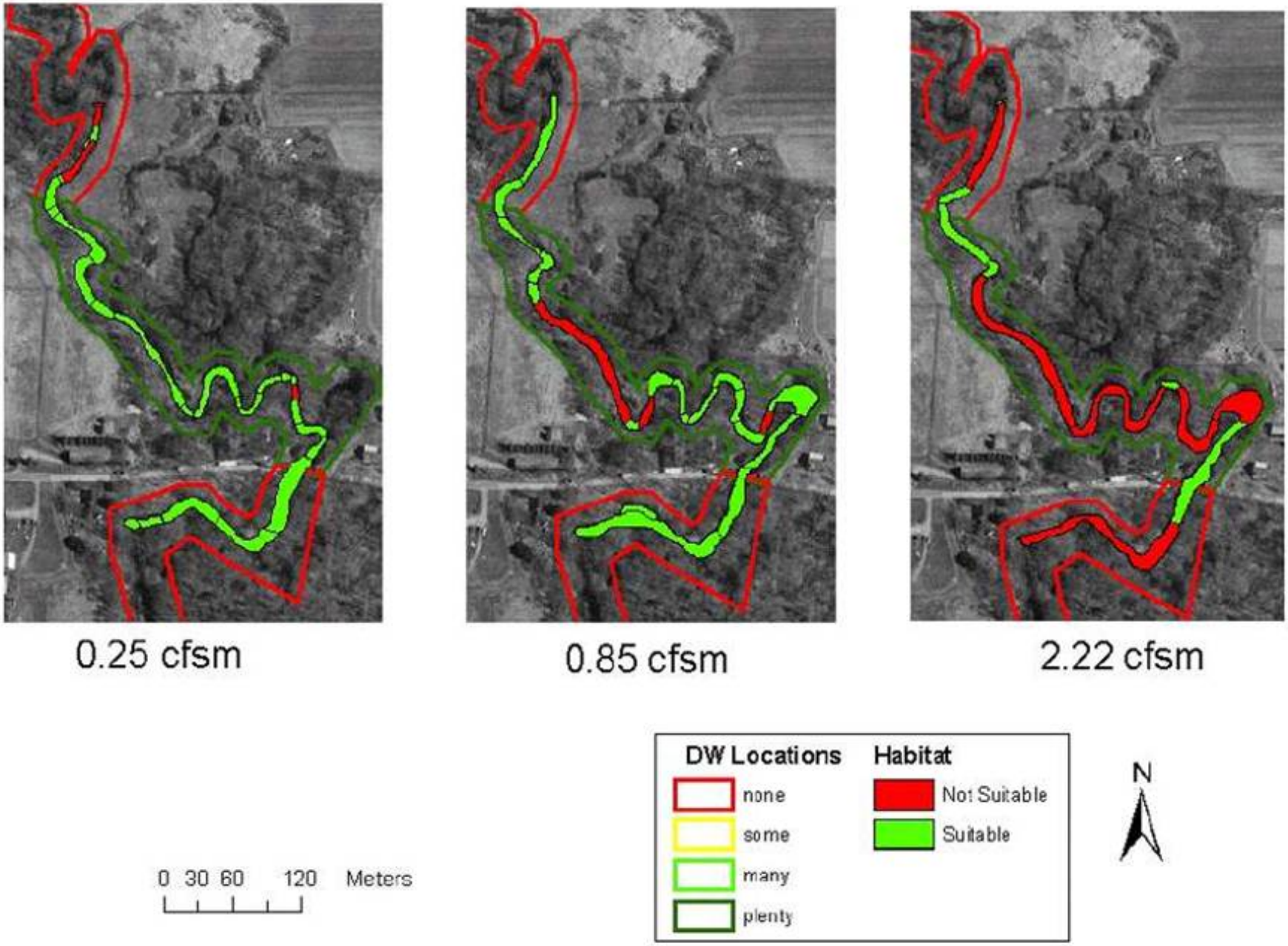


FALLFISH

Presence (76%)		Beta
	BOULDER	1.95
	SHADING	-1.07
	DEPTH 0-25 cm	-1.76
	VELOCITY 45-60 cm/s	1.08
	RUN	-0.57
High abundance (60%)		
	Overhanging vegetation	-0.97




Souhegan River
Habitat Mapping
Site 9
Legend
0.09 cfsm
BACKWATER
CASCADE
FASTRUN
GLIDE
PLUNGEPOOL
POOL
RAPIDS
RIFFLE
RUFFLE
RUN
SIDEARM
N
W
E
S
Meters
0 20 40 80 120 160 200
http://www.neihp.org

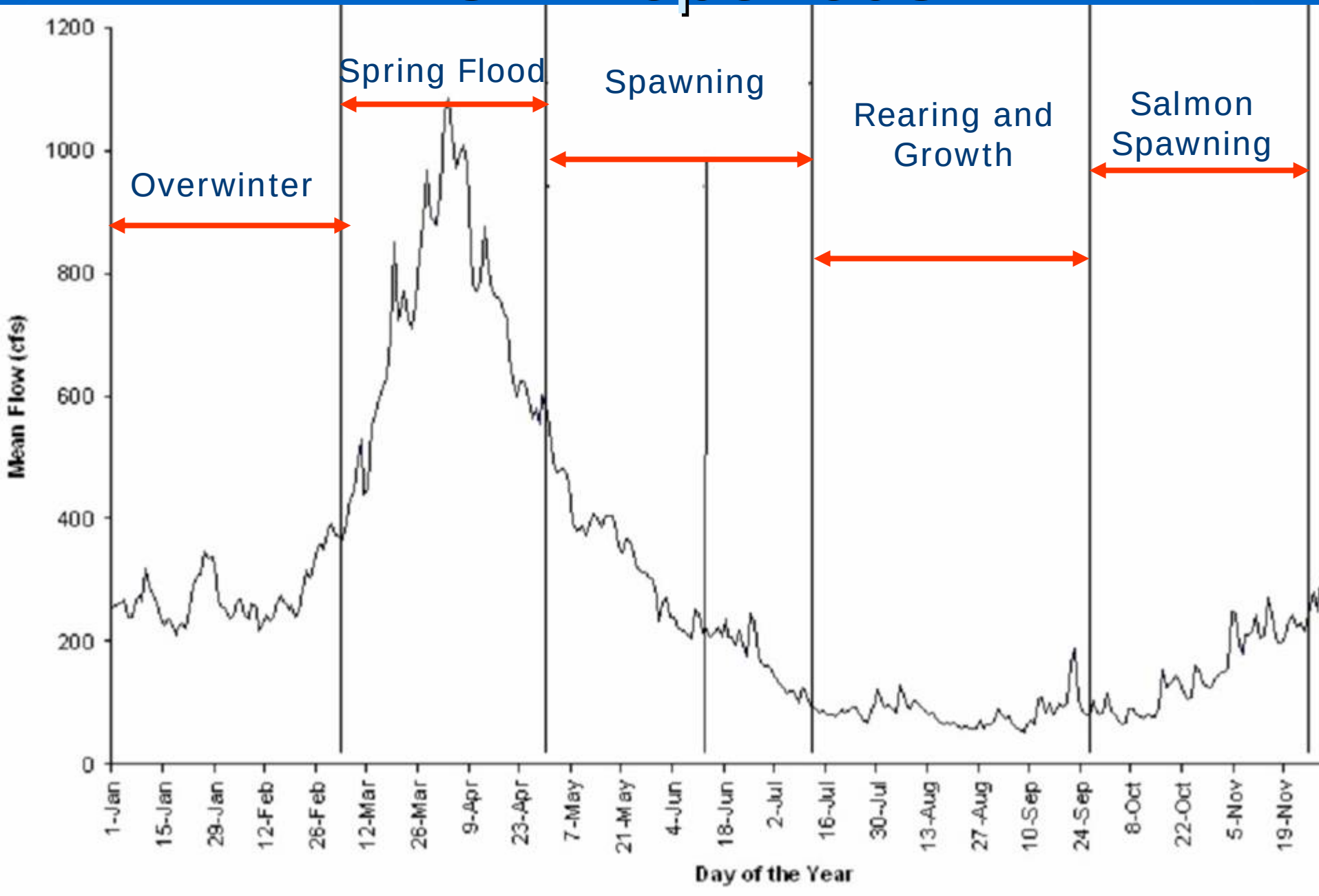


A3: 3. Relative suitable dwarf wedgemussel habitat at Site 2b depicting suitable and not suitable areas. The outline of the study site represents mussel locations in four different abundances.

Fish PISF: Timing, Flow, and Duration

- Timing – Time of year (bioperiods)
- Flow determines the size of the habitat
- Duration is associated with the time that fish can survive stress

