Managing flow downstream of impoundments:

A case study using volunteer streamflow monitoring data

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New England Association of Environmental Biologists Conference
March 26-28 2008, New Hampshire

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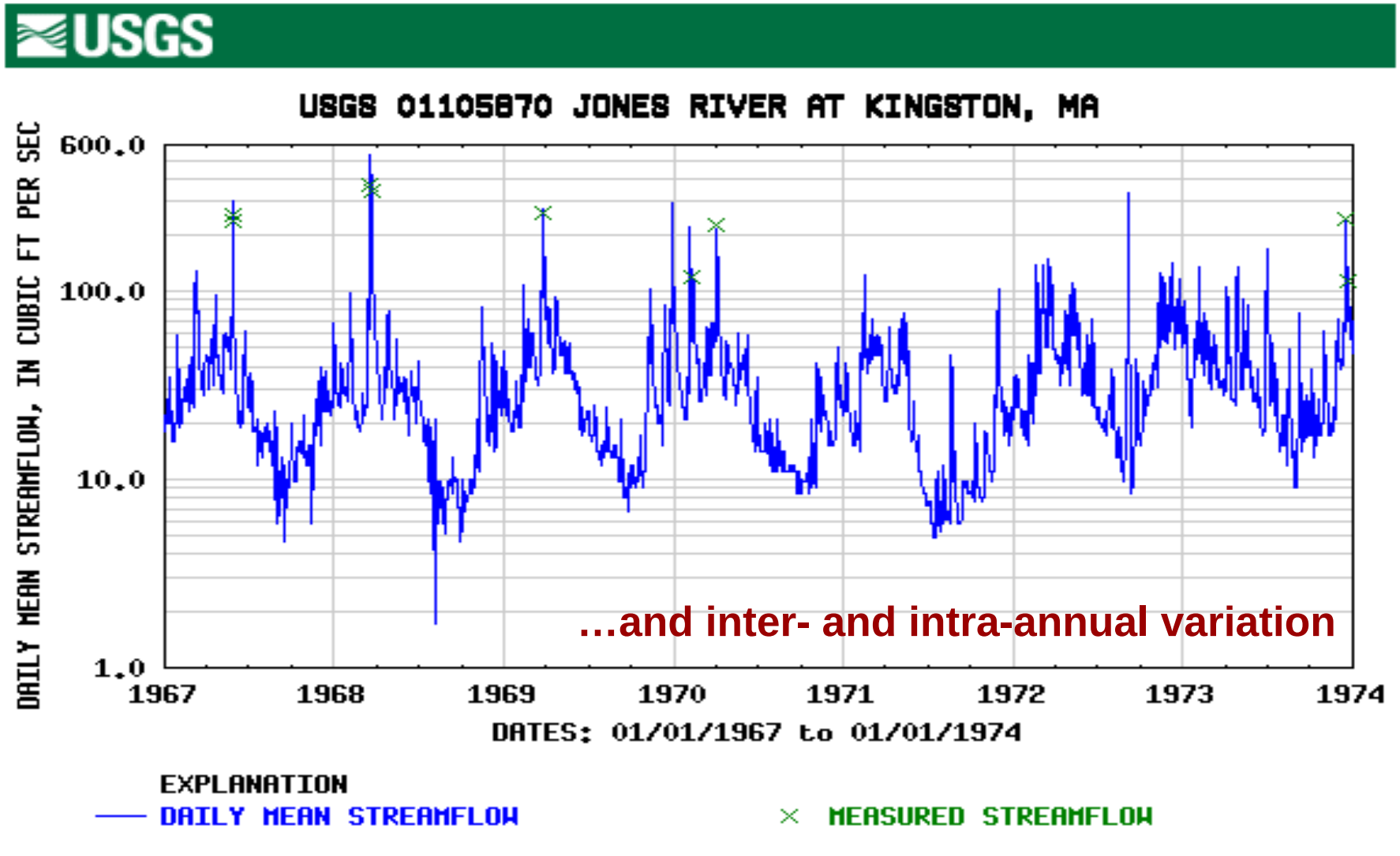
Deval L. Patrick, Governor
Ian A. Bowles, Secretary EOEEA
Mary B. Griffin, Commissioner DFG
Joan Kimball, Director Riverways

A Flow Regime



Timing Frequency Duration Magnitude Rate of Change

Background on RIFLS Program

Low flow reoccurring problem in Massachusetts

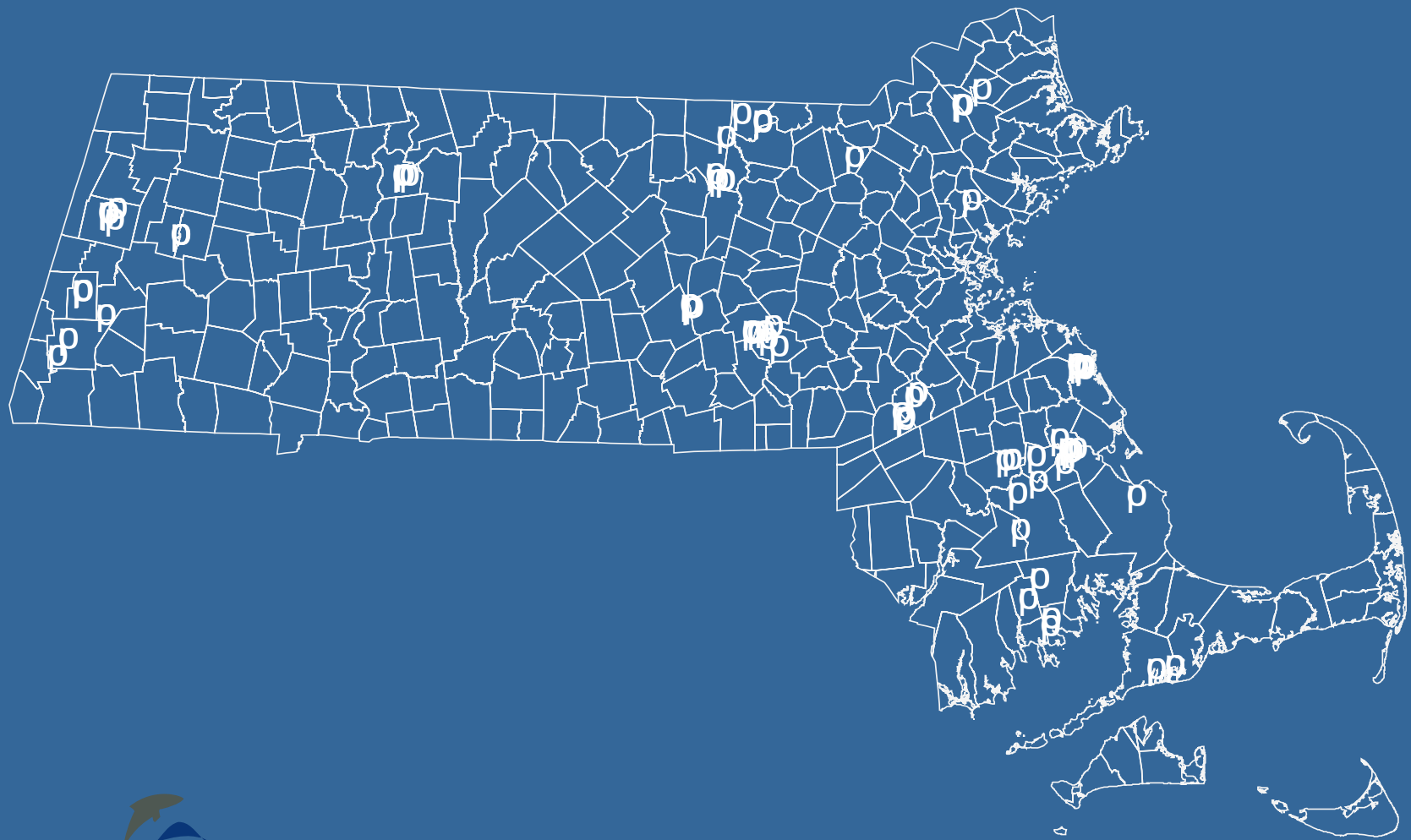
Riverways Program started the **R**iver **I**nstream **Fl**ow **S**tewards (RIFLS) program 2002 to address streamflow

