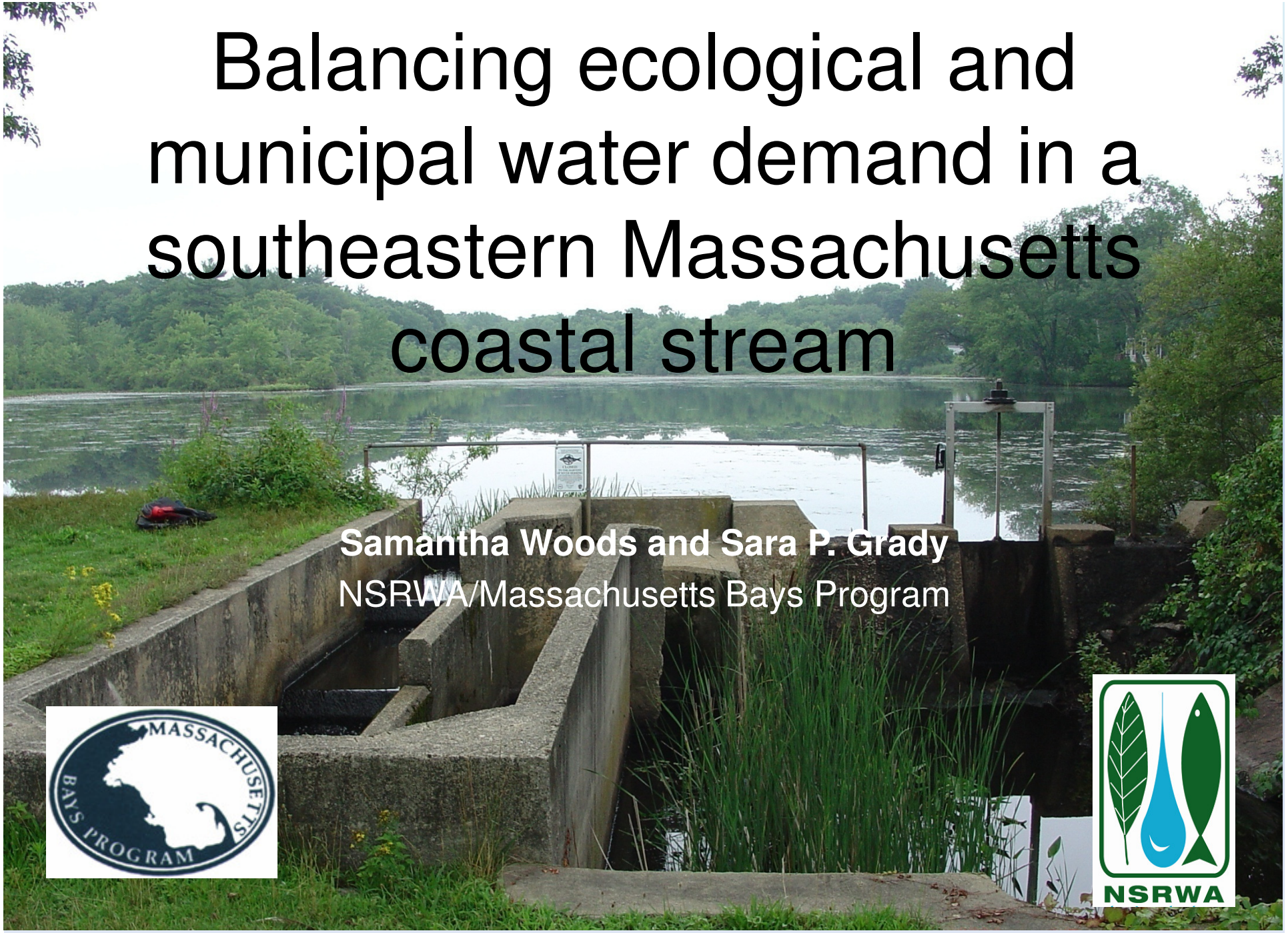
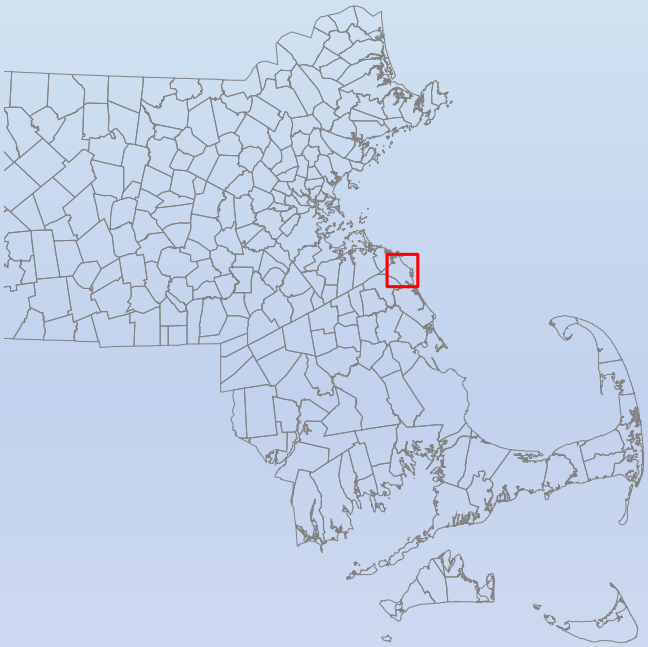
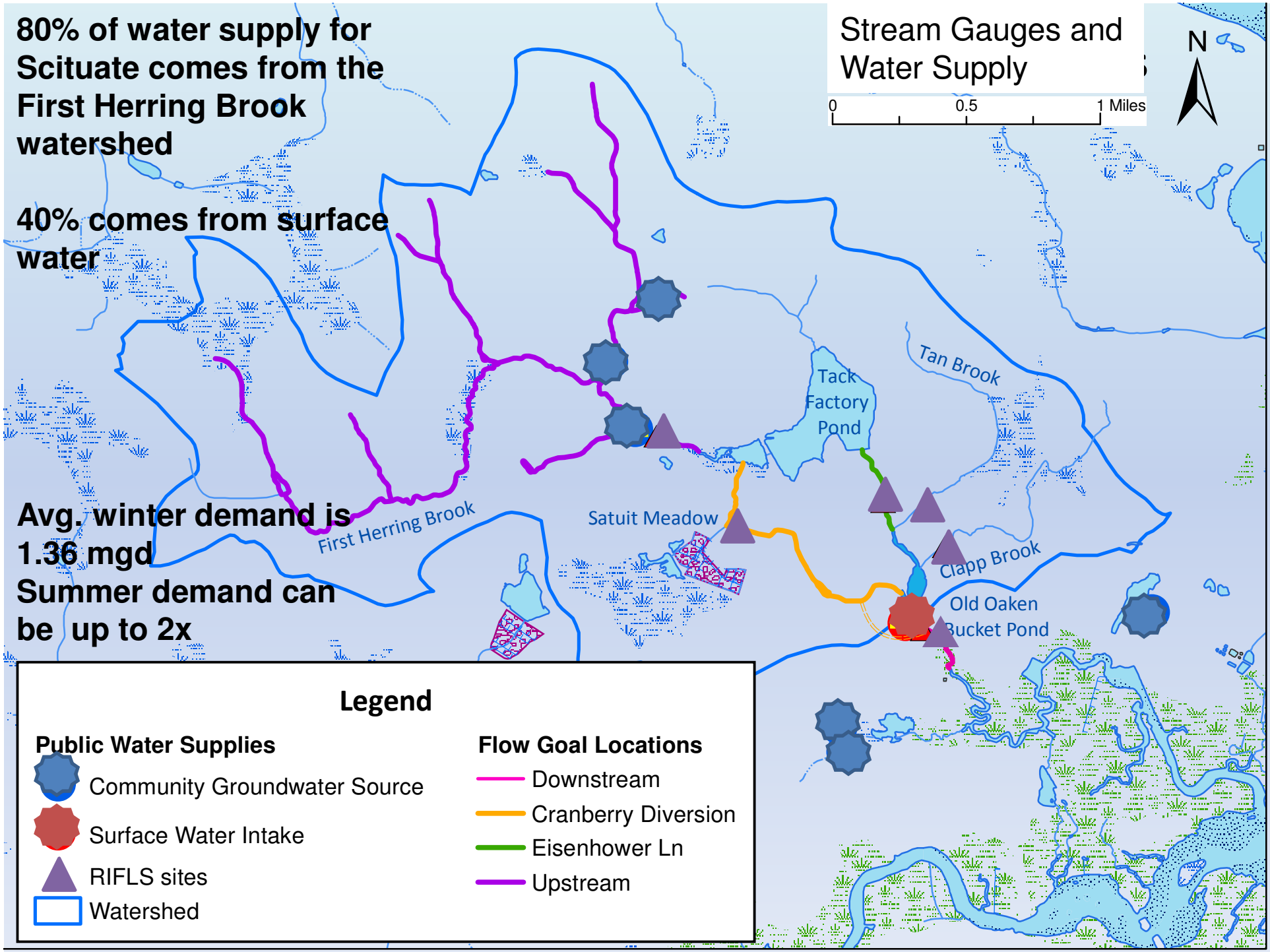
Balancing ecological and municipal water demand in a southeastern Massachusetts coastal stream