Fish Bioperiods



Fish Flow (Habitat) Levels

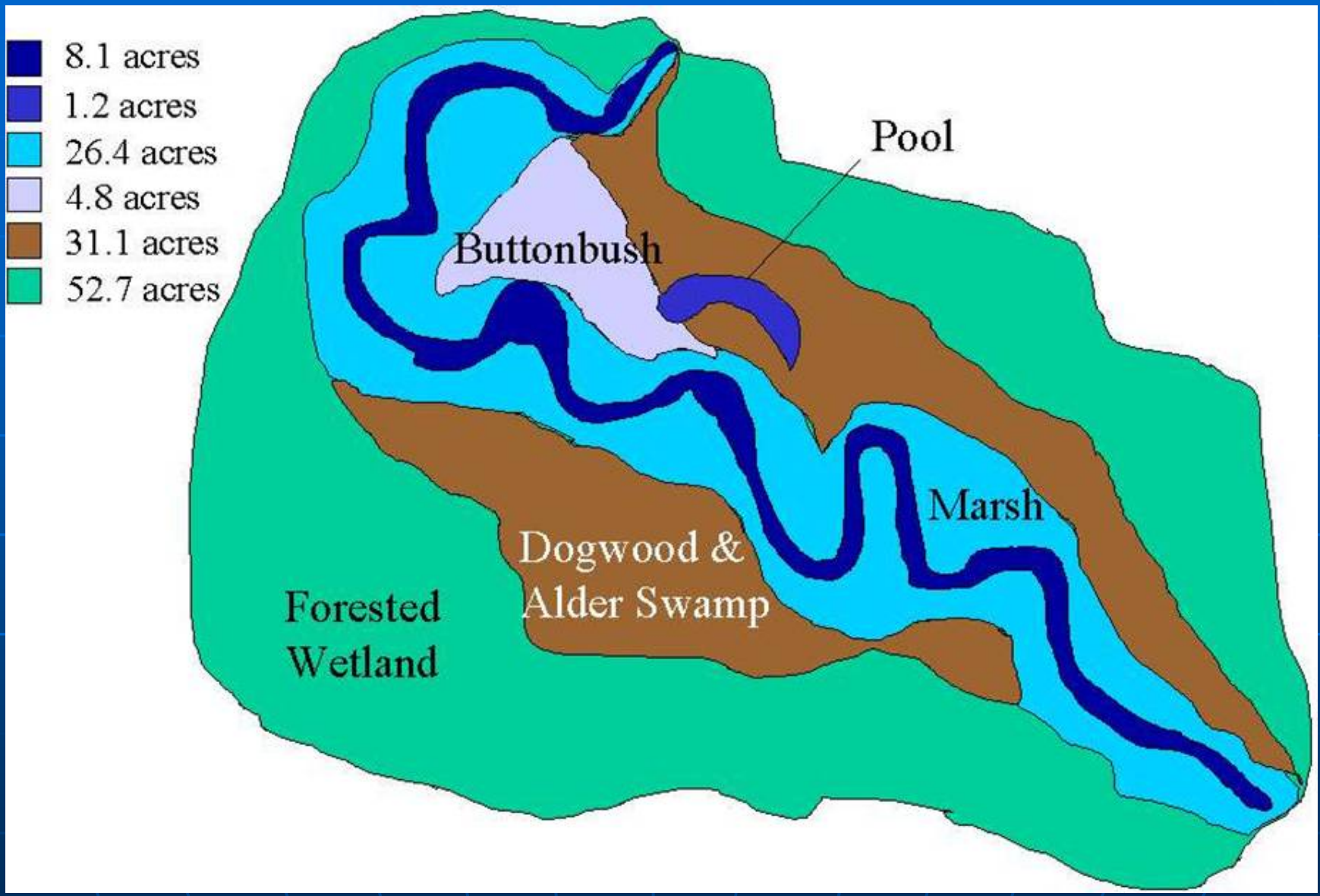
- Common – Preferred habitat
- Critical - Not much quality habitat, frequency of occurrence 2-3 years
- Rare - Very little habitat, decadal frequency

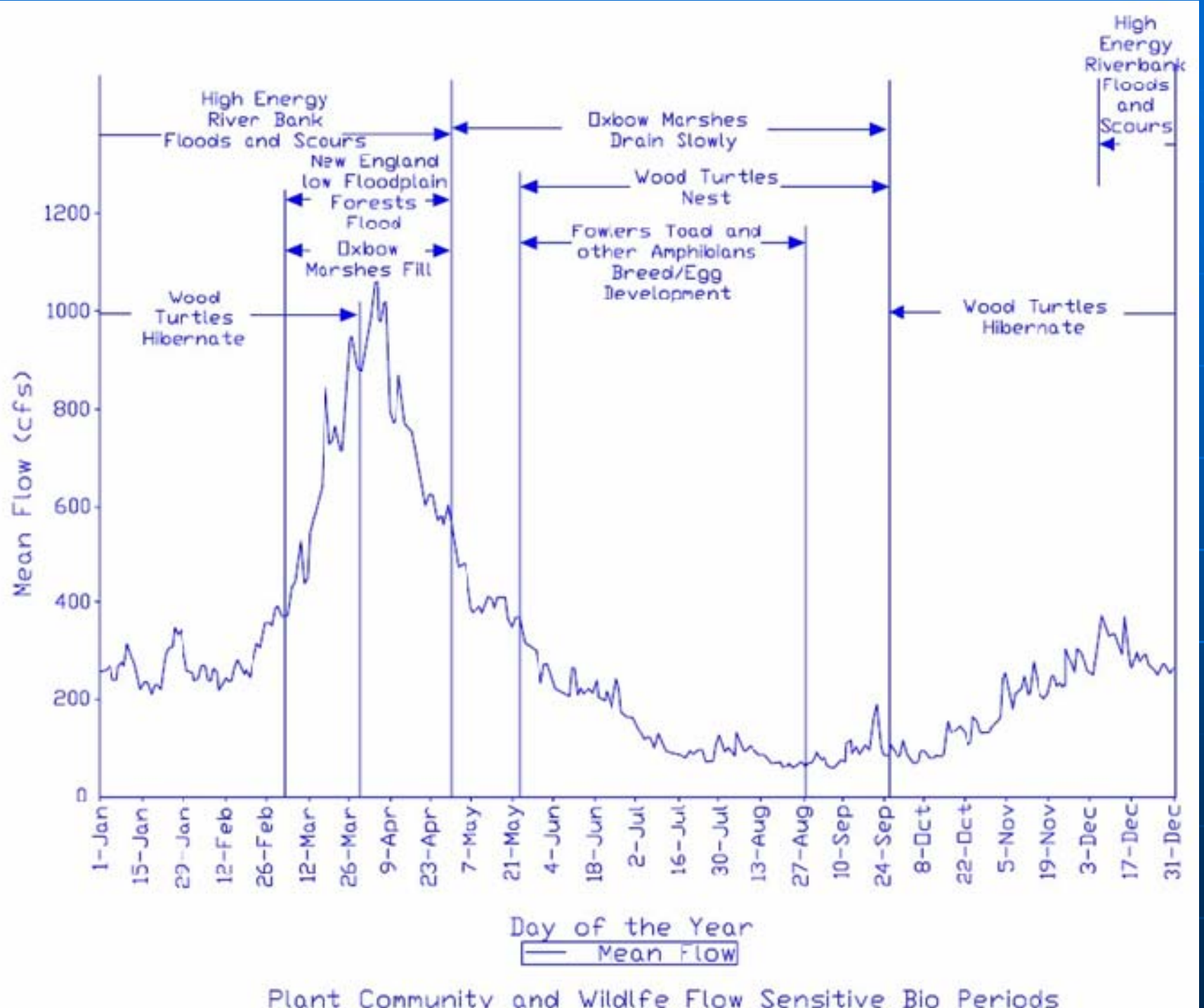
Bioperiod	Rearing & Growth		Salmon Spawning		Over-Wintering	
Approximate dates	July 15 - Sept. 30		Oct. 1 - Nov. 14		Nov. 15 - Feb. 28	
	Recommended flows		Recommended flows		Recommended flows	
Concurrent Gauge (SR#)	SR 25	USGS	SR 25	USGS	SR 25	USGS
Watershed area (mi^2)	102	171	102	171	102	171
Location	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Common flow (cfs)	**31**	**103**	**41**	**184**		**342**
Common flow (cfsm)	**0.3**	**0.6**	**0.4**	**1.1**	**1.1**	**2.0**
Allowable duration under (days)	30	20	30	23		35
Catastrophic duration (days)	42	40	40	40		50
Critical flow (cfs)	**16**	**26**	**10**	**96**		**86**
Critical flow (cfsm)	**0.16**	**0.15**	**0.1**	**0.6**	**0.5**	**0.5**
Allowable duration under (days)	15	15	12	12		15
Catastrophic duration (days)	35	20	30	40		30
Rare flow (cfs)	**10**	**17**	**10**	**70**		**51**
Rare flow (cfsm)	**0.1**	**0.1**	**0.1**	**0.4**	**0.3**	**0.3**
Allowable duration under (days)	5	5	10	5		5
Catastrophic duration (days)	30	10	23	10		10

Bioperiod	Spring Flood		Shad Spawning		GRAF Spawning	
Approximate dates	March 1 - April 30		May 1 - June 14		June 15 - July 14	
	Recommended flows		**Recommended flows**		**Recommended flows**	
Concurrent Gauge (SR#)	SR 25	USGS	SR 25	USGS	SR 25	USGS
Watershed area (mi^2)	102	171	102.3	171	102.3	171
Location	**Upper**	**Lower**	**Upper**	**Lower**	**Upper**	**Lower**
Common flow (cfs)	**N/A**	**N/A**	**215**	**178**	**24**	**39**
Common flow (cfsm)	**1.1**	**1.1**	**2.1**	**1.0**	**0.23**	**0.23**
Allowable duration under (days)	N/A	N/A	25	15	20	17
Catastrophic duration (days)	N/A	N/A	40	25	27	25
Critical flow (cfs)	N/A	N/A	61	96	11	**239**/19
Critical flow (cfsm)	0.4	0.4	0.6	0.6	0.11	**1.4**/0.11
Allowable duration under (days)	N/A	N/A	10	5	10	**13**
Catastrophic duration (days)	N/A	N/A	15	10	20	**23**
Rare flow (cfs)	N/A	N/A	38	88	8	**325**/19
Rare flow (cfsm)	0.3	0.3	0.37	0.5	0.08	**1.9**/0.11
Allowable duration under (days)	N/A	N/A	4	5	10	**10**
Catastrophic duration (days)	N/A	N/A	7	10	15	**10**

Rare, Threatened, and Endangered Species (RTE) Flow Needs

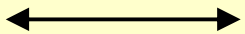
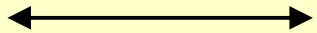
- Identify the relevant species
- Identify habitat characteristics and relate habitat to flow need


8.1 acres
1.2 acres
26.4 acres
4.8 acres
31.1 acres
52.7 acres
Pool
Buttonbush
Marsh
Dogwood &
Alder Swamp
Forested
Wetland