Goal of RIFLS Program: Gather *streamflow data* on ungaged rivers in Mass involving local *volunteers* and *raising awareness* of water quantity issues throughout the Commonwealth

Current RIFLS Program Statistics:

- **57** stream gauges
- **150** volunteers
- **16** local partner organizations

2007 RIFLS Sites



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How the RIFLS program works:

(**RIFLS** = **R**iver **I**nstream **Fl**ow **S**tewards)

1. Determine stream needs a gage
2. RIFLS staff installs gage, develops rating curve
3. Volunteers read gage
4. QA/QC
5. Data analysis

After five years of data collection, we're finally ready to analyze data!

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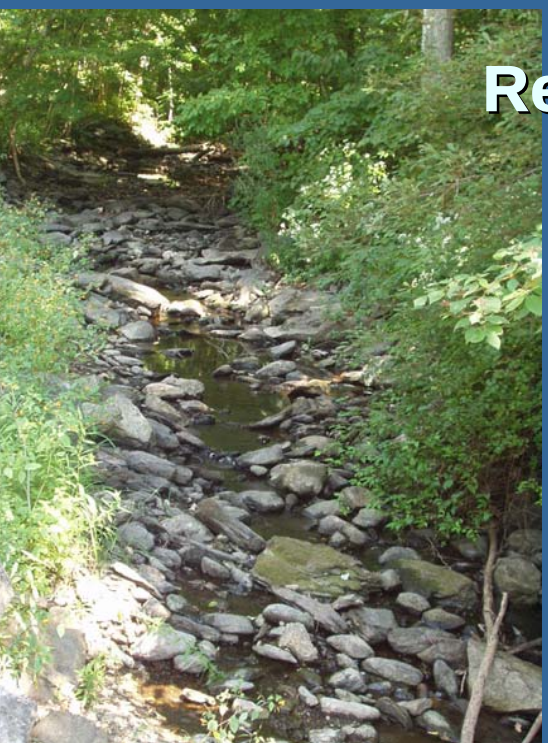
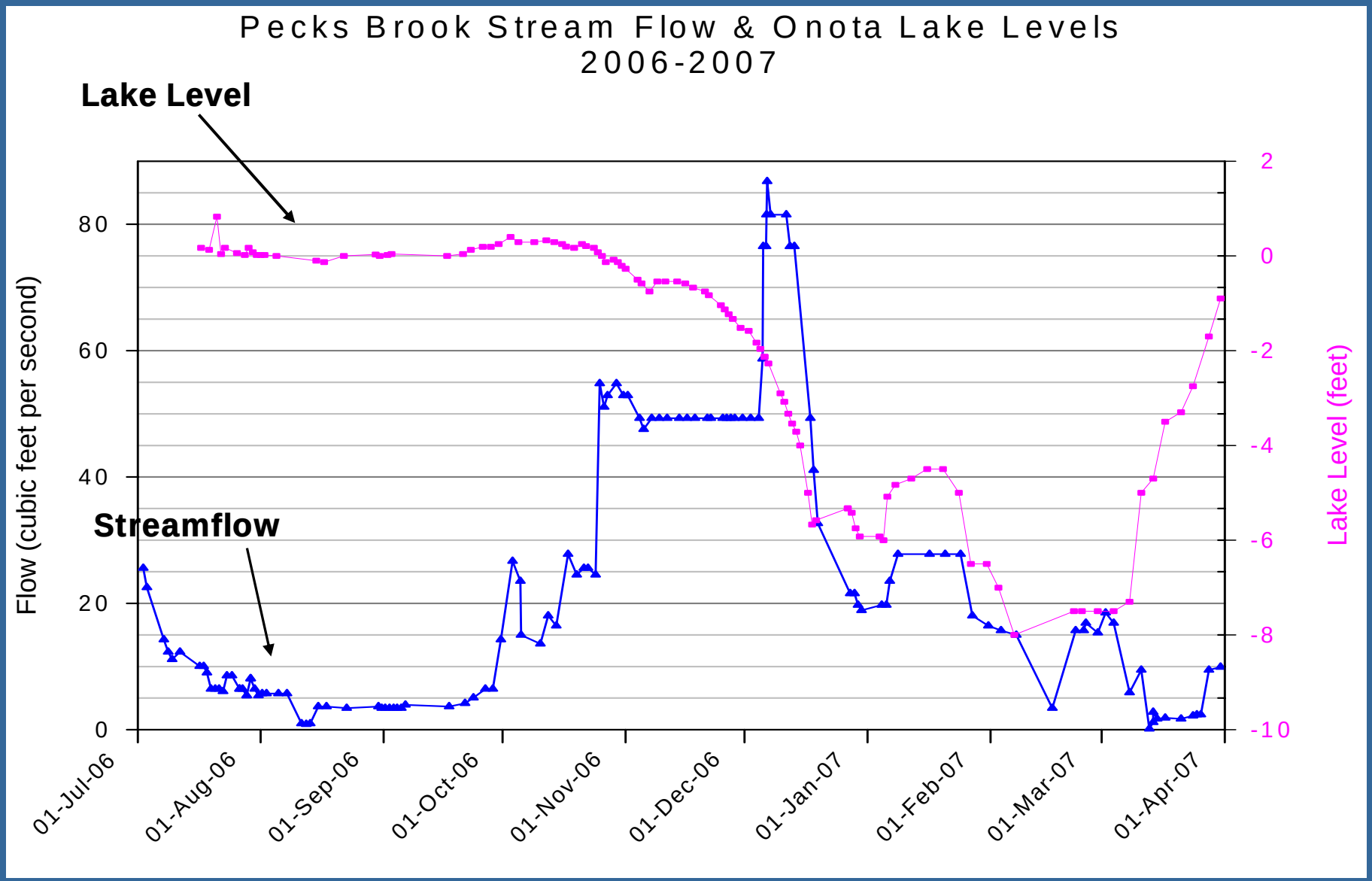
Dam Management of Recreational Impoundments Affects Streamflow!



