Lamprey River
Protected Instream Flow Study

October 20, 2006

Lamprey River
Protected Instream Flow Study

- Reintroductions
- Acceptance of meeting minutes
- Presentation on PISF Study and Water Management Plan:
  - Project Team
  - Project Status and Updates
  - Questions and Answers

Project Team

- **Normandeau Associates**

  Limnology, aquatic ecology, aquatic ecosystem restoration, impact assessment, permitting, wetland and terrestrial assessment.

- **University of New Hampshire**

  Hydrology, hydraulics, geomorphology, ground water, water resources management, economics, financial possibilities and management plan.

- **University of Massachusetts**

  Instream flow, habitat modeling, fish ecology and fisheries management.

Project Task Update

- **Evaluation of flow dependent Instream Public Uses, Outstanding Characteristics and Resources (IPUOCR).**

  - **Recreation – boating and swimming**
  - **Natural Communities and Wildlife Habitat**
  - **Rare, Threatened and Endangered Species**
  - **Instream Resources – aquatics and fish habitat**
  - **Public Water Supply (surface and ground water)**

Project Task Update

- **Additional tasks:**

  - **Concurrent flow analysis for PISF.**

  - **Identification, survey and interviews with Affected Water Users (AWU) and Affected Dam Owners (ADO) for Water Management Plan (WMP).**

  - **Multicriteria Decision Analysis (MCDA) of water use for water management planning.**

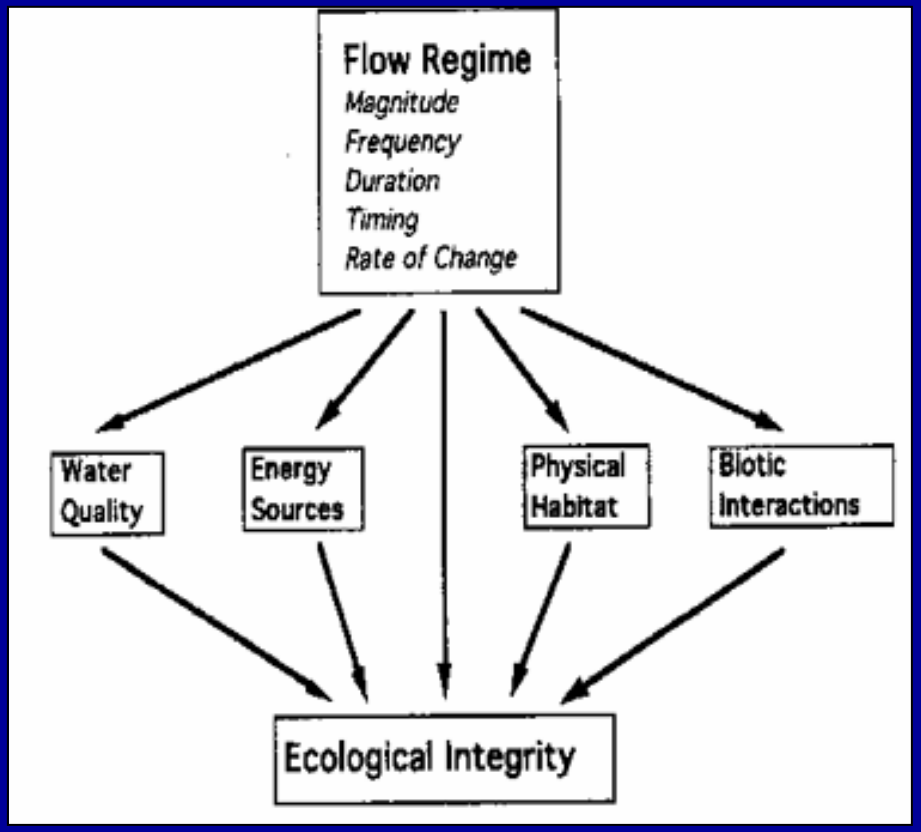
Natural Flow Paradigm

- **Basis for the Protected Instream Flow (PISF) study of the Lamprey River.**

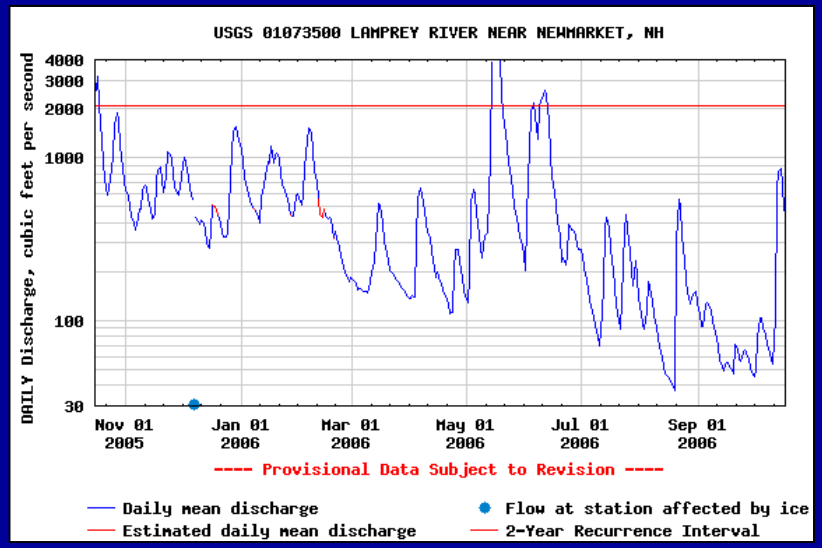
- **Flow regime is of central importance in sustaining the integrity of flowing water systems (Poff and others 1997). Species adapt to flow regime.**

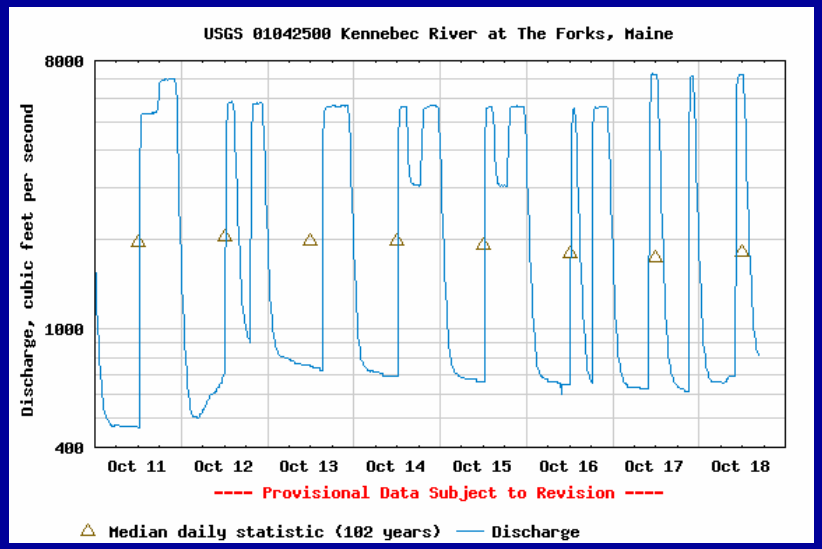
- **Where flow regime includes: magnitude, frequency, duration, timing and rate of change in flows.**

Natural Flow Paradigm

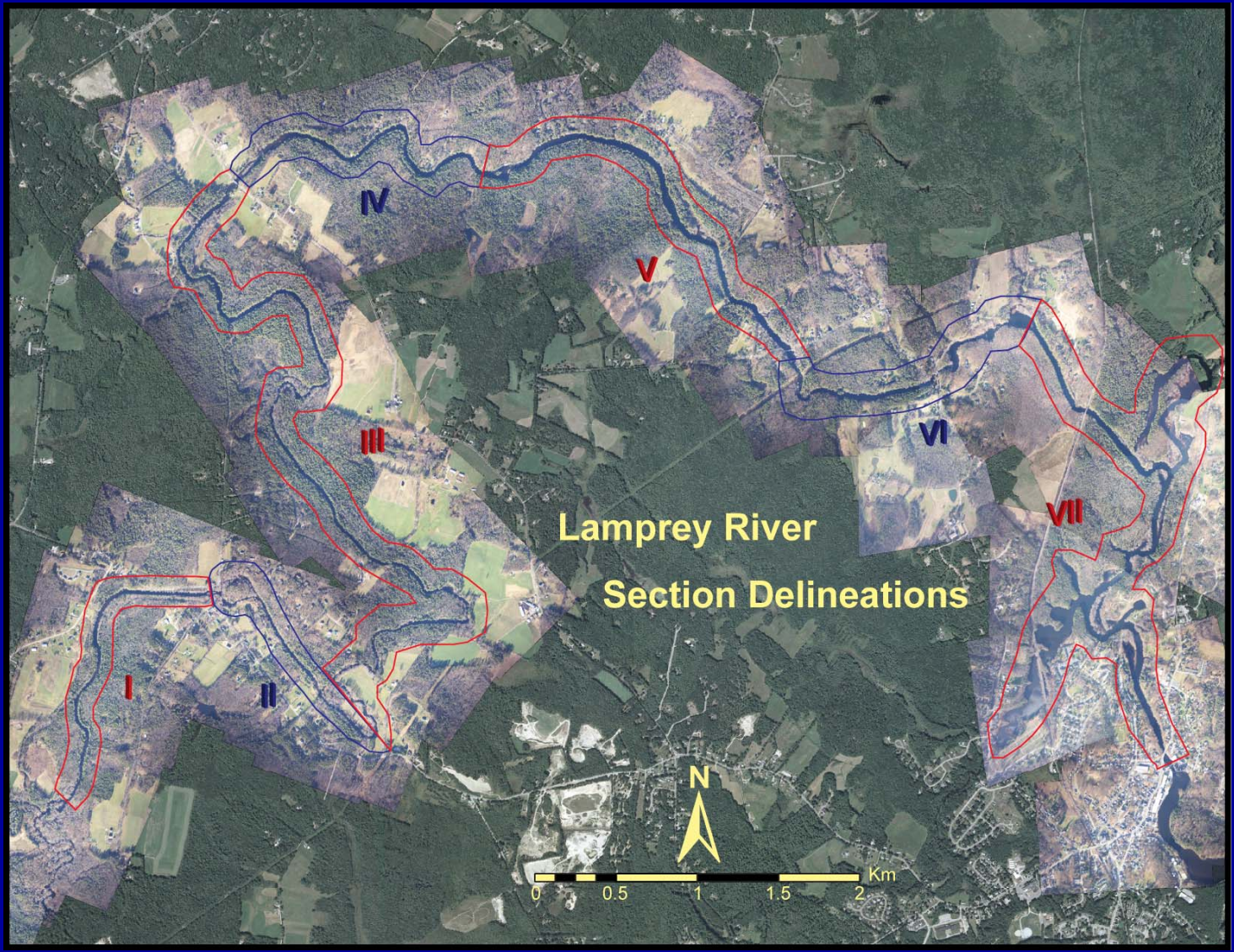


From Poff and others 1997





River Characteristics



River Characteristics

Sections III, V and VII (clockwise)

River Characteristics

Sections I/II and VI (clockwise)

Flow Dependent Resources

- Recreation (boat/swim)
- Water Storage
- Pollution Abatement

- Floodplain forests
- Oxbow/backwater wetlands
- Vernal pools
- High energy riverbanks
- River rapids

RTE Plants

- Water marigold
- Sharp-flowered mannagrass
- Knotty Pondweed
- Blunt Sphenopholis
- Small-crested Sedge
- Slender Blue Flag
- Climbing Hempweed

RTE Wildlife

- Wood Turtle
- Spotted Turtle
- Blanding's Turtle
- Pied Billed Grebe
- Osprey
- Bald Eagle
- Sedge Wren

- Fish and Fish Habitat
- Mussels
- Insects
- T/E Bridled Shiner
- Banded Sunfish
- Endangered Brook Floater