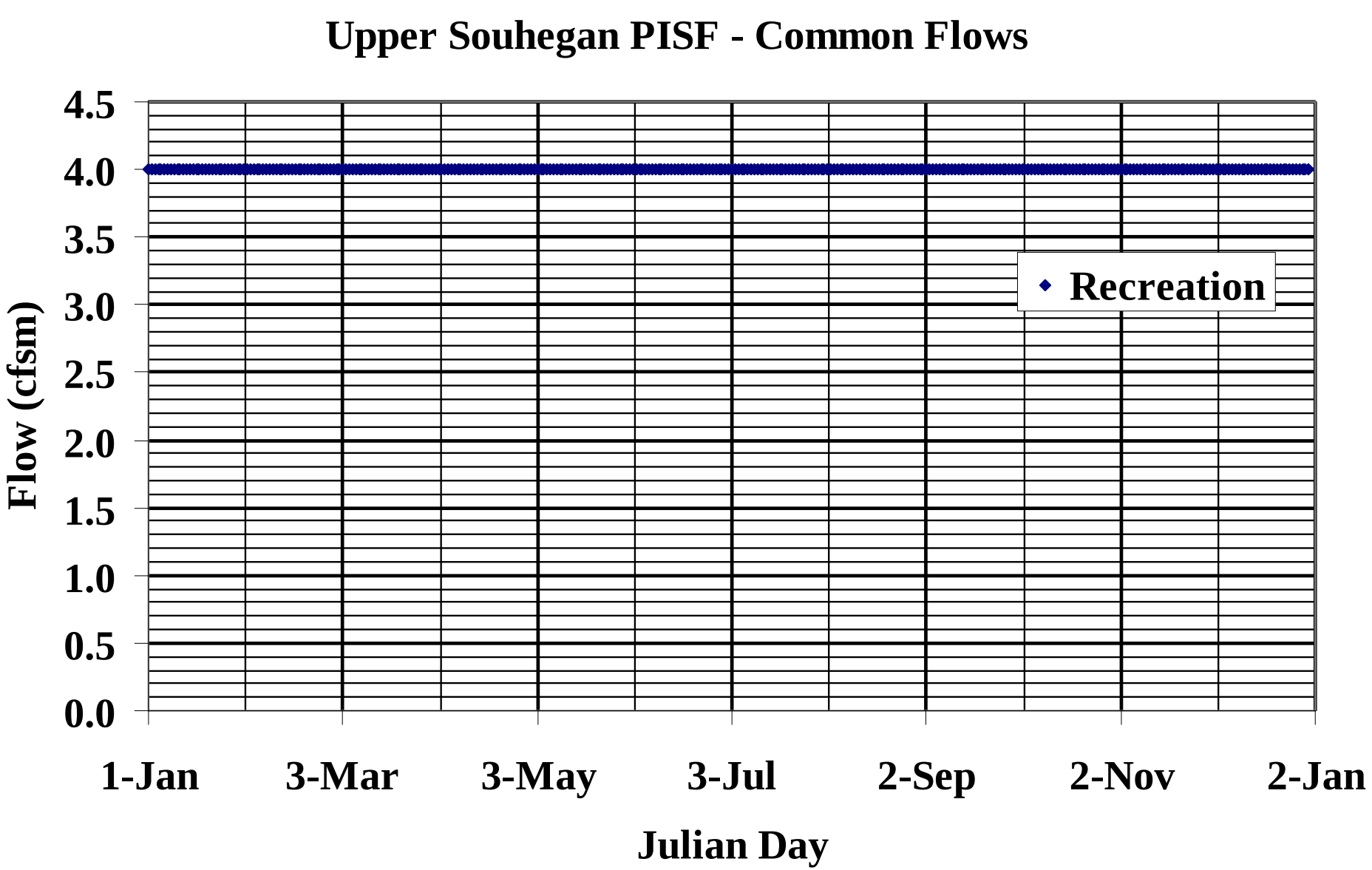


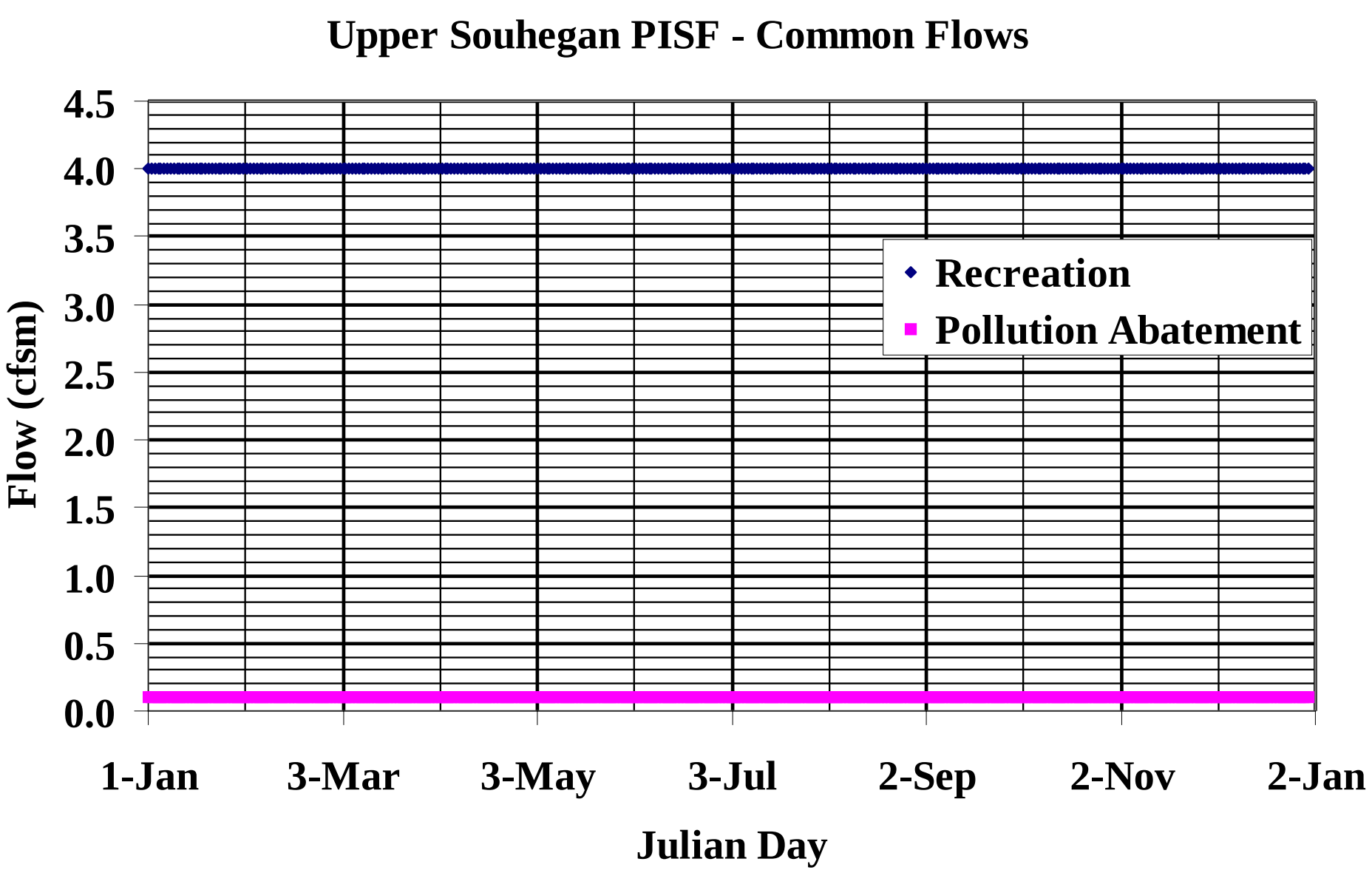
Plant Community and Wildlfe Flow Sensitive Bio Periods

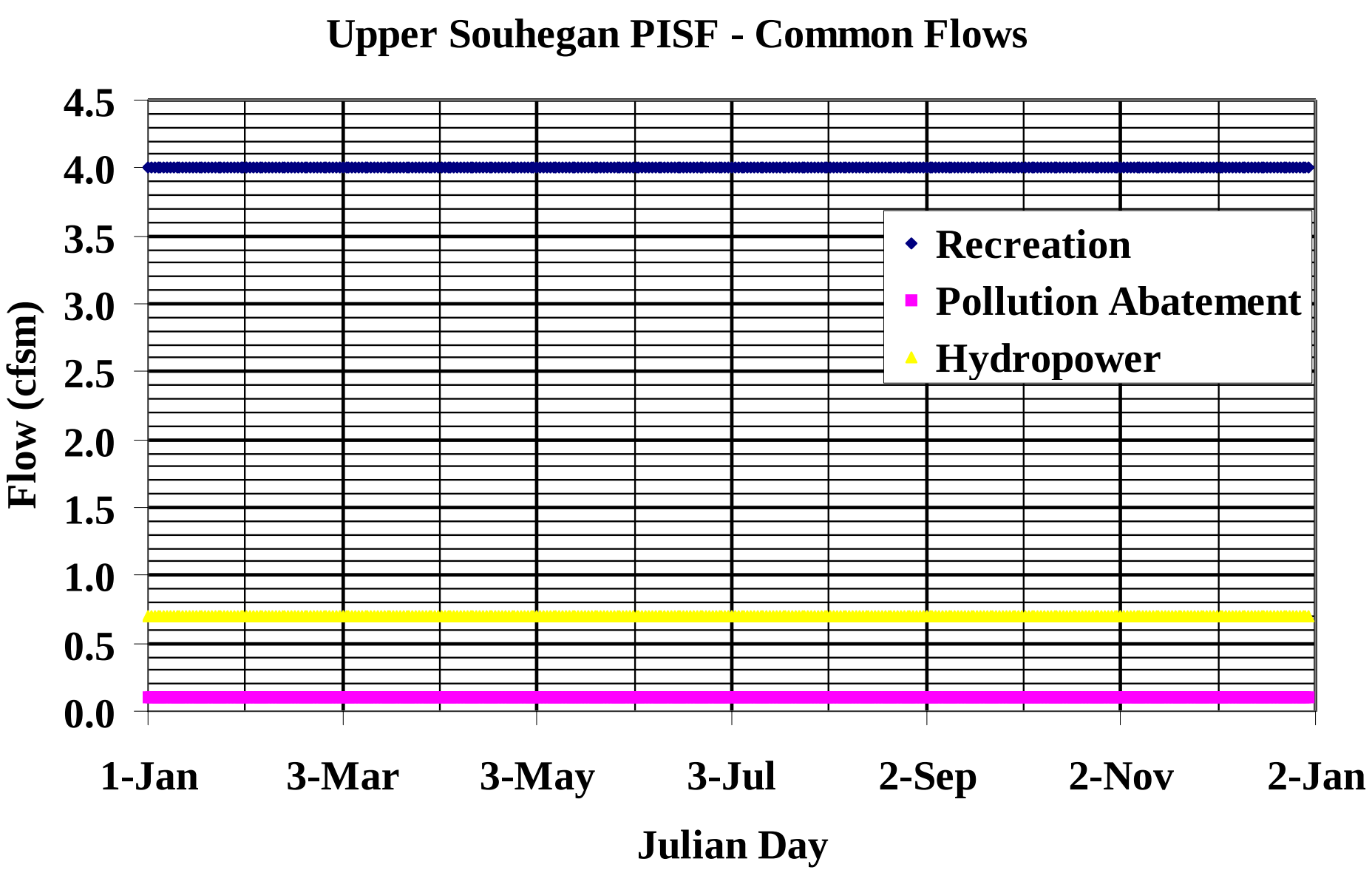
Month	J	F	M	A	M	J	J	A	S	O	N	D
Species	**Timing and value of instream flow**											
Wood Turtle (lower Souhegan only)	<5.85 cfsm > 0.97 cfsm											
Fowler's Toad (lower Souhegan only)	>2.335 cfsm a few times to fill wetlands >0.175 cfsm a few times to maintain breeding pools											
Wild Senna and Wild Garlic	>18.7 cfsm on a frequency of once every 2-10 years											
Twisted Sedge/Fern Glade (upper Souhegan)	>2.8 cfsm once every 1-3 years											