Lake Management drives streamflow and may result in unnatural streamflow patterns



Notice when the highest stream flow occurs – late December!

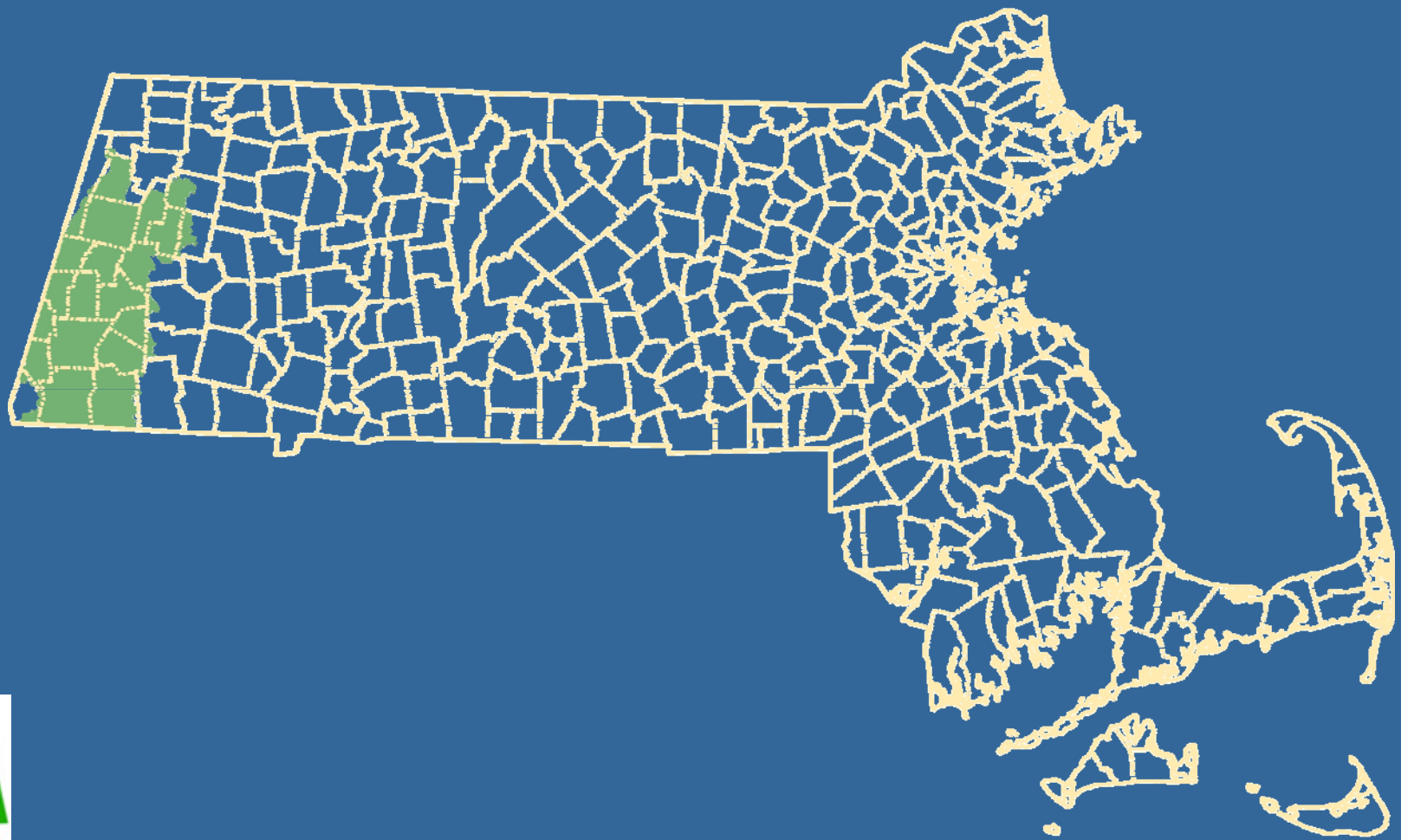
Problems with current lake management:

- Drawdown and refills disturb natural flow regime
- Concerns over lake levels often trump concerns of instream flow
- Conservation Commissions limited guidance on how to Condition dam operations
  - Typically Condition only drawdown and refills periods
  - Use State lake management guidance (0.5 cfsm minimum flow, 4.0 cfsm maximum flow during drawdown)

But what about the rest of the year?