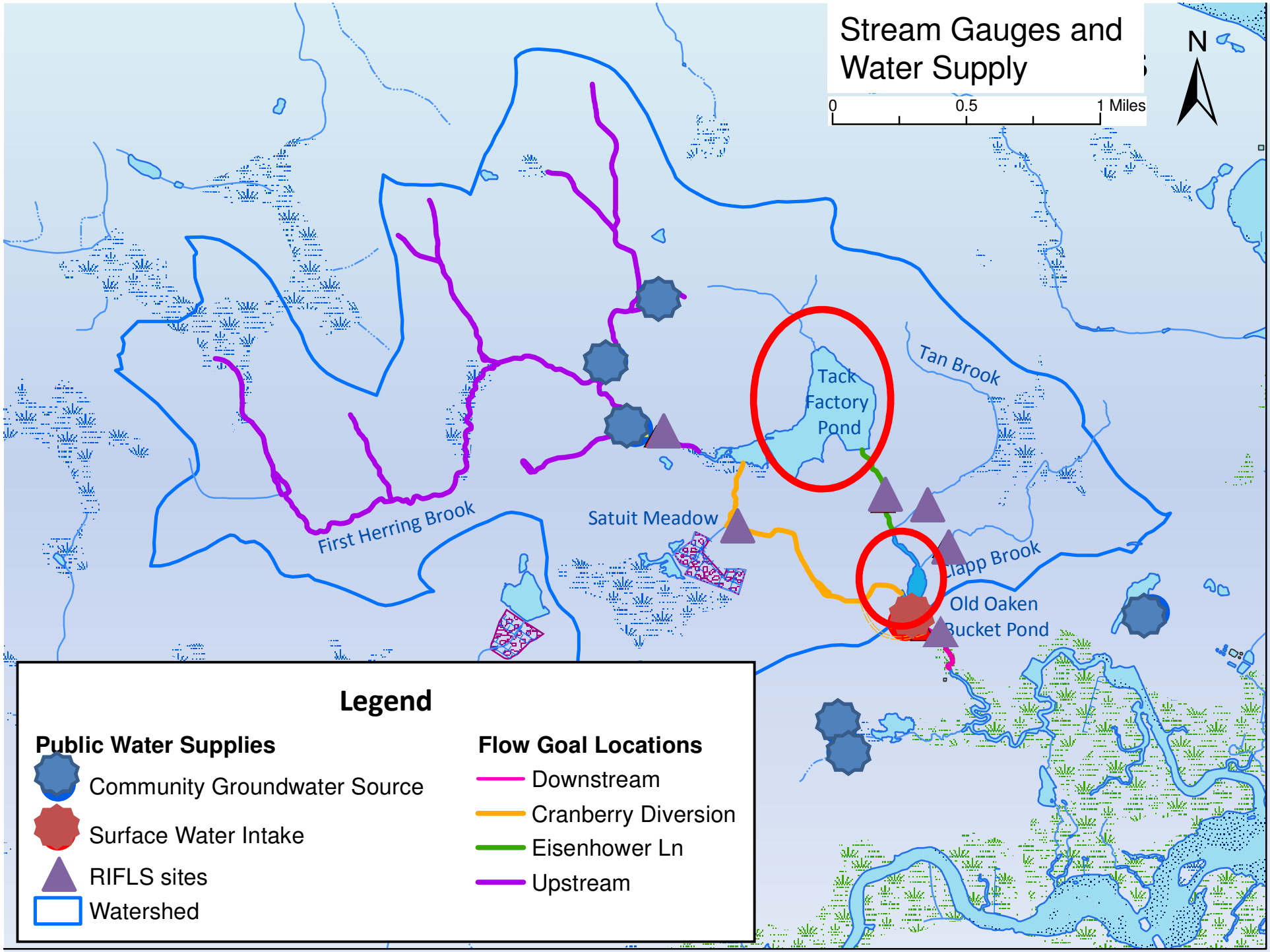


Samantha Woods and Sara P. Grady
NSRWA/Massachusetts Bays Program

First Herring Brook, Scituate, MA




80% of water supply for Scituate comes from the First Herring Brook watershed
40% comes from surface water
Avg. winter demand is 1.36 mgd
Summer demand can be up to 2x
Stream Gauges and Water Supply
N
0
0.5
1 Miles
Tack Factory Pond
Tan Brook
First Herring Brook
Satuit Meadow
Clapp Brook
Old Oaken Bucket Pond
Legend
Public Water Supplies
Community Groundwater Source
Surface Water Intake
RIFLS sites
Watershed
Flow Goal Locations
Downstream
Cranberry Diversion
Eisenhower Ln
Upstream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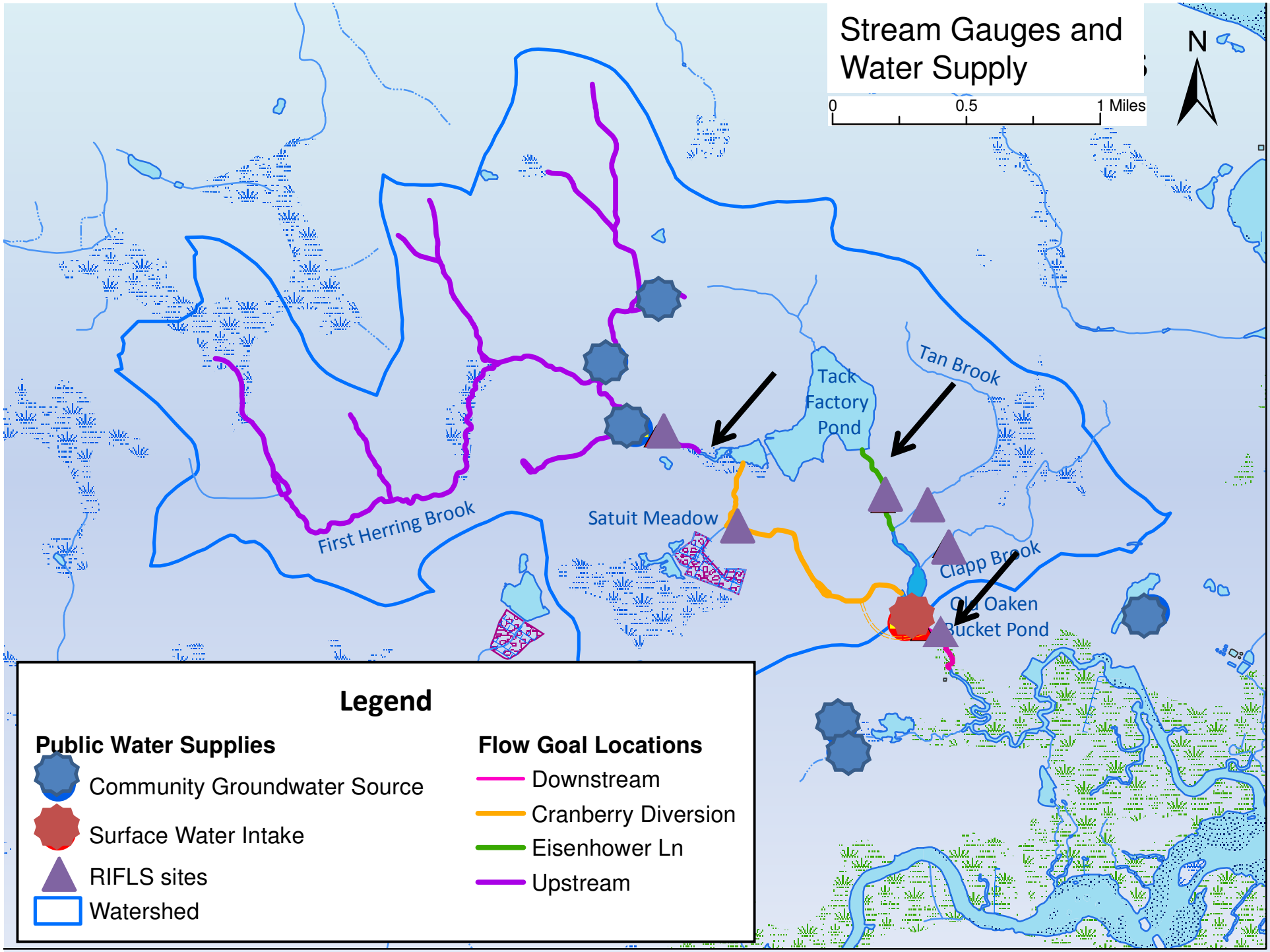
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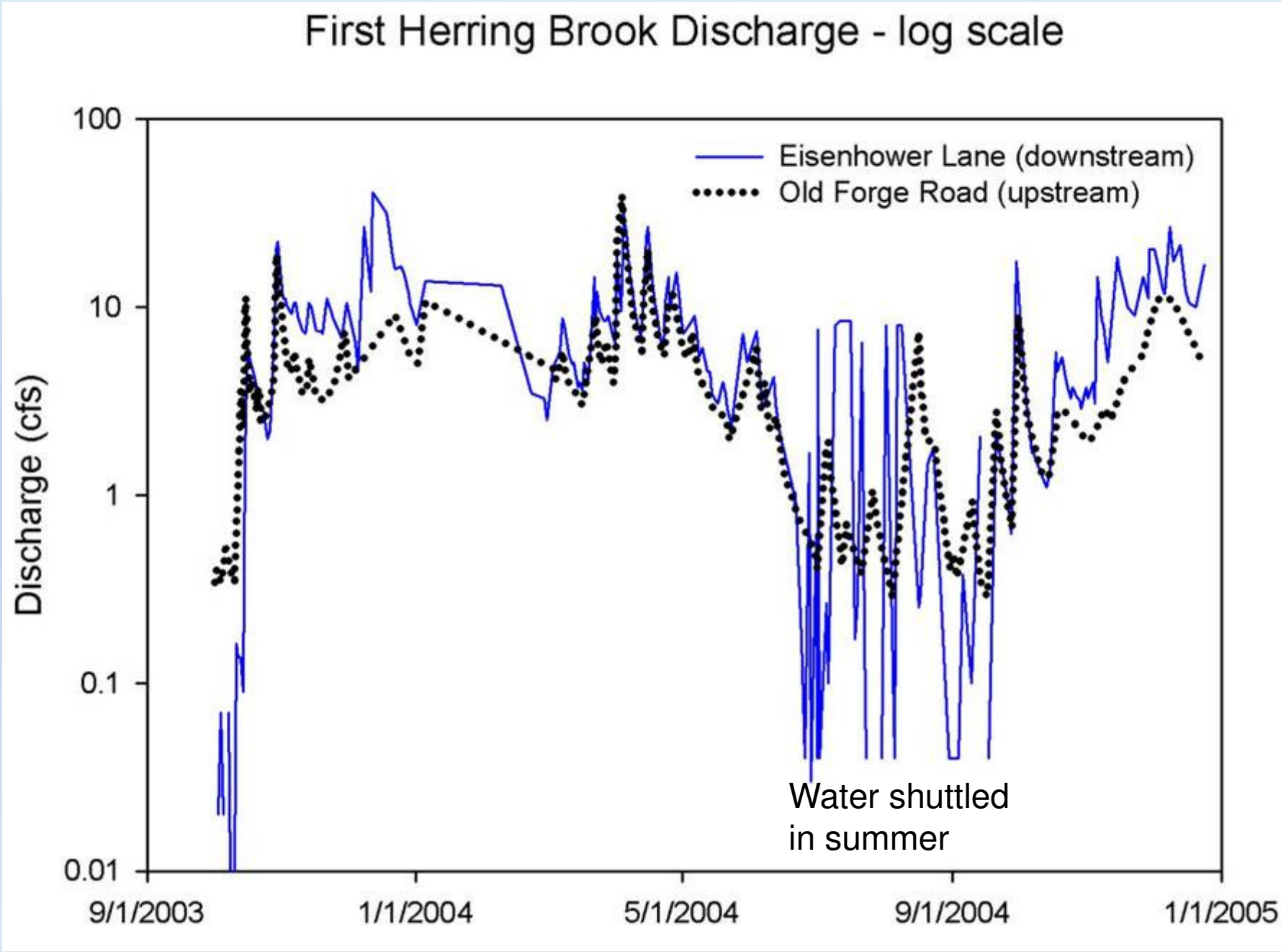
Volunteer Monitoring

- NSRWA and First Herring Brook Watershed Initiative (FHBWI) interested in restoring herring population and instream habitat
- MA Riverways Program's River Instream Flow Stewards program helped FHBWI monitor stream flow by installing gages, developing rating curves, and training volunteers.

FHBWI Volunteers measuring flow

Volunteers read the staff gages


First Herring Brook Discharge - log scale
Discharge (cfs)
100
10
1
0.1
0.01
9/1/2003
1/1/2004
5/1/2004
9/1/2004
1/1/2005
Eisenhower Lane (downstream)
Old Forge Road (upstream)
Water shuttled
in summer

Eisenhower Lane RIFLS Site

Eisenhower Lane stream segment links Reservoir and Old Oaken Bucket – water department controls releases

Fish runs and dams

Old Oaken Bucket

Reservoir

Project Impetus

- Town became interested in restoring herring to First Herring Brook
- At the same time, the town was reaching its permit limit and applied to increase its authorized withdrawals from 1.73 mgd to 1.85 mgd.
- Letters sent to DEP stating their interest in maintaining enough flow in the river to restore a herring run, while meeting the needs of the town.
- Current permit states that the town should continue partnerships and investigate restoration feasibility.