- Public Water Supply
- Groundwater

Recreation

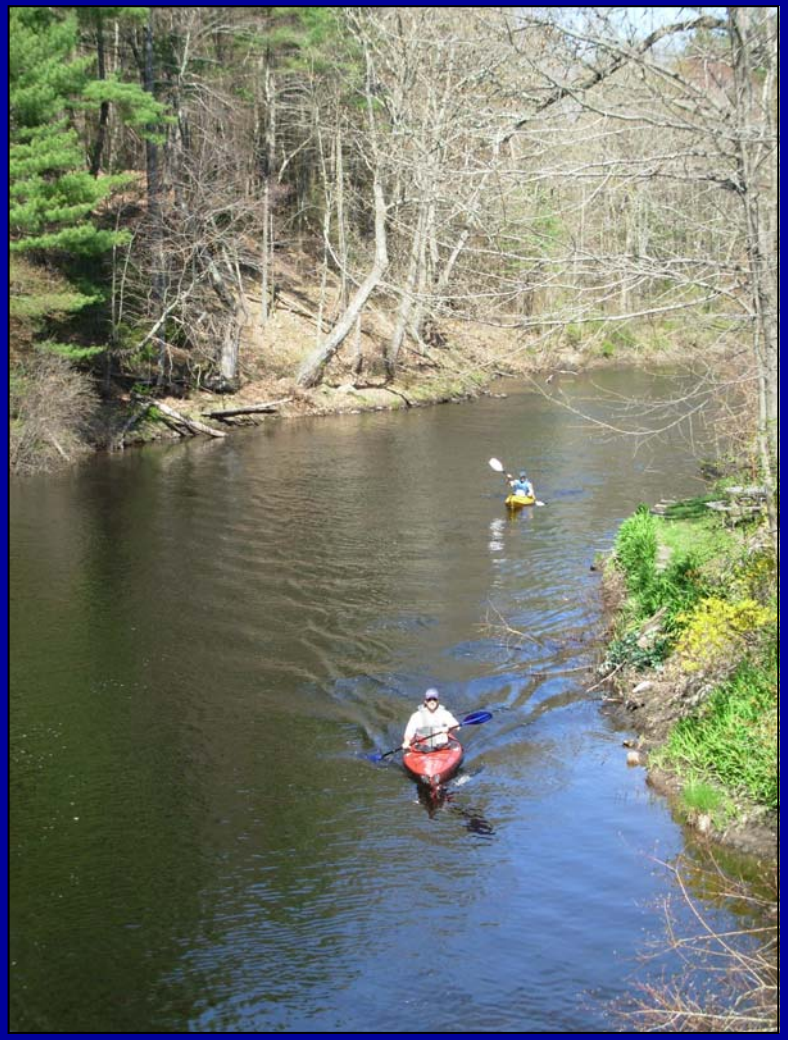
- IPUOCR is swimming, kayaking , canoeing and rowing.
- Flow dependent at average to high flows.
- Many non-impounded reaches not navigable at low flow.
- Evaluated if WMP alternatives influence average to high flows.

Recreation - Boating

- Developed written survey to obtain information on:

  - Frequency of river use and location
  - Means of monitoring flow levels
  - Preferred water level or flow
  - Acceptable minimum flow for boating
  - Attraction of Lamprey River
  - Home town

Recreation - Boating



- Visited known put in/pull outs on the designated reach on April 16 and 29, July 1,3 and 20 and October 8, 2006.

- Attended NH River Council paddling trip on April 16 and Epping canoe race on April 29, 2006.

Not Designated.

Recreation - Boating

- April 16 and April 29 events, 60 surveys distributed.

- Also visited following lower Lamprey River put in/take outs: (no boaters observed).

  - Wadleigh Falls
  - Lee Hook Road
  - Wiswall Dam
  - Packers Falls

Recreation - Boating

- **July 1 & 3, July 20 and October 8, 2006 visited lower Lamprey River put in/take outs:**

  - Wadleigh Falls (no boaters)
  - Lee Hook Road (no boaters)
  - Wiswall Dam (no boaters, fisherman)
  - Packers Falls (no boaters, fisherman)
  - Newmarket (Water Works, Cemetery and Boat Launch) – boaters

Recreation - Boating

Lamprey River Flow (USGS gage at Packers Falls):

- **April 16 – 184 cfs, 1.00 cfsm**
- **April 29 – 152 cfs, 0.83 cfsm**
- **July 1 – 249 cfs, 1.36 cfsm**
- **July 3 – 177 cfs, 0.97 cfsm**
- **July 20 – 100 cfs, 0.55 cfsm**
- **October 8 – 64 cfs, 0.35 cfsm**

Mean annual flow (35-04) – 281 cfs, 1.54 cfsm

Boating Survey Results

- Upper Lamprey (Not Designated):
  - Most paddle 1-2 times a year, usually spring.
  - Paddlers from southern NH, also MA + ME.
  - Monitor flow by word of mouth or visual.
  - Typically paddle from Blair Park to Rte 87.
  - Minimum flow should be higher than on April 16 and 29 (0.8 to 1.0 cfsm).
  - Attraction of river: wildlife, feeling of remoteness, beautiful scenery, variable paddling conditions.

Boating Survey Results

- Lower Lamprey (Designated):
  - Most paddle more than 2 times a year, during spring, summer and fall.
  - Paddlers from Durham and Dover NH.
  - Monitor flow by word of mouth or visual.
  - Paddle flatwater sections upstream of falls or dams.
  - Minimum flow should be about what was observed on July 1 (1.4 cfsm).
  - Attraction of river: quiet, lack of development, beautiful scenery and fishing.

Recreation - Boating

- Input from Lamprey River Watershed Association on Lower Lamprey:
  - Popular sections: Wadleigh Falls to Wiswall Dam, Packers Falls and McCallen Dam Impoundment.
  - Put in/take out at Lee Hook Road and Wiswall Dam.
  - Indicator of water level – flow over rapids/riffles downstream of Lee Hook Road Bridge. If you can pass this with a canoe, whole trip usually good.

Recreation - Boating

- Input from Lamprey River Watershed Association on Lower Lamprey:
  - Spring some whitewater on nonimpounded sections. Particularly between Wiswall Dam over Packers Falls to McCallen Dam impoundment.
  - Lower impounded section multiple use, particularly on weekends – canoes, kayaks and power boats.
  - Durham Boat Company operates sculling center on lower impounded section.

Recreation - Swimming

- Four locations were identified to conduct surveys of recreational swimmers based on the presence of an advertised beach.
- A survey was developed to evaluate swimming use of the river qualitatively.
- Surveys were conducted on July 29 and August 5, 2006 at four designated beaches on the designated reach.

Swimming Survey

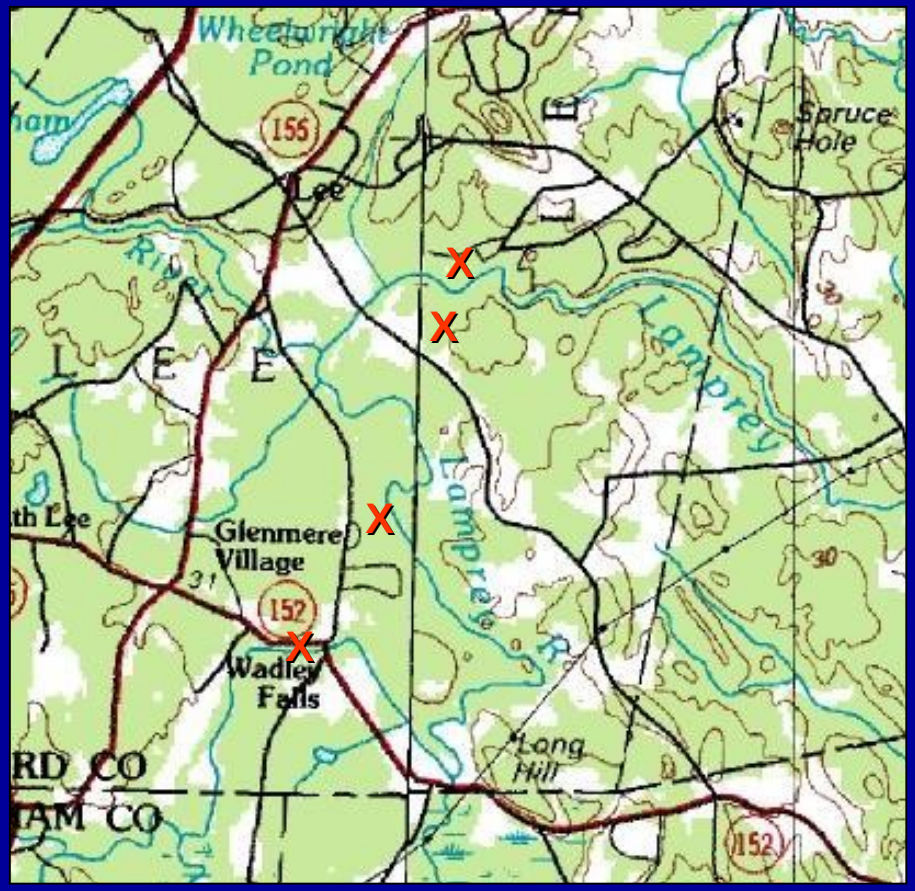
- The survey was implemented via canvassing the beaches and verbally querying swimmers or potential swimmers.

- The survey included questions regarding:

  - Use of the river
  - Frequency of use
  - Favorite swimming locations
  - Preferred flow conditions or levels, sources of information on swimming conditions.

Swimming Areas Surveyed

- Ferndale Acres Campground
- Glenmere Village Association
- Wadleigh Falls Campground
- Wellington Camping Park



Ferndale Acres Campground Beach

Campground Limitations

- One location did not have a usable beach (Glenmere).
- Two of the locations contained a beach and a pool (Ferndale and Wadleigh).
- One location was occupied by semi-permanent residents (Wellington).
- Only two locations had transient or seasonal campers (Ferndale and Wadleigh).

Swimming Survey Results

- Swimmers came from 9 towns in NH, 10 towns in MA, 1 from NY and RI.
- Months of use ranged from April to October, most activity centered June to August.
- Almost half of the respondents said they swam at least once a week or more within the swimming season.

Swimming Survey Results

- Half of the swimmers did not check flow levels; almost all that did checked flow by looking at the river or driving by.
- The most common reason given for choosing the river for swimming was its proximity to campsite or home.
- Second was hot weather/cool water.

Swimming Survey Summary

- **Outside of large-scale drought or flood events, swimmers will use the river when it is convenient and it is warm enough.**

- **Reasons given for <u>not</u> swimming in the river:**

  - too dirty

  - leeches and snapping turtles

  - pool nearby

  - bottom is mucky and smells

Water Storage

- Storage above Wiswall used by Durham for drinking water.
- Interview with Durham and review records to determine flow needs.

Pollution Abatement

- One permitted discharge at Epping above designated reach.
- Permits, waste load allocation studies and regional wastewater alternative reports to be reviewed.

Flow Dependent Resources

- Recreation (boat/swim)
- Water Storage
- Pollution Abatement

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- High energy riverbanks
- River rapids