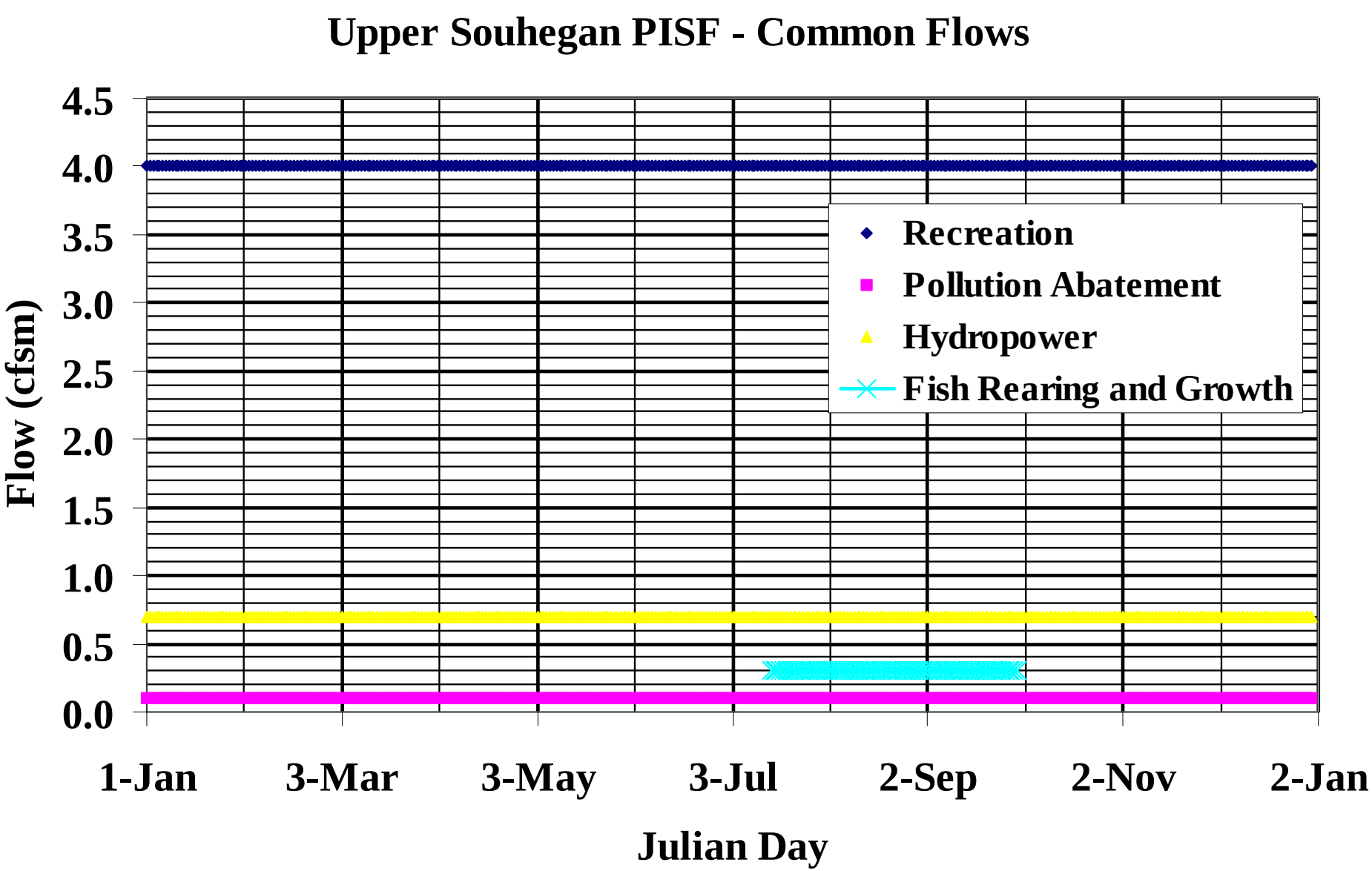
Month	J	F	M	A	M	J	J	A	S	O	N	D
Species	**Timing and value of instream flow**											
Silver Maple Floodplain Forest (lower Souhegan only)	>11.7 cfsm once every 1-3 years											
Sycamore Floodplain Forest (lower Souhegan only)	>17.5 cfsm once every 1-3 years											
Oxbow/Backwater Marsh (lower Souhegan only)	 >3.5 cfsm a few times to fill  >0.2cfsm periodically in summer											

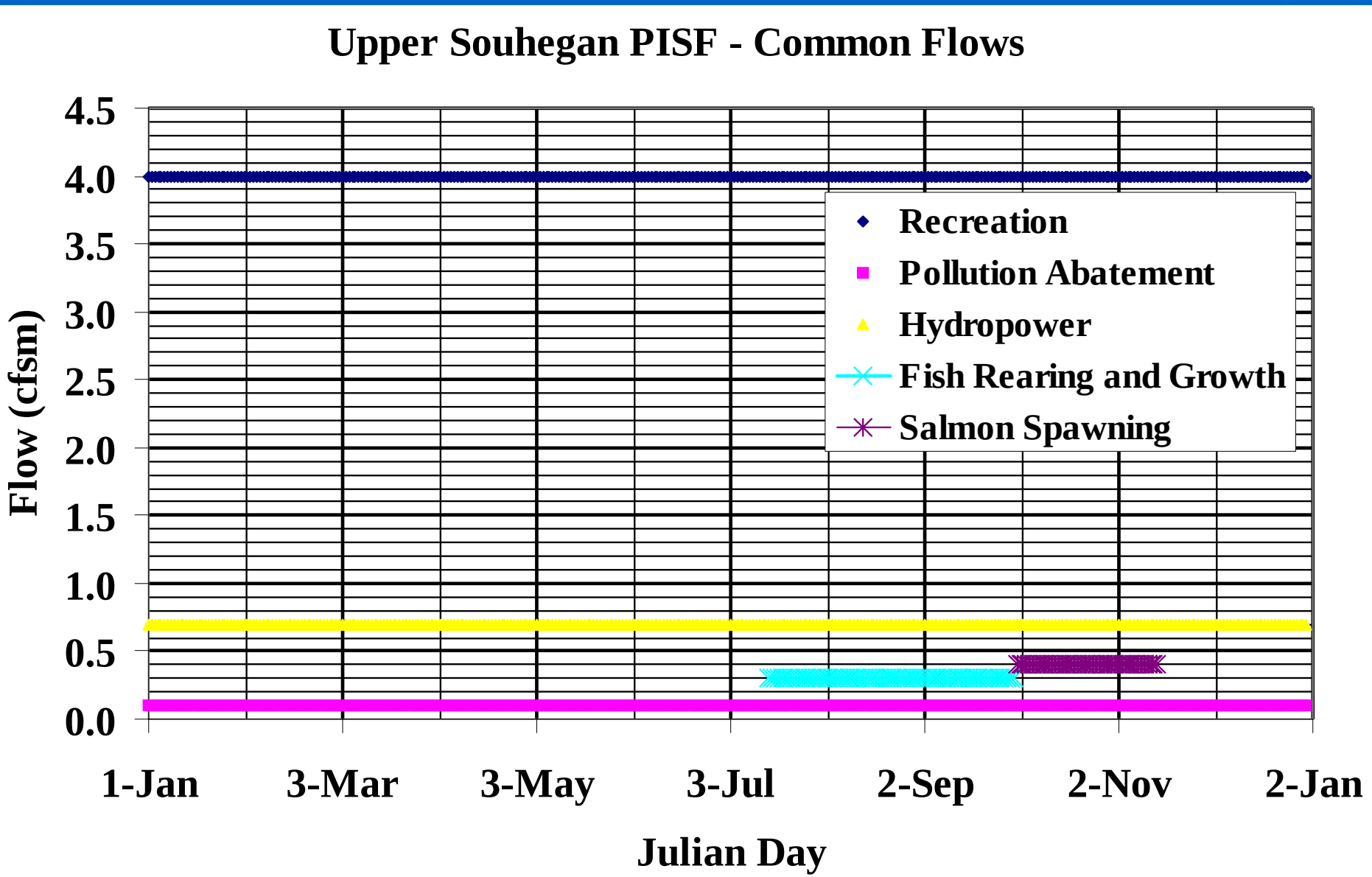
Example of the PISF for Each IPUOCR and Then Synthesizing

