Echoes from the Past: Using Historical Imagery to Identify Habitat Restoration Projects in Hidden Landscapes

Prepared for:

SNEP Symposium 2024

Prepared by:

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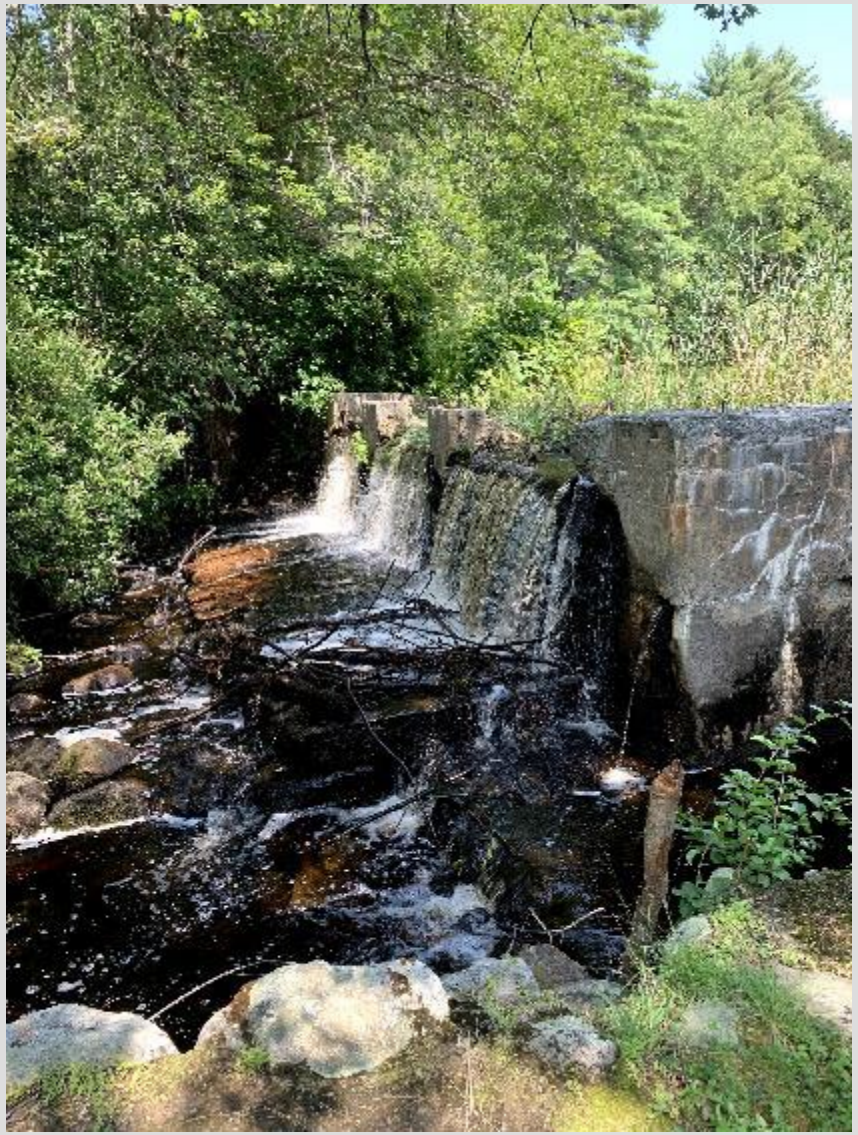
June 12, 2024

