Fluvial Wetlands and Nitrogen Retention in Coastal Watersheds

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Acknowledgements: Sarah Bower, Drew Robison, Chris Whitney

Bower, S.E. 2020. Effects of storms on nitrate removal and greenhouse gas emissions from fluvial wetland dominated surface water flow paths. MS Thesis. University of New Hampshire

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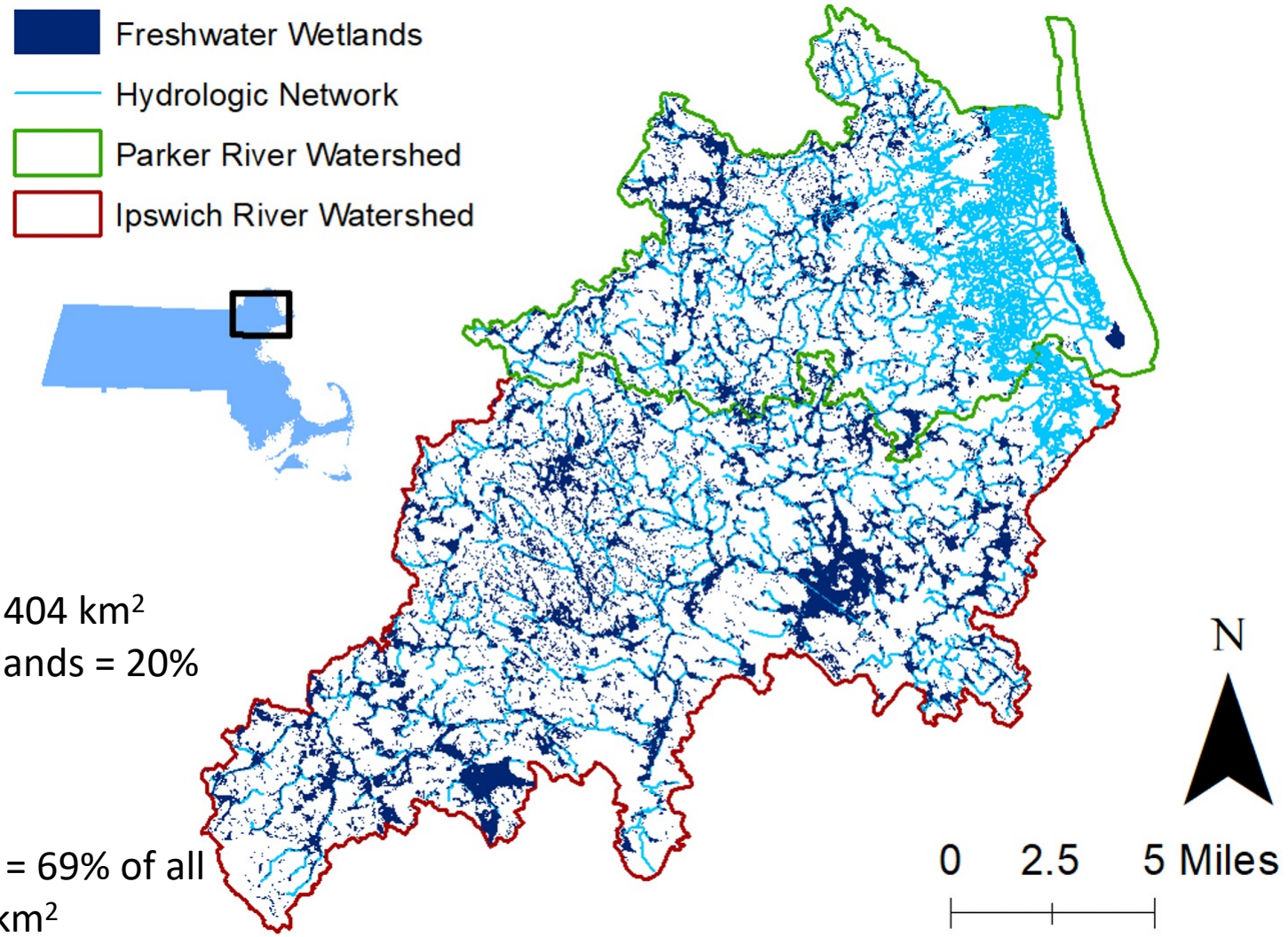
Plum Island Ecosystems Long Term Ecological Research

University of New Hampshire

LTER NETWORK

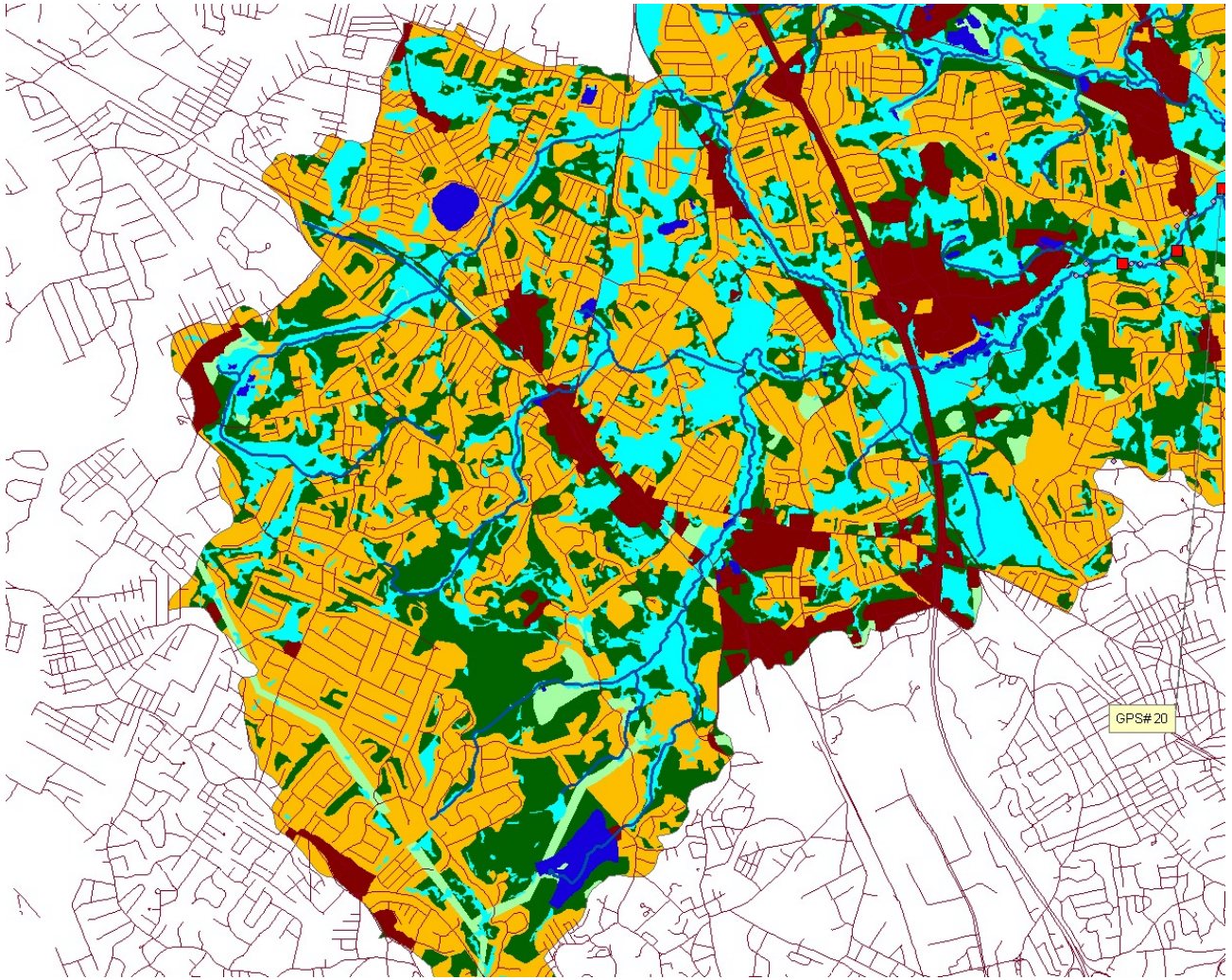
Fluvial Wetlands in PIE watersheds



<u>Ipswich</u>
Drainage Area = 404 km^2
Freshwater Wetlands = 20%

Fluvial wetlands = 69% of all wetlands = 55.7km^2

Fluvial Wetlands and Suburbia

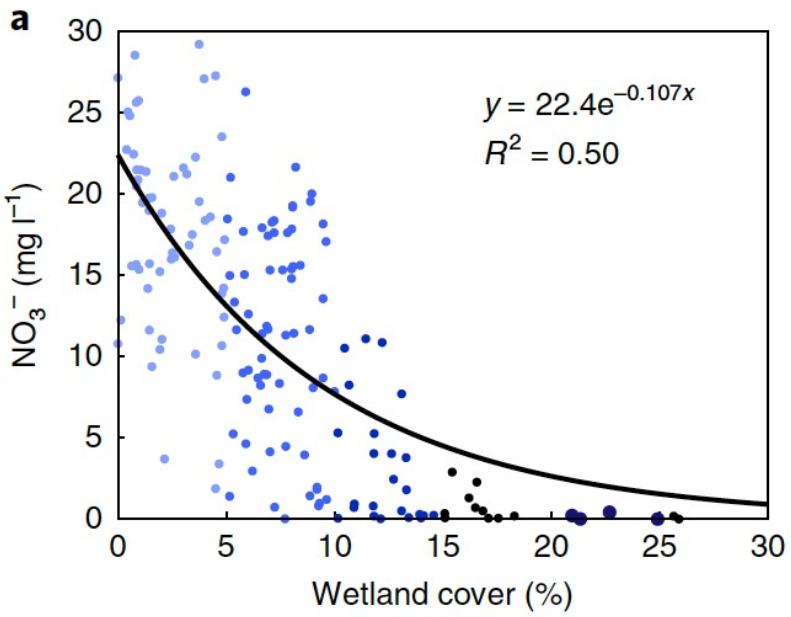


Suburban Boston, MA (Burlington and Wilmington
(upper Ipswich R. Watershed)

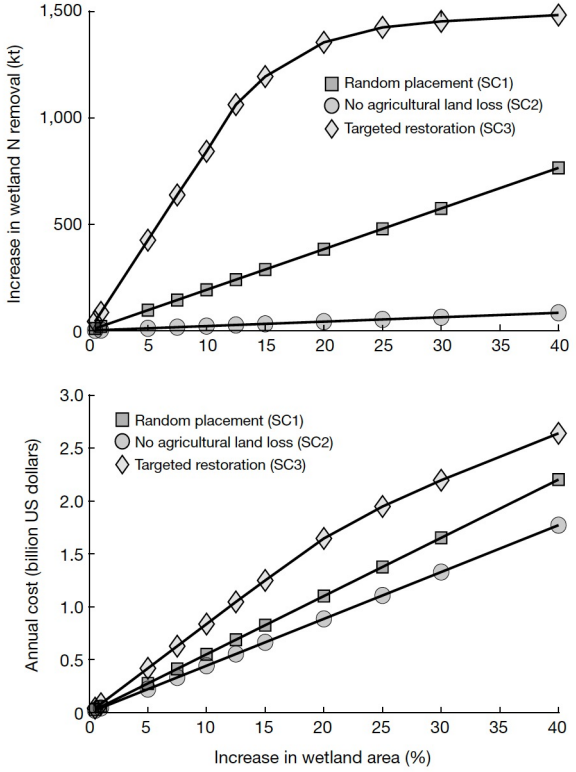
What do these wetlands do?

- Do they impact water quality?
  - Do they improve it or make it worse?
- Do they impact nitrogen fluxes?
  - Do they help the estuary by reducing nitrogen?
- Do they contribute to greenhouse gas production?
  - Are they a major source?
- How do their functions respond to storms?
- Is their function changing with suburbanization?
  - Does the changing chemistry alter their function?
- Are they becoming more abundant?
  - Beaver ponds!
  - Culverts
  - What does that mean for fluxes to estuary?