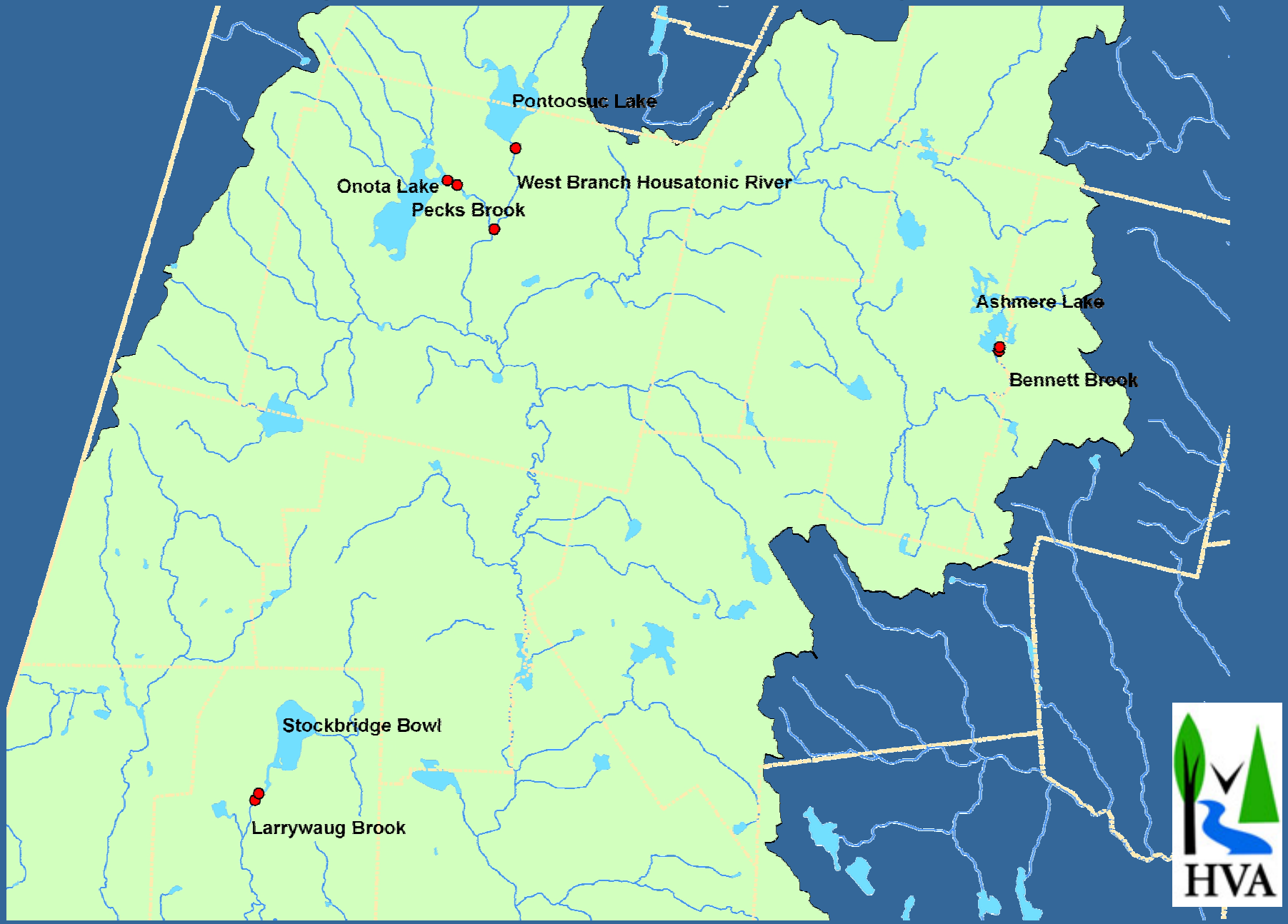
Housatonic Valley Watershed

in Massachusetts



HVA

Pilot Projects in Housatonic Valley Watershed



Pecks Brook, Pittsfield
Outfall of Lake Onota

April 19, 2006

July 14, 2006

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Bennett Brook
at Ashmere Lake Outfall
Hinsdale, MA

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Bennett Brook
at Ashmere Lake Outfall
Hinsdale, MA

Massachusetts Environmental Trust awards grant to HVA!

Goals of Project:

1. Encourage more natural flow regime downstream of dams through creation of Dam Management Plans
   - Monthly flow recommendations
   - Range flows for all Months
   - Increase variability of streamflow during summer months - *not a minimum flow project!*

2. Create tool to be used by Conservation Commissions throughout the Commonwealth
   - Recommendations to be included in Orders of Conditions for dam projects

3. Work more closely with other state agencies, such as DCR, to improve management of state-owned dams.

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HVA

Index Streamflows

Targets Natural Flow Conditions in Absence of Human Alteration

Two Reports:

1) 2004 USGS Index Gage Study
2) 2007 DCR Index Streamflows for Massachusetts

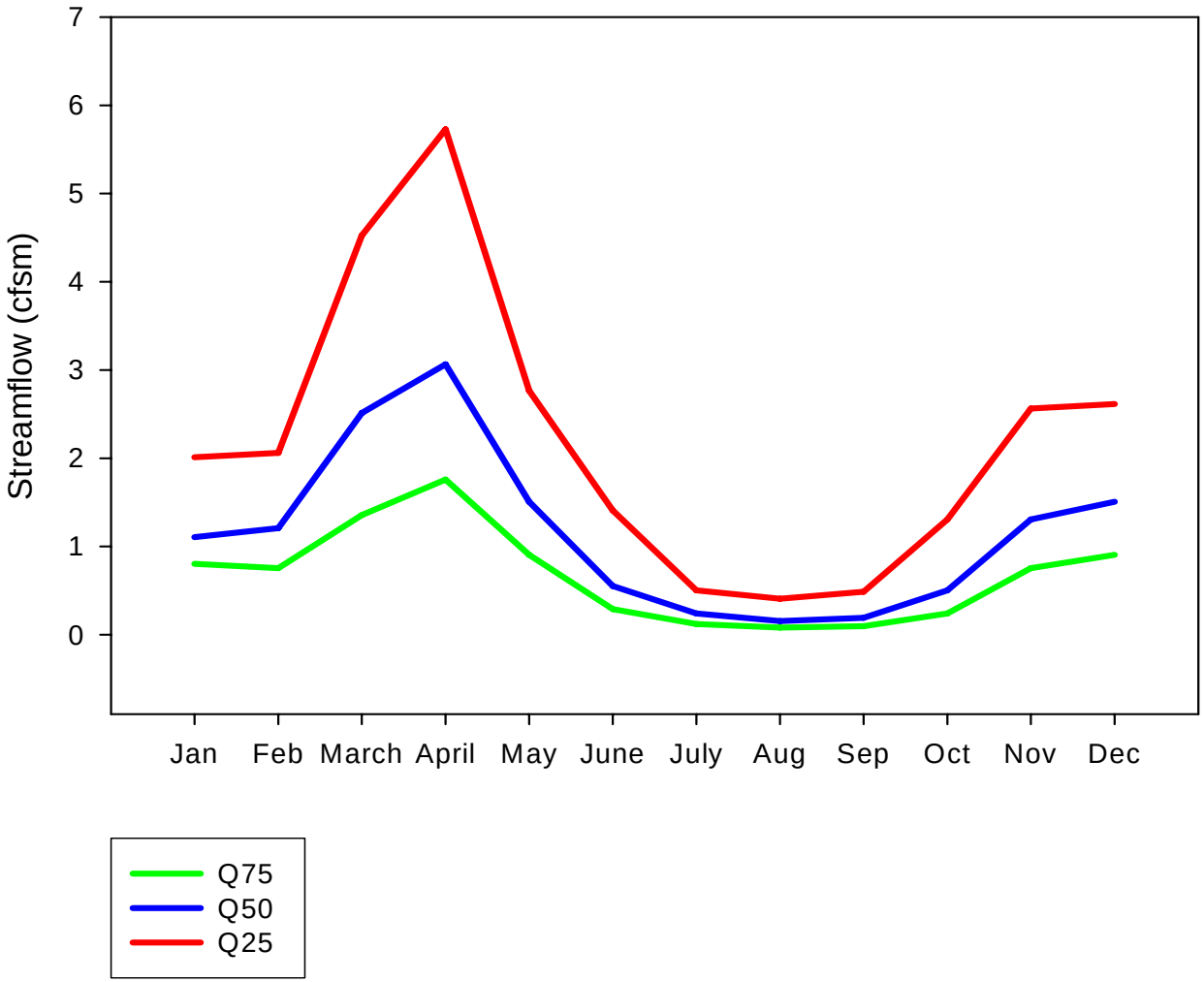
- Specific to Massachusetts and Southern New England
- Follows direction of State policy and Water Resource Commission