Project Background

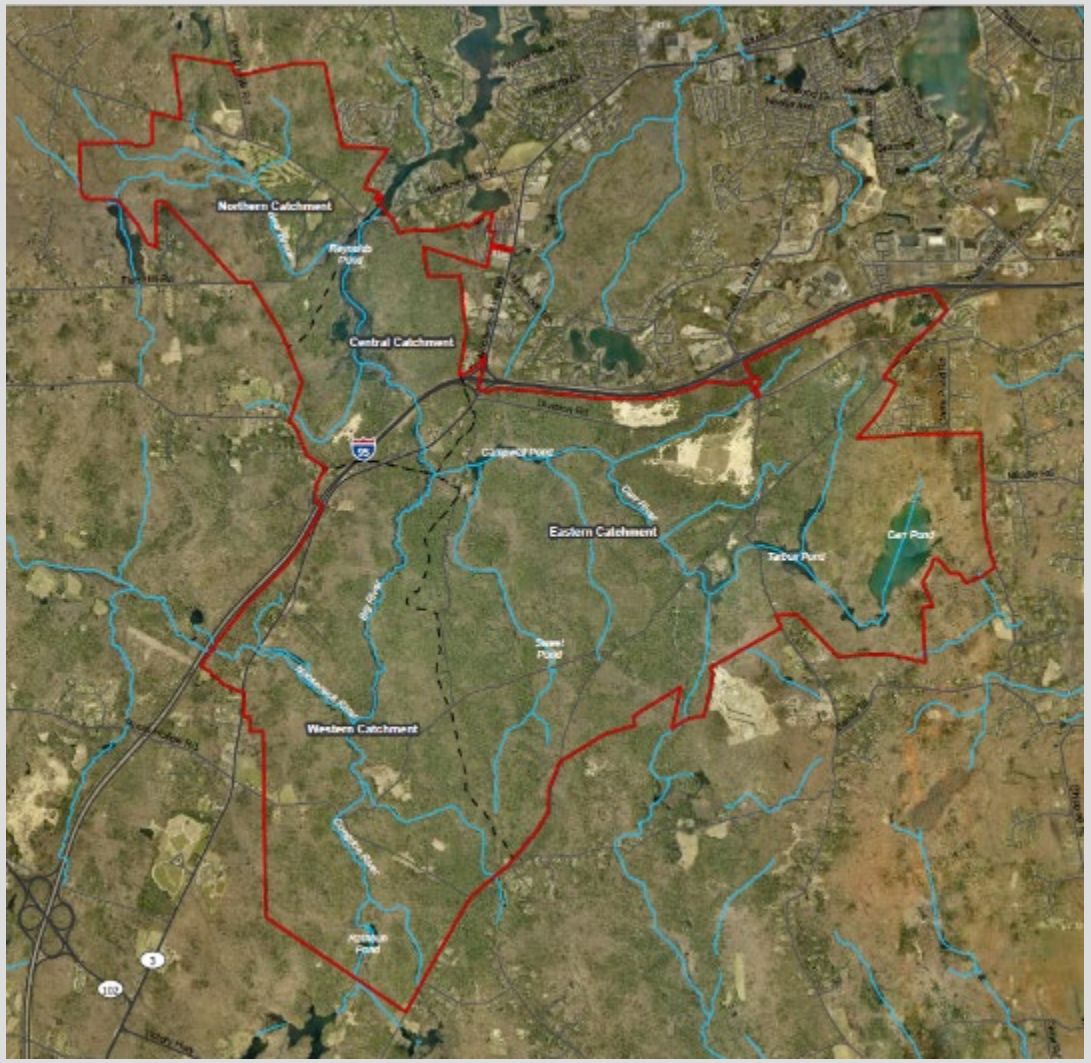
- Dams and culverts of all sizes can cause significant adverse impacts to water quality, water temperature, and aquatic organisms
- It's estimated that there are over 10,000 historic mill dams throughout New England
  - Most were constructed 80+ years ago and no longer serve a purpose
- Similarly, there are many historic road-stream crossings/culverts along former roads that are no longer in use
- Many of these features are not mapped by local or state agencies