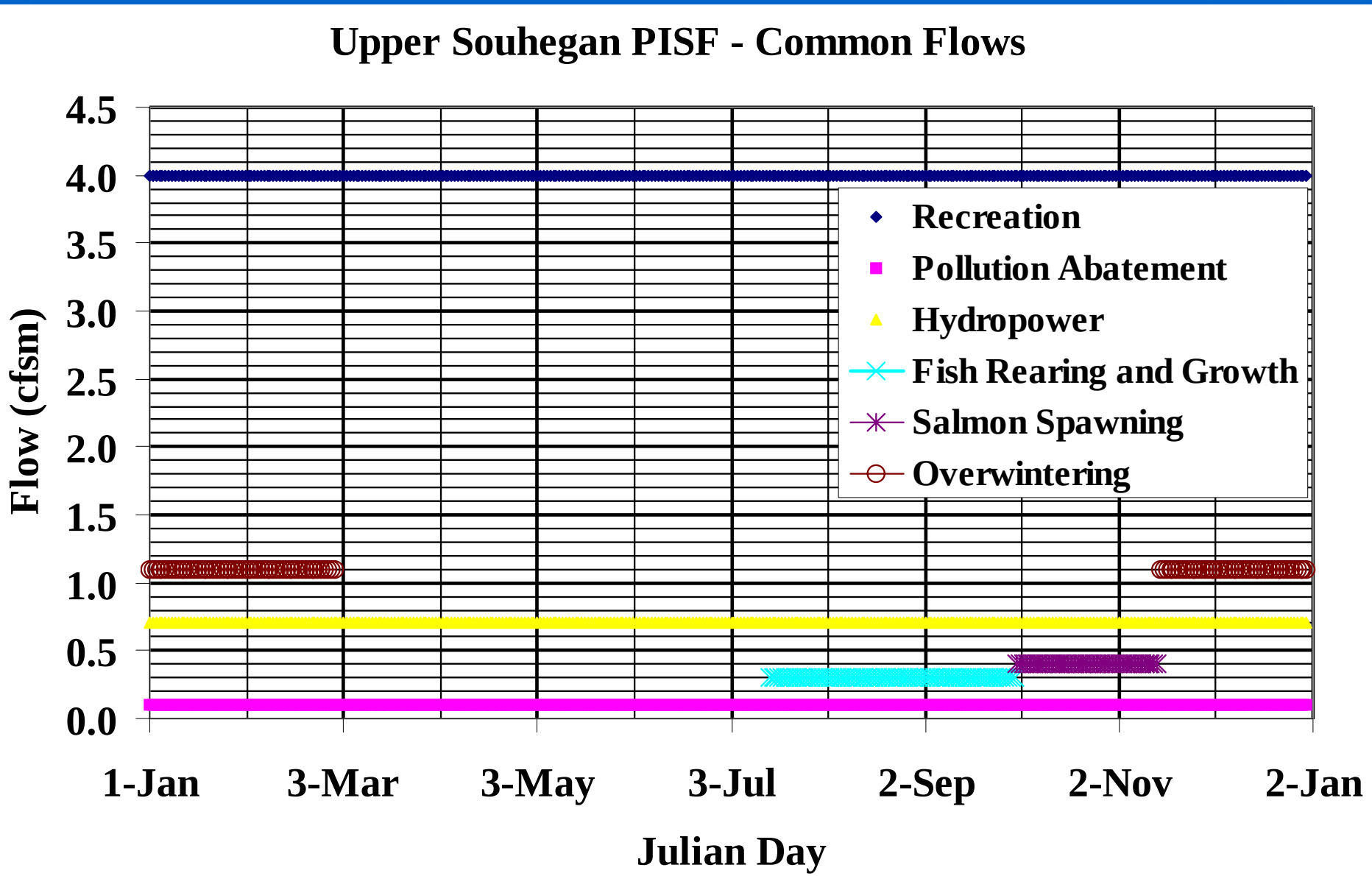

Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day

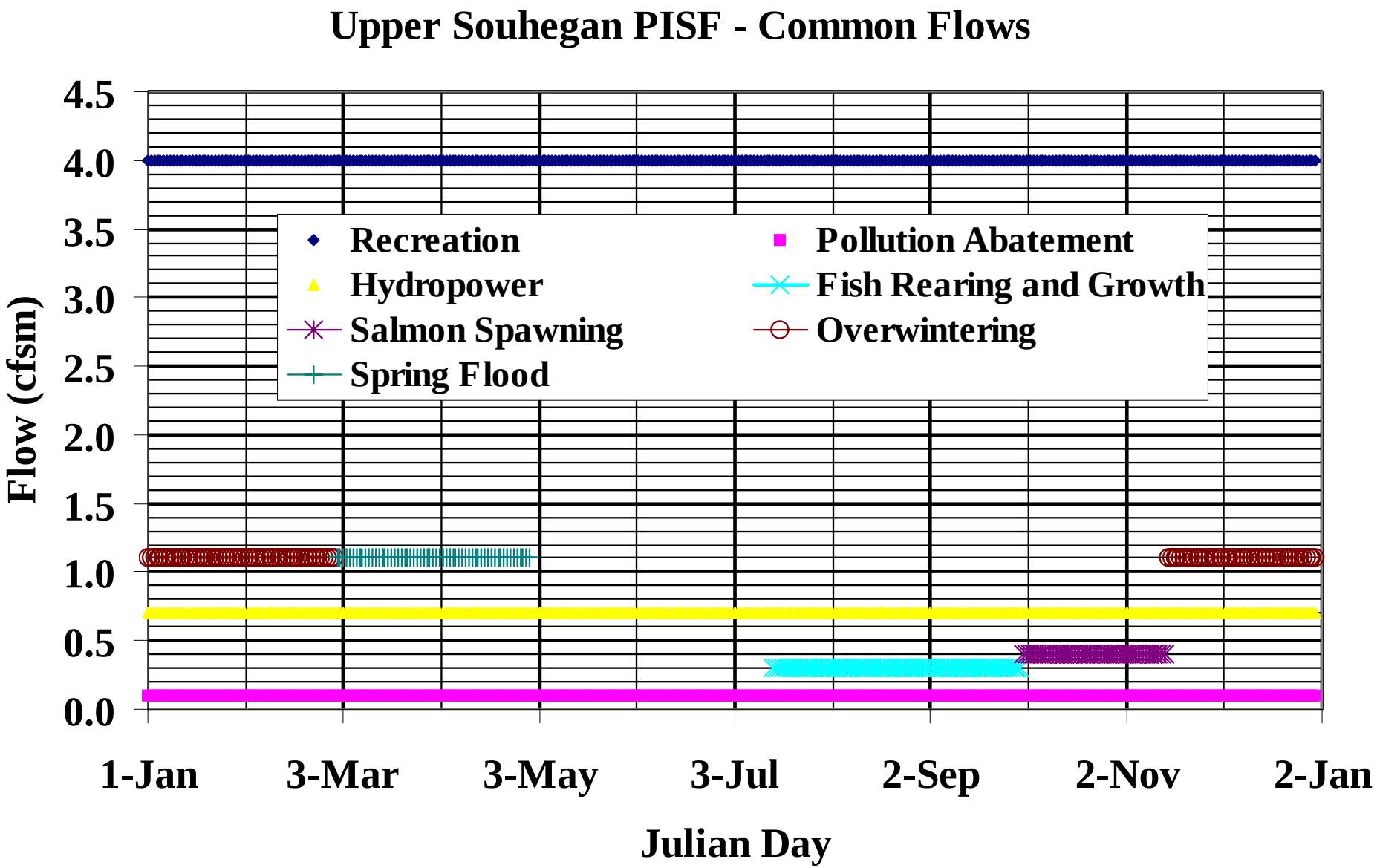

Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Pollution Abatement
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day

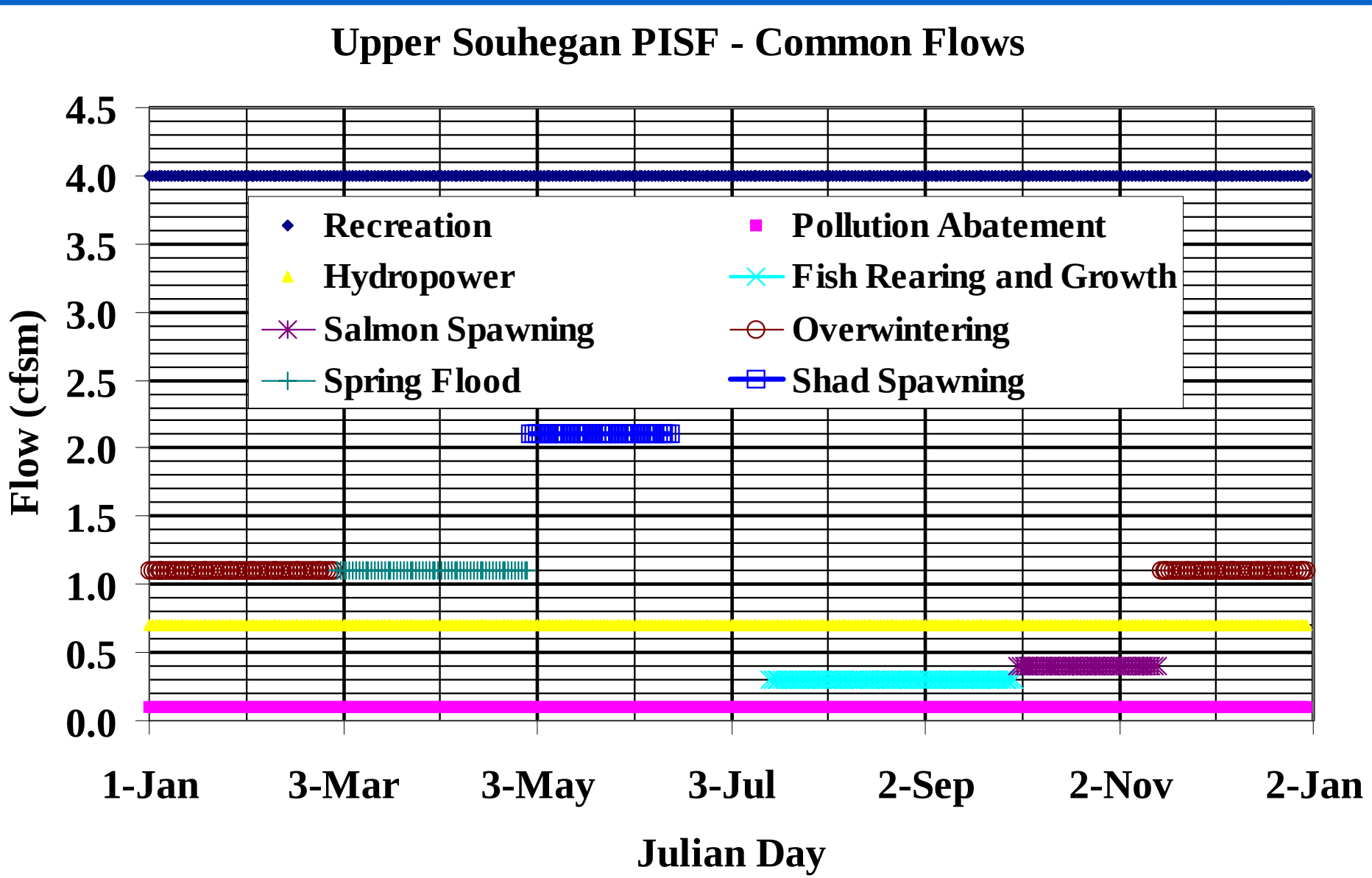

Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Pollution Abatement
Hydropower
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day