Reports identify least impacted streams (23 in Southern New England) and their basin characteristics (slope, surficial geology, drainage area)

Report calculates annual target hydrograph for each Index Gage

For example...

USGS 01187300 Index Gage Monthly Quantile Flows
Annual Target Hydrograph



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q75	0.80	0.75	1.36	1.76	0.90	0.29	0.12	0.08	0.10	0.24	0.75	0.90
Q50	1.11	1.21	2.51	3.07	1.51	0.55	0.24	0.16	0.19	0.50	1.31	1.51
Q25	2.01	2.06	4.52	5.73	2.76	1.41	0.50	0.41	0.49	1.31	2.56	2.61

Using Index Streamflows to determine adequate flows

1. Identify basin characteristics of RIFLS sites (drainage area, slope, surficial geology) using USGS StreamStats
2. Use this data to determine Index Gage
3. Analysis of RIFLS data – determine where problems exist in hydrograph

- Compare RIFLS vs Index Gage in cfsm using same period of record
- Identify periods of abnormal streamflow
- Compute Recommended Flows by multiplying Index Gage streamflow (in cfsm) by drainage area of RIFLS site

For example...

Identify Basin Characteristics of RIFLS Site and Match with Index Gage

River	Drainage Area (sq miles)	Slope (percent)	Stratified Drift (sq miles per mile)
Pecks Brook at Onota Lake Outfall (RIFLS Site)	10.70	8.44	0.05
Priest Brook, Winchendon MA (Index Gage)	19.40	6.50	0.06

Normalize Records for Drainage Area
(convert streamflow of both gages to cfsm by dividing by drainage area size)

Use Statistical software to compute quartiles of flow for both gages for same period of record for comparison of RIFLS vs Index Gage

Comparing RIFLS flows with Index Flows: Determining the Problem

Quartiles Flows of Index Gage (Preist Brook) 2003-2007

Month	Q75	Q50	Q25
Jan	1.08	1.96	3.02
Feb	0.57	0.77	1.70
Mar	1.08	**1.44**	2.81
Apr	2.32	3.58	6.08
May	1.24	2.06	3.22
Jun	0.57	1.19	1.96
Jul	0.23	0.39	0.88
Aug	0.15	0.29	0.72
Sep	0.09	0.22	0.39
Oct	0.57	1.13	2.22
Nov	1.13	**2.01**	3.30
Dec	1.60	2.22	3.92

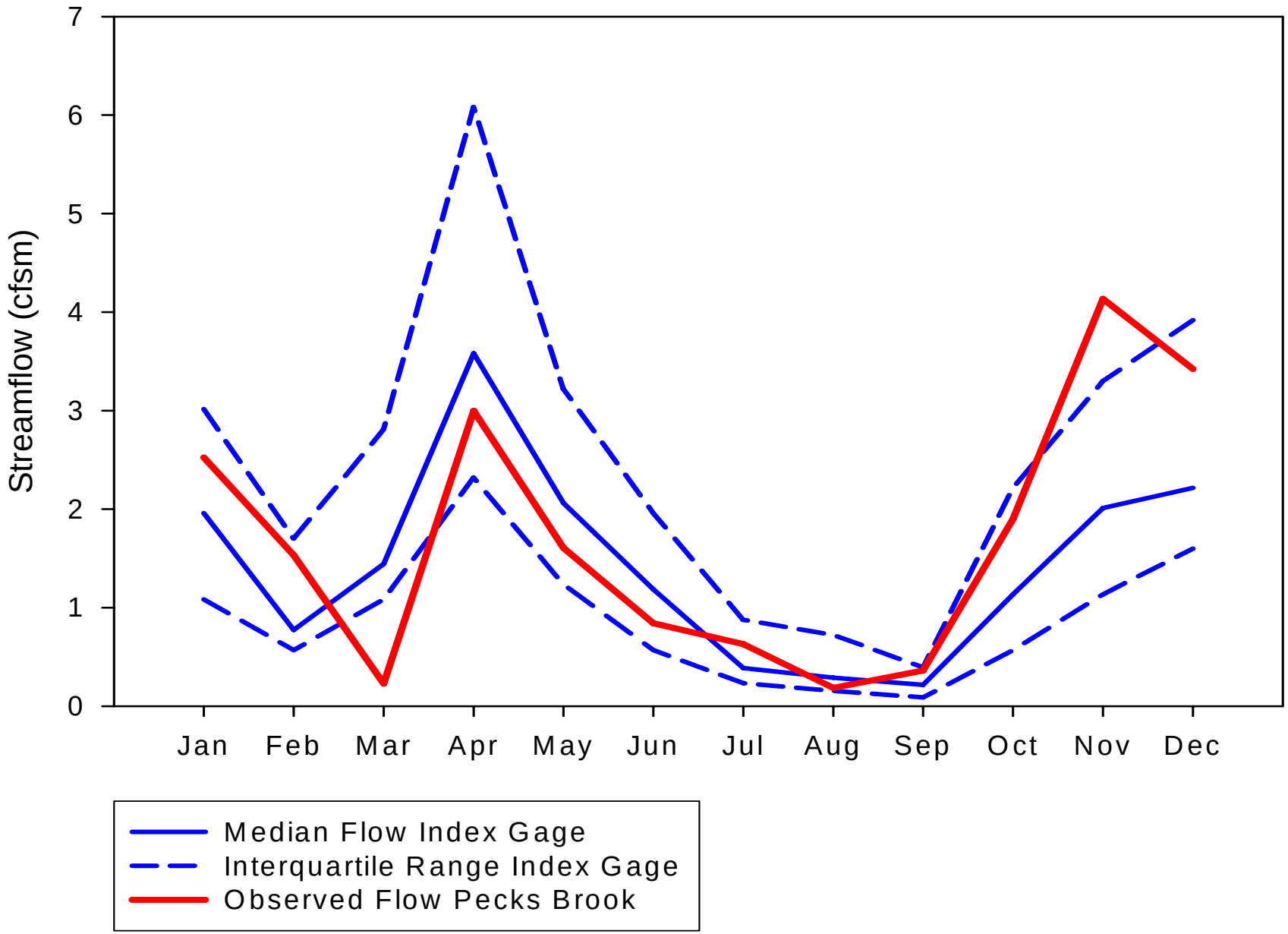
vs.