Site Introduction

Big River Management Area (BRMA)

- Located in central Rhode Island, and includes portions of the towns of West Greenwich and Coventry
- BRMA includes 8,400 acres and has over 30 miles of mapped streams
- Protected as a future water supply areas for Rhode Island
- ~10 mapped stream crossings
- 7 RIDEM mapped dams
- Unique and contentious history
- Very limited existing development



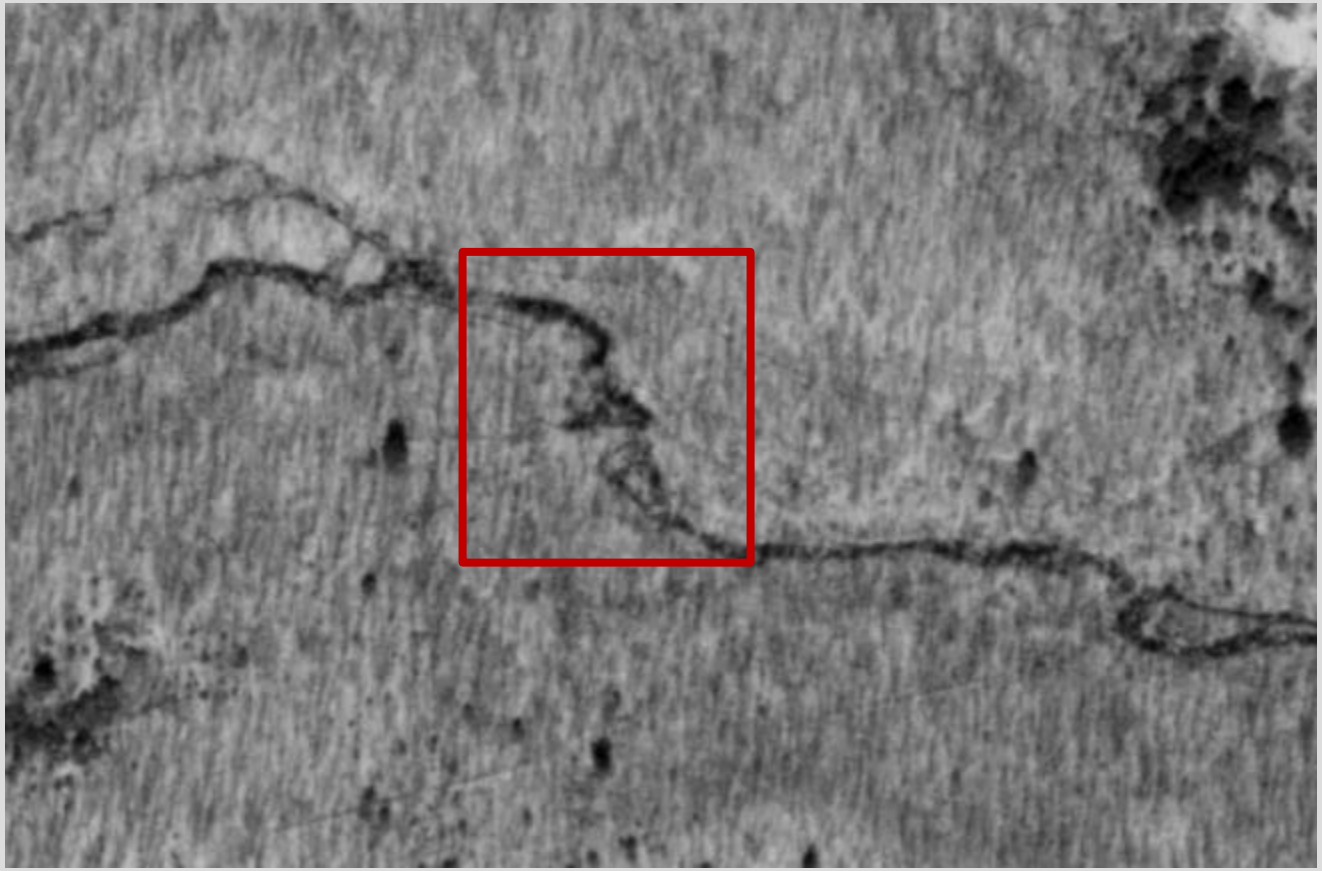
Desktop Historical Aerial Imagery Analysis