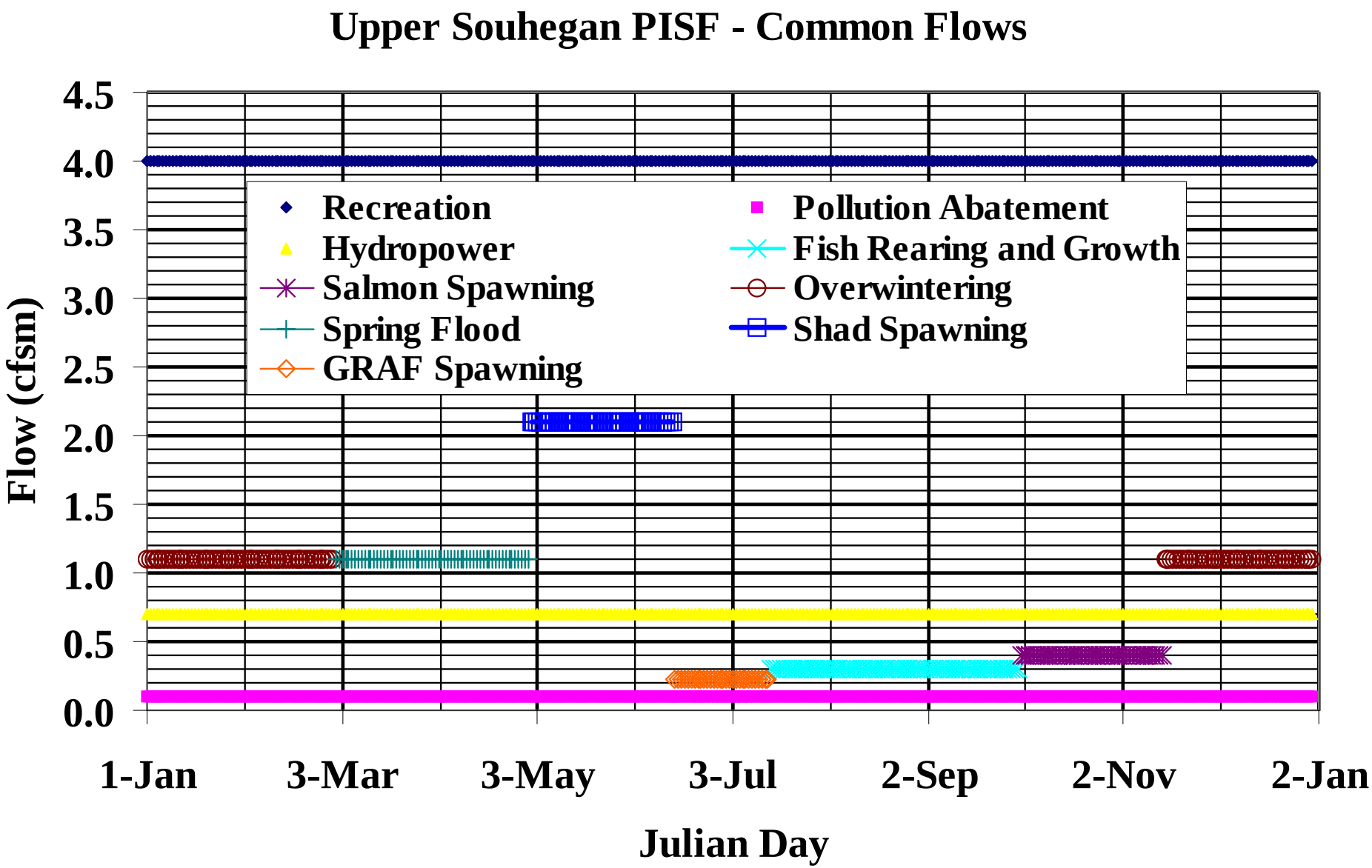

Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Pollution Abatement
Hydropower
Fish Rearing and Growth
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day


Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day
Recreation
Pollution Abatement
Hydropower
Fish Rearing and Growth
Salmon Spawning


Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day
Recreation
Pollution Abatement
Hydropower
Fish Rearing and Growth
Salmon Spawning
Overwintering


Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Pollution Abatement
Hydropower
Fish Rearing and Growth
Salmon Spawning
Overwintering
Spring Flood
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day

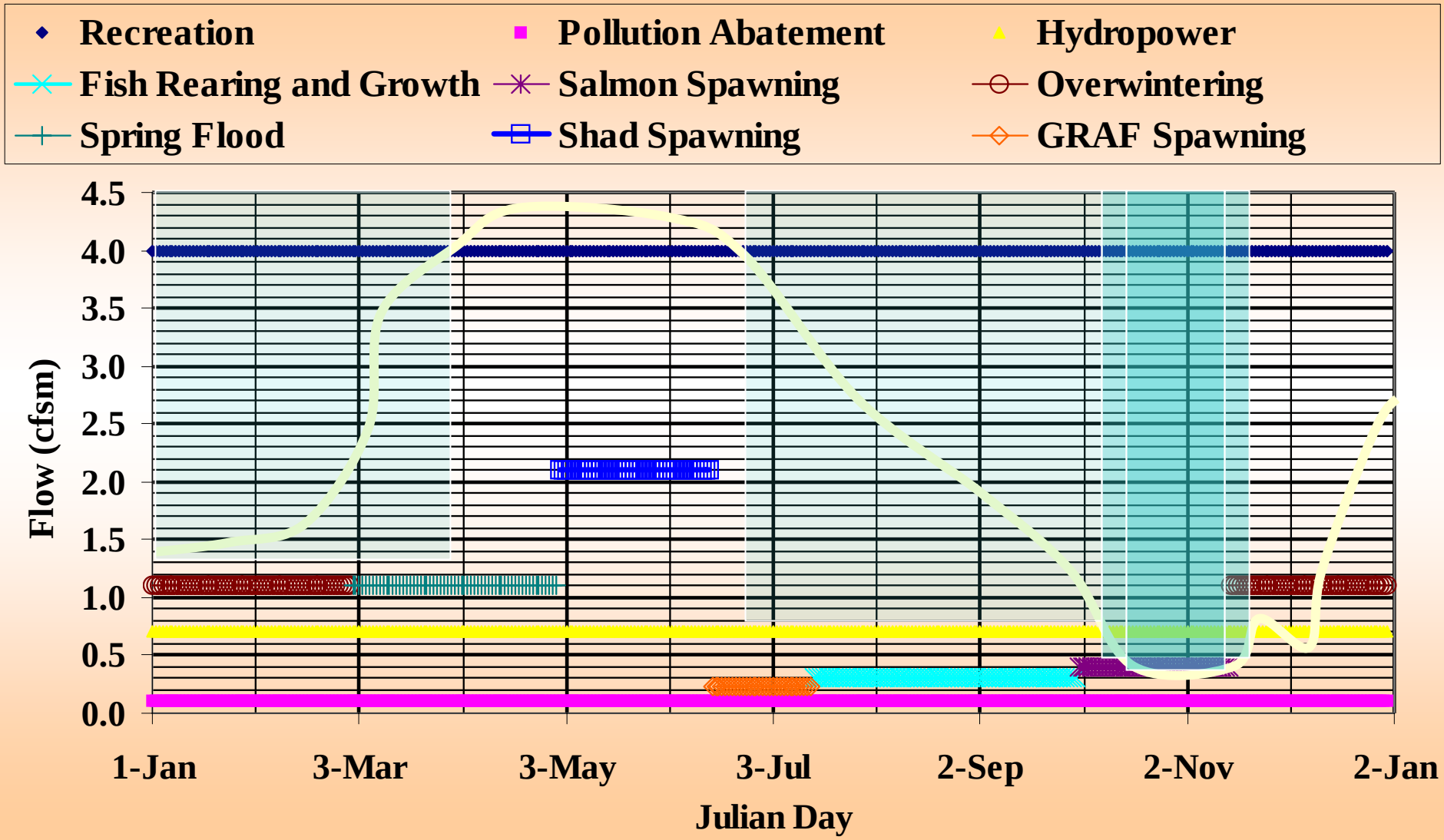

Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Pollution Abatement
Hydropower
Fish Rearing and Growth
Salmon Spawning
Overwintering
Spring Flood
Shad Spawning
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day


Upper Souhegan PISF - Common Flows
Flow (cfsm)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Recreation
Hydropower
Salmon Spawning
Spring Flood
GRAF Spawning
Pollution Abatement
Fish Rearing and Growth
Overwintering
Shad Spawning
1-Jan
3-Mar
3-May
3-Jul
2-Sep
2-Nov
2-Jan
Julian Day

All PISF Are Overlaid to Understand which IPUOCR Flow is the Strictest (and When)

By satisfying the highest of these PISF, all others are satisfied: the most IPUOCR are protected when flow in the river equals or exceeds the highest of these PISF

Upper Souhegan PISF - Common Flows



Synthesized PISF

When comparing the PISF need for each IPUOCR for every day of the year, on the low flow end, the largest of the individual IPUOCR PISF controls: meeting that PISF means that all other PISF are met.