Landscape scale wetlands can help solve nitrogen pollution problem

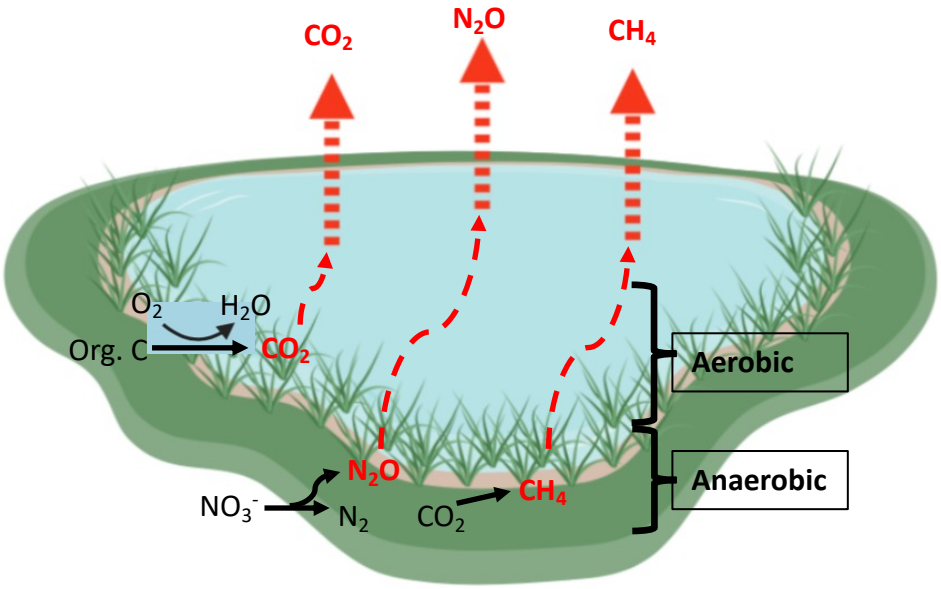


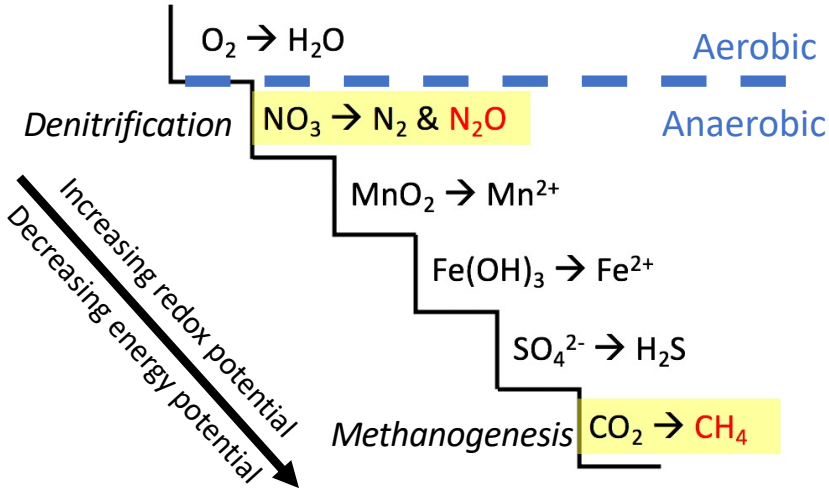
Hansen et al. 2018



Cheng et al. 2020

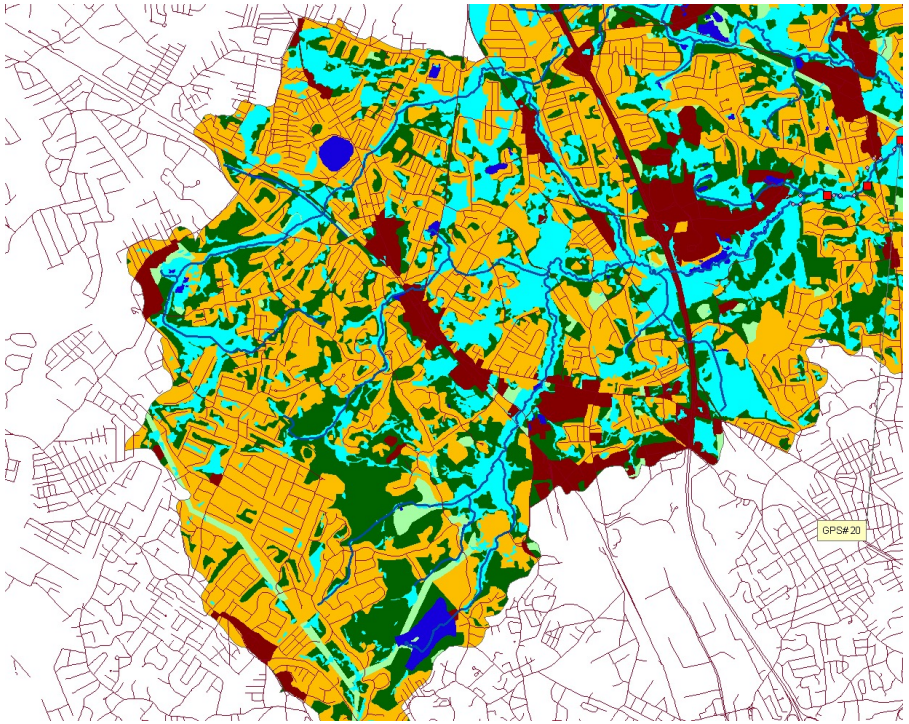
But wetlands are a source of greenhouse gases and consume dissolved oxygen!





Research Questions

- Does the effectiveness of fluvial wetland flow paths to remove nitrogen decline during storms?
- Is there a tradeoff between N removal and GHG emissions at baseflow or during storms?



Residential

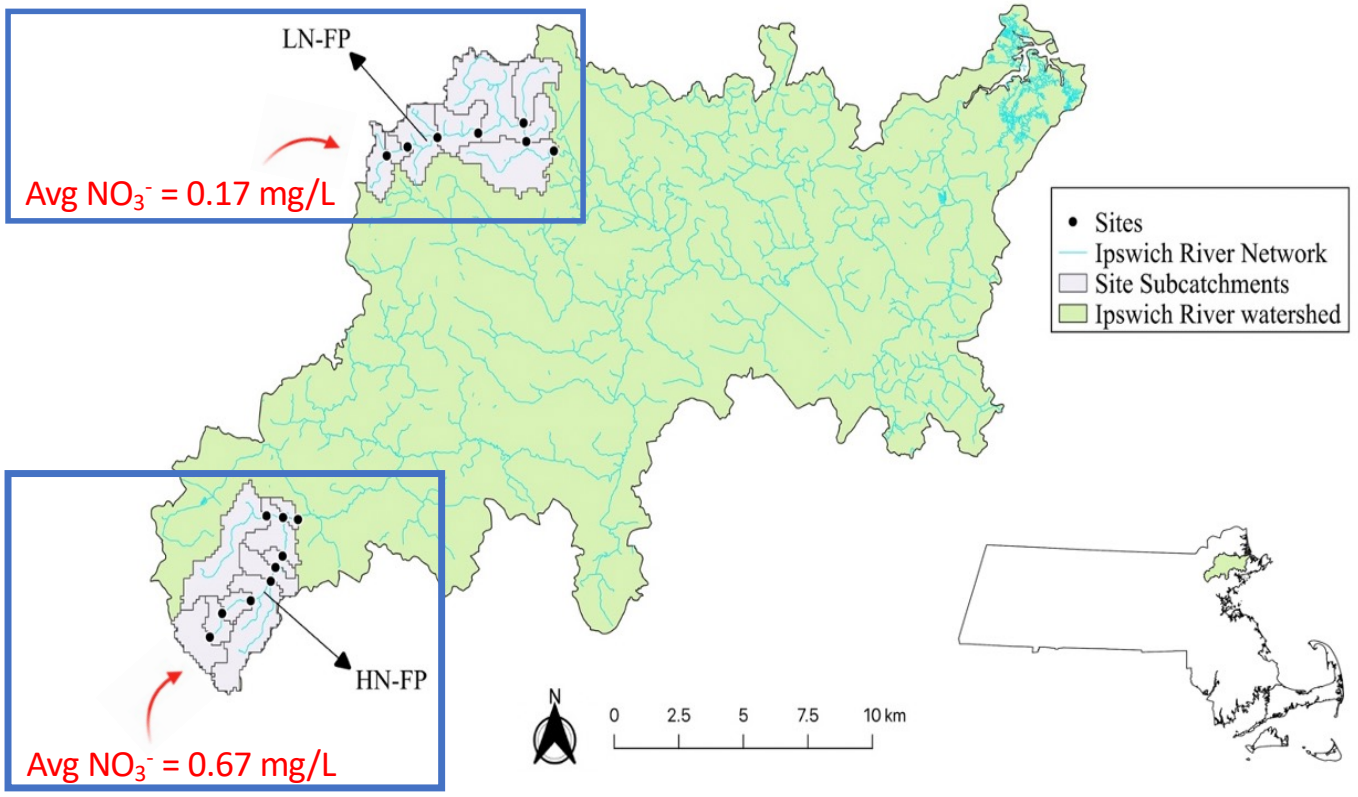
Commercial

Forest

Wetland

Suburban Boston, MA
(upper Ipswich R. watersheds

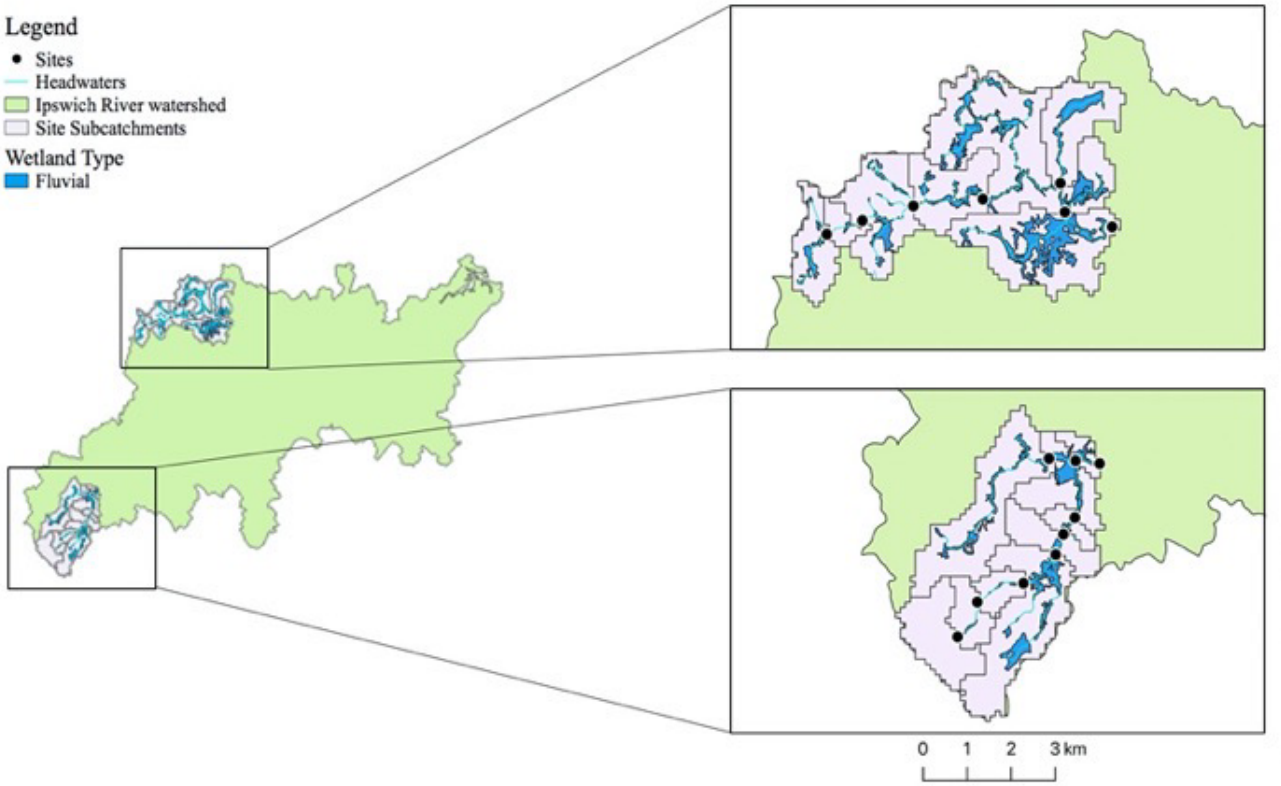
Approach: Biogeochemical patterns in two different fluvial wetland flowpaths.

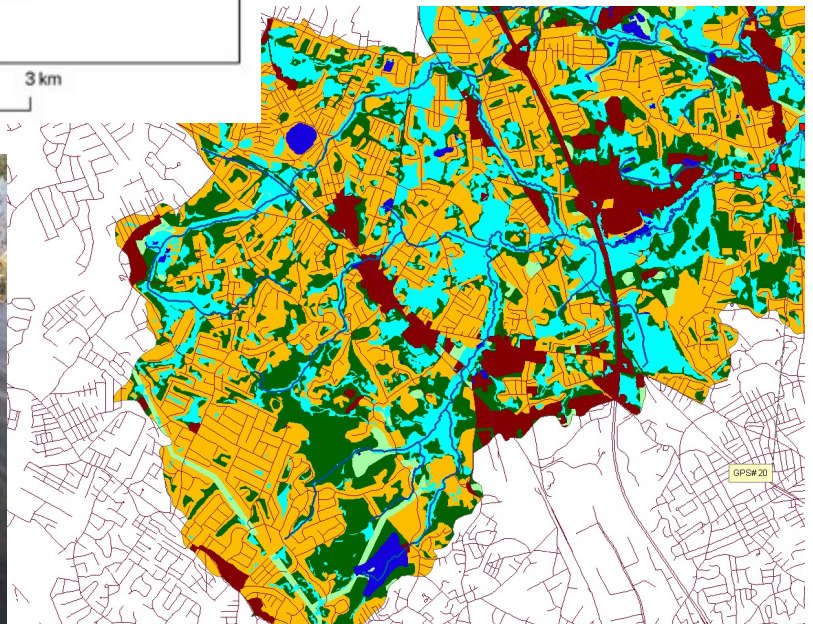


Fish Br. (LN-FP)
- Low Nutrient
- 15% urban
- 51% forested
- 32% wetland

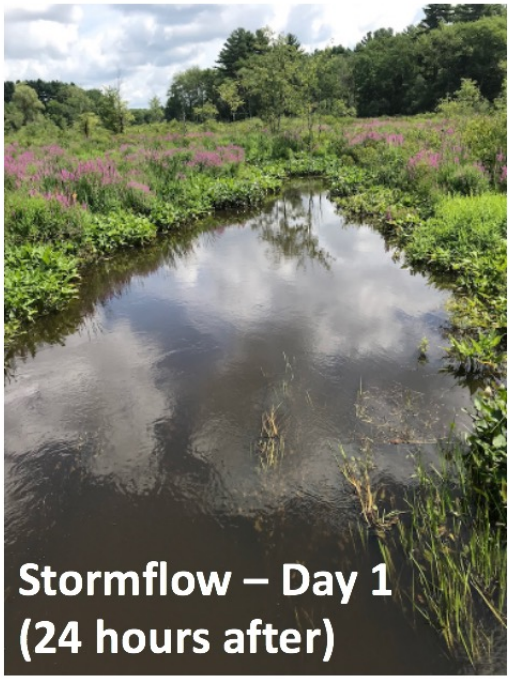
Maple Meadow Br.
- High Nutrient
- 30% urban
- 41% forested
- 23% wetland

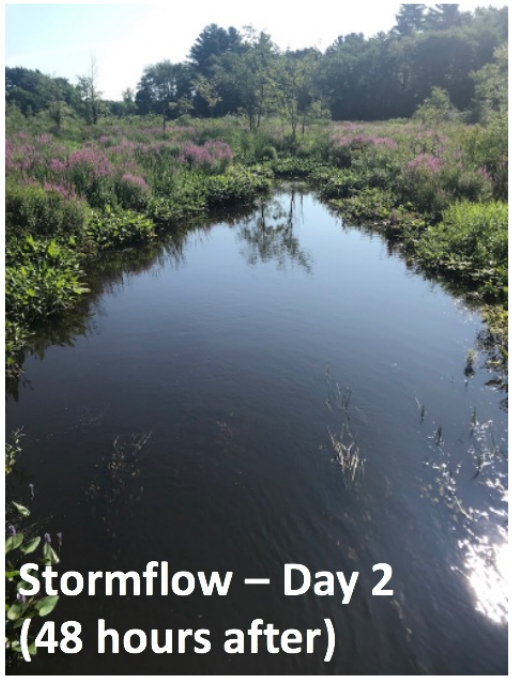
Increasing fluvial wetland abundance downstream