- EA used historical aerials to identify dams and culverts that were previously unmapped
- Historical aerials allow you to dive into the history of the landscape and give better context on what was going on hydrologically

The **RIDEM Environmental Resource Map** has aerial imagery dating back to 1939

Desktop Historical Aerial Imagery Analysis

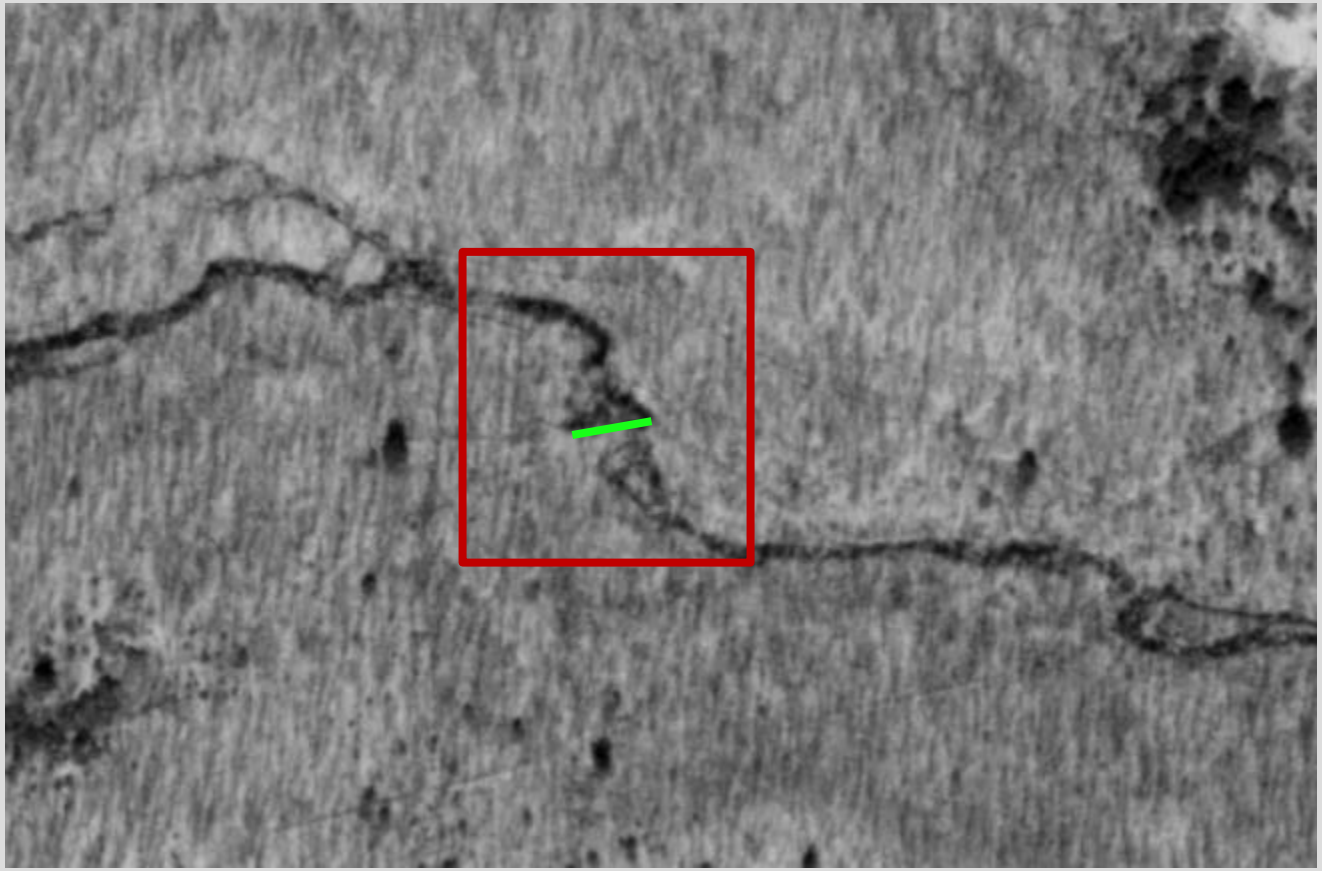
1962 Aerial Imagery



2024 Aerial Imagery

Desktop Historical Aerial Imagery Analysis

1962 Aerial Imagery

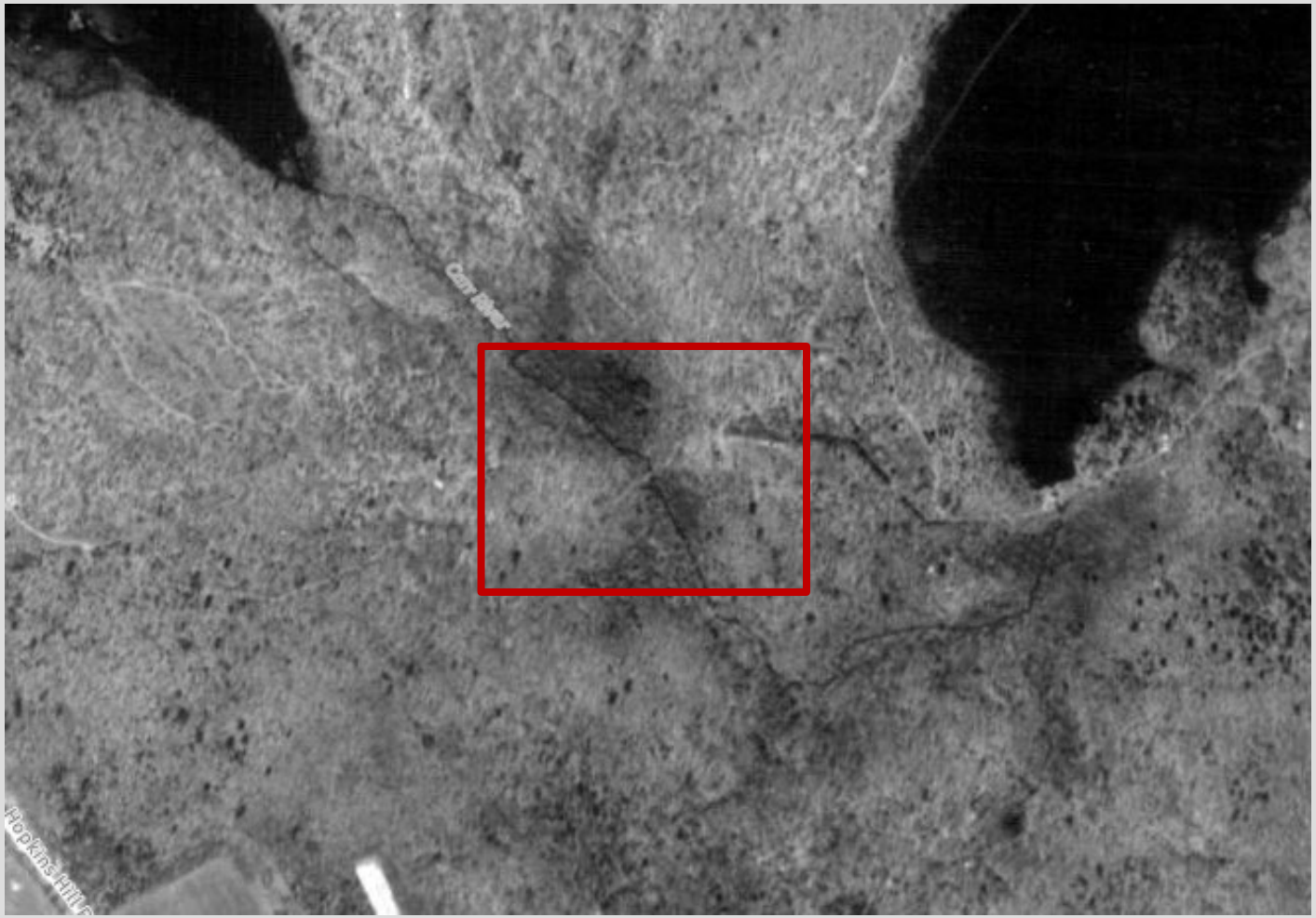


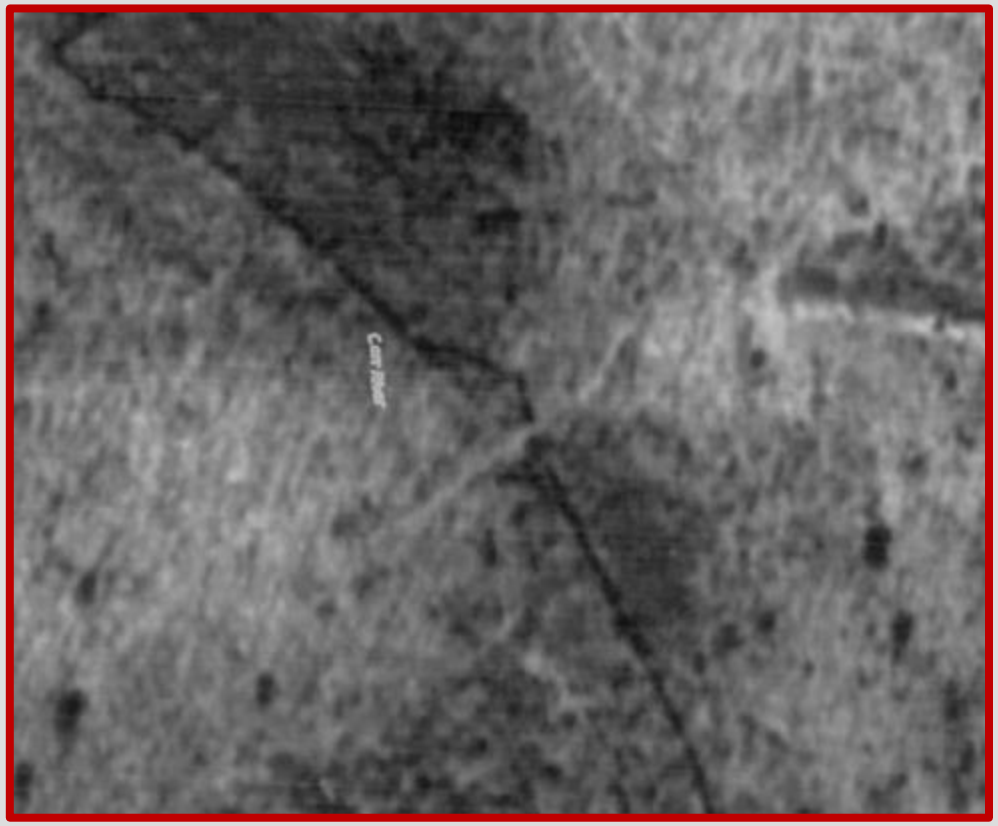
2024 Aerial Imagery

Desktop Historical Aerial Imagery Analysis

Desktop Historical Aerial Imagery Analysis