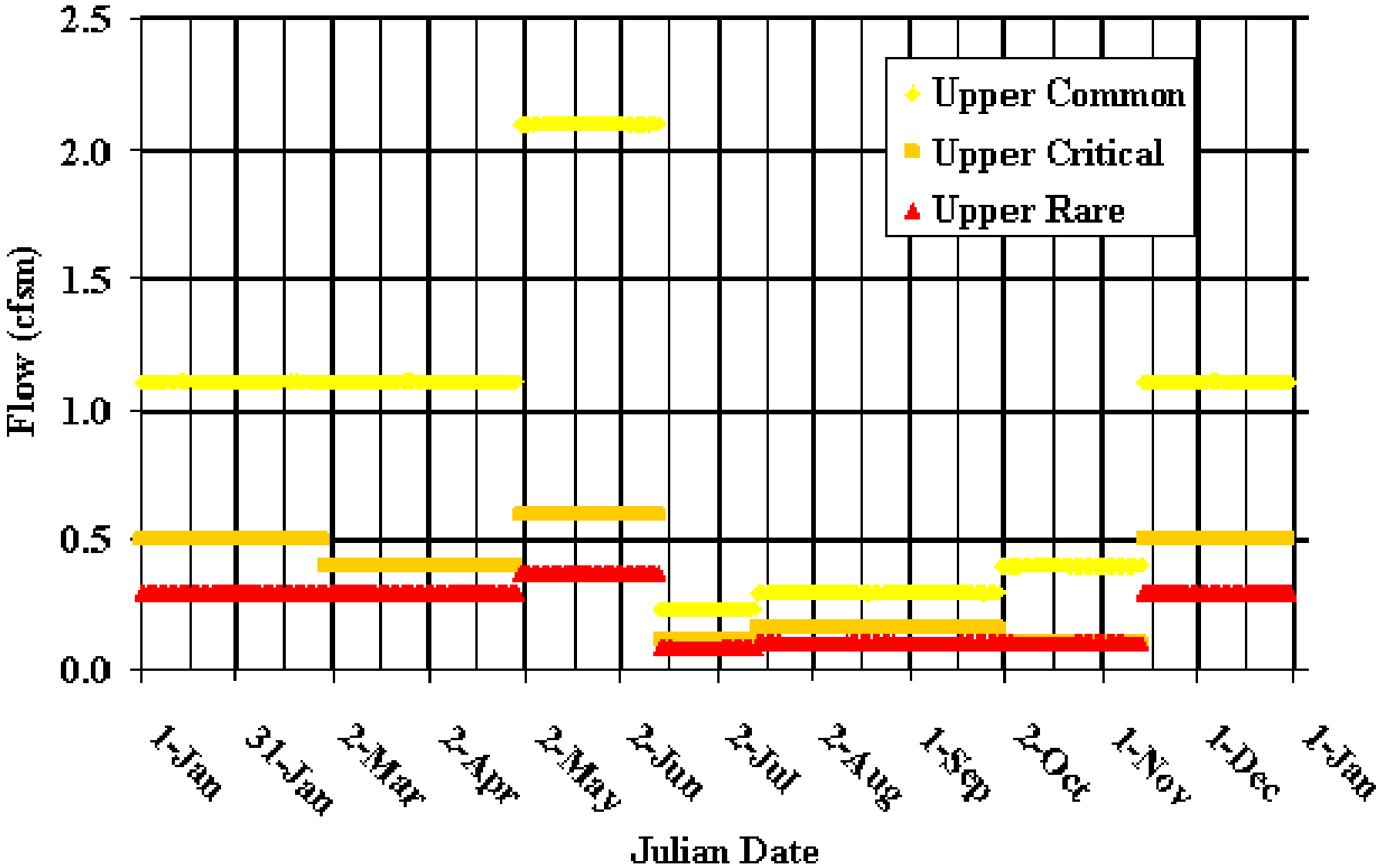
Human needs (recreation and hydropower) are the largest of the low flow PISF.

Achievable Synthesized PISF

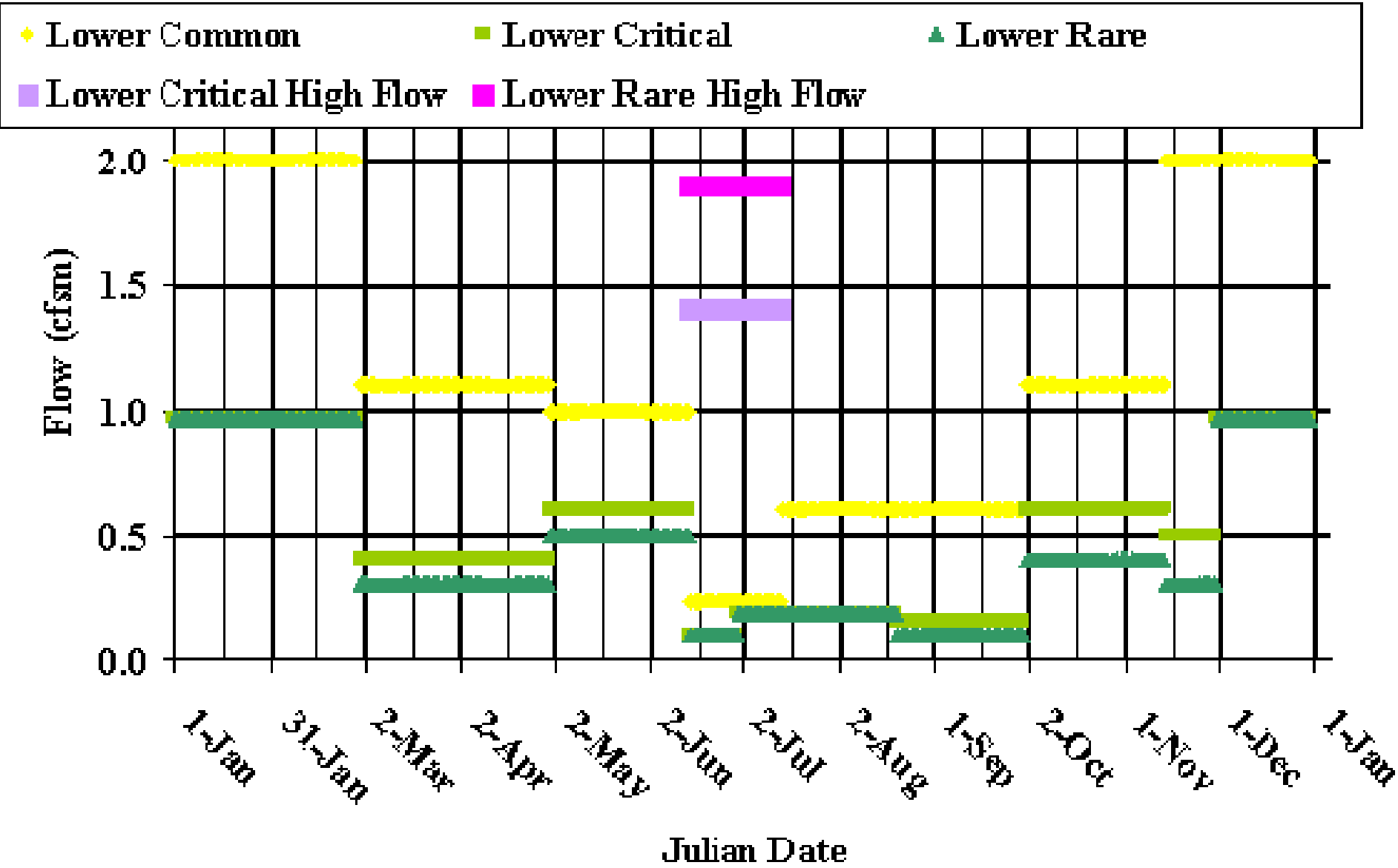
The river system has very little conservation storage (stored water that could be released over long periods) to meet human PISF when river is low.

It was decided that the human PISF would be met as they have been historically: “run-of-river”, and therefore subsequent water management strategies will focus on the non-human, synthesized PISF.

Upper Souhegan Synthesized PISF



Lower Souhegan Synthesized PISF



The Natural Flow Paradigm

Natural variability in river flow creates a wide range of habitat types and ecosystem processes that maintain the natural biological diversity of aquatic and riparian (stream side) species. A major consequence of this natural variability is that all species experience favorable conditions at some time, preventing any one species from dominating.