Paired storm sampling in advective zones

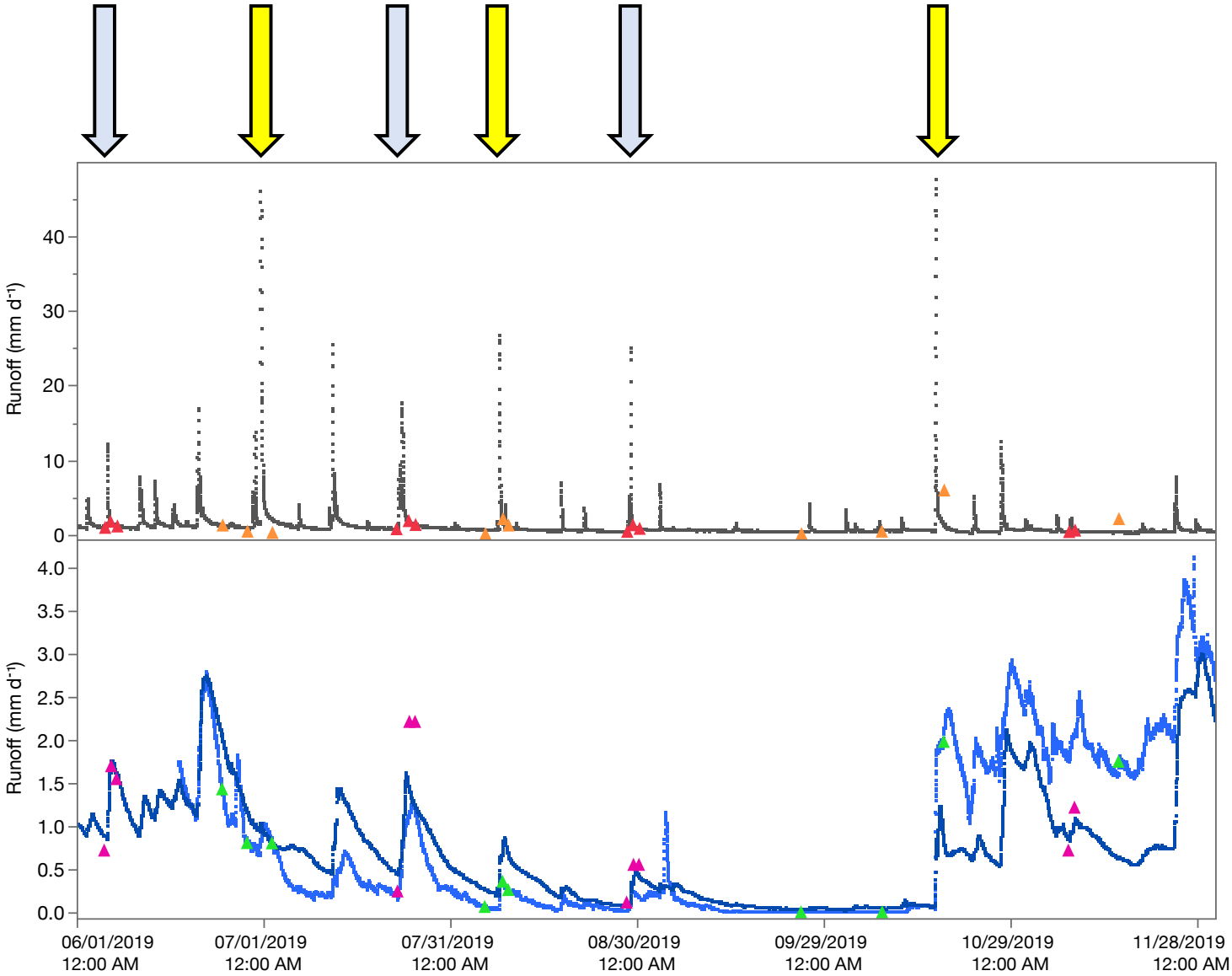




Flow and storm sampling

Channels

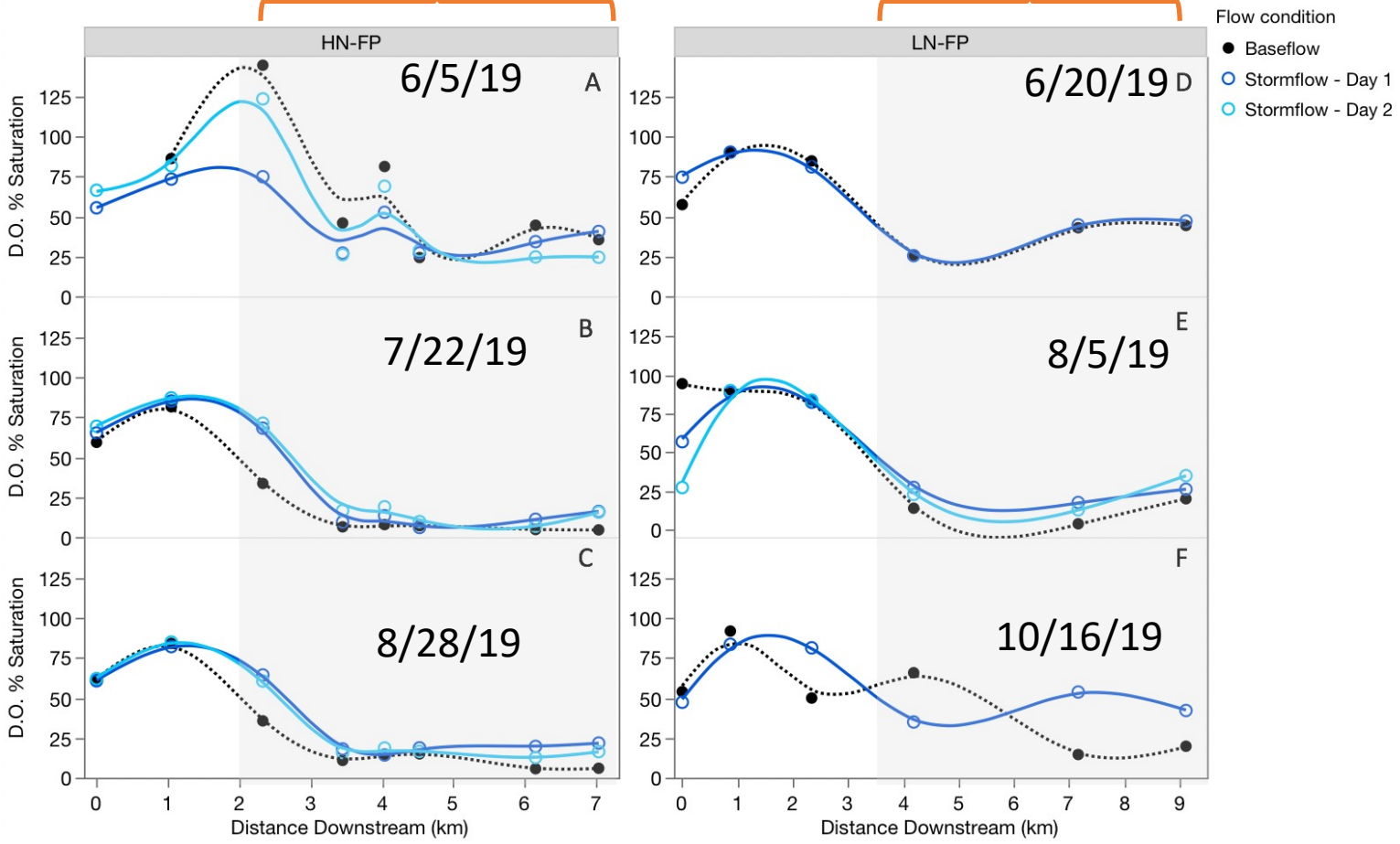
Fluvial wetlands



DISSOLVED OXYGEN: Fluvial wetlands remove oxygen, regardless of flow condition

HIGH NUTRIENT FLOW PATH **LOW NUTRIENT FLOW PATH**

Fluvial wetland dominated streams

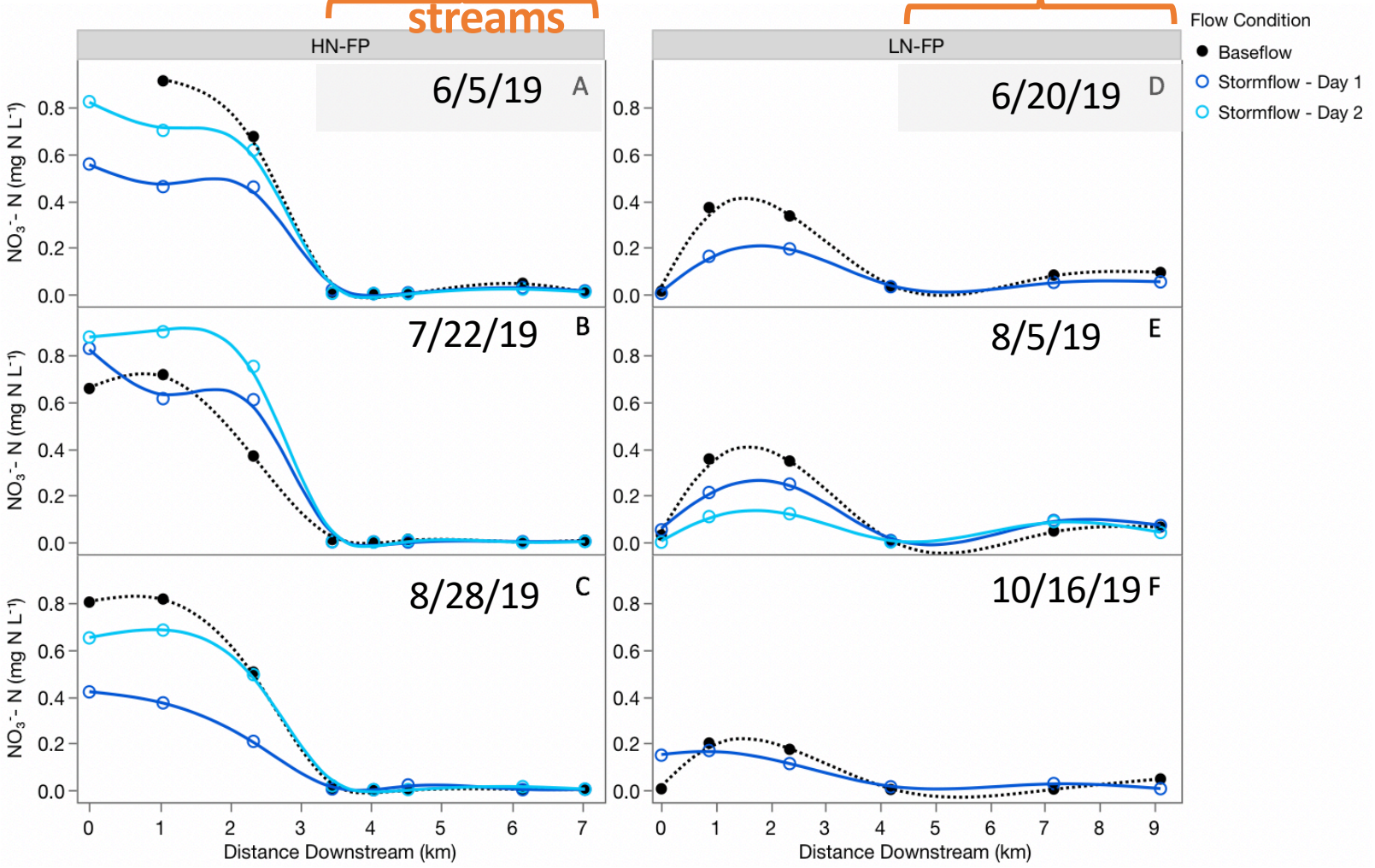


Upstream to Downstream →

NITRATE: Fluvial wetlands remove nitrate, regardless of flow: No NO_3^- shunt during storms