RTE Plants

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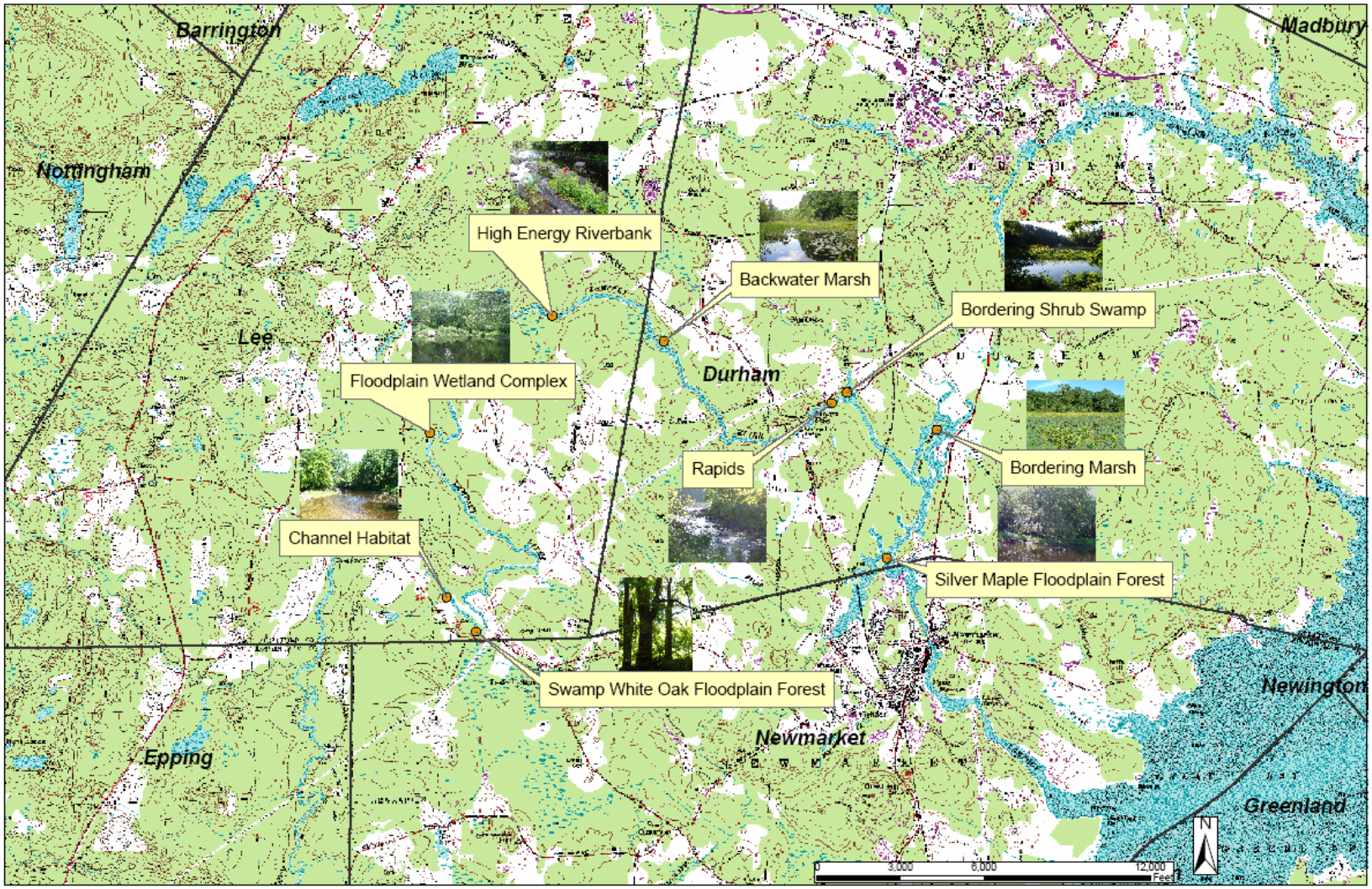
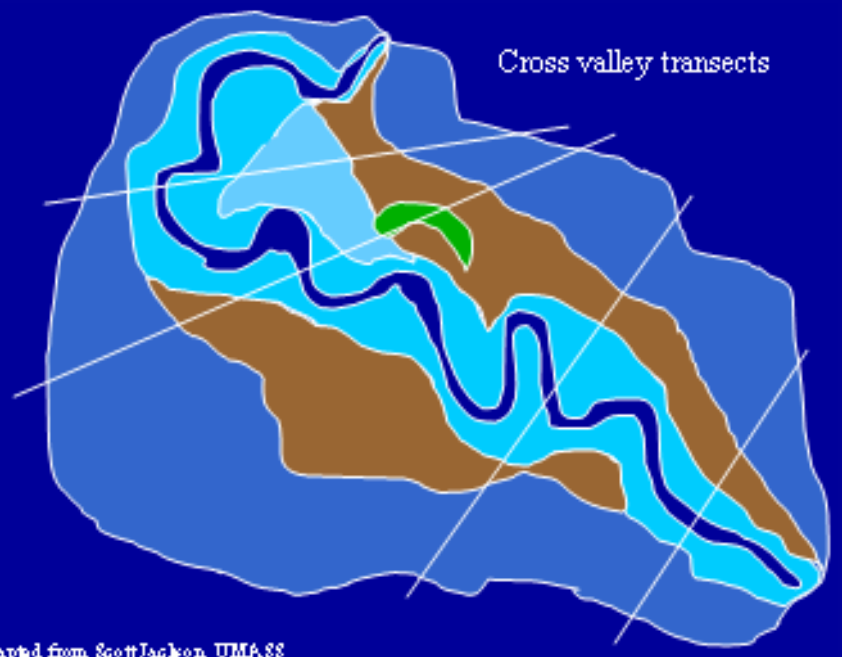
Wildlife Habitat and Plant Communities



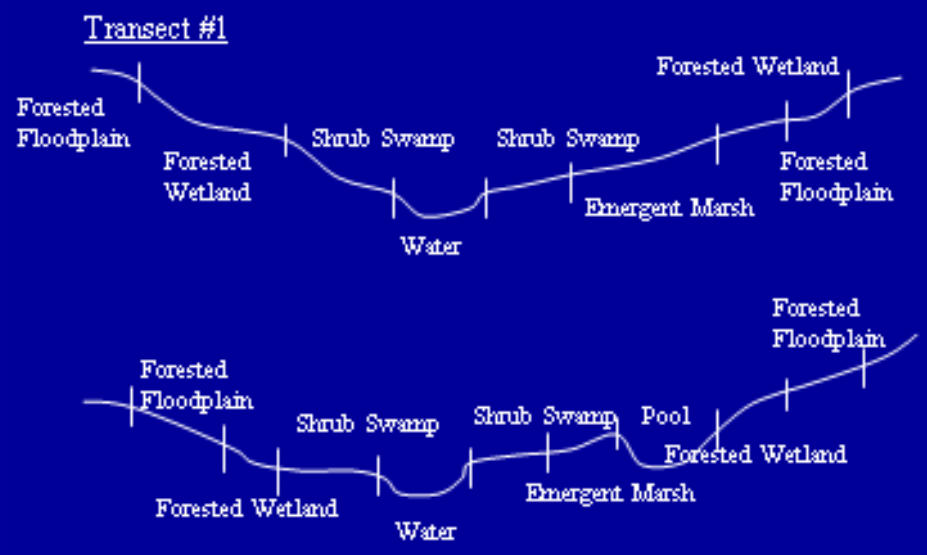
Wildlife, RTE Species and Natural Communities

- **Progress to date:**
  - **Selection of 5 IPUOCR evaluation locations.**
  - **Topographic survey of two transects (Tuttle and Lee Hook).**
  - **Collection of monthly water level and plant community development photographs and data.**

Transect Method



Adapted from ScottJackson, UMASS



Adapted from ScottJackson, UMASS

Selected Transect Locations

Tuttle Swamp

Related IPUOCRS

- Exemplary Swamp White Oak Floodplain Forest
- Silver Maple Floodplain Forest
- Backwater Swamp
- RTE Plants
- Wildlife Habitat

Wetland North of Glenmere Village

Related IPUOCRS

- Potential Spotted and Blanding's turtles
- Floodplain Vernal Pools
- Alluvial Red Maple Swamp
- Oxbow Shrub Swamp
- Wildlife Habitat

UNH Pump Station Wetland

Related IPUOCRS

- Backwater Marsh
- Silver Maple Floodplain Forest
- Wildlife Habitat – waterfowl, raptors, shorebirds, amphibians

Lee Hook Road Riffles

Related IPUOCRS

- High Energy Riverbank Community
- River Rapids Community
- RTE Plants

Moat Island Marsh

- RTE Plants
- Pied-billed Grebe
- Waterfowl and Shorebird Habitat

This location will be evaluated through aerial photo/digital elevation modeling only

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- Endangered Brook Floater

- Public Water Supply
- Groundwater

Instream Resources

Investigations by:

Northeast Instream Habitat Program
University of Massachusetts

Eastern Elliptio

Banded Sunfish

Ringed Boghaunter

MesoHABSIM

Meso – intermediate (scale)

HAB – habitat (instream)

SIM – simulator

Used to quantify physical habitat attributes and relate those to habitat suitability requirements of selected species and life stages as a function of flow.

MesoHABSIM

Analysis includes:

- **Mapping of hydromorphological units (riffles, pools, etc.) at specific flows.**
- **Inventory of hydraulic and cover attributes.**
- **Development of Target Fish Community.**
- **Analyze suitability using multivariate statistics.**
- **Determine variation in spatial distribution of mesohabitats and change in quantity with different flows.**

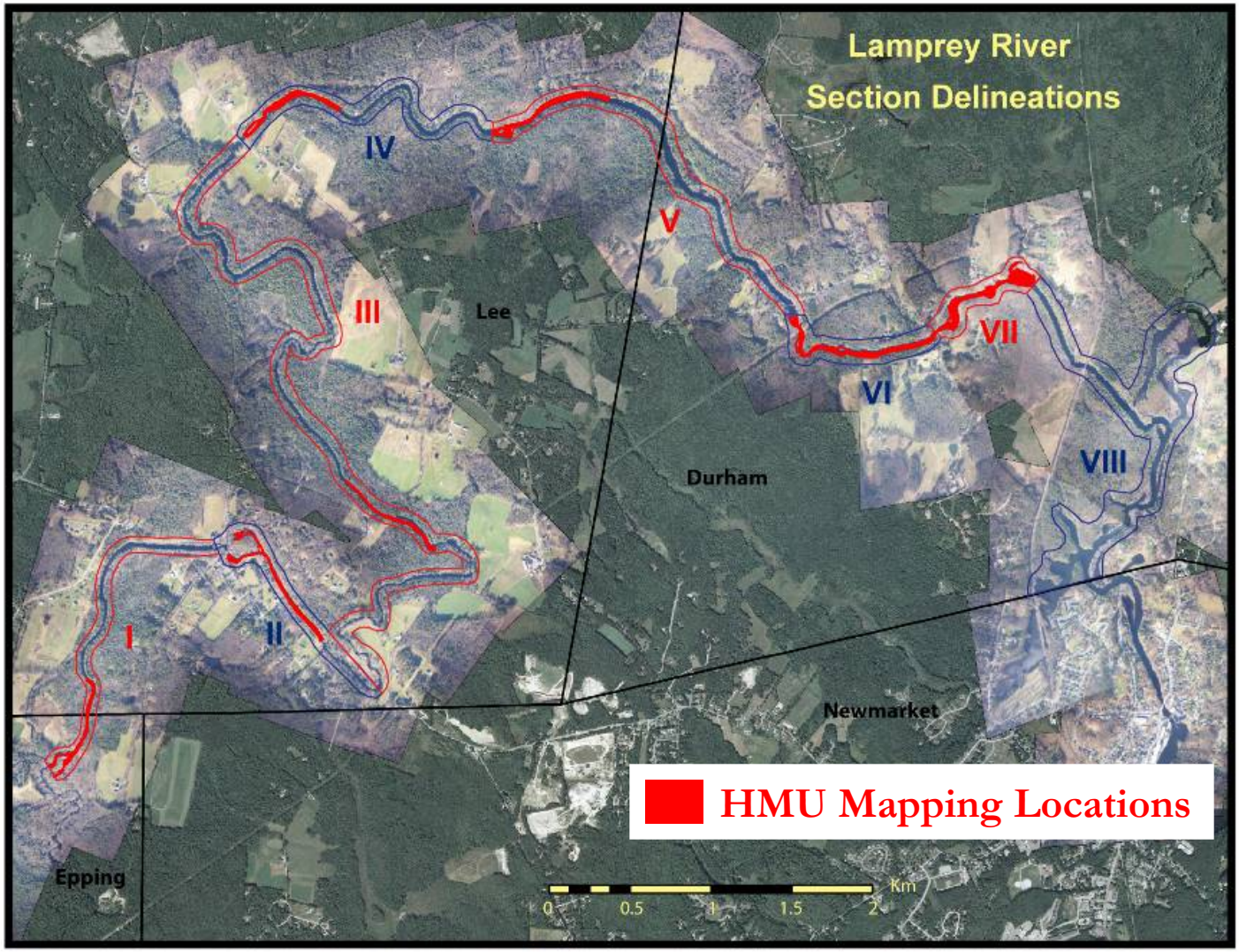
Field Investigations

- Mapped Hydromorphological Units (HMU).
- Recorded depth/velocity measurements.
- Deployed temperature/depth data loggers.
- Surveyed impoundments.
- Aerial photography obtained.
- Sampled invertebrates.

HMU Surveys

- All four HMU surveys completed.
- 211 HMU's Mapped.
- 1540 depth/velocity measurements recorded.
- Each HMU records 50+ attributes unique to that location in the river.
- All HMU data has been quality controlled and entered into Geodatabase.
- Project data is linked to MesoHABSIM Database and ready for analysis.