Quartiles of Observed Flow Pecks Brook (RIFLS Site)

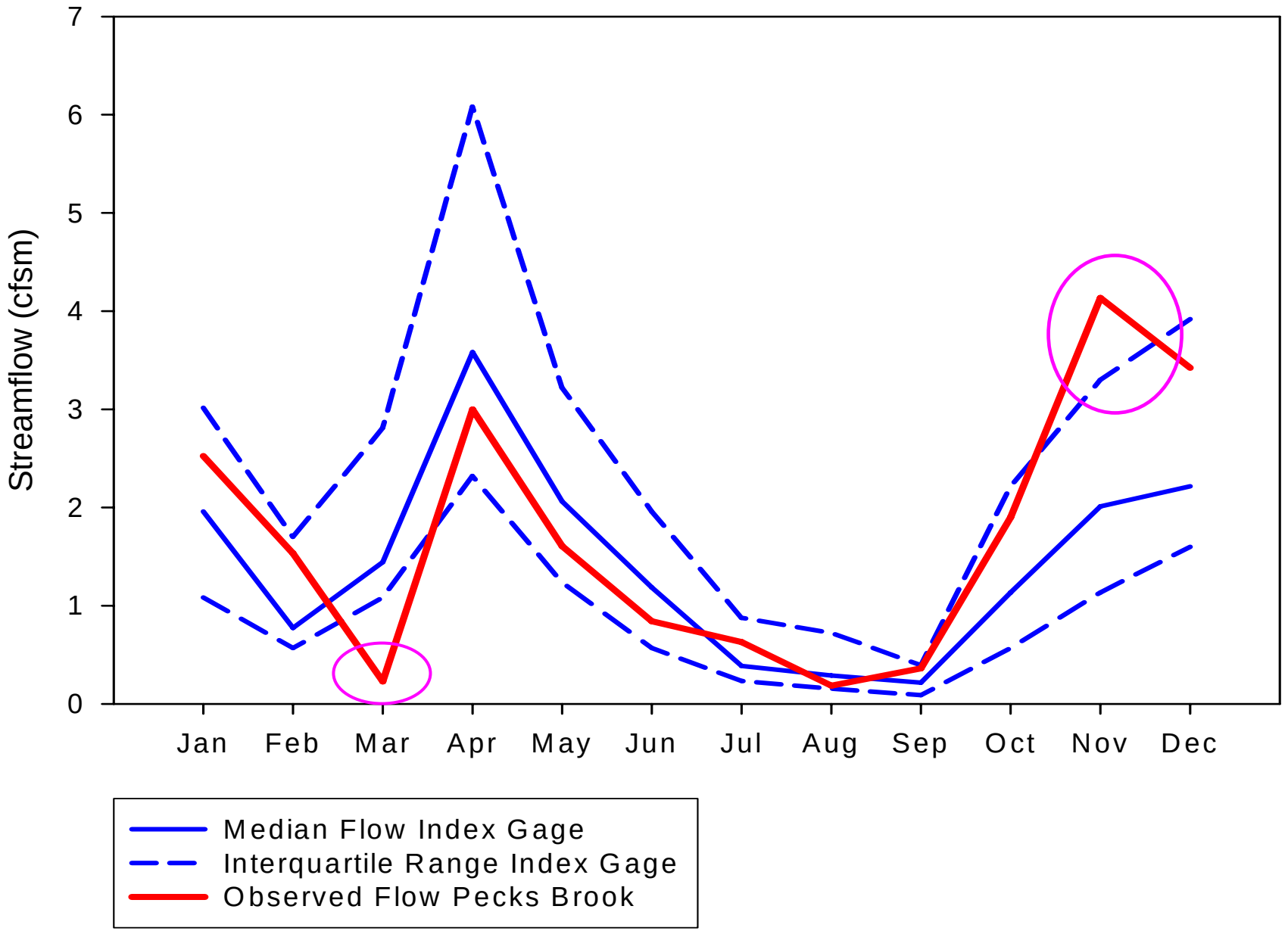
Month	Q75	Q50	Q25
Jan	1.90	2.52	2.52
Feb	1.46	1.53	1.53
Mar	0.18	**0.23**	0.90
Apr	2.20	3.00	5.40
May	1.20	1.61	1.79
Jun	0.59	0.84	1.09
Jul	0.53	0.63	0.88
Aug	0.16	0.18	0.39
Sep	0.17	0.36	0.43
Oct	1.10	1.90	2.40
Nov	3.89	**4.14**	4.14
Dec	2.04	3.42	5.73

Q75=Flow exceeded 75% of time, Q50=Median flow, Q25=Flow exceeded 25% of time

Observed Flow Pecks Brook vs. Index Gage



Observed Flow Pecks Brook vs. Index Gage



Pecks Brook, Pittsfield
Outfall of Lake Onota

April 19, 2006

July 14, 2006

Computing Recommended Flows

Monthly Quartile Flows (cfsm)
Index Gage (Preist Brook)

Month	Q75	Q50	Q25
Jan	0.62	0.98	1.70
Feb	0.62	1.03	1.75
Mar	1.08	2.11	4.23
Apr	2.11	3.61	5.88
May	0.93	1.49	2.58
Jun	0.31	0.62	1.39
Jul	0.13	0.25	0.52
Aug	0.08	0.16	0.41
Sep	0.09	0.20	0.45
Oct	0.18	0.40	1.03
Nov	0.51	1.08	1.91
Dec	0.72	1.29	2.27