HIGH NUTRIENT FLOW PATH **LOW NUTRIENT FLOW PATH**

Fluvial wetland dominated streams

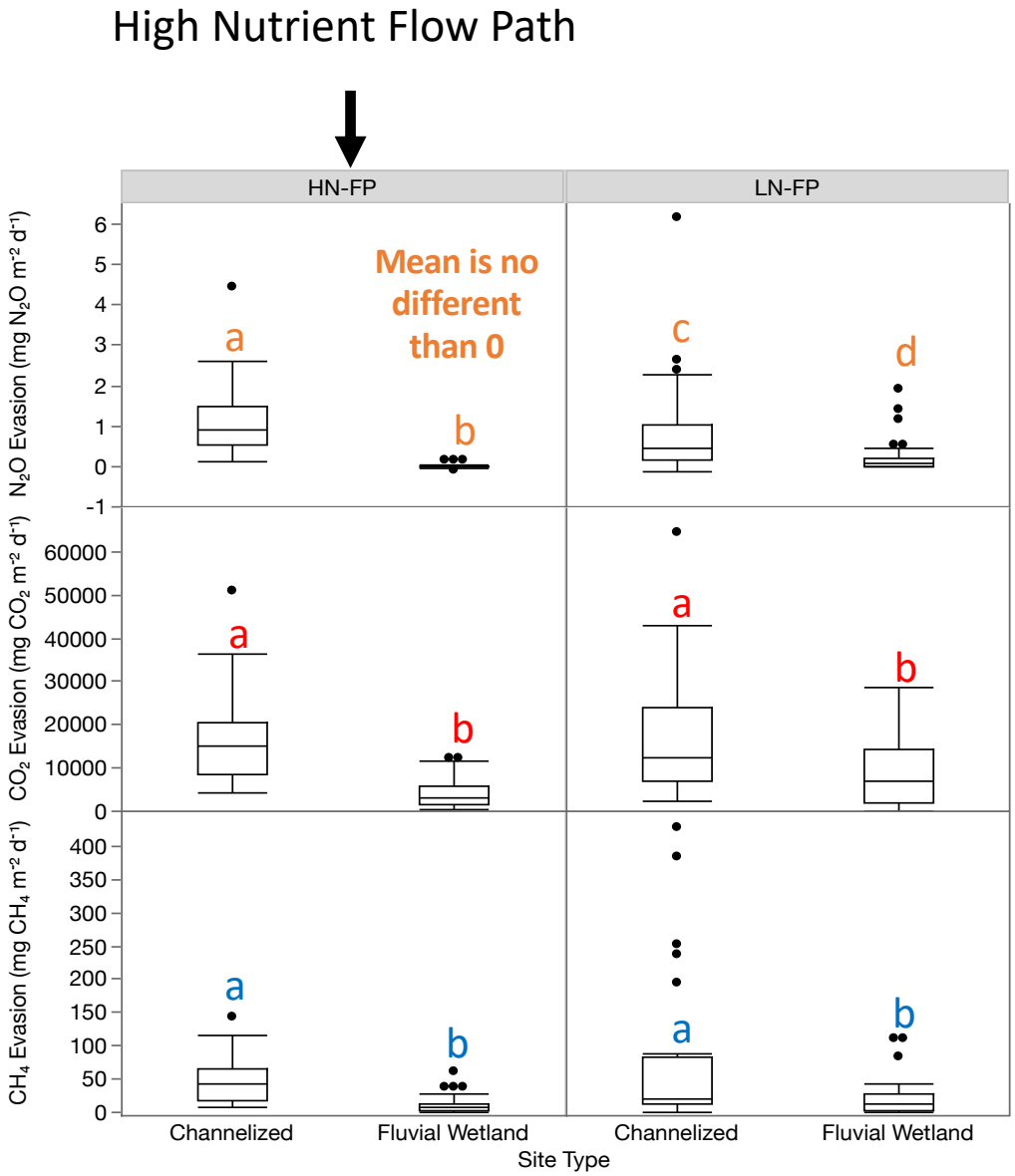


Upstream to Downstream →

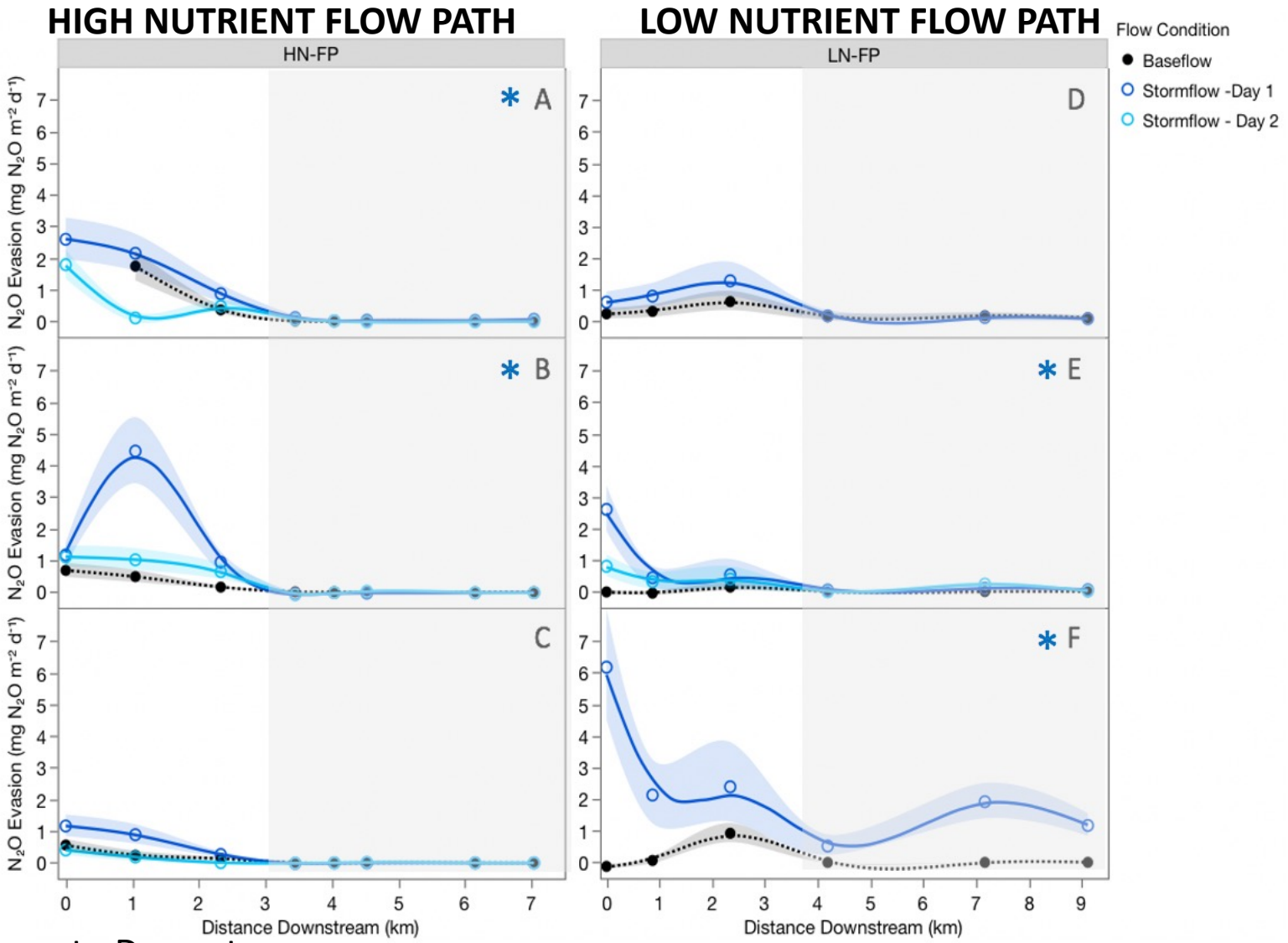
GREENHOUSE GASES: Lower GHG evasion (per unit area) by fluvial wetlands

Fluvial wetland dominated streams are **much larger sources** of GHG when total area is considered

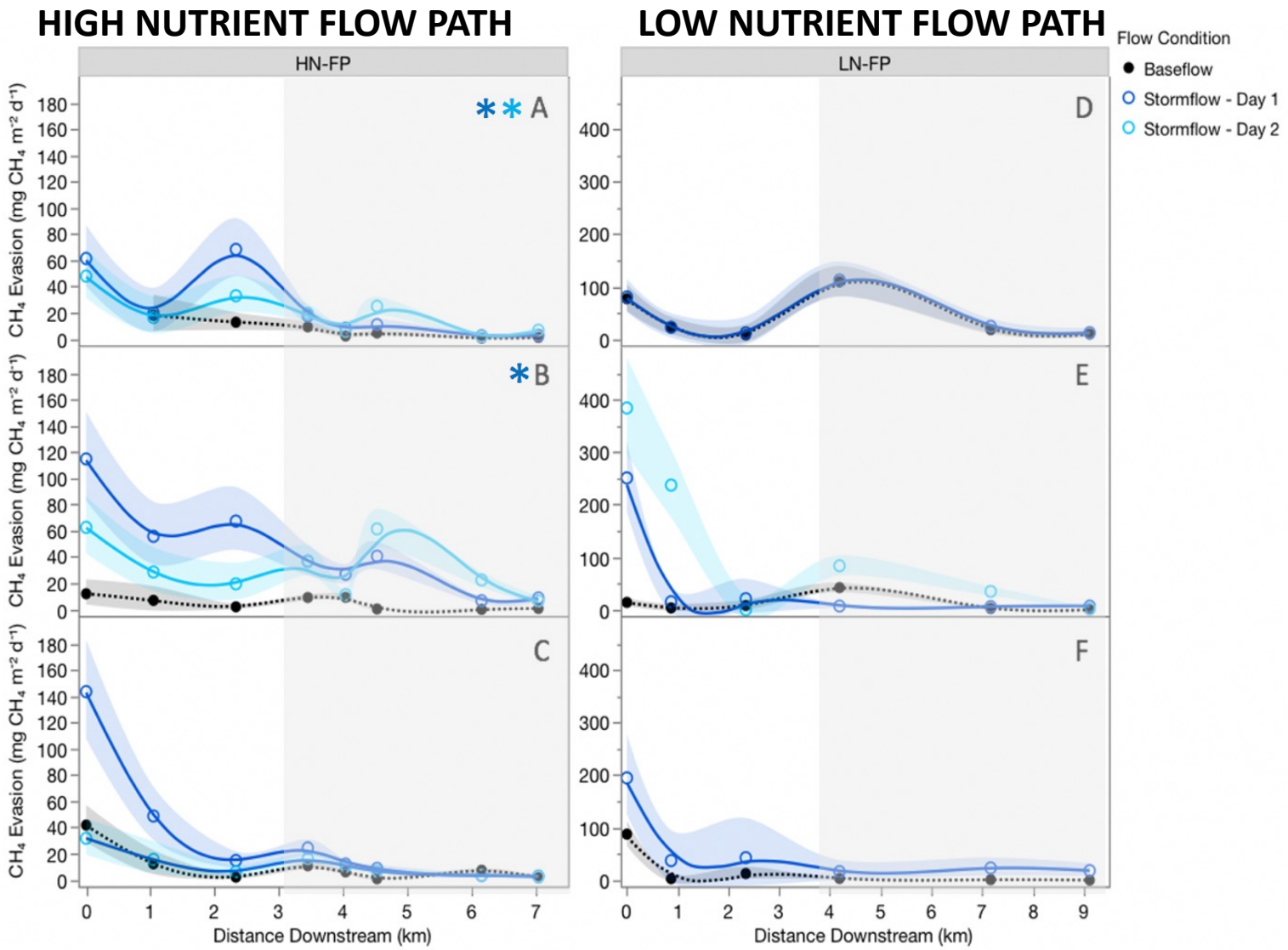
Fluvial wetlands in high nutrient flow paths do not have higher GHG evasion



NITROUS OXIDE: Response to storms: No pulse in N_2O evasion



METHANE: Response to storms: Diffusive CH_4 evasion increases, channel > fluvial wetland



Upstream to Downstream →

Total Evasion of GHG (summers)

Site Type	Flow Path	Area (km^2)	CH_4 Evasion ($mg\ m^{-2}\ d^{-1}$)	CO_2 Evasion ($mg\ m^{-2}\ d^{-1}$)	N_2O Evasion ($mg\ m^{-2}\ d^{-1}$)	Total CH_4 Evasion ($kg\ d^{-1}$)	Total CO_2 Evasion ($kg\ d^{-1}$)	Total N_2O Evasion ($g\ d^{-1}$)
Fluvial Wetland	HN-FP	1.91	6.76	2997	-0.01	12.92	5726	-9.8
	LN-FP	4.56	12.15	6809	0.09	55.43	31074	396.8
Channelized	HN-FP	0.05	41.77	15213	0.90	2.26	822	48.7
	LN-FP	0.10	20.08	12490	0.44	1.96	1222	43.3

Because area of fluvial wetlands is so high, they contribute much more to GHG evasion than stream channels.

But the high nutrient flow path evaded less per unit area than than the low nutrient flow path.

Key takeaways

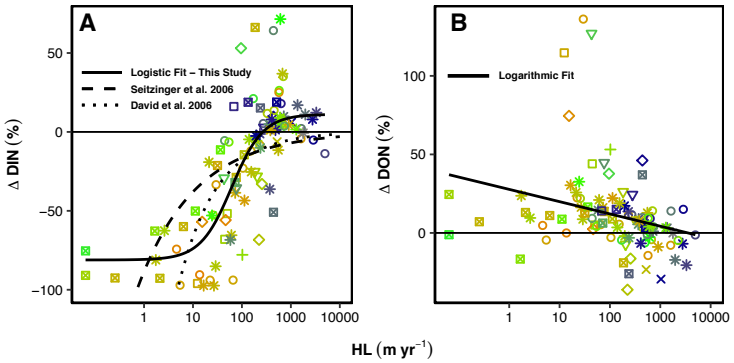
Fluvial wetland dominated flow paths are **VERY** effective at nitrate removal, across flow conditions (during growing season)

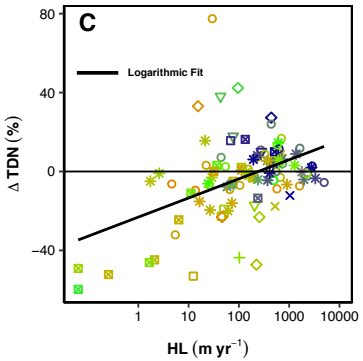
Fluvial wetland dominated flow paths show increased GHG evasion under high flows

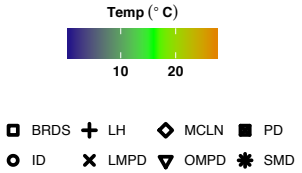
The ability for fluvial wetland dominated streams to effectively remove NO_3^- **does not** come at the expense of greater GHG emissions beyond what naturally occurs

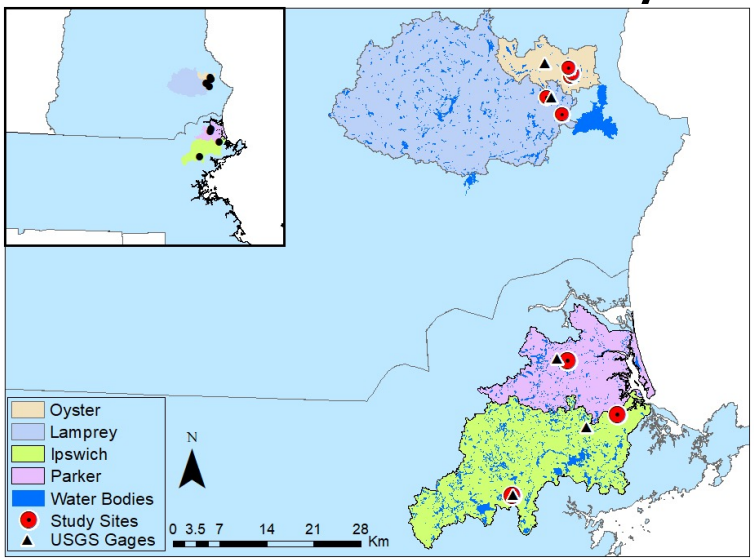
Fluvial wetlands do cause a decline in dissolved oxygen, but this is a natural process due to high organic matter and low reaeration rates

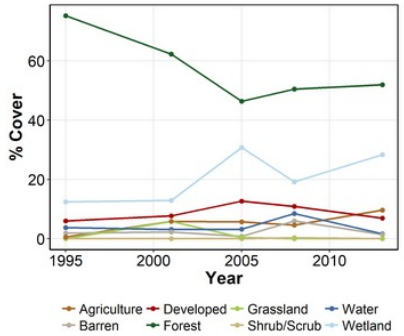
Beaver Pond Dynamics vs. Human Reservoir Dynamics - UNH PhD Student Chris Whitney