HMU Surveys


Lamprey River
Section Delineations
IV
V
III
Lee
VII
VI
VIII
Durham
I
II
Newmarket
HMU Mapping Locations
Epping
0
0.5
1
1.5
2
Km

Flow Measurements

ws area = 183

Lamprey HMU Survey Chart

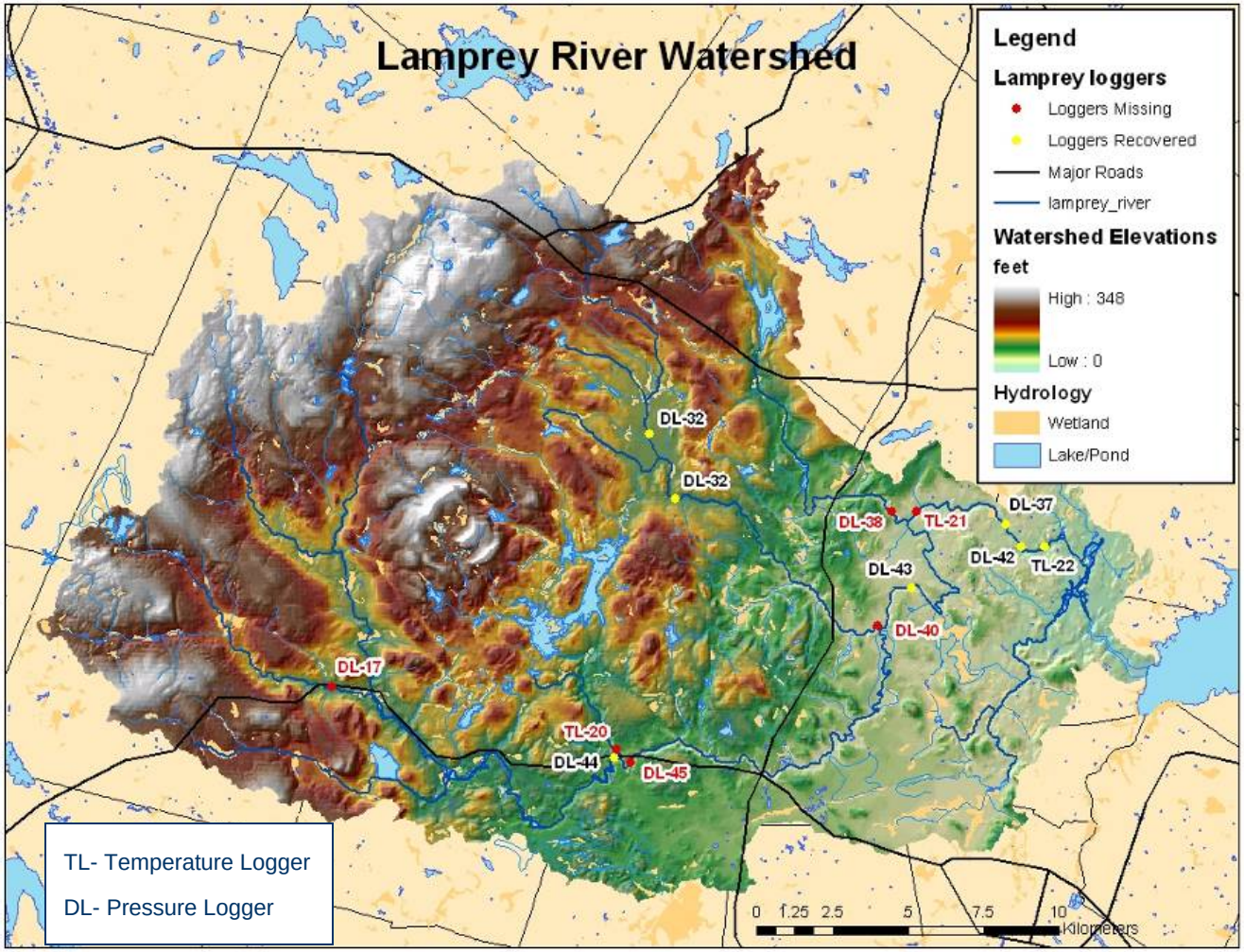
	~37	0.2 cfsm				~90	0.5 cfsm			
	Date	**cfsm**	**cfs**	**start**	**stop**	**Date**	**cfsm**	**cfs**	**start**	**stop**
Site 1	9/19/2006	**0.26**	**47**	47	47	7/20/2006	**0.56**	**103**	104	102
Site 2	9/19/2006	**0.25**	**47**	47	46	7/20/2006	**0.55**	**101**	102	100
Site 3	9/19/2006	**0.25**	**45**	45	45	7/20/2006	**0.53**	**98**	98	97
Site 4	9/19/2006	**0.25**	**45**	45	45	7/20/2006	**0.53**	**97**	97	97
Site 5	9/28/2006	**0.28**	**52**	52	52	7/20/2006	**0.52**	**95**	95	95
Site 6	9/28/2006	**0.28**	**52**	52	51	7/21/2006	**0.48**	**88**	89	87
Site 7	9/28/2006	**0.27**	**50**	51	49	7/21/2006	**0.48**	**87**	87	87

	~183	1.0 cfsm				~275 -360	1.5 -2.0 cfsm			
	Date	**cfsm**	**cfs**	**start**	**stop**	**Date**	**cfsm**	**cfs**	**start**	**stop**
Site 1	4/28/2006	**0.95**	**173**	174	172	7/25/2006	**2.00**	**366**	370	362
Site 2	4/27/2006	**1.28**	**235**	241	229	7/25/2006	**1.89**	**345**	354	336
Site 3	4/27/2006	**1.24**	**227**	227	227	7/25/2006	**1.81**	**331**	333	328
Site 4	4/27/2006	**1.22**	**223**	225	220	7/26/2006	**1.47**	**269**	271	266
Site 5	4/27/2006	**1.19**	**217**	218	216	7/26/2006	**1.42**	**261**	262	259
Site 6	4/28/2006	**1.00**	**183**	188	178	7/26/2006	**1.37**	**251**	257	245
Site 7	4/28/2006	**0.96**	**176**	176	176	7/26/2006	**1.30**	**239**	241	236

Data Loggers

- 13 data loggers installed April 2006 (10 pressure/temperature and 3 temperature).
- 7 loggers retrieved October 2006 (6 pressure/temperature and 1 temperature).
- 5 loggers lost in mid-May 2006 flooding. Hope to recover 2 of the missing 5 data loggers in the next two weeks.
- Data has been downloaded and initially reviewed.

Data Logger Locations

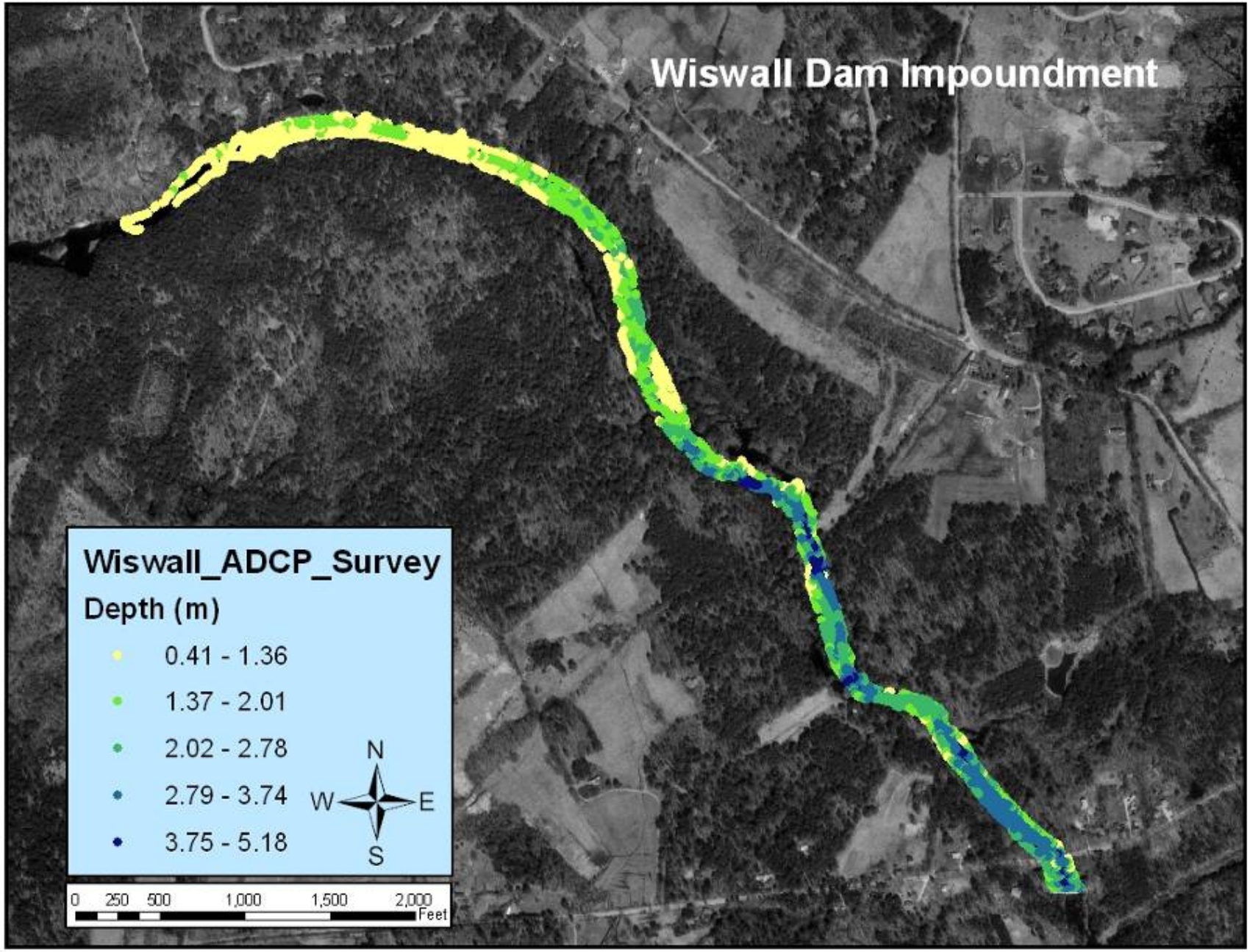


TL- Temperature Logger

DL- Pressure Logger

Impoundment Surveys

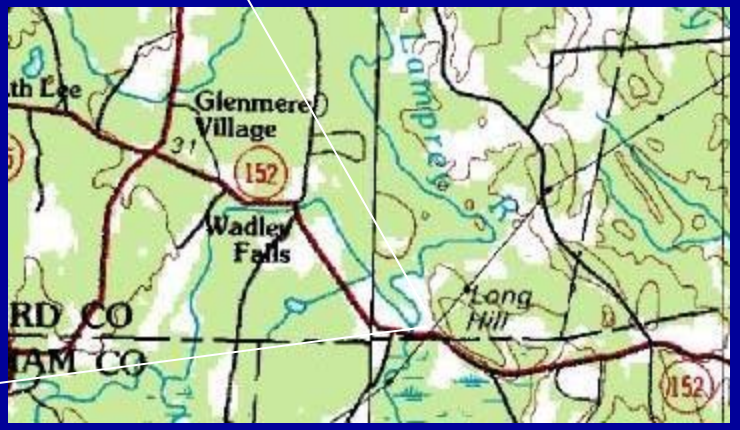
- A two day survey was completed for the Wiswall Dam impoundment.
- Depths recorded using an Acoustic Doppler Current Profiler (ADCP).
- Initial investigation of data has occurred and awaits further processing.
- McCallen Dam impoundment survey scheduled for week of October 30th.


Wiswall Dam Impoundment
Wiswall_ADCP_Survey
Depth (m)
0.41 - 1.36
1.37 - 2.01
2.02 - 2.78
2.79 - 3.74
3.75 - 5.18
N
W
E
S
0 250 500 1,000 1,500 2,000
Feet

Aerial Photography

- Four flights collected imagery of the designated reach between April and September 2006 during each of the river flows surveyed.
- Each flight involves 800+ images. Images have been cataloged and processing is underway.
- One reconnaissance flight from 17 Nov 2004 has been georeferenced and mosaiced.