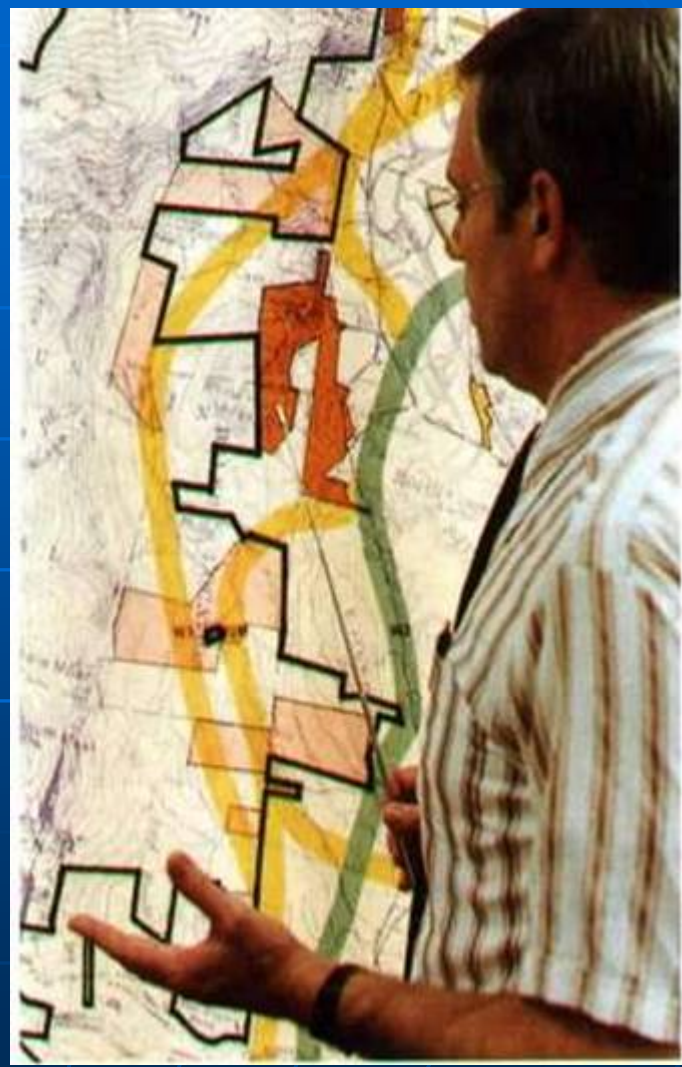
Human Changes to the Natural Flow Regime

- Flow control (floods, droughts)
- Dams (fragmentation, water quality)
- Land use (runoff characteristics, wetlands resources, woody debris)

Task 6: PISF Public Hearing

- Deliver Draft PISF Report
- Prepare Public Hearing Materials
- Update the DES Instream Flow Website
- Record Public Comments

March 2007



Task 7: PISF Final Report

- Review Public Comments
- Meet with DES to Review Responses
- Finalize PISF Report
- Add Public Comments Section

Task 8. Assessment of Water Use with the Established PISF

- River flow to be constructed along the Souhegan River for various non-exceedance probabilities
- Water uses and return flows quantified, located, and delineated.
- PISF identified at distinct river locations
- All data synthesized to reveal locations and flows when sections of the river cannot meet both PISF and demands

Task 9. Development of WMP Sub-plans

- Conservation Plan
- Water Use Plan
- Dam Management Plan

Conservation Plan

- Identify AWUs
- Identify Water Use Types
  - Conservation Measures
  - BMPs
- Description of AWU
  - Characteristics
  - Flow
  - Pattern
  - Variability
  - History
  - Conservation Opportunities
  - Historic Conservation
  - BMPs
  - 5-year Plan
  - Economics
  - New Technologies
- Implementation Schedule
  - Description of Measures
  - Target Dates

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH AWU

Water Use Plan

- AWU Water Use Data
- Potential Modifications
- Effect of PSIF on Hydropower
- Overall Water Use Plan
- Implementation Schedule
- Economic Assessment

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH AWU

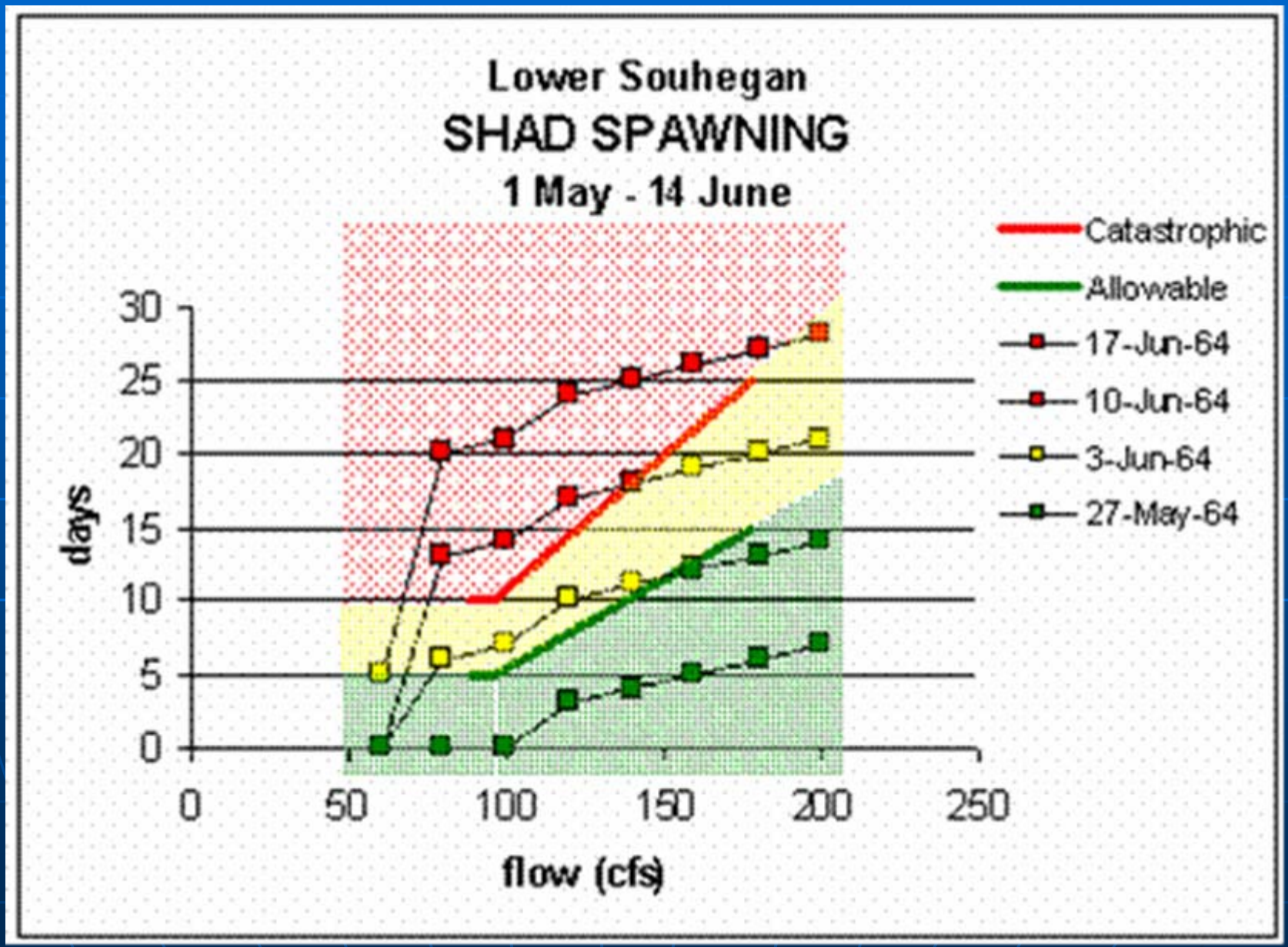
Dam Management Plan

- Individual ADO Information and Specifications
- Potential for Low Flow Augmentation/Regulation (Relative Reservoir Size)
- Downstream Ecologic Restrictions
- Operation Strategies to Meet PISF
- Implementation Schedule
- Economic Assessment

ALL PERFORMED THROUGH MEETINGS AND DISCUSSIONS WITH EACH ADO

Task 10. Proposed WMP

- Integration of Sub-Plans
- System-wide strategies
- MCDA of strategies
- Economic assessment for AWUs and ADOs
- Financial Assistance


Lower Souhegan
SHAD SPAWNING
1 May - 14 June
Catastrophic
Allowable
17-Jun-64
10-Jun-64
3-Jun-64
27-May-64
days
30
25
20
15
10
5
0
0
50
100
150
200
250
flow (cfs)

Task 11. WMP Public Hearing

Task 12. WMP for the Souhegan River Designated Reach

To provide any input, please contact:

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Instream Flow Specialist

Watershed Management Bureau

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Public comment:

Open until end of business

April 20, 2007

END

RTE ISF – (part 1)

IPUOCR	Status	General Location	Sensitive Bioperiod(s)	General Flow Requirements.	PISF (at Merrimack Gauge)
Wood Turtle *Clemmys insculpta*	Special Concern	Lower Souhegan	June through Sept.	No flooding during nesting in mid to high floodplain	< 1,000 cfs (5.8 cfsm)
			Nov. through March	No exposure during in-channel hibernation	Dec-March flows above mean Oct-Nov flows (107 – 225 cfs)
Fowler's Toad *Bufo* Fowleri	Special Concern	Lower Souhegan	April through May	High spring flows to fill backwaters/oxbows	>600 cfs (3.5 cfsm) (based on transect obs.)
			Late May through mid-Aug.	Sufficient inundation of eggs/tadpoles in backwaters	>30 cfs (0.18 cfsm) (based on transect And mesoHABSIM)
Osprey *Pandion* haliaetus	State-Threatened	Lower Souhegan	Spring through Fall	Sufficient flows to protect prey (fish) in channel	(see GRAF Fish recommended flows)
Common Loon *Gavia* immer	State-Threatened	Lower Souhegan	Spring through Fall	Sufficient flows to protect prey (fish) in channel	(see GRAF Fish recommended flows)

RTE ISF (part 2)

IPUOCR	Status	General Location	Sensitive Bioperiod(s)	General Flow Requirements.	PISF (at Merrimack Gauge)
Wild Garlic *Allium* canadense	State-Threatened	Lower Souhegan	Spring	Occassional scouring by high spring floods	>5,000 cfs (29.2 cfsm) every 10 years (10-yr flood)
Wild Senna *Cassia* hebecarpa	State Endangered	Lower Souhegan	Spring	Occassional scouring by high spring floods	>5,000 cfs (29.2 cfsm) every 10 years (10-yr flood)
High-Energy Riverbank	S3/S4	Upper Souhegan	Spring/Winter	Flood and ice scour of bankfull channel	>500 cfs (2.9 cfsm)
Silver Maple Floodplain Forest	S2	Lower Souhegan	Spring	1-3 year flooding (< 2 yr return flood)	>2,000 cfs (11.7 cfsm) every 1-3 years
Sycamore Floodplain Forest	S1	Upper Souhegan	Spring	1-3 year flooding (>two-year return flood)	>3,000 cfs (17.5 cfsm) every 1-3 years
Oxbow/Backwater Marsh	S3	Lower Souhegan	Spring	Filling of backwaters/oxbows	>600 cfs (3.5 cfsm) in spring
			Summer	Transect obs. of water levels	>30 cfs (0.18 cfsm) part of summer