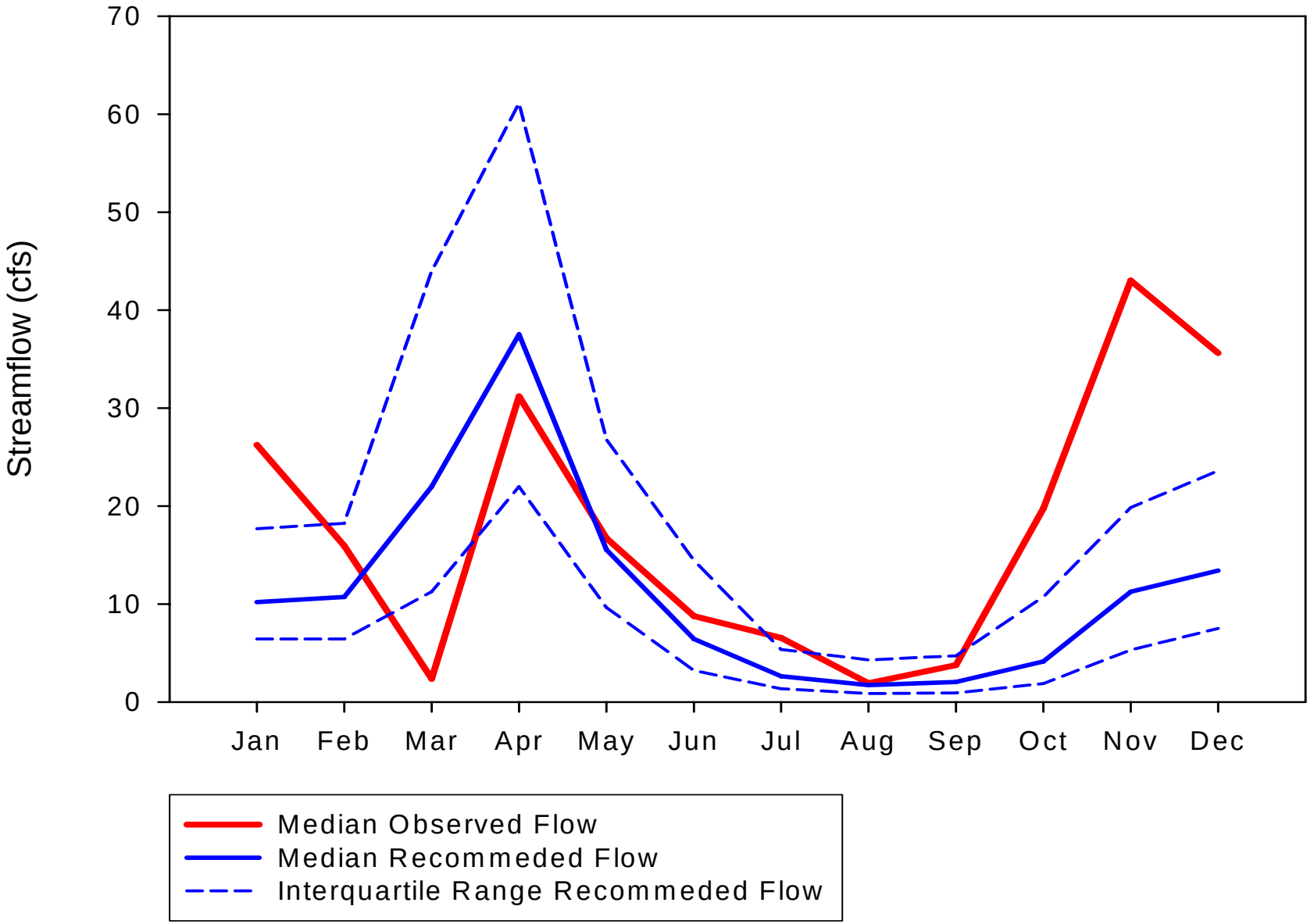
x 10.7

Recommended Flows (cfs)
Pecks Brook Pittsfield, MA

Month	Q75	Q50	Q25
Jan	6.43	10.19	17.69
Feb	6.43	10.72	18.23
Mar	11.26	21.98	43.96
Apr	21.98	37.53	61.11
May	9.65	15.55	26.80
Jun	3.22	6.43	14.47
Jul	1.34	2.63	5.36
Aug	0.86	1.72	4.29
Sep	0.91	2.04	4.72
Oct	1.88	4.13	10.72
Nov	5.31	11.26	19.84
Dec	7.51	13.40	23.59

Q75=Flows exceeded 75% of time, Q50=Median Flow, Q25=Flows exceeded 25% of time

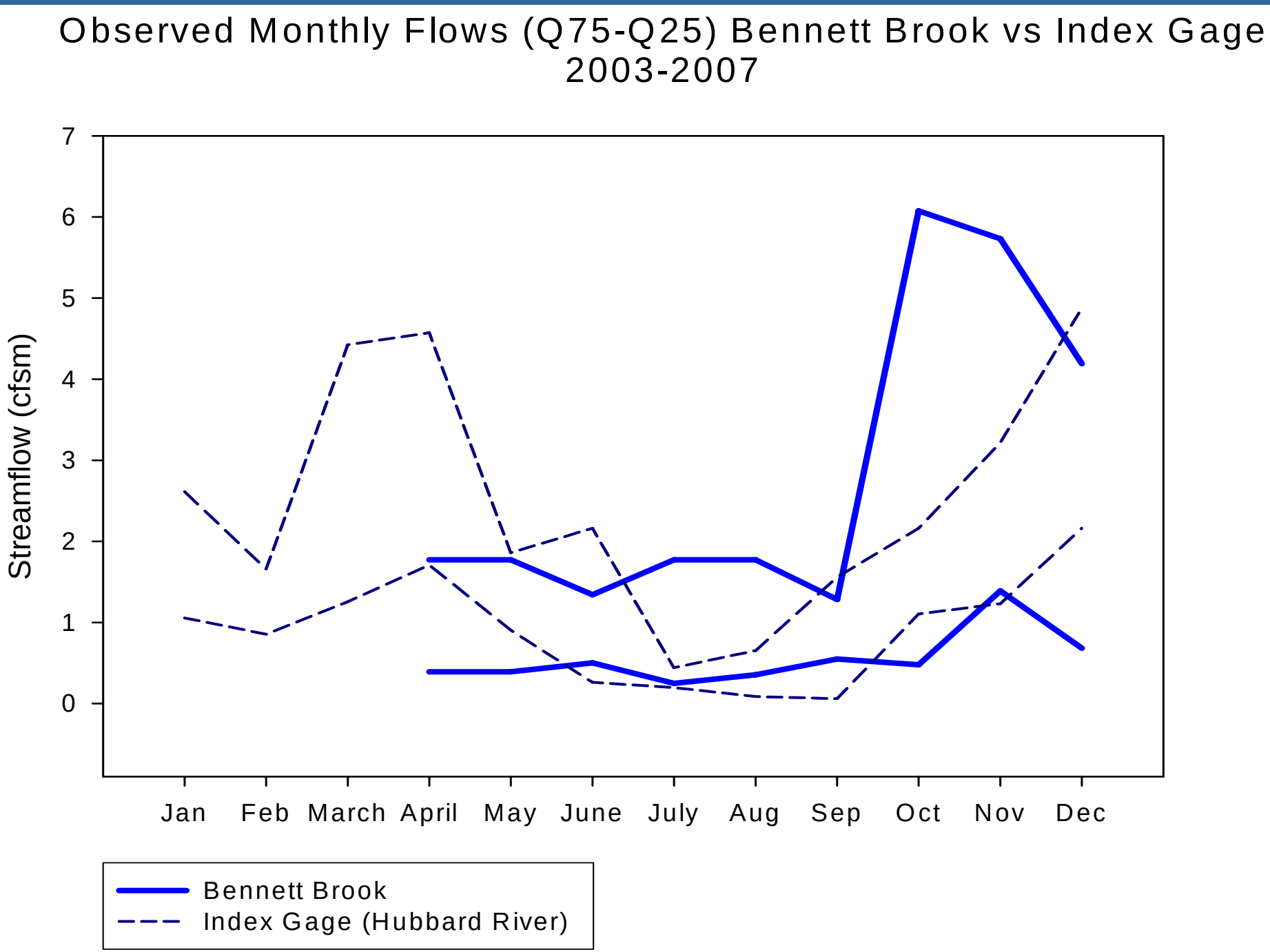
Recommended Flows Pecks Brook at Onota Lake Outfall, Pittsfield