Aerial Photography



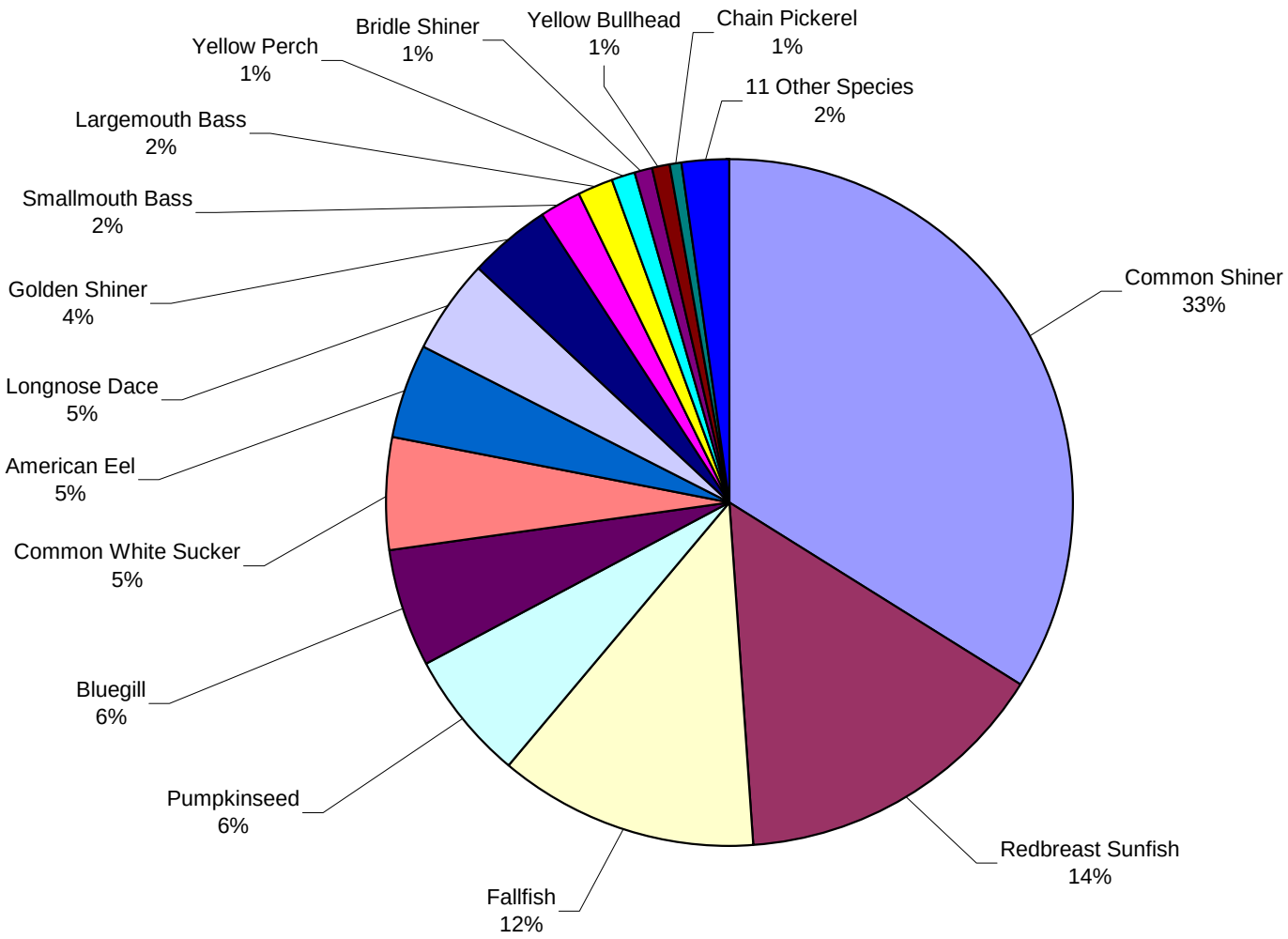
Invertebrate Sampling

- 39 1 m^2 grids were surveyed in Section 2 for mussels and invertebrates.
- Mussels were counted and identified, invertebrates were collected for lab identification.
- Goal of collecting 100 grids in doubt due to high fall flows and generally unfavorable weather conditions.
- Invertebrate identification on collected samples is currently underway.

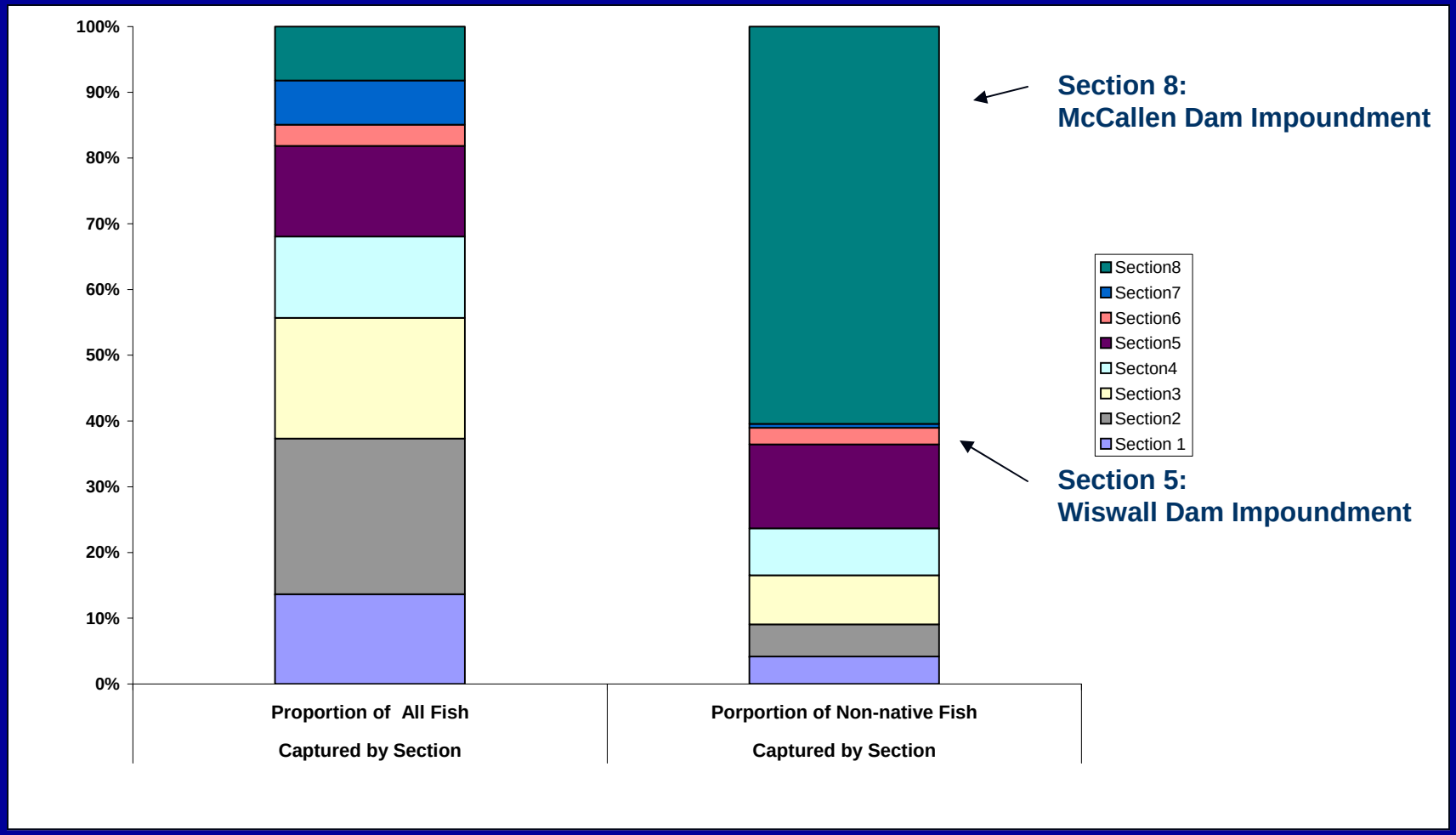
Lamprey River Existing Fish Community

- The Lamprey River existing fish community data, (collected during the Lamprey River Baseline Fish Community Study [NHDES 2003]), has been sorted based on 8 delineated study sections.
- The fish community compositions for each section have been calculated.
- The data has been analyzed to identify study sections dominated by non-native and/or non-fluvial fish communities.

Lamprey River Existing Fish Community



Evaluation of the Distribution of Non-native Fish Species by Study Section



Target Fish Community (TFC) Development

- A list of known fish species, or those with potential to occur in the Lamprey River, has been compiled.
- Potential reference rivers in New England (CT, NH, MA and ME) have been selected using a Reference River Selection Model (RRSM).
- Fisheries data from the reference rivers is being collected from various state agencies to aid in the development of the TFC.

Target Fish Community Development Progress

- In the process of gathering and analyzing fish collection data provided by various state agencies (NHDES, NHF&GD, MEIFW, MADF&W, and CTDEP).

- At this time more data is needed in order to develop a suitable TFC.

Obstacles Encountered

- Unexpected severe weather lead to extrication of field crew and temporary cancellation of field surveys on two occasions (leading to additional time and travel).
- Poor weather and high fall flows has interrupted invertebrate sampling.
- Historic flooding and loss of data loggers.

Upcoming Tasks

- Develop and apply suitability coefficients for Lamprey MesoHABSIM model.
- Develop target fish community.
- Process temperature probe data.
- Process aerial imagery and investigate geomorphological and hydromorphological changes.

Concurrent Flow Measurements to Support the Development of the PISF - UNH

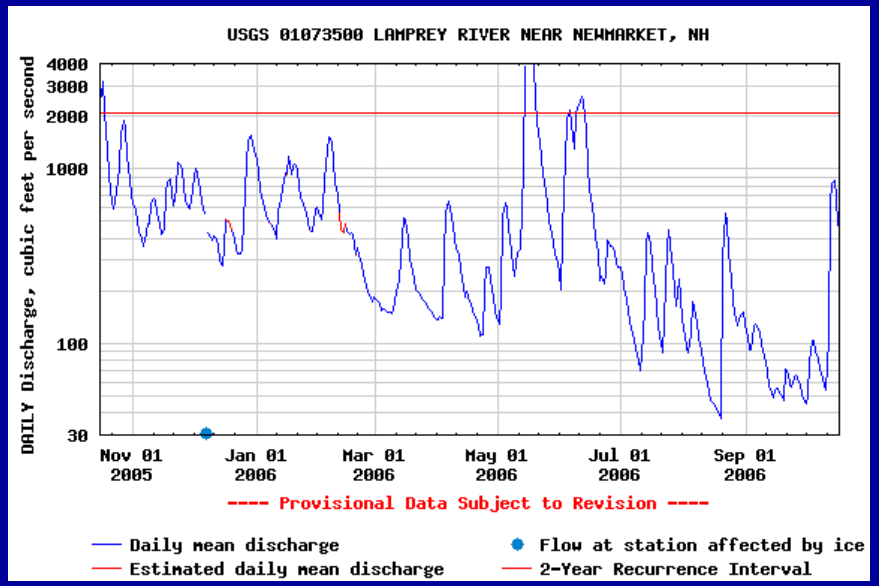
Long term flow data is needed along the river in order to determine the habitat suitability and frequency at various locations for the range of flows.

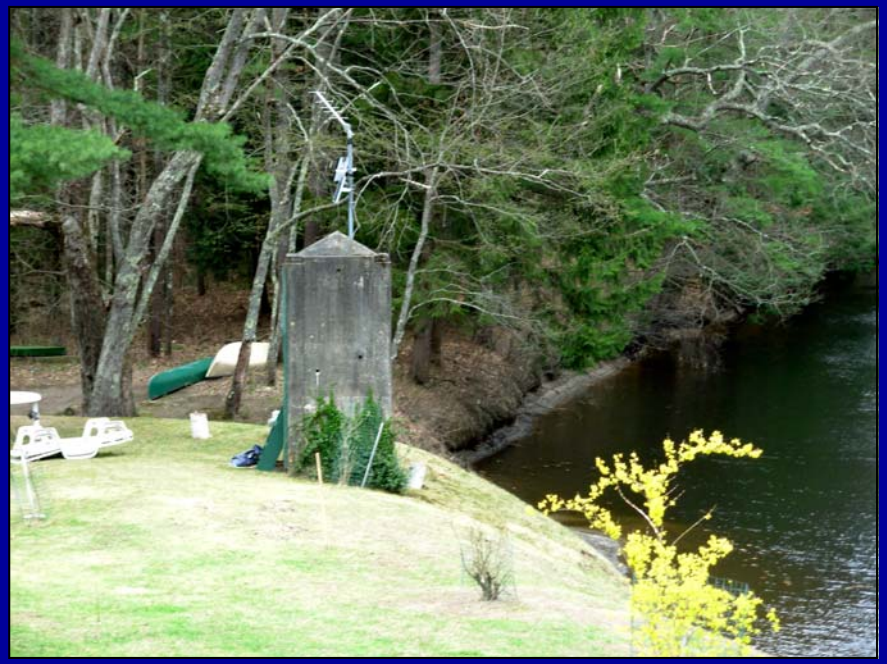
Preferably, these flows are the “natural” (pre-European settlement) flows.

Problem: only one stream gage at Packers Falls and a discontinued gage on the North River.