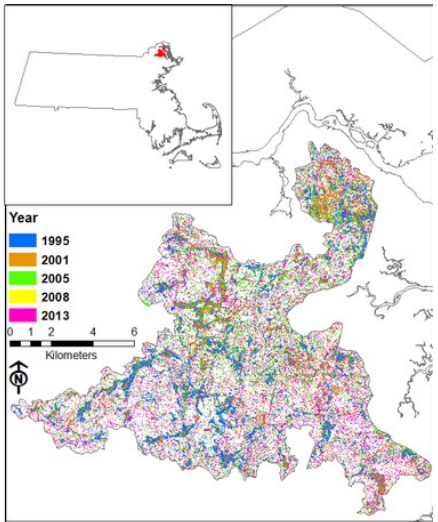






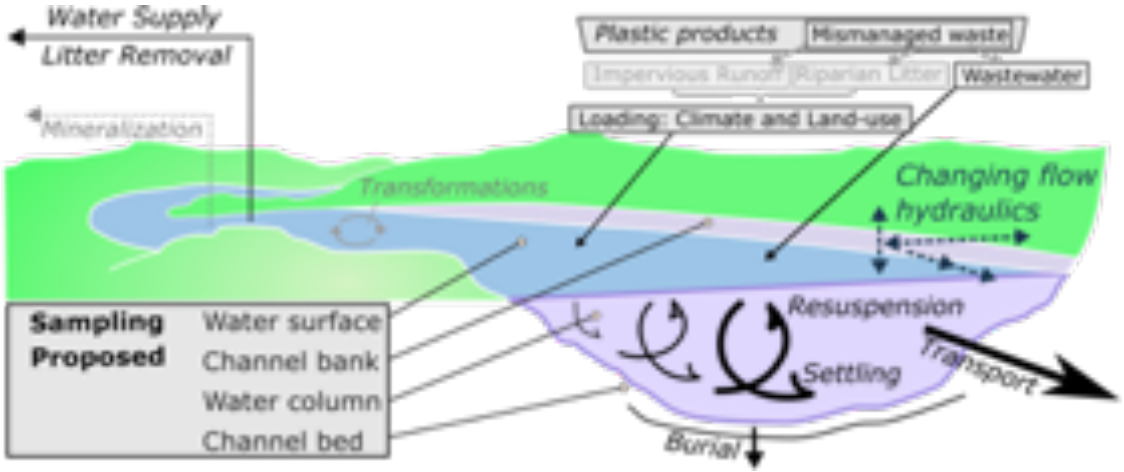


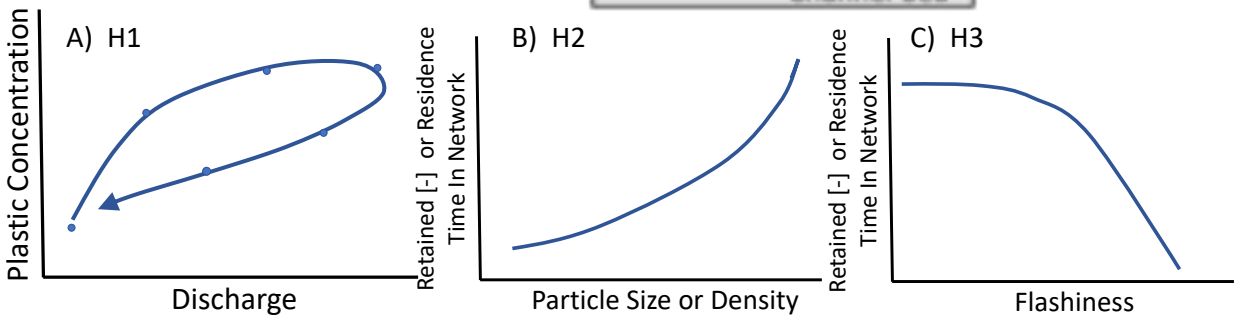




New NSF-funded Study: Plastic Spiraling In River Networks (PSIReN)

Collaboration among:
UNH
Loyola U. - Chicago
U. of Toronto





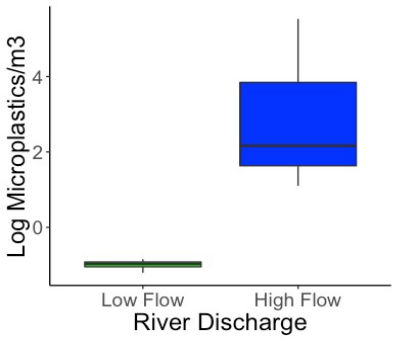


Figure 3. Microplastic concentrations in surface water from Mimico Creek (Toronto, Canada) in low and high flow. (Rochman, unpublished data).

- We would love to talk with you regarding:
  - small streams draining an urban area where plastic is a concern.
  - About places where plastic accumulates in larger streams and rivers.
- Please contact me, or Emily Lever (UNH MS student)
  - Wil.wollheim@unh.edu
  - Emily.lever@unh.edu

Thank You!

Other UNH
LTER Students/Personnel
who you might see around the watersheds

Josh Buonpane

Reese Levea

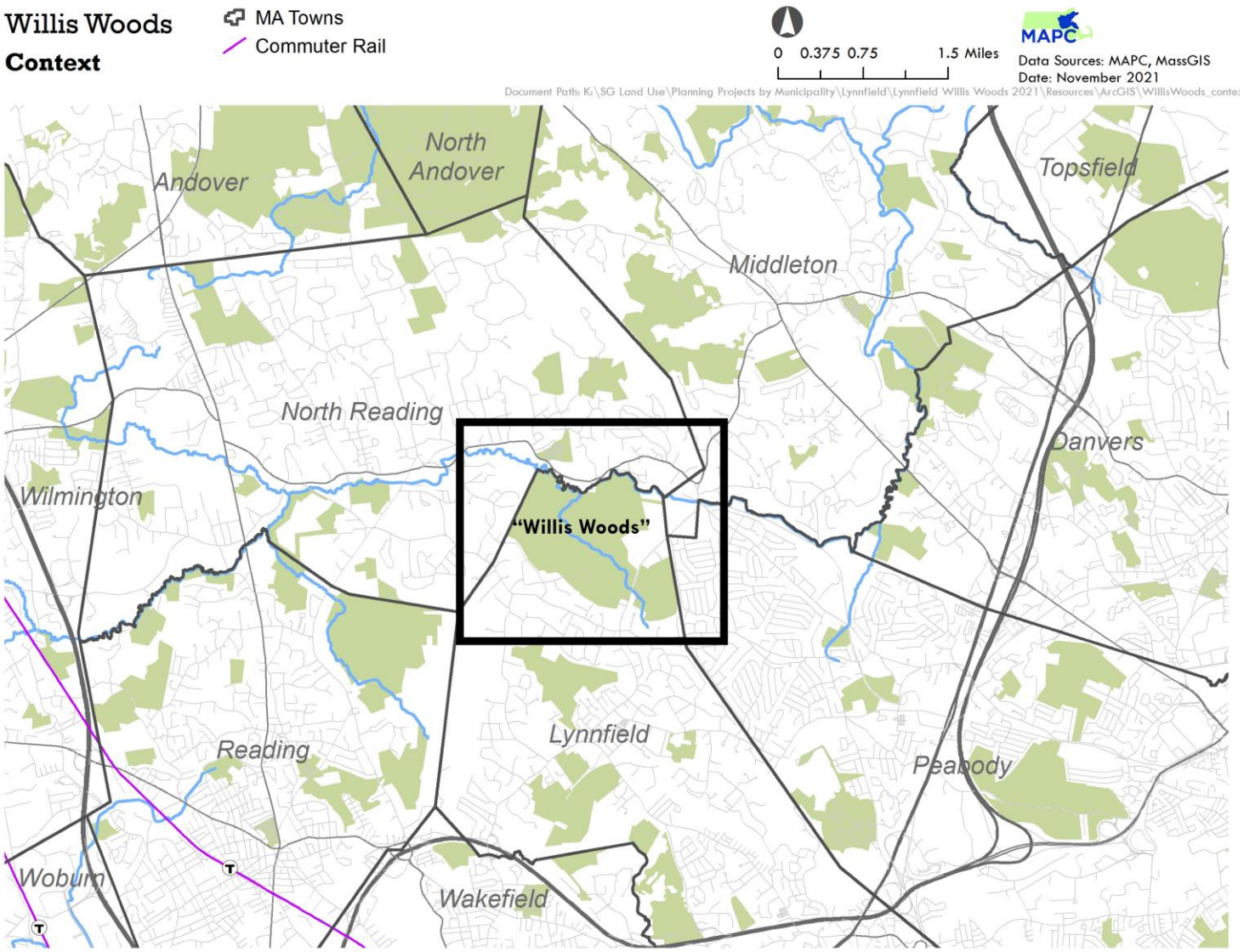
Shan Zuidema

E-mail: wil.wollheim@unh.edu
Twitter: @WilWollheim

A Vision for Willis Woods

What is Willis Woods?

- 600+ acres of forestland along the Ipswich River
- Largest undeveloped area in the Ipswich River Watershed, much larger than Walden Woods
- Owned primarily by Lynnfield Center Water District and Town of Lynnfield
- Until now, has had prohibited/limited public access



What is “A Vision for Willis Woods”?

Develop a shared vision and action steps for protecting open space and natural resources and developing new recreational opportunities at the confluence of Lynnfield, North Reading, Peabody, and Middleton.

Project team

Lynnfield:

Emilie Cademartori, Director of Planning & Conservation;

Jennifer Welter, Planning and Conservation staff

Middleton:

Katrina O'Leary, Town Planner

North Reading:

Danielle McKnight, Town Planner;

Phil Hertz, Land Utilization Committee member

Peabody:

Brendan Callahan, Assistant Director of Planning

Greenbelt, Essex County Land Trust:

Chris LaPointe, Director of Land Conservation

Ipswich River Watershed Association:

Patrick Lynch, Director of Policy & Planning

MAPC:

Ella Wise, Senior Land Use Planner;

David Loutzenheiser, Senior Transportation Planner

Why now ? What are the new opportunities? What has changed?

- Interest in providing public access, including to the existing rail bed

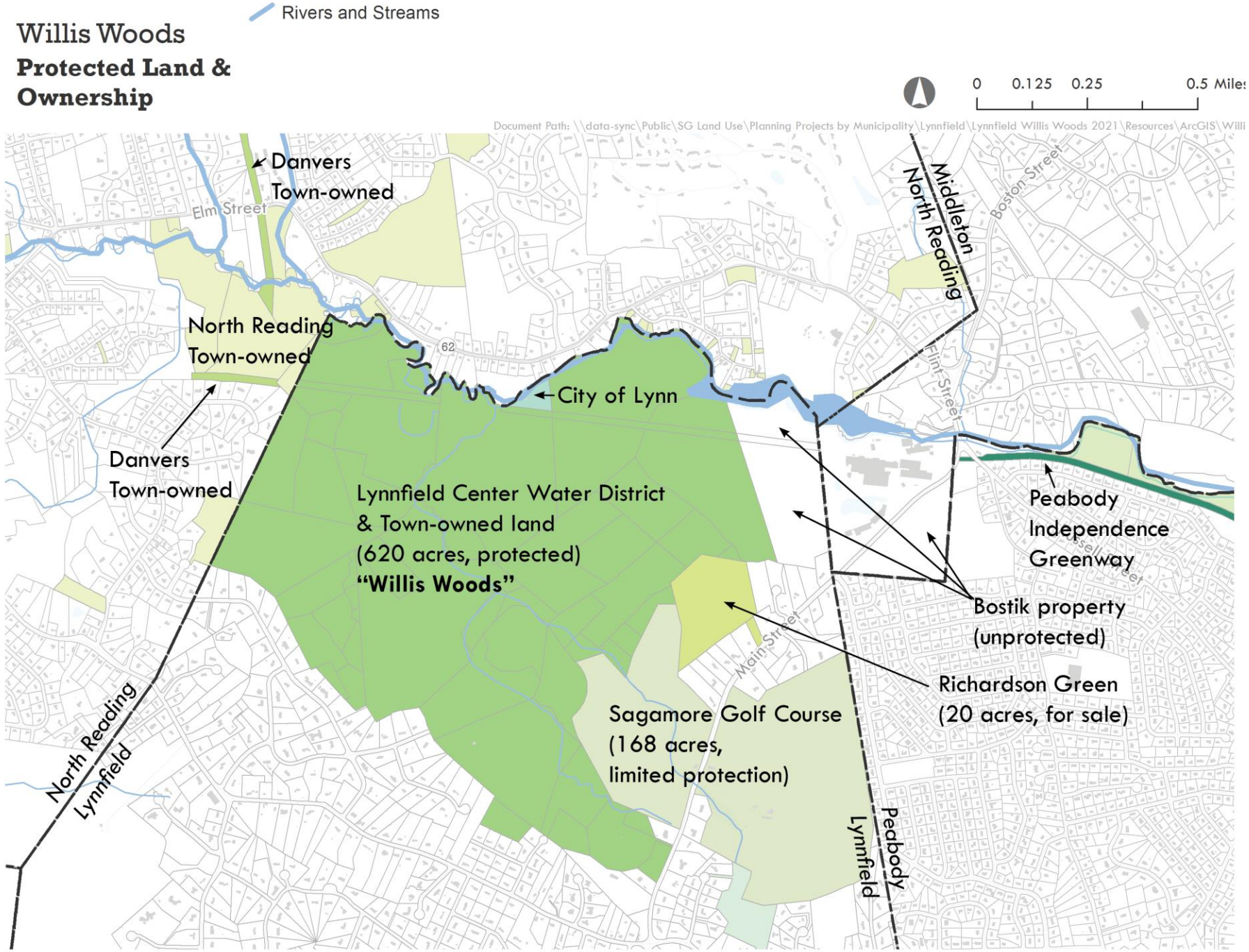
What are the new opportunities? What has changed?

- Interest in providing public access, including to the existing rail bed
- Protection of Richardson Green, a key parcel adjacent to Willis Woods with access to Lynnfield's Main Street

What is the process?