Environmental Flow Goals

Provide flow that is protective to species like:

- Alewife and Blueback Herring
- American eel
- Rainbow smelt

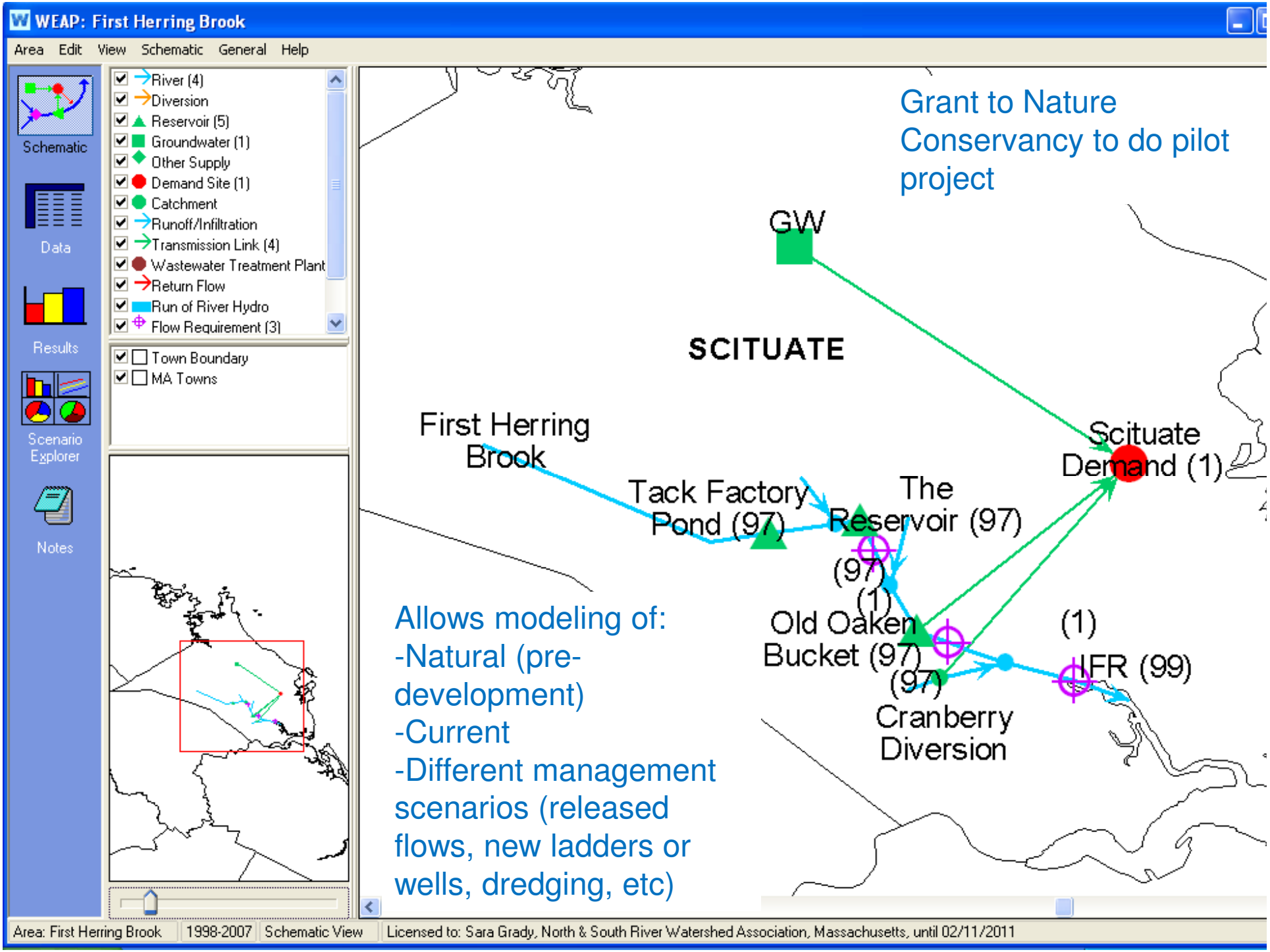
Water levels that maintain depth and area for spawning and flow for ladder function

Minimum flow for survival of stream organisms

Timing is also very important – bioperiods

(inmigration, outmigration)

Replicate natural flow conditions as closely as possible


WEAP: First Herring Brook
Area Edit View Schematic General Help
Schematic
Data
Results
Scenario Explorer
Notes
River (4)
Diversion
Reservoir (5)
Groundwater (1)
Other Supply
Demand Site (1)
Catchment
Runoff/Infiltration
Transmission Link (4)
Wastewater Treatment Plant
Return Flow
Run of River Hydro
Flow Requirement (3)
Town Boundary
MA Towns
Grant to Nature Conservancy to do pilot project
GW
SCITUATE
First Herring Brook
Tack Factory Pond (97)
The Reservoir (97)
Scituate Demand (1)
(97)
(1)
Old Oaken Bucket (97)
(97)
Cranberry Diversion
(1)
IFR (99)
Allows modeling of:
-Natural (pre-development)
-Current
-Different management scenarios (released flows, new ladders or wells, dredging, etc)
Area: First Herring Brook
1998-2007
Schematic View
Licensed to: Sara Grady, North & South River Watershed Association, Massachusetts, until 02/11/2011

Model Conclusions

- The model showed that the difficulty in meeting both water supply and environmental goals is limited to certain months and weeks during the year – late summer and early fall

- Results provide the pieces necessary to develop a system design and operations plan to meet all goals.