1939 Aerial Imagery



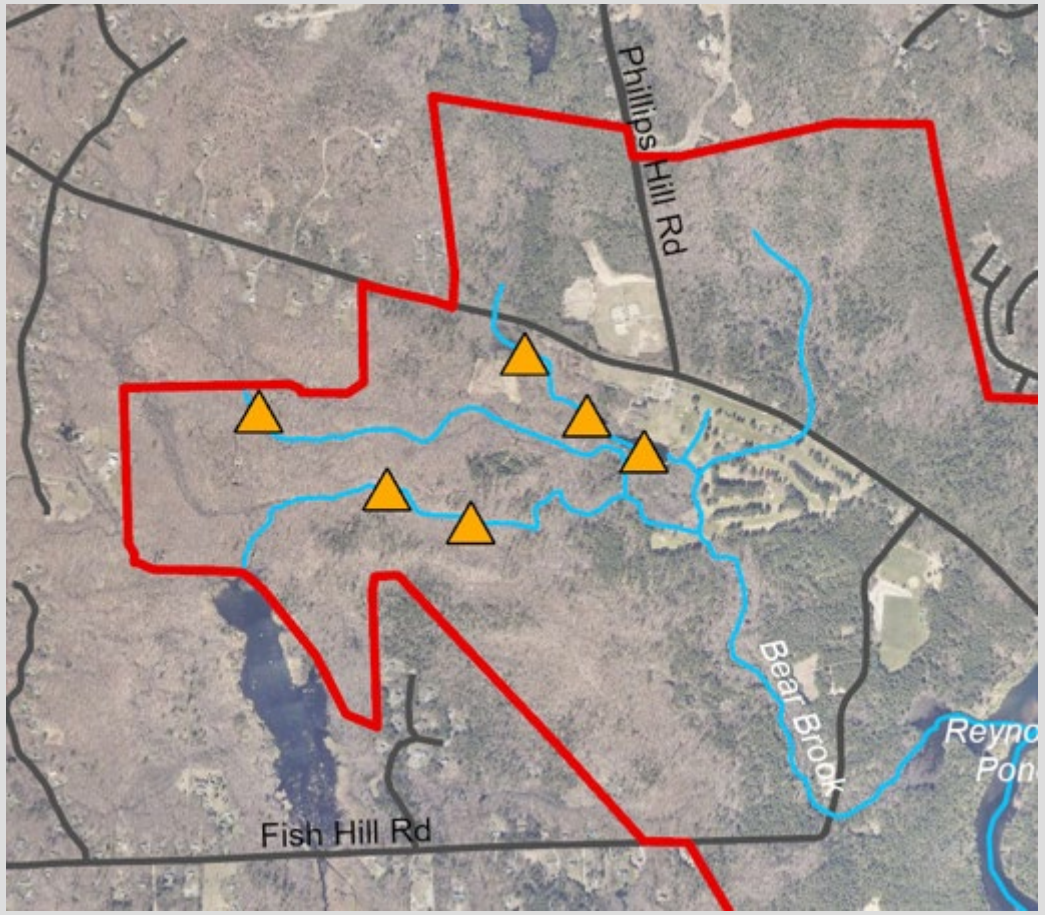


Desktop Historical Aerial Imagery Analysis

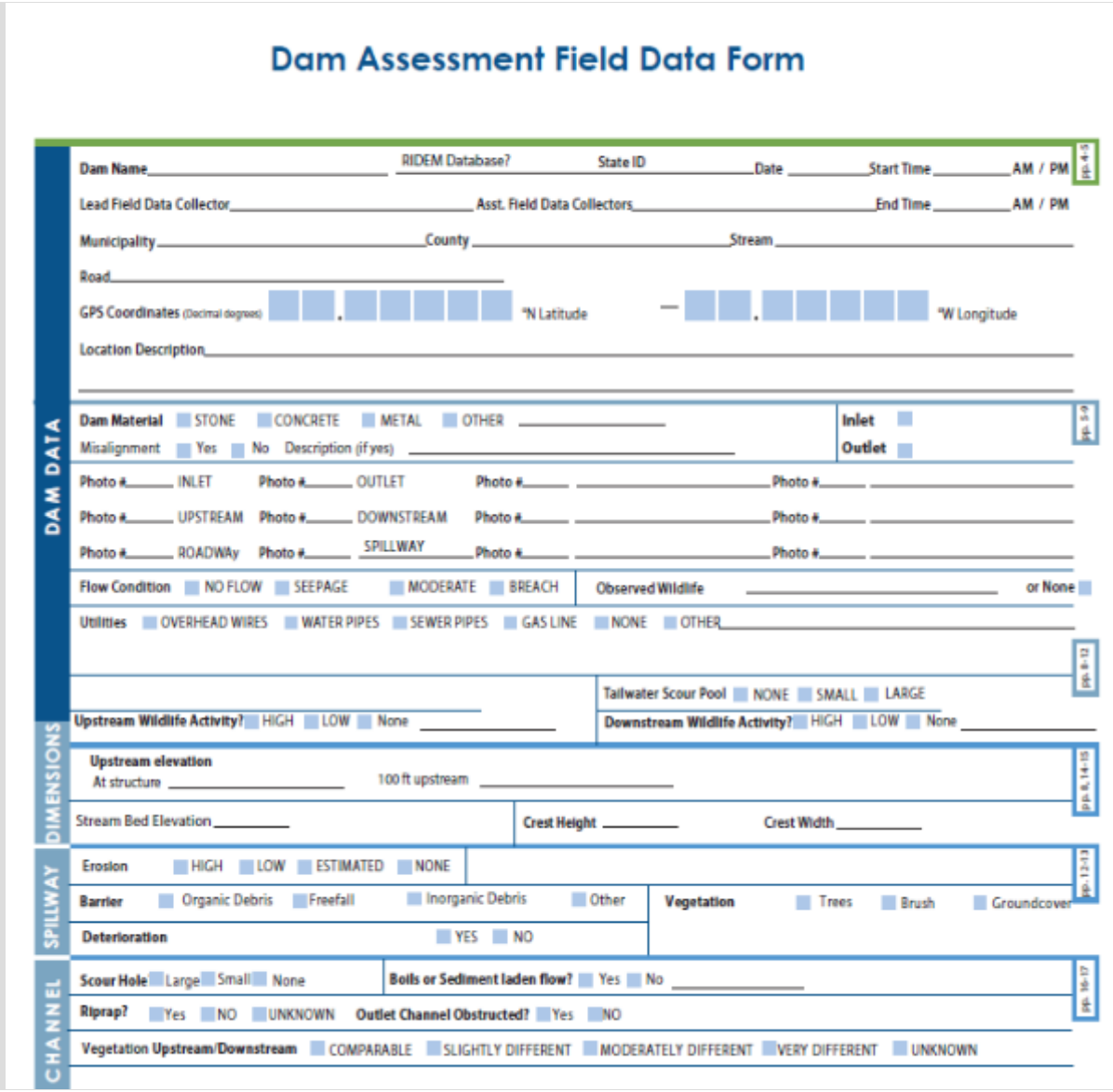
2024 Aerial Imagery

Mapped vs. Unmapped Dams

- 7 total mapped dams in the BRMA the RIDEM dam database
- EA identified 14 dams through aerial images (and there are likely more)