Existing conditions

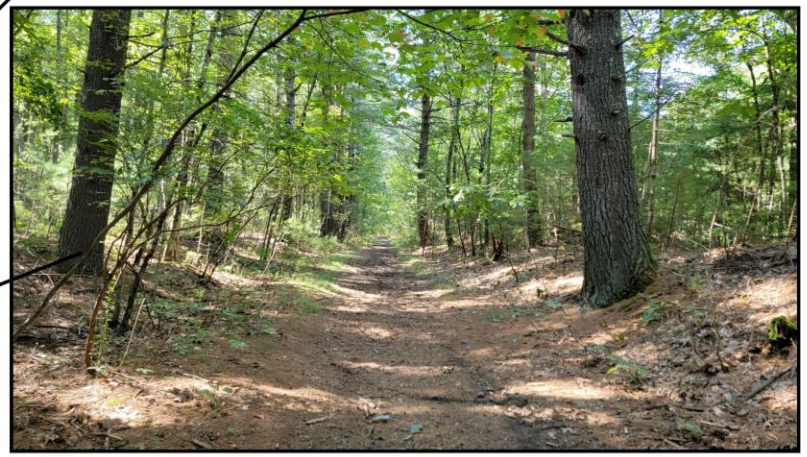
Willis Woods
Protected Land & Ownership



Existing rail bed

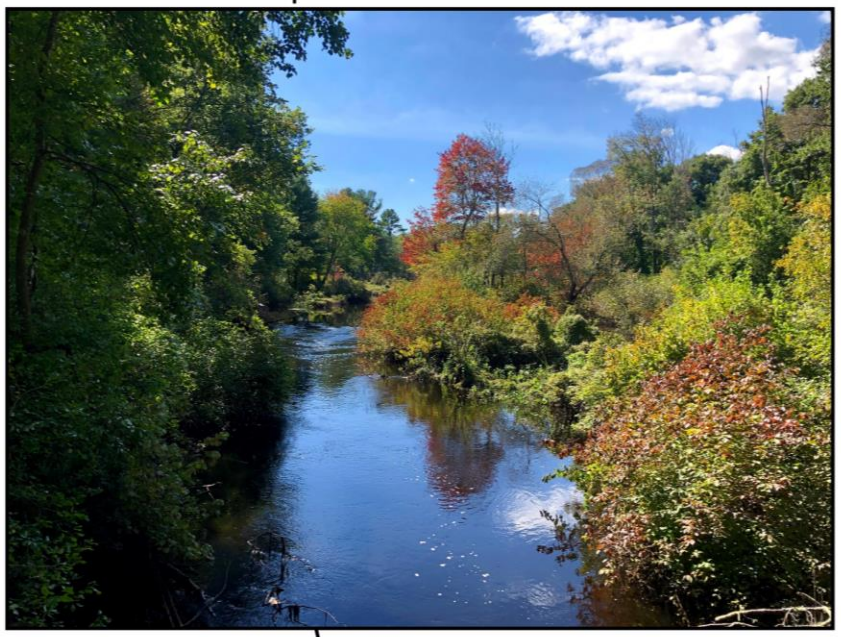
existing rail bed along the River

long, straight stretch of existing rail bed

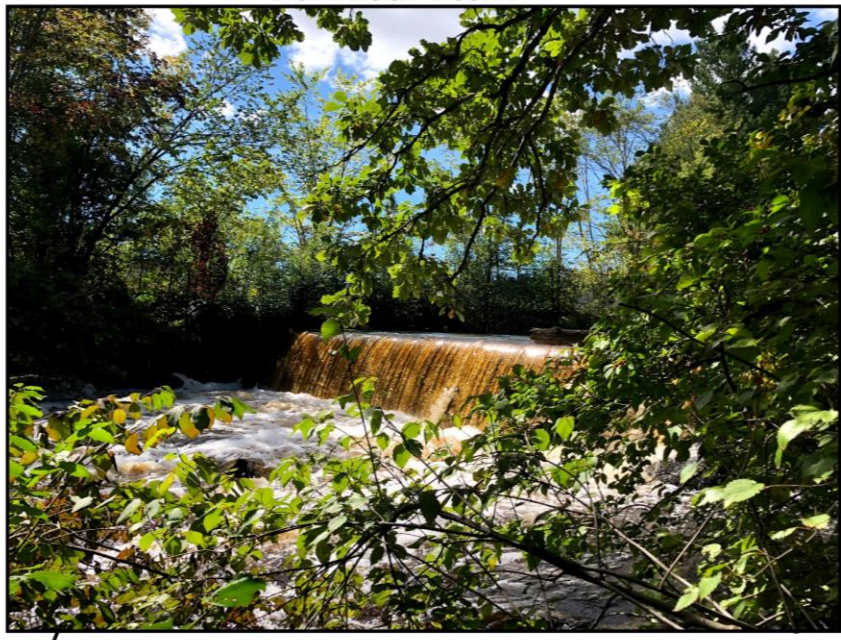


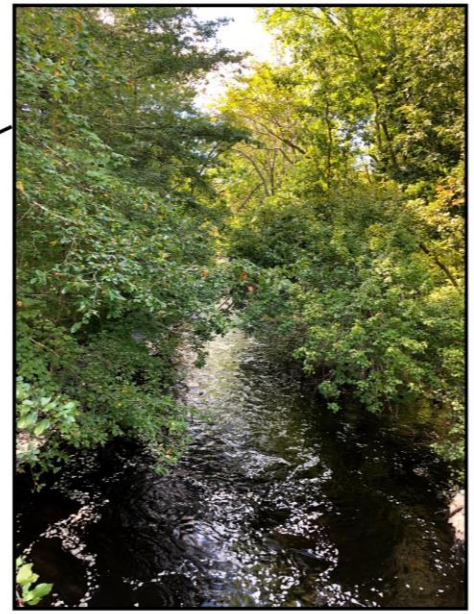
Ipswich River

Ipswich River



Dam near Bostik





Existing bridges

Pedestrian bridge

City of Lynn bridge

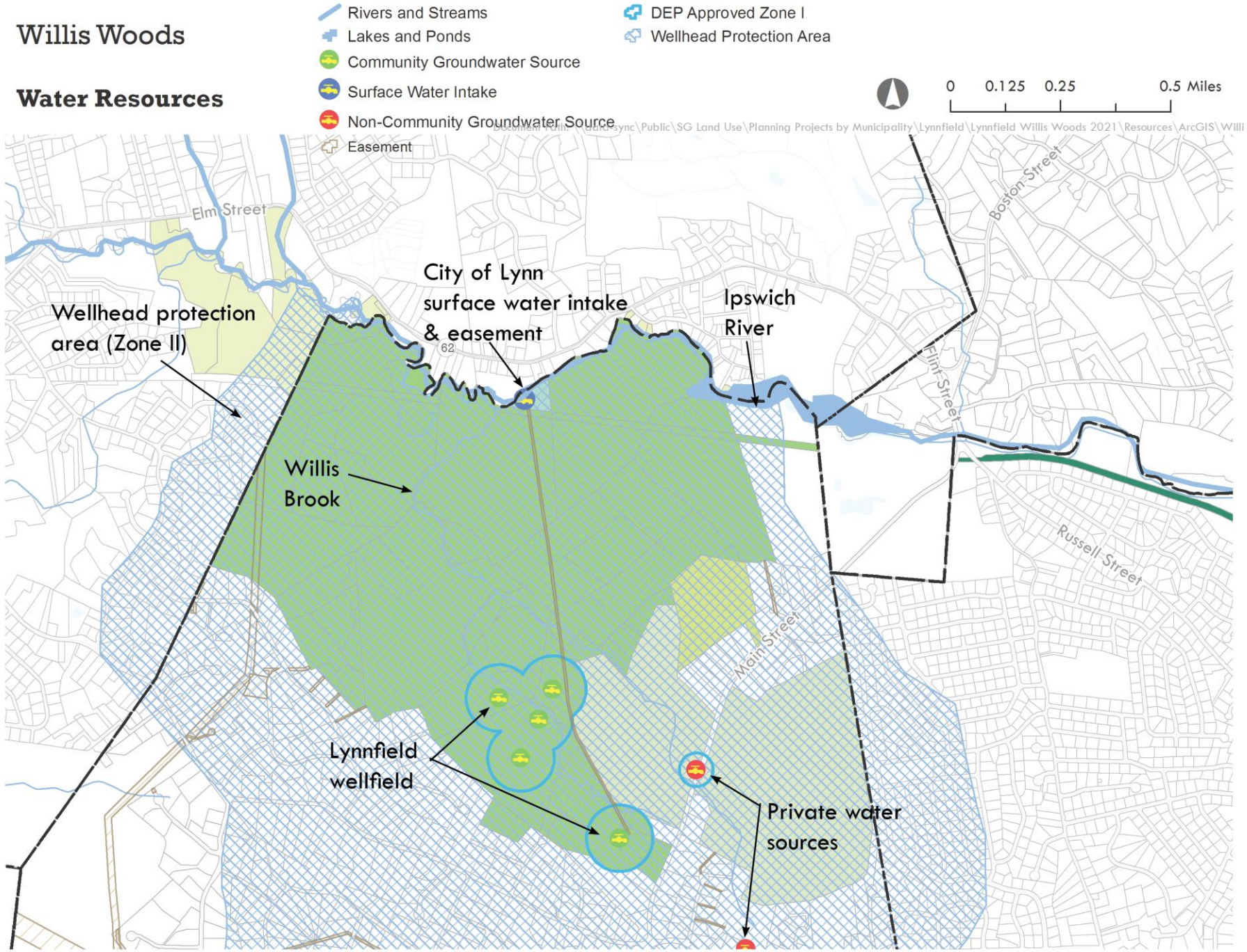
Prohibited ATV use

ATV course and recent use

Recent ATV use

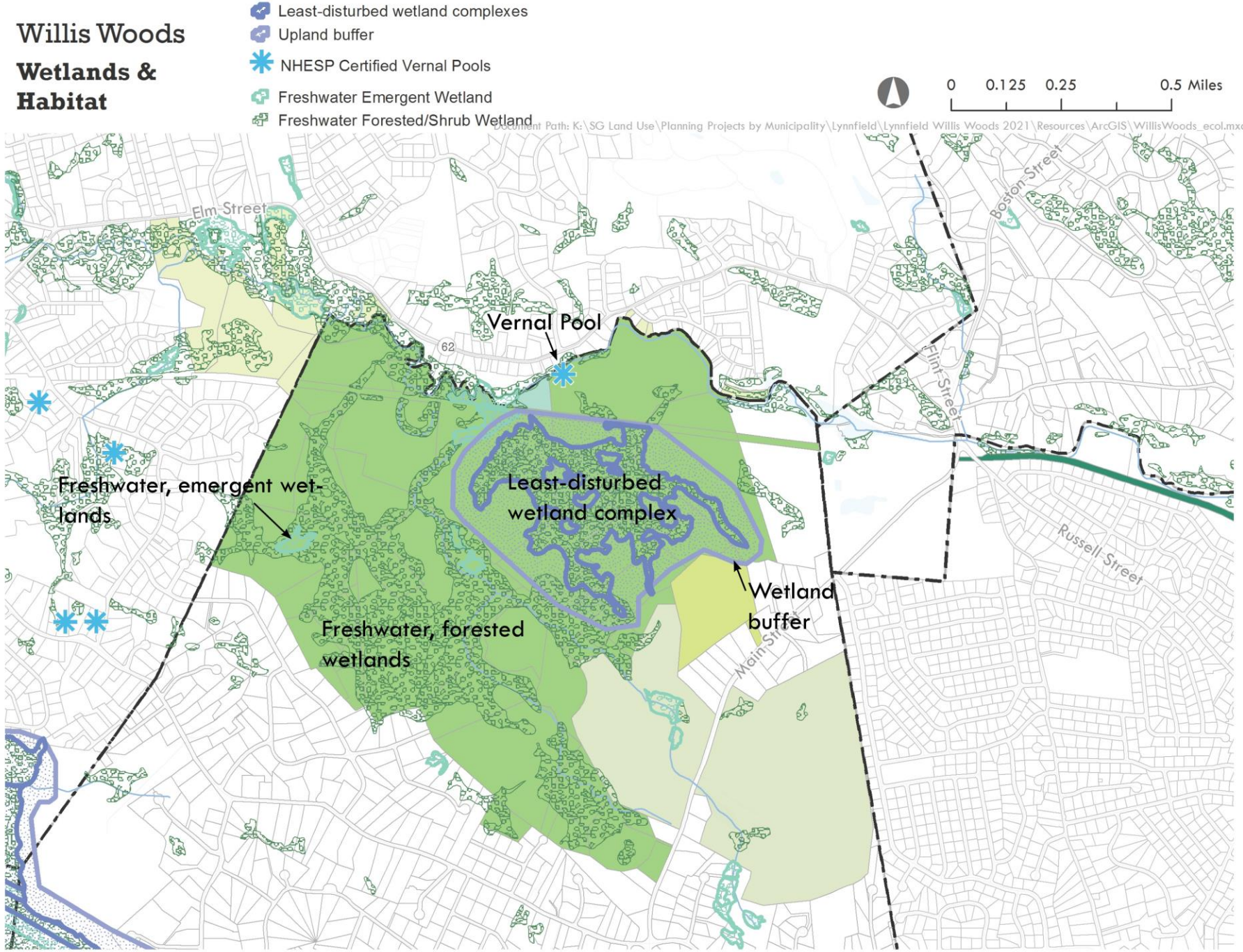
Willis Woods

Water Resources



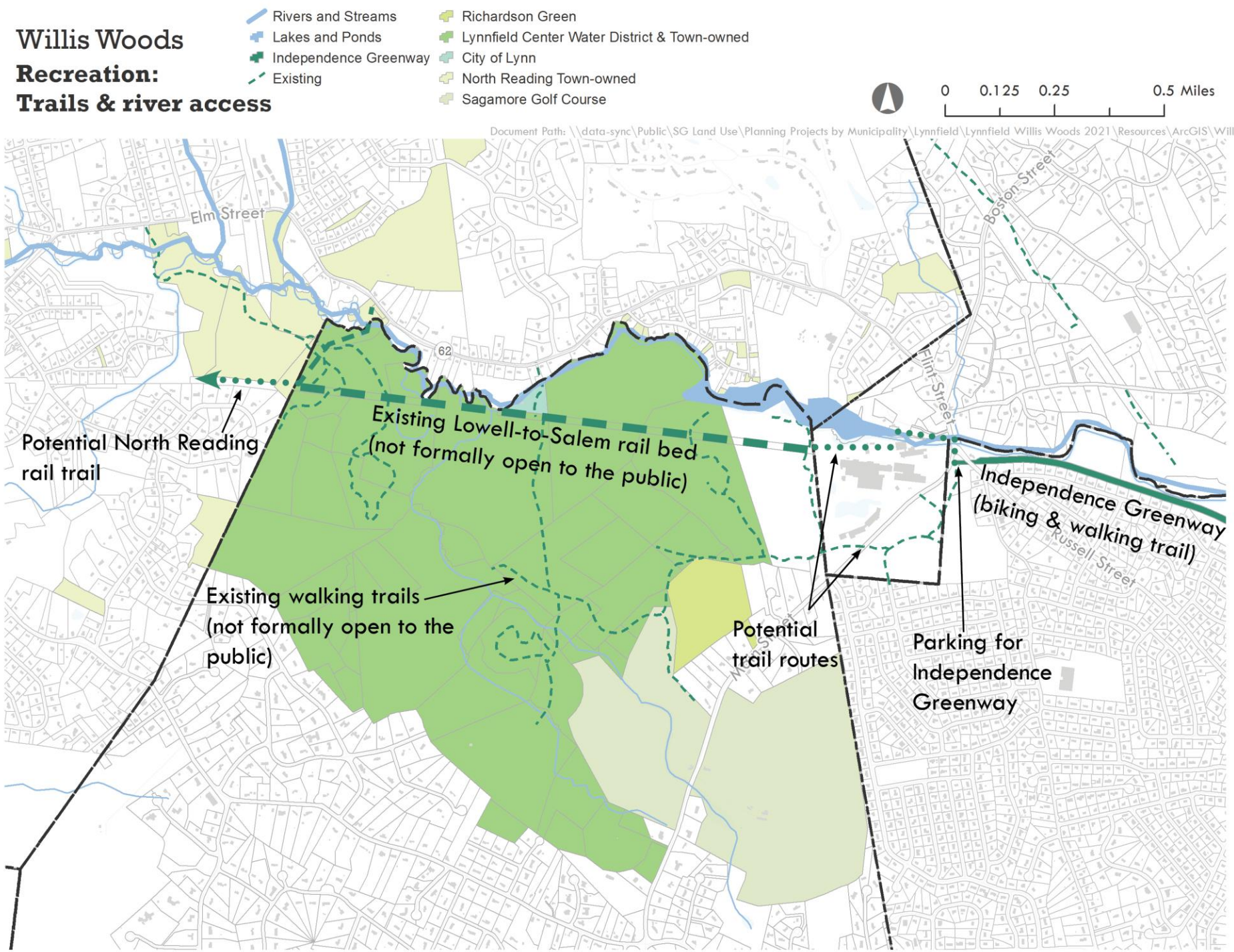
Willis Woods

Wetlands & Habitat



Willis Woods

Recreation: Trails & river access



Willis Woods

Recreation: Trails & river access

- Rivers and Streams
- Lakes and Ponds
- Independence Greenway
- Existing
- Richardson Green
- Lynnfield Center Water District & Town-owned
- City of Lynn
- North Reading Town-owned
- Sagamore Golf Course