- Objectives and water needs may be met or partially met by infrastructure modification and improvements, including:
    - **Increased use of demand management**
    - Improved fish ladders
    - Modifications of dams to allow more effective management of current surface water supplies (e.g. easy change of water levels at spillways)
    - Finding additional sources (including demand mgmt)

Implementation of Model Results

Grant from MassDER

- Lawn Irrigation Restriction - Opportunity to gain/save water through conservation during summer peak water use periods
- Operational Plan for the Water Division – Minimum flows and fish ladder depth targets
- Radio Meters for High Water Use Neighborhoods - faster information about water use in problematic areas

Lawn Irrigation Restriction

- Irrigation systems only
- Memorial Day-Labor Day
- Water 1x/week on day based on voting precinct
- Based on pilot effort in Franklin, MA (used trash days)
- Brochure sent to all water customers

Scituate Reservoir low water level, September 2007.

The new Lawn Irrigation Restriction is not only the cheapest and most effective tool for stretching the town's water supplies for people, but is also part of the long term plan to restore First Herring Brook.

Introducing ... Scituate's new
Lawn Irrigation System Restriction:

Your Voting Precinct is #3
You may use in-ground lawn irrigation systems
connected to the town's water supply system only on WEDNESDAYS.
Why does Scituate need a new Lawn Irrigation Restriction? Learn more inside! ->

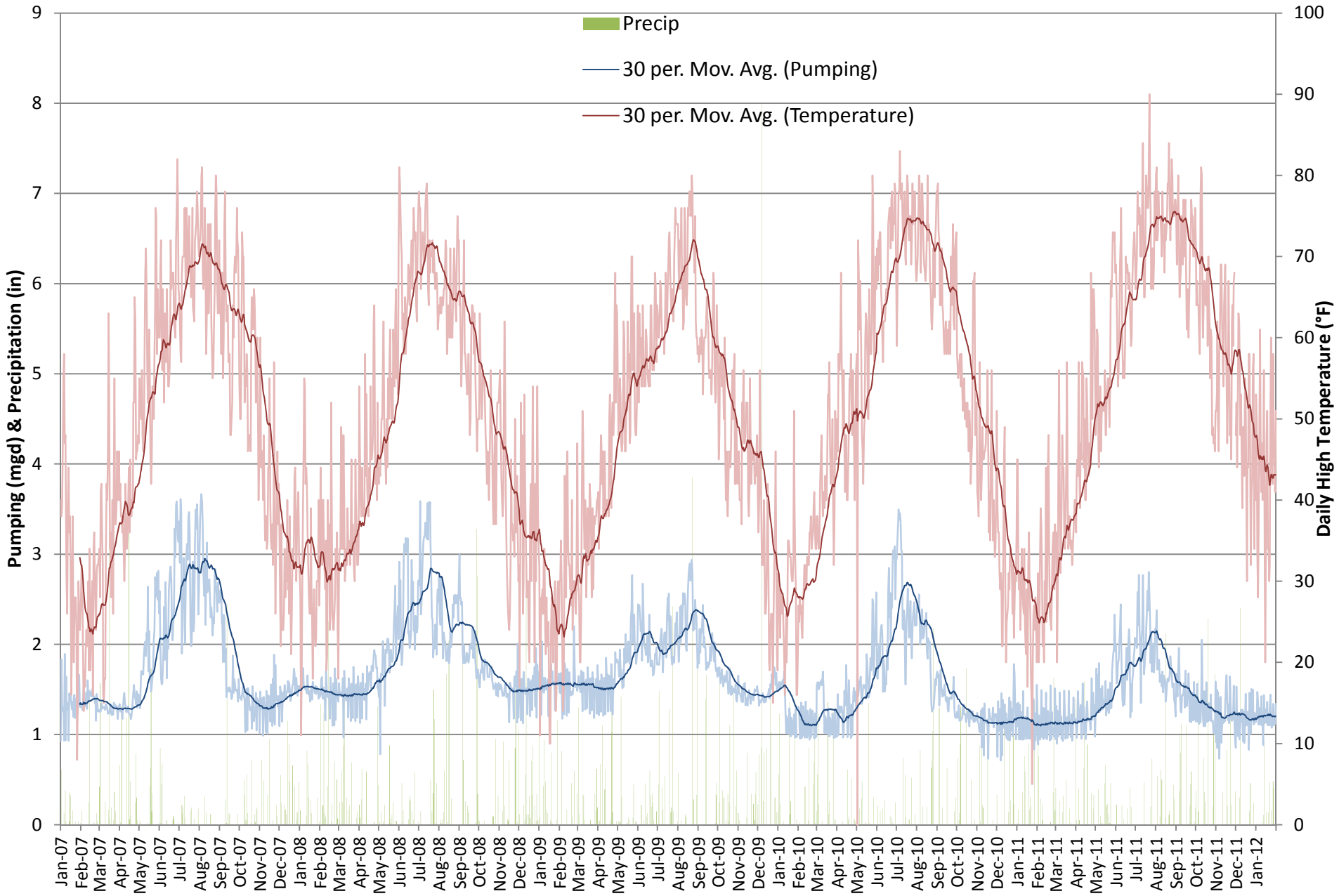
Water Use Analysis (from billing data)

Percent of total town water used

	With businesses		Without businesses	
	% total use	MGD	% total use	MGD
Top 5%	21.7	0.332	19.2	0.282
Top 10%	32.1	0.489	29.8	0.436
Top 25%	53.5	0.817	51.9	0.760
Top 50%	77.2	1.179	76.5	1.119
Bottom 50%	22.8	0.348	23.5	0.345

High water users use proportionally more water, on average, in summer

- Average and median households increase ~0% in summer
- Top 25% increase ~2%
- Top 10% increase ~7%
- Top 5% increase ~25%