Rapid Dam Assessment



Dam Assessment Field Data Form

DAM DATA

Dam Name _____ RIDEM Database? State ID _____ Date _____ Start Time _____ AM / PM (pp. 4-5)

Lead Field Data Collector _____ Asst. Field Data Collectors _____ End Time _____ AM / PM

Municipality _____ County _____ Stream _____

Road _____

GPS Coordinates (Decimal degrees) ____.____ °N Latitude — ____.____ °W Longitude

Location Description _____

Dam Material ☐ STONE ☐ CONCRETE ☐ METAL ☐ OTHER _____ (pp. 5-9)

Misalignment ☐ Yes ☐ No Description (if yes) _____ Inlet ☐ Outlet ☐

Photo #____ INLET Photo #____ OUTLET Photo #____ _____ Photo #____ _____

Photo #____ UPSTREAM Photo #____ DOWNSTREAM Photo #____ _____ Photo #____ _____

Photo #____ ROADWAY Photo #____ SPILLWAY Photo #____ _____ Photo #____ _____

Flow Condition ☐ NO FLOW ☐ SEEPAGE ☐ MODERATE ☐ BREACH Observed Wildlife _____ or None ☐

Utilities ☐ OVERHEAD WIRES ☐ WATER PIPES ☐ SEWER PIPES ☐ GAS LINE ☐ NONE ☐ OTHER _____

(pp. 8-12)

Tailwater Scour Pool ☐ NONE ☐ SMALL ☐ LARGE

Upstream Wildlife Activity? ☐ HIGH ☐ LOW ☐ None _____ Downstream Wildlife Activity? ☐ HIGH ☐ LOW ☐ None _____

DIMENSIONS

Upstream elevation At structure _____ 100 ft upstream _____ (pp. 8, 14-15)

Stream Bed Elevation _____ Crest Height _____ Crest Width _____

SPILLWAY

Erosion ☐ HIGH ☐ LOW ☐ ESTIMATED ☐ NONE (pp. 12-13)

Barrier ☐ Organic Debris ☐ Freefall ☐ Inorganic Debris ☐ Other Vegetation ☐ Trees ☐ Brush ☐ Groundcover

Deterioration ☐ YES ☐ NO

CHANNEL

Scour Hole ☐ Large ☐ Small ☐ None Boils or Sediment laden flow? ☐ Yes ☐ No _____ (pp. 16-17)

Riprap? ☐ Yes ☐ NO ☐ UNKNOWN Outlet Channel Obstructed? ☐ Yes ☐ NO

Vegetation Upstream/Downstream ☐ COMPARABLE ☐ SLIGHTLY DIFFERENT ☐ MODERATELY DIFFERENT ☐ VERY DIFFERENT ☐ UNKNOWN

STRUCTURE 1 Barrier ☐ Organic Debris ☐ Free Fall ☐ Inorganic Debris ☐ Other _____ (pp. 18-32)

OUTLET

Outlet Shape _____ Deterioration ☐ Yes ☐ No Apparent Modification ☐ NONE ☐ NOT EXTENSIVE ☐ EXTENSIVE

Outlet Grade (Pick one) ☐ AT STREAM GRADE ☐ FREE FALL ☐ CASCADE ☐ FREE FALL ONTO CASCADE ☐ UNKNOWN

Outlet Dimensions A. Width____.____ B. Height____.____ C. Substrate/Water Width____.____ D. Water Depth____.____

Outlet Drop to Water Surface____.____ Outlet Drop to Stream Bottom____.____ E. Abutment Height (Type 7 bridges only)____.____

L. Structure Length (Overall length from inlet to outlet) Erosion ☐ High ☐ Low ☐ Estimated ☐ None OUTLET ELEVATION____.____

INLET

Barrier ☐ Organic Debris ☐ Free Fall ☐ Inorganic Debris ☐ Other _____ INLET ELEVATION____.____ (pp. 32-39)

Erosion ☐ High ☐ Low ☐ Estimated ☐ None

Inlet Shape _____ Deterioration ☐ Yes ☐ No Apparent Modification ☐ NONE ☐ NOT EXTENSIVE ☐ EXTENSIVE

Inlet Grade (Pick one) ☐ AT STREAM GRADE ☐ INLET DROP ☐ PERCHED ☐ CLOGGED/COLLAPSED/SUBMERGED ☐ UNKNOWN

Inlet Dimensions A. Width____.____ B. Height____.____ C. Substrate/Water Width____.____ D. Water Depth____.____

ADDITIONAL CONDITIONS

Internal Structures ☐ NONE ☐ BAFFLES/WEIRS ☐ SUPPORTS ☐ OTHER_____ (pp. 20-21, 40-59)

Structure Substrate Type (Pick one) ☐ NONE ☐ SILT ☐ SAND ☐ GRAVEL ☐ COBBLE ☐ BOULDER ☐ BEDROCK ☐ UNKNOWN