0 0.125 0.25 0.5 Miles

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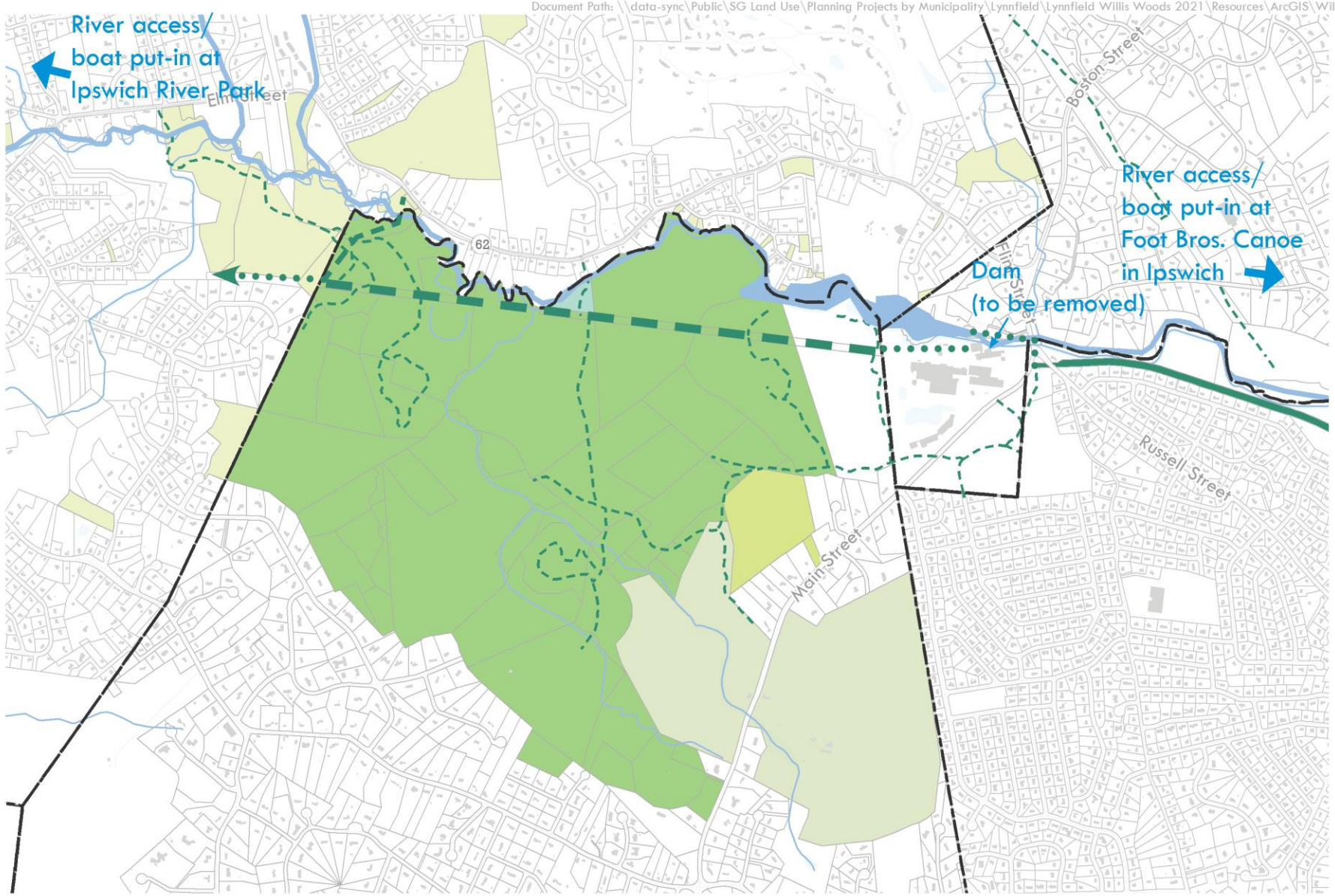


Lynnfield

Opportunities?

- Passive Recreation on hundreds of acres for residents/visitors
- Permanent protection of water resources – watershed protection for Lynnfield Center Water District wellfields, as well as surface water users in communities downstream
- Access to Ipswich River
- Protection of wildlife corridors, habitat
- Climate Resilience with preservation of forested acreage
- Restoration of damaged areas from unauthorized ATV trail use

Lynnfield

How does this build on existing efforts

- Answers long-published requests from residents for additional open space for passive recreation – Master Plan surveys-2002,2018, Open Space & Recreation Plan surveys-1998, 2010,2017
- Responds to goals of Lynnfield's MVP (Municipal Vulnerability Plan)
- Builds on possible "keystone" and formal access through Richardson Green 20-acre parcel if purchased by Town of Lynnfield
- Connects trails within Lynnfield to wider regional network – Peabody, North Reading, Middleton
- Continues efforts seeking further permanent protection of undeveloped private and municipal properties in the Ipswich River Watershed

Peabody

Support Regional Multi-Use Greenway Network Development

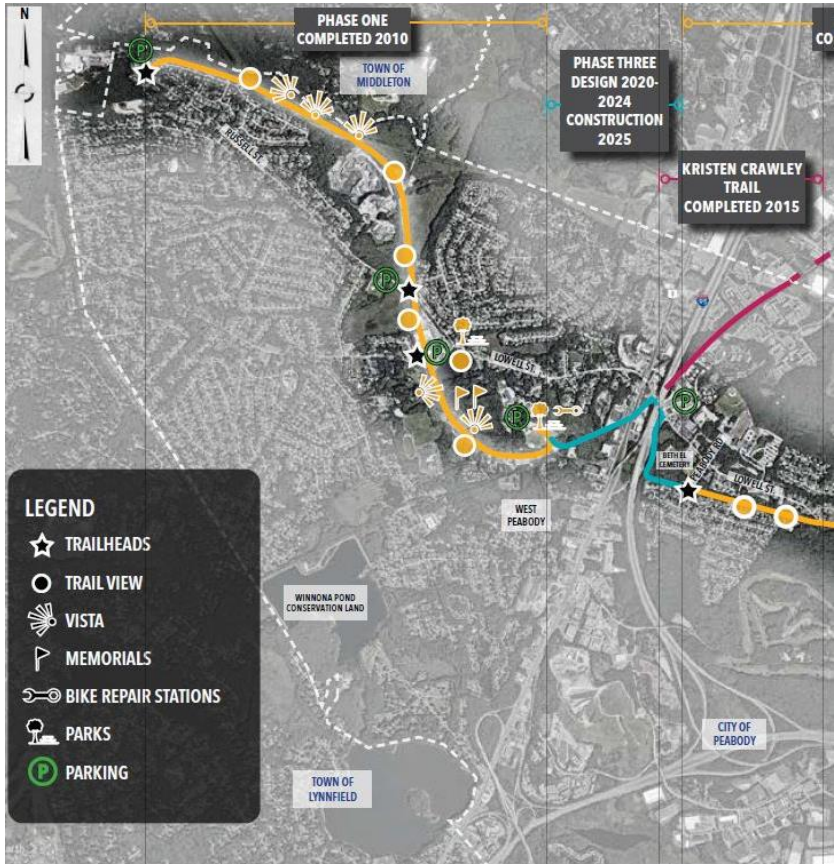
- The Independence Greenway acts as the critical link within the region's Border to Boston shared use trail network that links approximately 20 communities for non-motorized uses including walking, bicycling, and more.
- Working with Willis Woods project partners advances the larger vision of this greenway system connecting with our neighboring communities like Middleton, Lynnfield, North Reading, and Essex County trail networks.

Support Alternative Transportation Resources for the Region

- The development of the region's greenway network will connect residents to important commercial, residential, and transportation nodes within the region and existing park and recreation facilities.
- The greenway will serve the regions need for safer and more convenient active transportation infrastructure.

Promote Healthy Lifestyle and Open Space Connections

- The development of the greenway will provide the region recreational opportunities, promote healthy lifestyle, and connect communities to the regions open spaces.

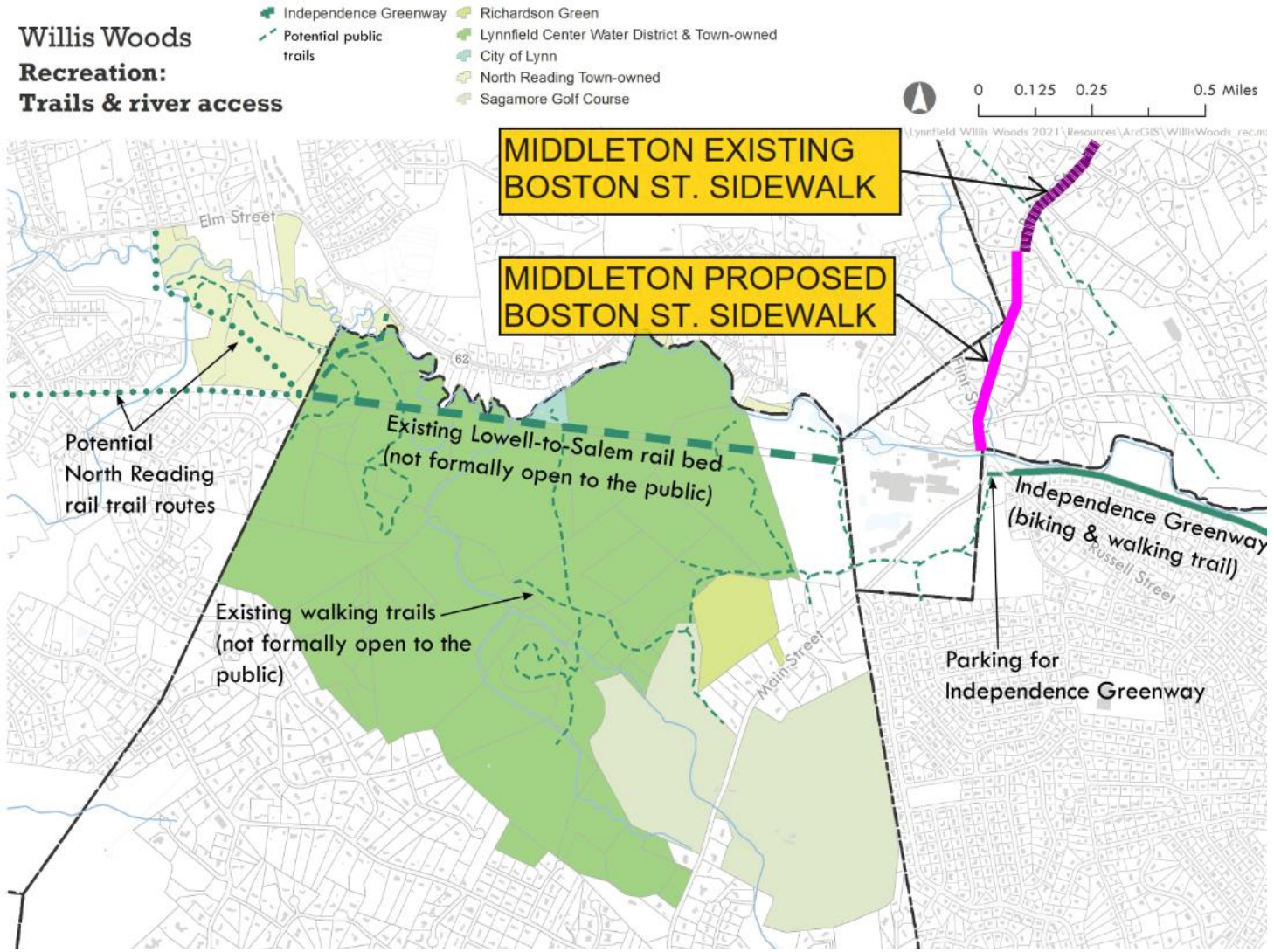


North Reading

- The western portion of Willis Woods is largely publicly owned land within N. Reading
- This area of Town offers trails and lovely vistas of the Ipswich River
- However, there is no public access
- The Willis Woods project potentially provides access from the east through Lynnfield and Middleton
- The proposed N. Reading Recreational Trail could also provide access via new bridges over the River to Elm St/ Rt. 62
- When completed, the Recreational Trail would connect this area to Ipswich River Park and possibly Route 28.

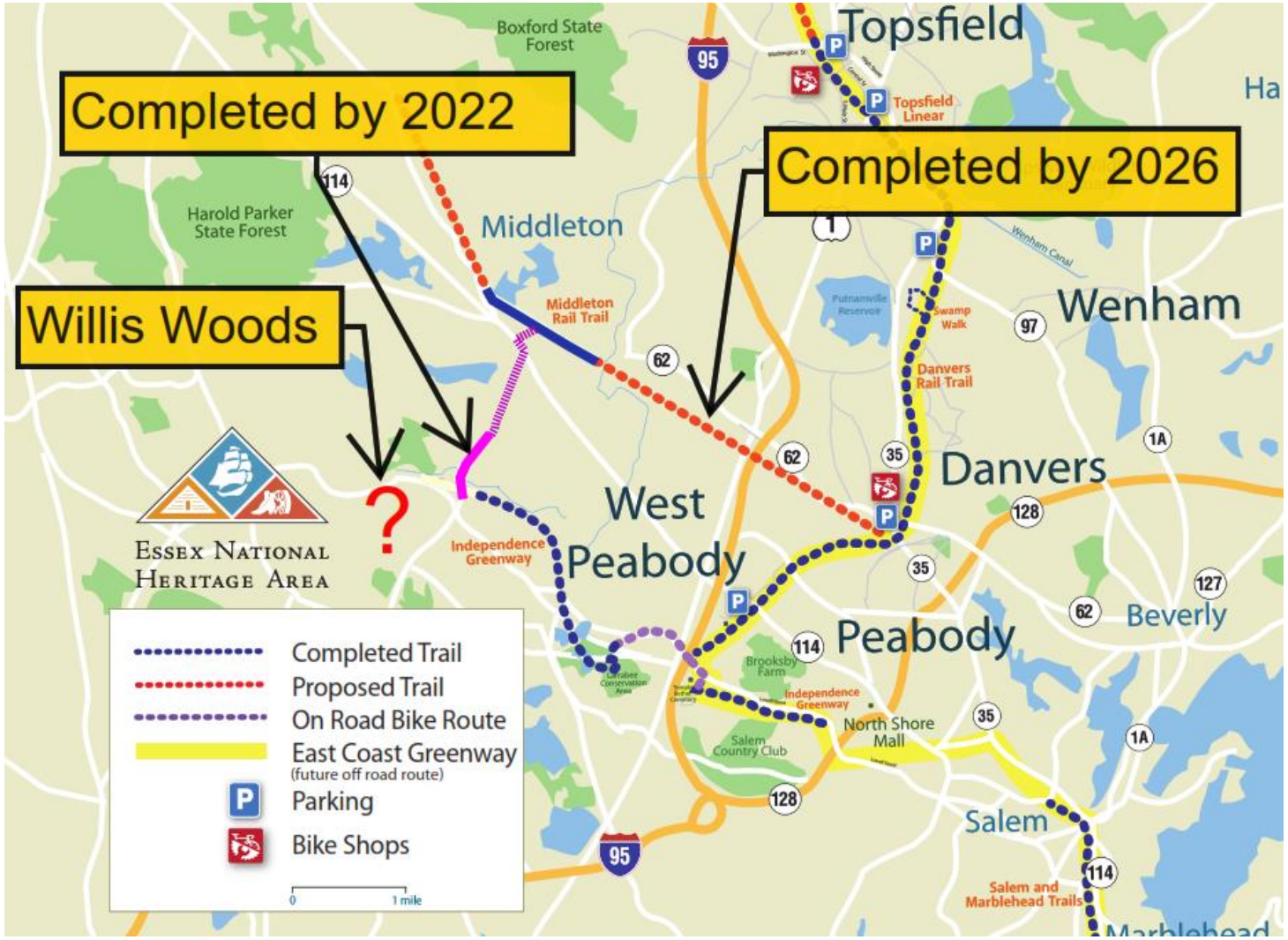
Middleton

- Creates incentive to expand existing sidewalk network
- Boston Street Sidewalk is high priority for Town



Middleton

- Small connections have big impacts on the larger network
- By 2026, newly finished trails will allow safe pedestrian/bicycling across the Northshore



Ipswich River

- Upper Ipswich Watershed aka "The Headwaters"
- Local leaders maintain free public access
- Water Trail navigable from Wilmington to Ipswich!
- S. Middleton Dam removal: final permitting stages

Next

- Please visit the project webpage to sign up for updates:

www.town.lynnfield.ma.us/willis-woods

- Project team will start drafting the Vision Plan, including action steps.