Precip
30 per. Mov. Avg. (Pumping)
30 per. Mov. Avg. (Temperature)
Pumping (mgd) & Precipitation (in)
Daily High Temperature (°F)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60
70
80
90
100
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Jul-07
Aug-07
Sep-07
Oct-07
Nov-07
Dec-07
Jan-08
Feb-08
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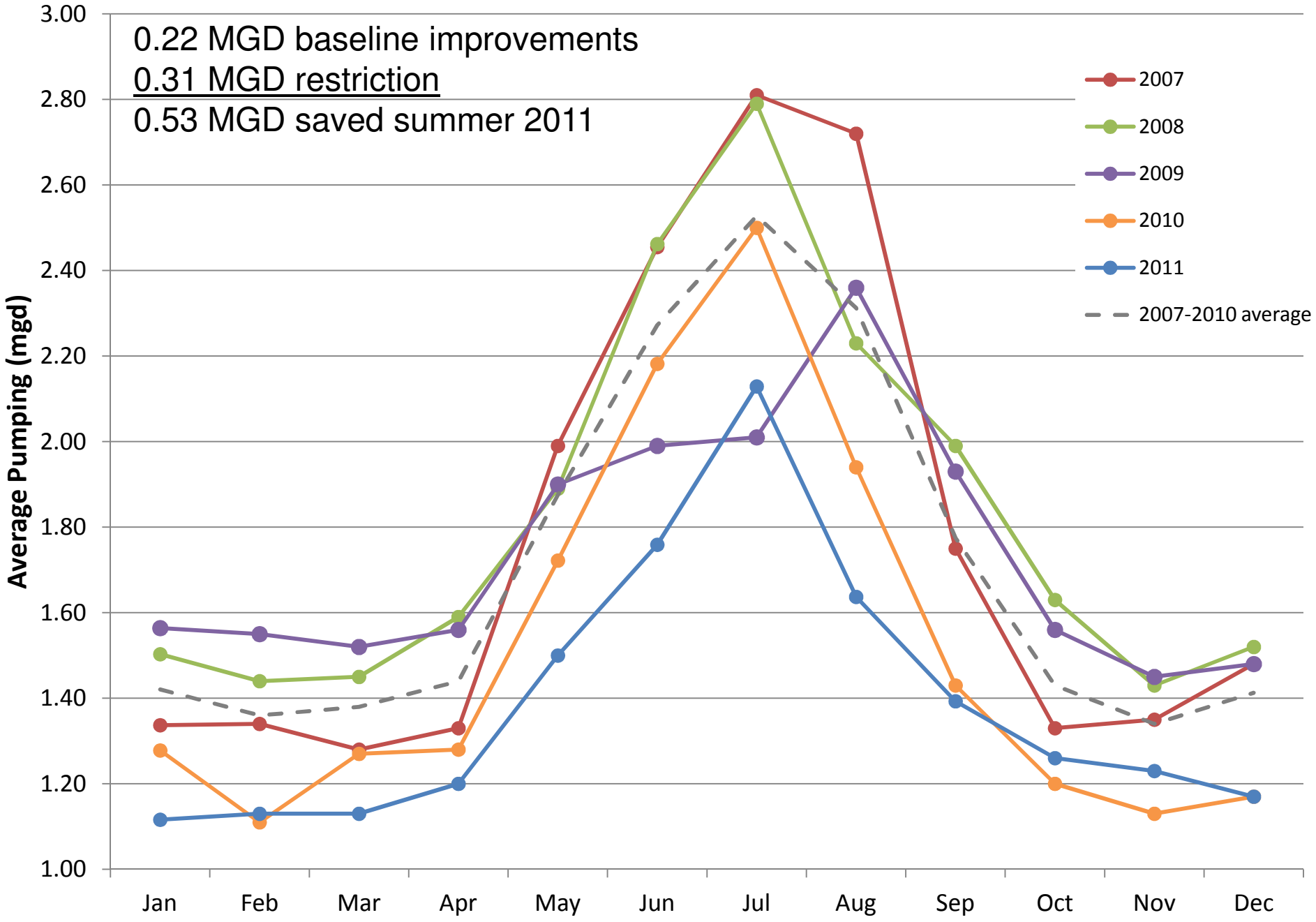
Mar-11
Apr-11
May-11
Jun-11
Jul-11
Aug-11
Sep-11
Oct-11
Nov-11
Dec-11
Jan-12

Results from Summer 2011

- 170 million gallons used in summer (JJA) 2011 compared to:
  - 197 MG (recent min. in 2009, +27MG)
  - 219 MG (average 2007-2010, +49MG)
  - 245 MG (recent max. in 2007, +75MG)
- Average daily pumping in summer 2011 = 1.84 MGD compared to:
  - 2.12 MGD (recent min. in 2009, +0.28MGD)
  - 2.37 MGD (average 2007-2010, +0.53MGD)
  - 2.66 MGD (recent max in 2007, +0.82MGD)


0.22 MGD baseline improvements
0.31 MGD restriction
0.53 MGD saved summer 2011
Average Pumping (mgd)
3.00
2.80
2.60
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2007
2008
2009
2010
2011
2007-2010 average

Other municipal benefits

- The Town used more groundwater than surface (pond) water, meaning better tasting water and a reduction in treatment chemicals
- The Town could run the system at lower pressure, reducing water main breaks from 123 in 2010 to 29 in 2011 and resulting in ¼ the complaints by customers about “brown water”
- The Town met the state mandated average of 65 gallons/person/day with an average use of 63 gpppd
- The Town avoided a water ban on all residents - including homes with irrigation systems. (Three neighboring towns had mandatory bans on outdoor water use last summer)
- 82% of customers felt the restriction was a good idea
- Potentially saved enough that they may not have to find additional sources (which cost a lot!)