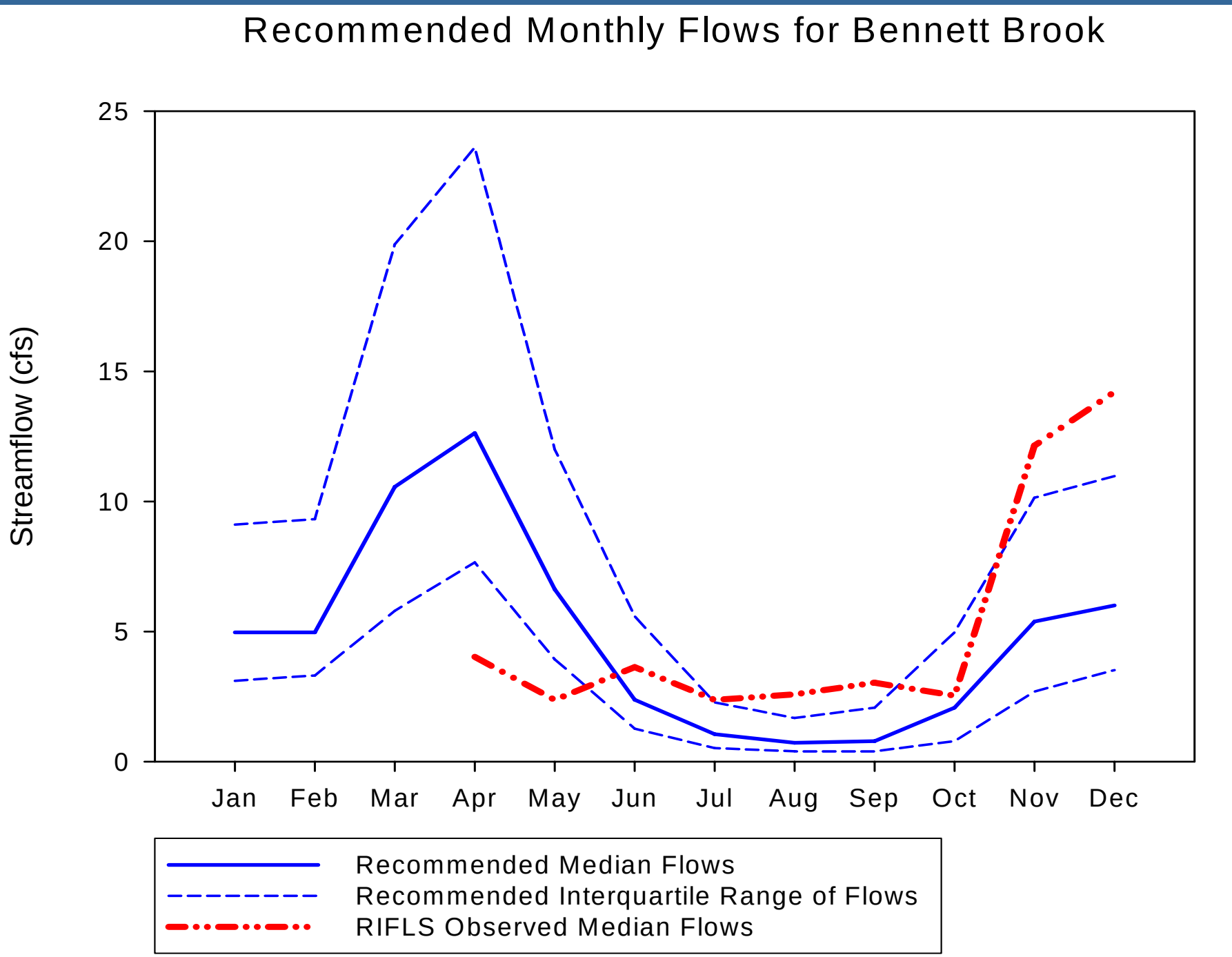


Bennett Brook
at Ashmere Lake Outfall
Hinsdale, MA

May 20, 2004

October 1, 2004


Observed Monthly Flows (Q75-Q25) Bennett Brook vs Index Gage
2003-2007
Streamflow (cfsm)
7
6
5
4
3
2
1
0
Jan
Feb
March
April
May
June
July
Aug
Sep
Oct
Nov
Dec
Bennett Brook
Index Gage (Hubbard River)


Recommended Monthly Flows for Bennett Brook
Streamflow (cfs)
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Recommended Median Flows
Recommended Interquartile Range of Flows
RIFLS Observed Median Flows

Implementing these changes

Work with stakeholders to create mutually agreed-upon Orders of Conditions

- Lake Associations
- Local Parks and Recreation employees
- Regional Planners
- Dept Conservation and Recreation Managers
- Division of Fisheries and Wildlife

Unsurprisingly, each Stakeholder has different concerns

Concluding thoughts:

- Challenges and limitations of this process
  - Not going to get rid of drawdown and refills as lake management technique
- Pilot project phase
  - Examining feasibility of regulating flow out of dams for natural flow regime
- Adaptive Management Approach
  - Start small with monthly targets
  - Simulated storm events in years to come...!
- We know other states doing more (ie. CT)

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Further information:

- 2004 USGS Index Gage Study by Armstrong, Parker and Richards (Water-Resources Investigations Report 03-4332)

- 2007 Draft Index Streamflows for Massachusetts by Linda Hutchins, MA Dept Conservation and Recreation

For further info please contact:

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