Major Advantage

70 Years of stream flow data at Packers Falls.





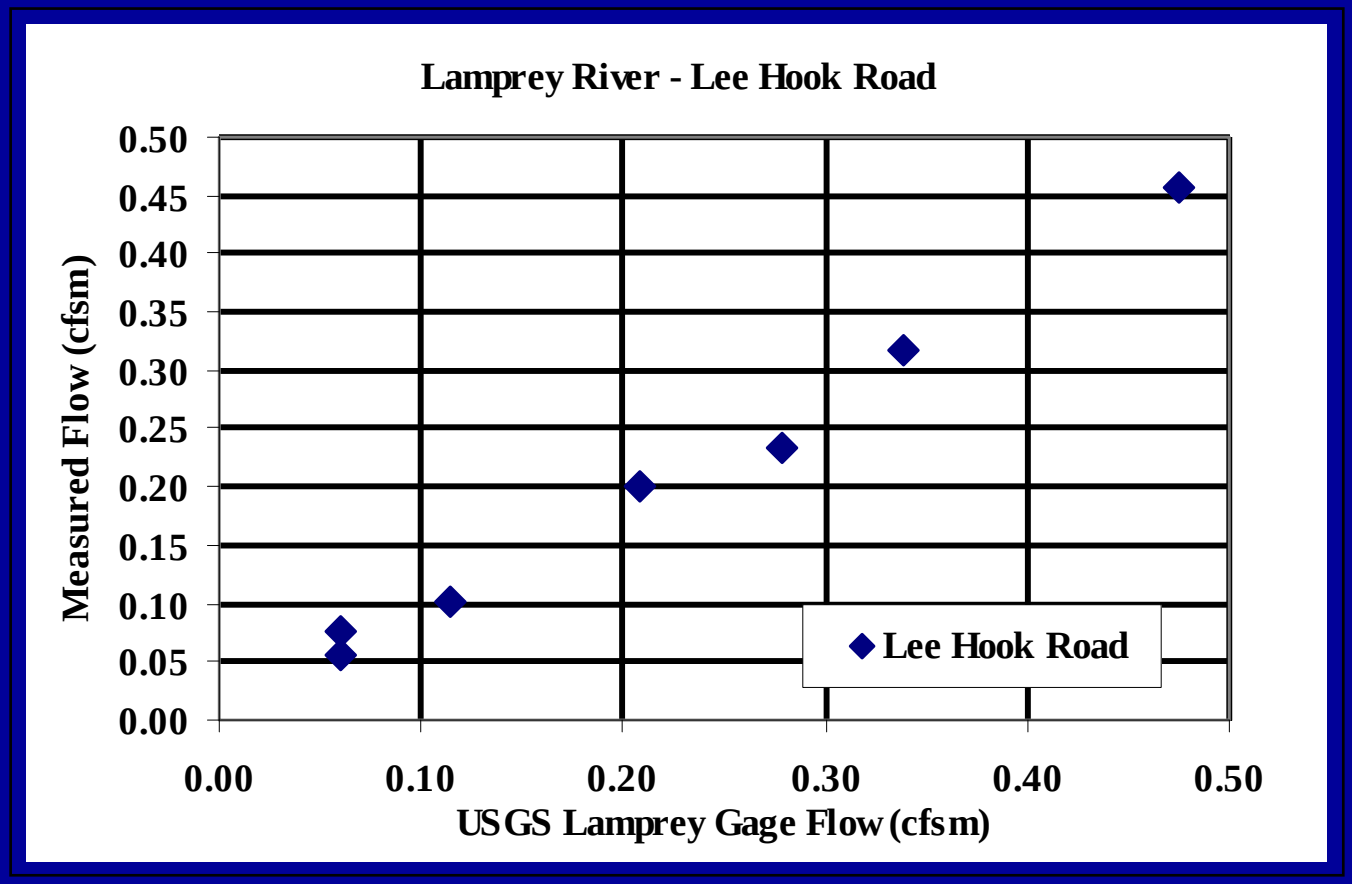
Development of Long Term Hydrographs Along the Lamprey River

- Measure the flow (stream gage) at selected times along the river concurrently with the USGS gage readings.
- Develop statistical relationships between USGS flows and the measured flows.
- Transform the 70-year USGS record at Packers Falls to 70-year records at the measurement locations.

Measurement Locations

- Downstream of Wadleigh Falls (left and right channels).
- Lee Hook Road
- Upstream of Hook Island

Concurrent Flow Measurements



Flow measurements recorded in 2005 and 2006

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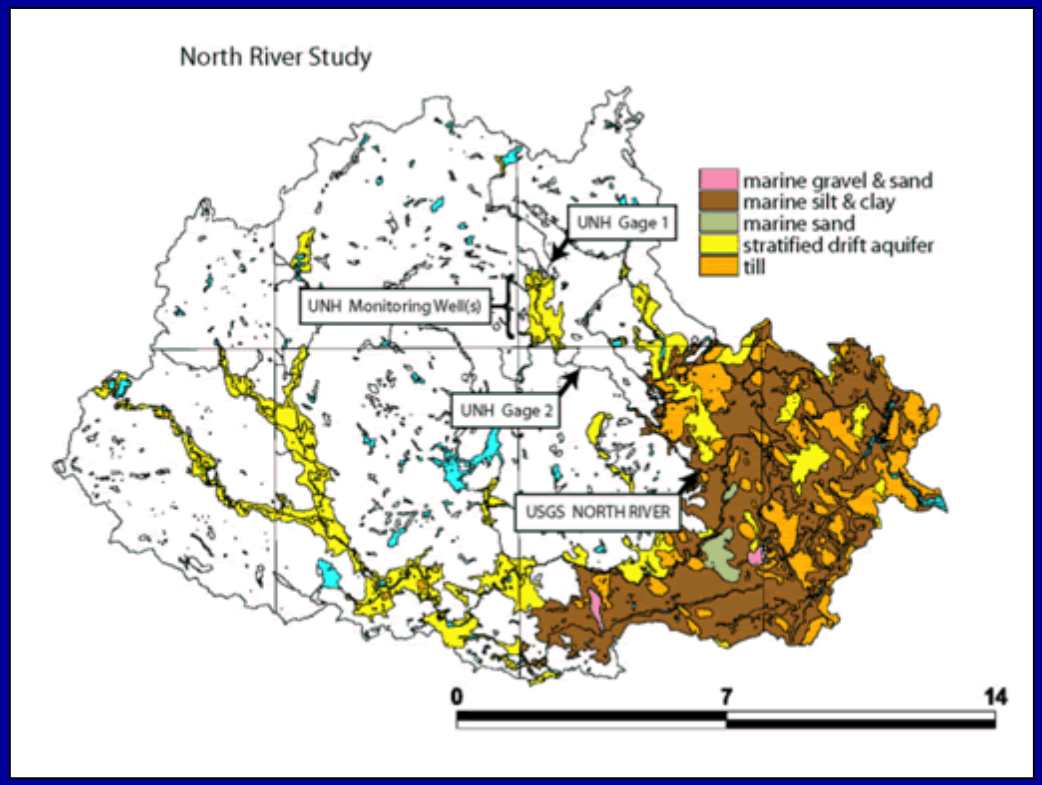
- Public Water Supply
- Groundwater

Public Water Supply

- Durham withdraws water from above Wiswall Dam.
- Newmarket has a surface water withdrawal.
- Potential well sites for Lee and Newmarket along designated reach.

Groundwater Resources



M. Davis, UNH

- Stratified drift aquifers (sand & gravel).
- Drinking water sources (Raymond, potentially Epping, Durham, and Newmarket).

Assessment of Well Withdrawal Impacts on Surface Water - UNH

- Do groundwater withdrawals reduce streamflow?
- If so, can reductions to groundwater pumping be used at low flow times as one type of management strategy to meet instream flow needs?
- How effective are such strategies in comparison to other withdrawal reduction strategies?

Do Groundwater Withdrawals Reduce Streamflow?

If the groundwater had not been pumped, where was it going?

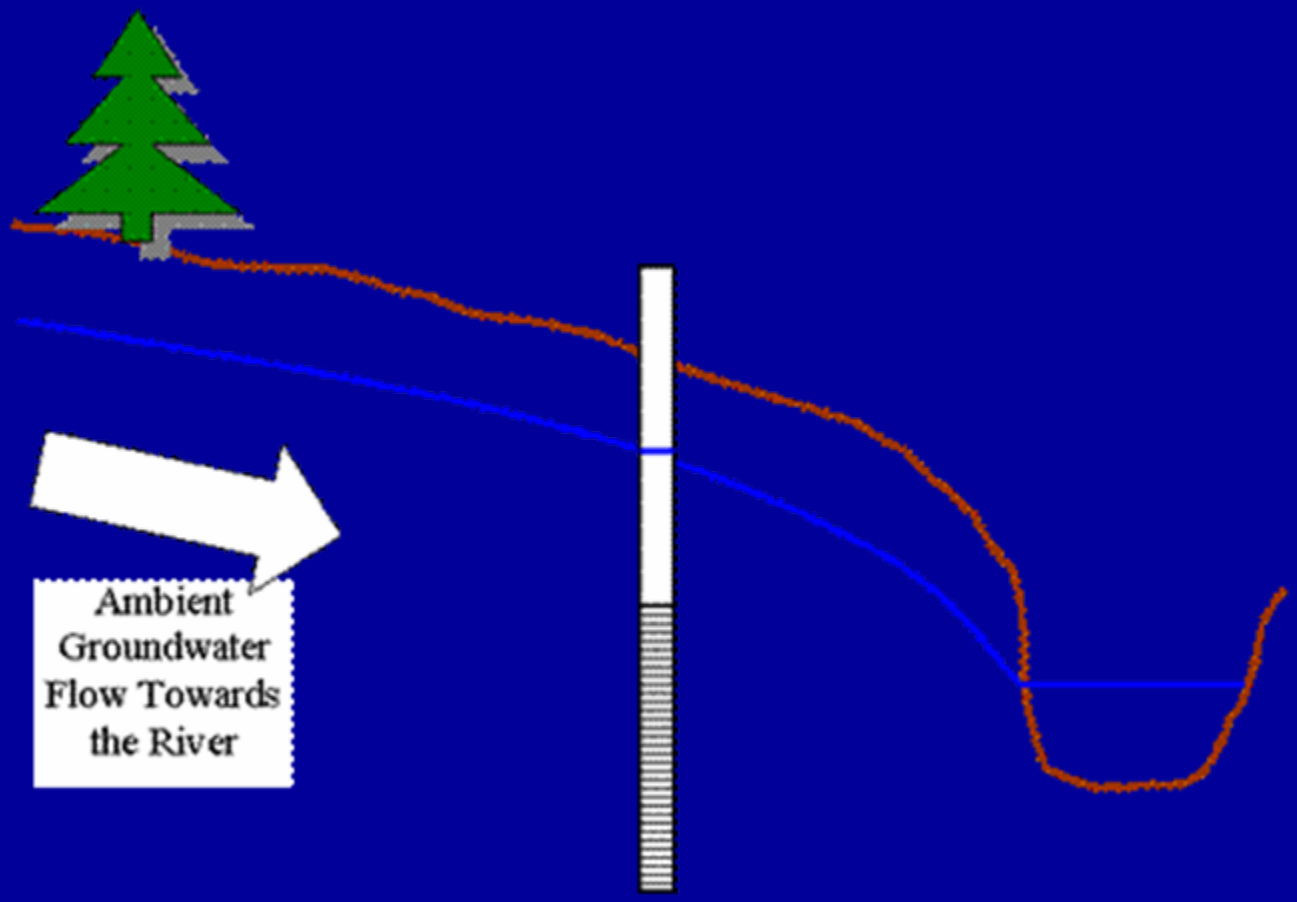
- **Discharge to river, tributaries, or other surface waters,**
- **Continued groundwater movement,**
- **Deeper groundwater circulation.**