Questions?

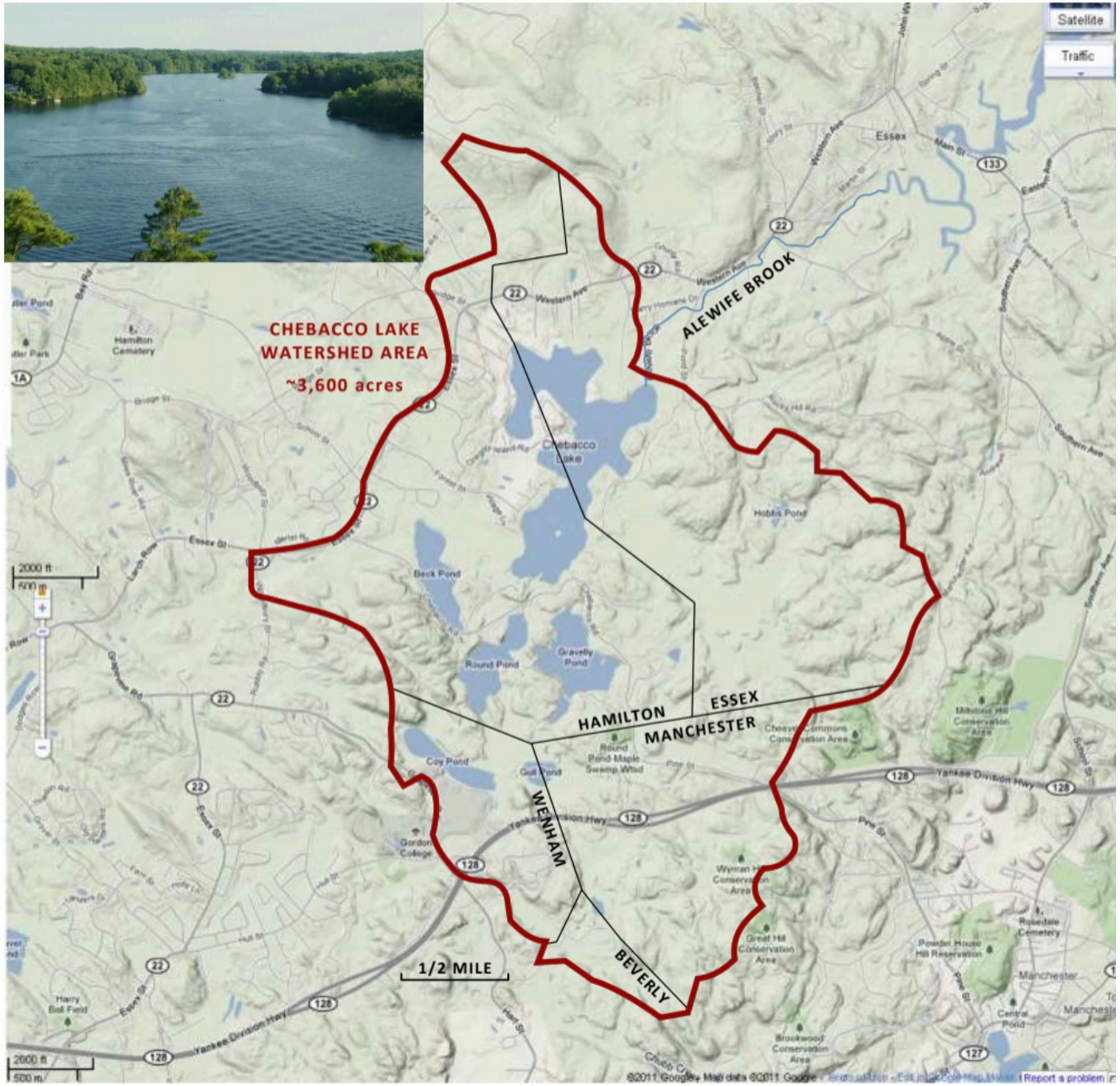

Thank you

Chebacco Lake Restoration

The Chebacco Lake Coalition

- Major Contributors (brief overview):
  - Senator Bruce Tarr
  - Representatives Brad Hill and Ann-Margaret Ferrante
  - Chebacco Lake and Watershed Association
  - Seaside Sustainability
  - MA Division of Marine Fisheries
  - Hamilton, Essex, and Hamilton Town Representatives
    - Selectpeople, Conservation Commission Members, Town Managers, Board of Health Members
  - Save Chebacco Trails
  - MA DEP
  - PIE Rivers Restoration Partnership and various members

Chebacco Lake Watershed Area- 5 towns



Problems

- Alewife Herring- decreased populations
- Nutrient Overloading- legacy and current issues
- Cyanobacteria and HABs- past 2-3 years emergence
- Sedimentation/Siltation
- Invasive Species and Overgrowth/Blockages
- Beaver Dams
- Lake and watershed usage- boating, swimming, etc.
- Senior Housing Development- Save Chebacco Trails

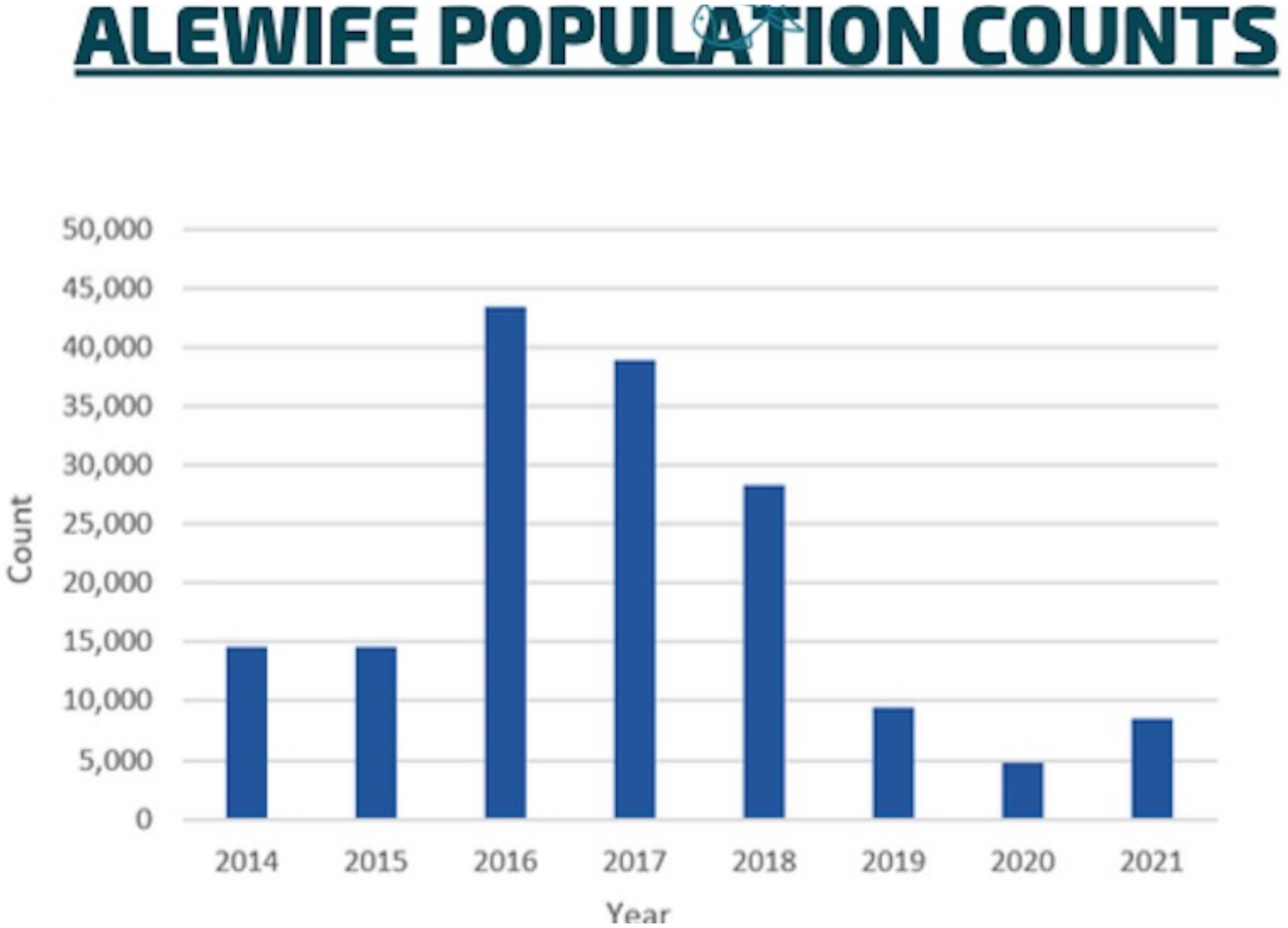
PIE Rivers Related Priority Actions

Water Conservation

Water Quality Management

River & Stream Continuity

Land Use



Historical Imagery- May 1952 in Alewife Brook

Historical Imagery- May 1952 in Alewife Brook

What Have We Done?

- In the first year, our main goal was to get some work started on the cleanup efforts of the Alewife Brook which is used by the herring on their spawning path
- Initially attempted to get permitting for numerous identified sites of concern, however, due to permitting issues, we decided to submit for a much smaller area
- From end of July-beginning of September we were able to get a large portion of the overgrown brook cleared using volunteer help

SEASIDE SUSTAINABILITY

GIVING TUESDAY DONATE NOW

ACTION ABOUT EDUCATION GET INVOLVED BLOG SHOP

CHEBACCO LAKE RESTORATION

Volunteer for the Restoration Effort:

Seaside Sustainability is excited to be spearheading the Chebacco Lake Coalition working towards the restoration of Chebacco Lake and the surrounding watershed. By convening members of state agencies as well as members of local government, organizations, and the community who are committed to the health of the watershed, we hope to restore this valuable resource so it can be enjoyed for many years to come. We are currently seeking volunteers during the month of August to sign up for 2-3 hour morning and afternoon shifts to take part in the Alewife Brook restoration efforts at the corner of Apple St. and Western Ave. in Essex. The scope of work and more information regarding the volunteer work to be performed is described below. Together, we can work to protect this vital ecosystem.

SIGN UP! SignUpGenius

Location: The work site is at the corner of Apple Street and Western Avenue (Rt. 22) in Essex, but we will be looking to expand the scope of the project to other parts of the Brook and the lake in the future.

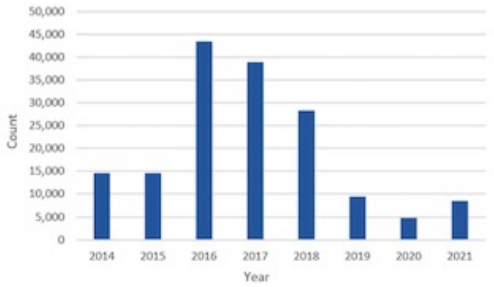
Logistics

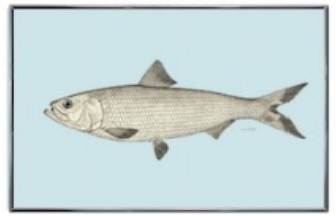
Alewife Brook Restoration

CHEBACCO LAKE COALITION

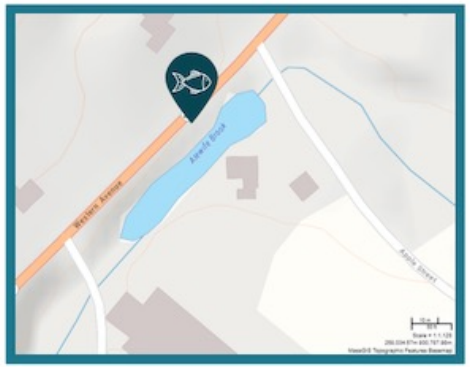
Volunteer to Provide Safe Alewife Passage Without Altering Watershed Function

ALEWIFE POPULATION COUNTS





Volunteer With Us at the Apple Street Location!



SCAN THE QR CODE TO SIGN UP TO VOLUNTEER!

OUR EFFORTS WILL BE FOCUSED ON APPLE STREET SITE BETWEEN 8/5 AND 9/3

SEASIDE SUSTAINABILITY

June 2021- pre-work

Day 1- July 31, 2021

Material Removal

August 5, 2021

August 8, 2021

August 9, 2021

Aug 12, 2021

August 17, 2021

June vs. August

(More work was completed prior to these photos being taken)

What is next for us?

- Our main concern for 2022 is obtaining permits for the numerous additional sites of concern we have identified– mainly stream continuity issues
- We hope to use funds set aside in the State budget through Senator Tarr as well as the Town of Essex to hire a consultant which can assist in identifying best next steps
- We also would like to address the growing cyanobacteria/HAB problem- hope to explore regulatory options (fertilizers/land use laws, etc.) but also potential engineering solutions such as aeration or chemical treatments

How can you help?

- We are looking for any and all help from any groups or individuals which may be interested in getting involved.
- With a wide range of issues being addressed, having a wide range of expertise will
- If interested, please reach out to Max Rudzinsky, Alan McCoy, or Dave Lash (rudzinskym@seasidesustainability.org, mccoya@seasidesustaianbility.org, dave@davelash.com) and we can meet with you one on one to find a role that fits for you
  - We will also get you added to our mailing list and invited to our large group meetings