Cost/Benefit

The water division saved $45,200 in chemicals and $21,400 in labor in 2011 compared to 2010

But, lower water billings in July-November

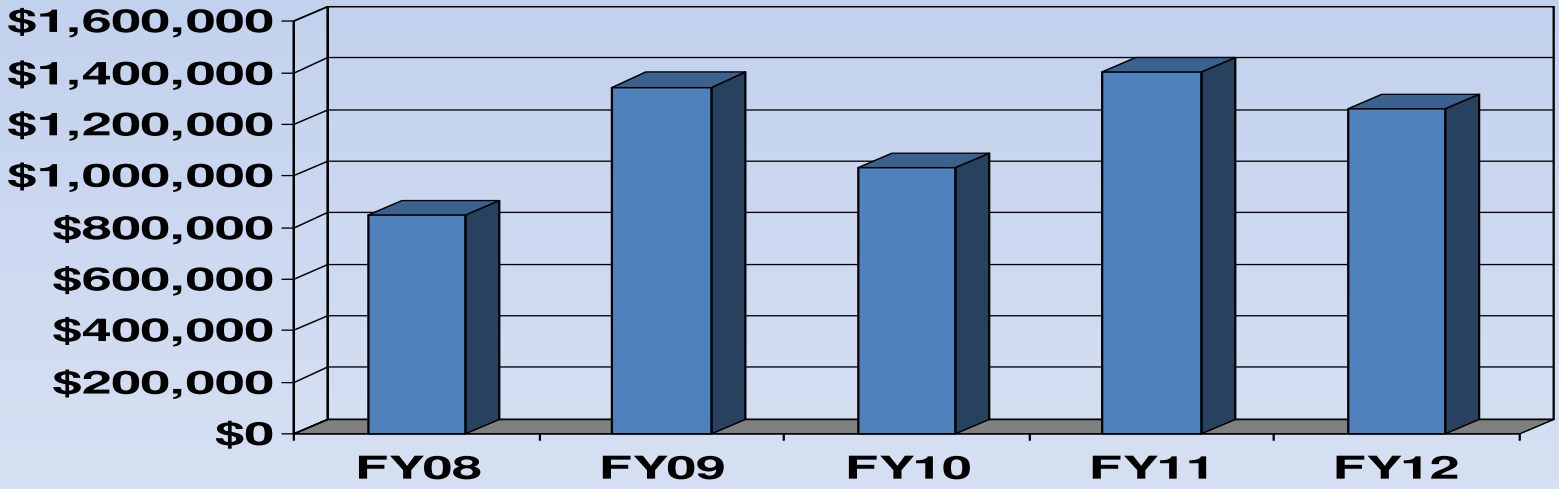


Table 1. Interim Streamflow Guidelines

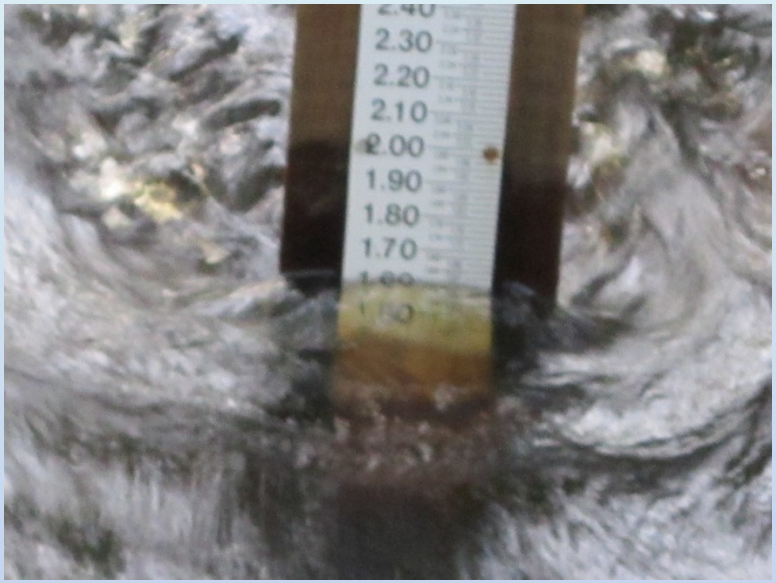
	Country Way (downstream of Old Oaken Bucket Pond)			Eisenhower Ln. (downstream of Reservoir)	
Bioperiod	River (cfs)	Staff Gauge (ft)	Fish Ladder** (inches)	River (cfs)	Staff Gauge (ft)
Mar	3.78	1.01	0	2.56	4.80
Apr –May	[3.78**]	1.01	8”	2.56	4.80
Jun – Aug	0.39	0.61	0	0.22	4.13
Sep – Oct	[0.45**]	0.63	5”	0.25	4.16
Nov	0.45	0.63	0	0.25	4.16
Dec – Feb	3.15	0.97	0	2.13	4.75

April - May, Sept - Oct - Manage using GREEN inches over fish ladders or weirs unless there is not enough water. If drought conditions are occurring then use staff gage heights to maintain minimum streamflows in river.

** Eight inches of depth equals 5.2 cfs and five inches of depth equals 2.6 cfs. Because these flows exceed the river flow goals all downstream releases during the migration seasons should be made through the fish ladder.

- Interim plan until fish ladders are replaced and a weir installed at OOB
- Minimum flows downstream of Reservoir and Old Oaken Bucket (as measured at stream gauges)
- Flows superseded by fish ladder depths in April/May (inmigration) and Sept/Oct (outmigration) except in drought conditions


CLOSED


2.30
2.20
2.10
2.00
1.90
1.80
1.70

Current and next steps in project

- Adaptive streamflow releases – this spring was a great example!
- Collect data to keep analyses current (water consumption, instream and biological data and herring counts!)
- Refine and improve water conservation efforts
- Work with town to seek sustainable, additional water sources
- Seek funding and resources to upgrade system infrastructure (fish ladders, weir)

Acknowledgements