Groundwater Withdrawals

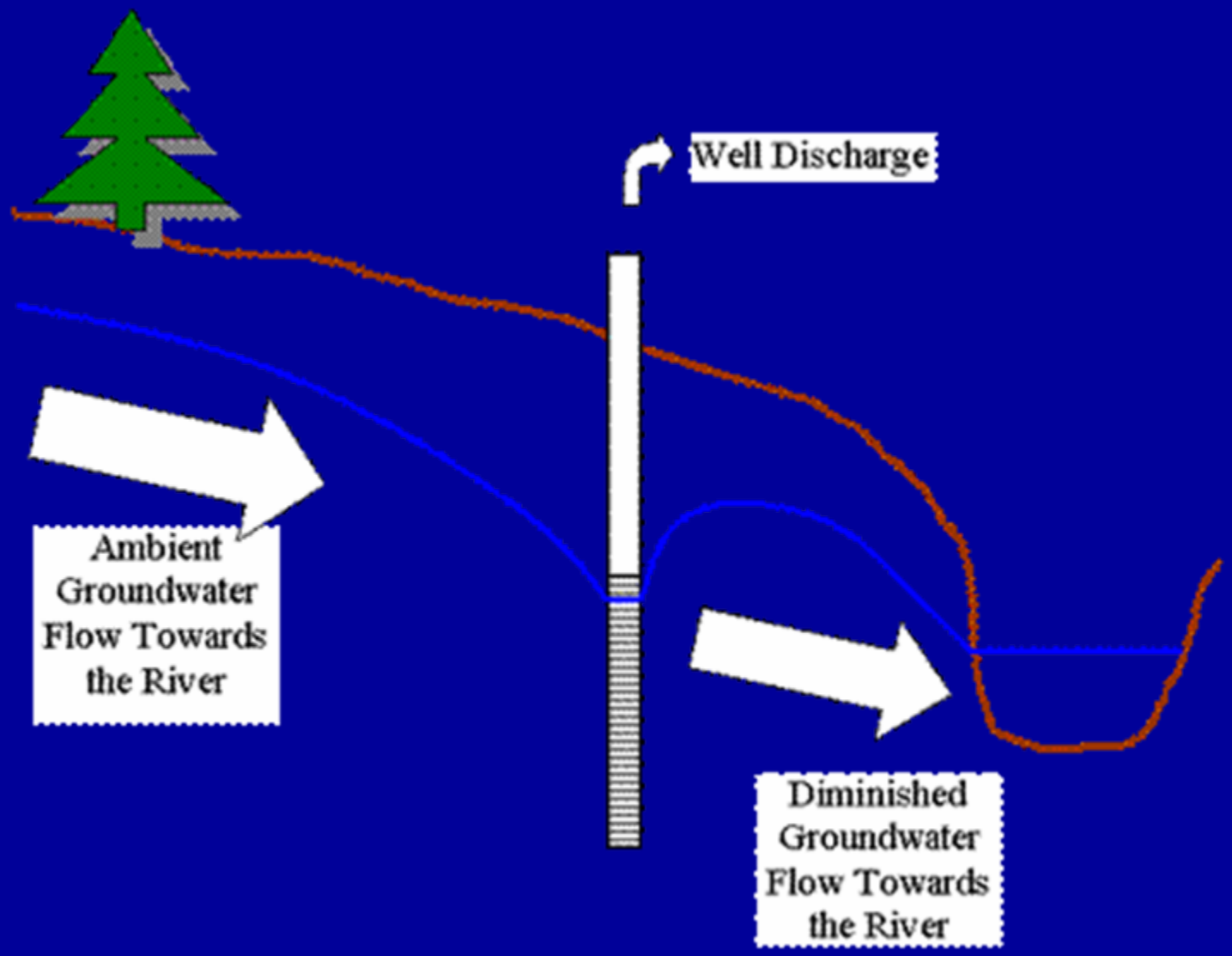
- Can reductions to groundwater pumping be used at low flow times as one type of management strategy to meet instream flow needs?

  - Are individual wells inducing river water recharge?

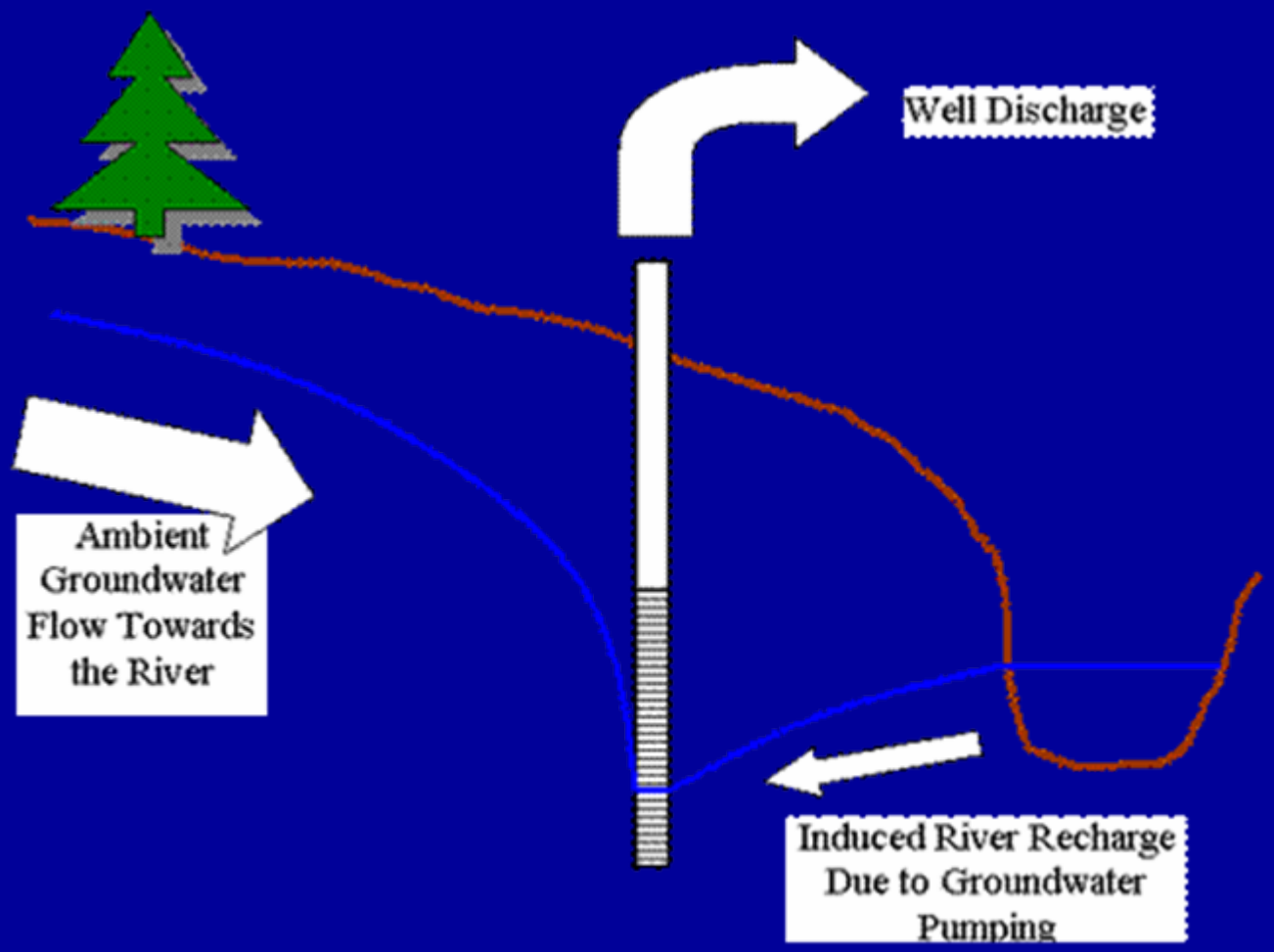
Ambient Groundwater Hydraulics



Effect of Small Groundwater Withdrawals



Effect of Increasing Groundwater Withdrawals

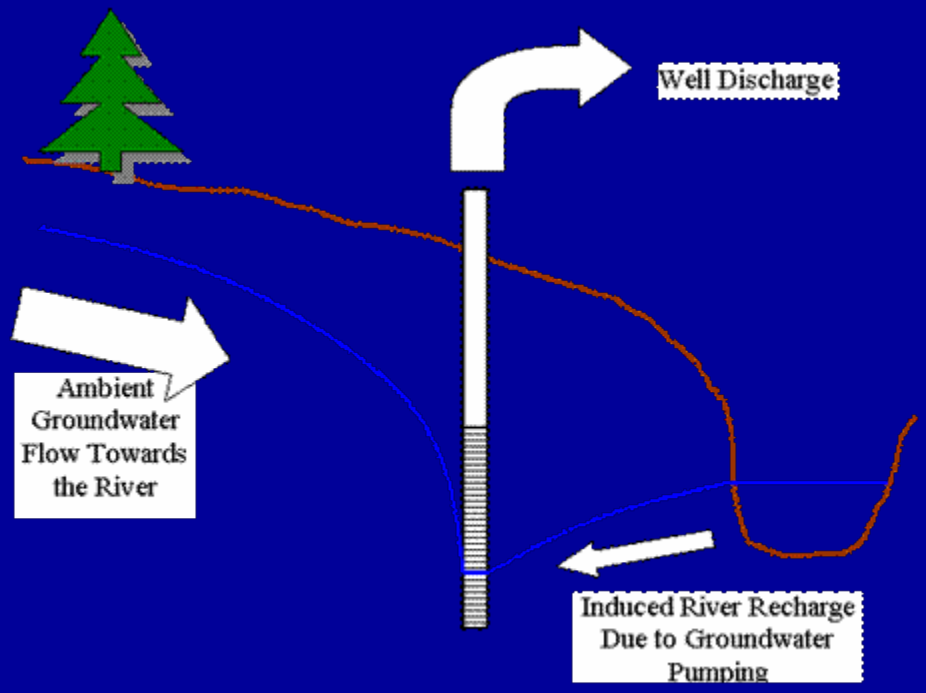


Induced Recharge

- In most cases, under ambient conditions, the slope of the regional groundwater table is towards the river.

- The pumping of groundwater from wells along the river would remove water that ultimately would have flowed into the river, whereas, <u>induced recharge</u> is surface water directly captured by groundwater pumping.

Induced Recharge



If the river discharge falls below the Protected Instream Flow (PISF) values, the most immediate flow control management strategy for groundwater is to halt induced recharge (reduce pumping).

Methods for Evaluating Induced Recharge

1. Existing studies – review existing permits or hydrogeologic reports for evidence of induced recharge at well(s).

2. Analytical estimation – using existing groundwater elevation data and evaluate induced recharge using groundwater flow equations.

Methods for Evaluating Induced Recharge

3. Limited field measurements and office analysis of drawdown and induced recharge.

4. Field investigations and analytical or numerical modeling of drawdown and induced recharge.
    - Miniature Piezometers or Wells
    - Seepage Meters
    - Tracers
    - Pumping Tests

Water Management Plan Activities

Affected Water Users and Dam Owners

Affected Water Users

- Epping Water Works and WWTF
- Newmarket Water Works and WWTF
- Raymond Water Department
- University of New Hampshire
- Town of Durham
- Pennichuck Water Works
- Epping WWTF
- Fernald Lumber, Inc.
- Scenic Nurseries, Inc
- Severino Trucking Company
- Leisure Village
- Nottingham Lake Dam
- Deluge Incorporated

Affected Water Users

- All identified AWUs were sent a survey, and follow-up was made until a response was provided.
- From the responses to the surveys, a profile was created for each AWU.
- At this time, responses are missing from Epping Water Works and WWTF, Deluge Incorporated, and Pennichuck Water Works for the Green Hills Community Water System.

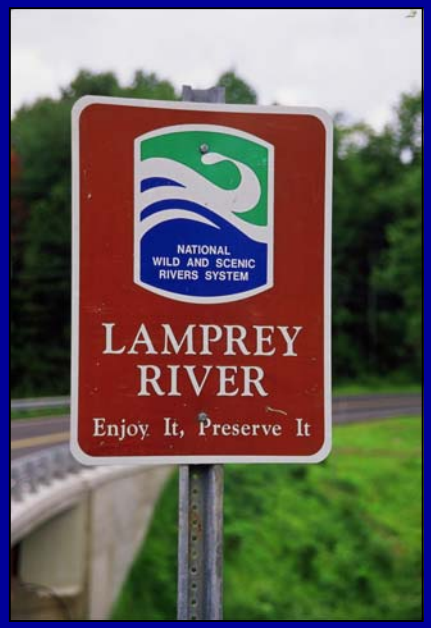
Affected Dam Owners

- Socha Dam
- Freeses Pond Dam
- Beaver Pond Dam
- Thurston Pond Dam
- Wiswall Dam
- Bunker Pond Dam
- Hoar Pond Dam
- Piscassic Ice Pond Dam
- Lucas Pond Dam
- Meadow Lake Dam
- Woodmans Marsh Dam
- Dole Marsh Dam
- Mendums Pond Dam
- Pawtuckaway Lake (Dollof, Drowns, Drowns dike, Gove dike)
- North River Pond Dam
- Nottingham Lake Dam
- Deer Pond Dam
- Burnhams Marsh
- Onway Lake Dam

Affected Dam Owners

- The Dam Bureau has a Dam Profile for each dam within their file system.
- A file review was conducted for each dam listed and important information was checked and updated or corrected as needed with assistance from the Dam Bureau staff.
- Each ADO was mailed a copy of the profile with a letter asking for their review and correction to be made should there be errors on the profile. Only one returned.

Stakeholder and Citizen Participation in the Lamprey River ISF Study and WMP



Shannon Rogers, Dr. John Halstead, Dr. Thomas Seager

The National Institutes for Water Resources

University of New Hampshire

Department of Resource Economics and Development

NH WRRC

Overview of Project

1. Interviews with AWUs, ADOs, and other stakeholders.
2. Value narrative creation.
3. Identification of possible conflicts in the watershed.
4. Brief feedback survey of key stakeholder group.
5. Survey of watershed citizens.
6. Work with experts and managers to integrate findings of interviews and surveys.

Interviews

- 14 semi-structured interviews conducted this summer.
- Interviewees can be categorized into four groups—

1) Business Interests
2) Non-profit/Advocacy Groups
3) Dam Owners/Operators
4) Town/University employees or Representatives

Interview Questions

- What is important to you (or your organization) about the Lamprey River?
- How do you know when the river is able to provide what is important to you (e.g. adequate flows to allow withdrawals, acceptable water quality, ecological habitat)?
- What do your customers (constituents or members) tell you about the river?

Interview Questions

- How would you (or your organization) anticipate responding to certain management plan alternatives?
- Do you have suggestions or recommendations for such alternatives?
- Is there anyone you think I should talk with?

Value Narrative and Possible Conflicts

- **Preliminary analysis of interview responses included creation of value narrative.**

- **From value narrative, identified areas of possible conflict among AWUs, ADOs, other stakeholders and citizens.**

Possible Areas of Conflict

- Boundaries of Instream Flow Study.
- Commercial uses vs. ecological uses.
- Extractive use vs. active use vs. passive use.
- Right to current use of water vs. right to future use of water.
- Confidence in the decision making process.

Possible Areas of Conflict

- Town vs. Town.
- Development of future water supplies vs. physical development that usually follows new water supplies.
- Riparian landowners vs. other users of the river.
- Dam usage on the river.
- Complete water use vs. some water recycled back into the system.

Surveys

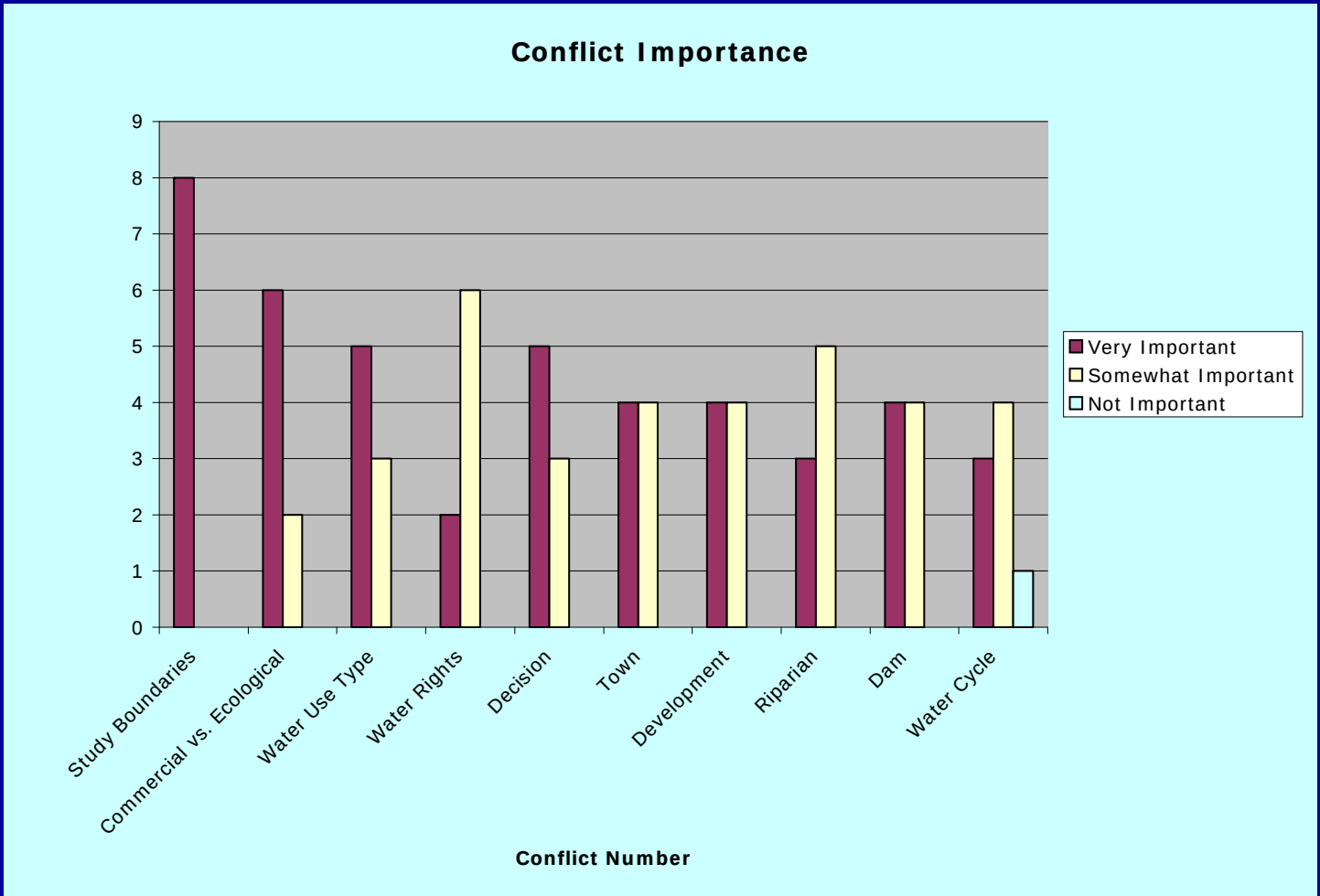
- **Brief survey to gain feedback from core stakeholder group on prioritizing areas of conflict.**

- **Mail survey to 1,000 citizens in the Lamprey Watershed.**

Stakeholder Survey

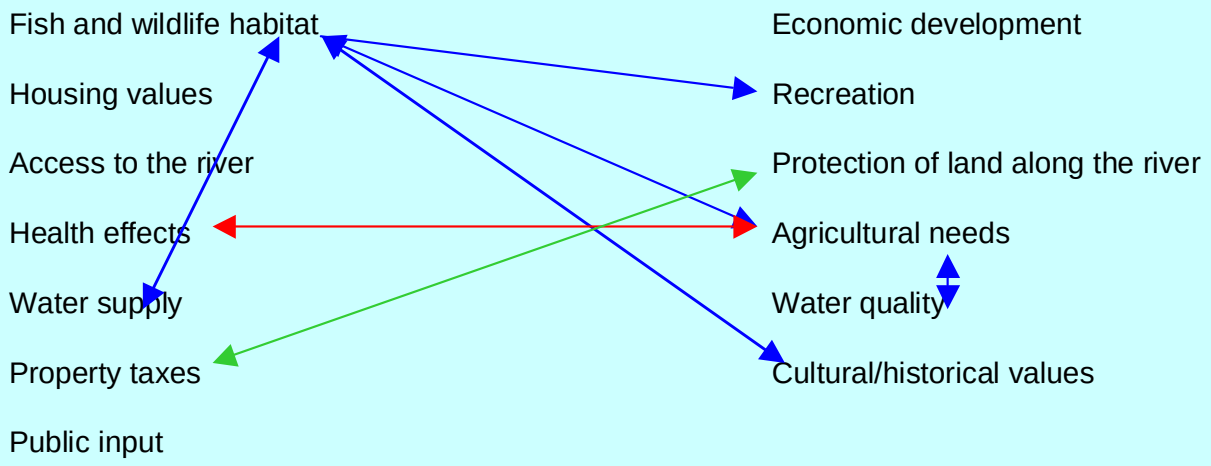
- Conflict prioritization.
- Opportunity to maintain contact with core stakeholder group.
- Feedback on value narrative.

Stakeholder Survey Results



Stakeholder Survey Results

Please indicate which of the following things may conflict by drawing a line between the words listed below. You may draw multiple lines and the lines do not need to go from one column to another, they can be in the same column.



Citizen Survey

- Watershed citizen survey will ask a variety of questions to obtain the values of homeowners in the watershed.

- Water Management Plan (WMP) is a multiattribute good. Conjoint analysis will be used to try to find the most salient attributes of WMP.

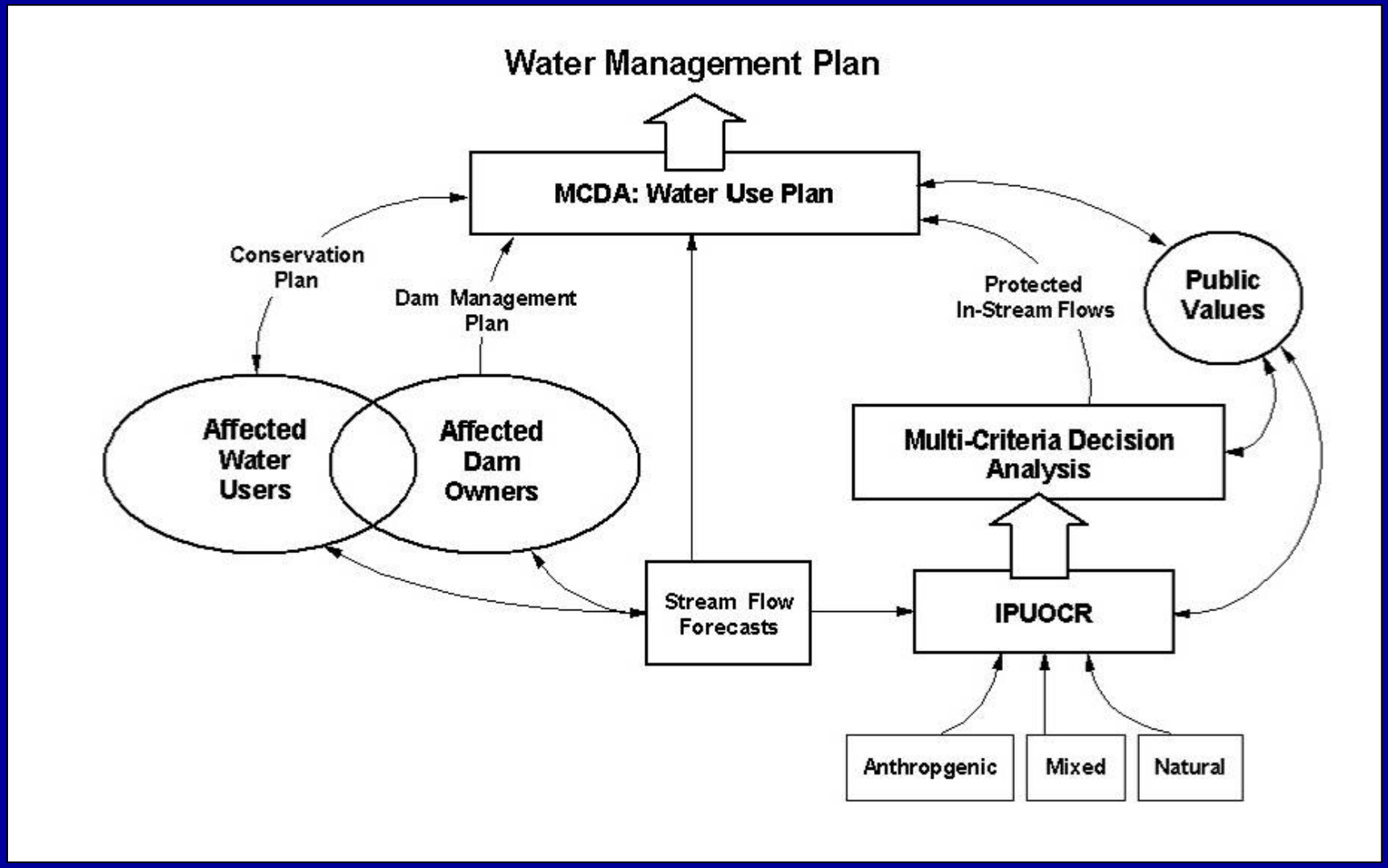
Attributes of WMP

- Withdrawal Amounts
- Ecological Impacts
- Water Quality
- Economic Impacts

Next Steps

- Launch citizen survey.
- Analyze results of citizen survey and provide them to other team members/water managers.

Multi-Criteria Decision Analysis



Multi-Criteria Decision Analysis

Steps in MCDA Process:

- **Find out what's important to the public (these are the criteria, based on survey).**
- **Find out what the options are (alternatives).**
- **Assess each option relative to the criteria are important.**

Multi-Criteria Decision Analysis

Steps in MCDA Process (cont.):

- **Rank the options from different perspectives based on what is most important (weightings).**
- **Analyze the ranking, looking for potential conflicts or compromises.**
- **Communicate the results to the decision makers and other stakeholders.**

Comments/Questions?

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