Dam Pool Substrate ☐ NONE ☐ SILT ☐ SAND ☐ GRAVEL ☐ COBBLE ☐ BOULDER ☐ BEDROCK ☐ UNKNOWN

General Substrate Description:

Physical Barriers (Pick all that apply) ☐ NONE ☐ DEBRIS/SEDIMENT/ROCK ☐ DEFORMATION ☐ FREE FALL ☐ FENCING ☐ DRY ☐ OTHER

Severity (Choose carefully based on barrier type(s) above) ☐ NONE ☐ MINOR ☐ MODERATE ☐ SEVERE

Turbid Discharge ☐ Severe ☐ Moderate ☐ Minor ☐ None Misalignment ☐ Severe ☐ Moderate ☐ Minor ☐ None

Settlement ☐ Severe ☐ Moderate ☐ Minor ☐ None Rodent Activity ☐ Severe ☐ Moderate ☐ Minor ☐ None

Dry Passage through Structure? ☐ YES ☐ NO ☐ UNKNOWN Height above Dry Passage_____

Earthen/Stone Dams

Road-Stream Crossing Assessments

Road-Stream Crossing Assessment Field Data Form

QA/QC INITIALS:_____ DATE:_____
Status ___FINAL ___FOLLOW-UP

CROSSING DATA

Crossing Code _____ State or Local ID/Name _____ Date _____ Start Time _____ AM / PM (pp. 4-5)

Lead Field Data Collector _____ Asst. Field Data Collectors _____ End Time _____ AM / PM

Municipality _____ County _____ Stream _____

Road _____ Type MULTI-LANE PAVED UNPAVED DRIVEWAY TRAIL RAILROAD

GPS Coordinates (Decimal degrees) ___.____ °N Latitude — ___.____ °W Longitude

Location Description _____

Crossing Type BRIDGE CULVERT MULTIPLE CULVERT FORD NO CROSSING REMOVED CROSSING BURIED STREAM INACCESSIBLE PARTIALLY INACCESSIBLE NO UPSTREAM CHANNEL BRIDGE ADEQUATE — Number of Culverts / Cells (pp. 5-9)

Photo #_____ INLET Photo #_____ OUTLET Photo #_____ _____ Photo #_____ _____

Photo #_____ UPSTREAM Photo #_____ DOWNSTREAM Photo #_____ _____ Photo #_____ _____

Photo #_____ ROADWAY Photo #_____ _____ Photo #_____ _____ Photo #_____ _____

Flow Condition NO FLOW TYPICAL-LOW MODERATE HIGH — Road-Killed or Observed Wildlife _____ or None

Utilities OVERHEAD WIRES WATER PIPES SEWER PIPES GAS LINE NONE OTHER _____

Alignment SHARP BEND MILD BEND NATURALLY STRAIGHT CHANNELIZED STRAIGHT — Road Fill Height _____ Road Crest Height _____ (pp. 8-12)

Bankfull Width_____ Confidence HIGH LOW/ESTIMATED — Constriction SEVERE MODERATE SPANS ONLY BANKFULL/ACTIVE CHANNEL

Tailwater Scour Pool NONE SMALL LARGE — SPANS FULL CHANNEL & BANKS

HY-8

Using HY-8? YES NO — Estimated Overtopping Length _____ Crest Width _____ — Road Surface Type PAVED GRAVEL GRASS (pp. 8, 14-15)

Channel Slope_____ — Side Slope 5:1 4:1 3:1 2:1 1:1 0.5:1 steeper than 0.5:1

GEO.

Bank Erosion HIGH LOW ESTIMATED NONE — Significant Break in Valley Slope YES NO UNKNOWN (pp. 12-13)

Sediment Deposition UPSTREAM DOWNSTREAM WITHIN STRUCTURE NONE — Stream Substrate MUCK/SILT SAND GRAVEL

Elevation of Sediment Deposits >= 1/2 Bankfull Height YES NO — COBBLE BOULDER BEDROCK UNKNOWN

TIDAL

Tidal? YES NO UNKNOWN — Tide Chart Location _____ — Tide Prediction ___:___ AM / PM (pp. 16-17)

Tide Stage LOW SLACK TIDE LOW EBB TIDE LOW FLOOD TIDE UNKNOWN OTHER _____

Vegetation Above/Below COMPARABLE SLIGHTLY DIFFERENT MODERATELY DIFFERENT VERY DIFFERENT UNKNOWN

Tide Gate Type NONE STOP LOGS FLAP GATE SLUICE GATE SELF-REGULATING OTHER _____

STRUCTURE 1

Structure Material SMOOTH PLASTIC CORRUGATED PLASTIC SMOOTH METAL CORRUGATED METAL CONCRETE WOOD ROCK/STONE FIBERGLASS COMBINATION (pp. 18-32)

OUTLET

Outlet Shape 1 2 3 4 5 6 7 FORD UNKNOWN REMOVED — Outlet Apron NONE NOT EXTENSIVE EXTENSIVE

Outlet Grade (Pick one) AT STREAM GRADE FREE FALL CASCADE FREE FALL ONTO CASCADE UNKNOWN

Outlet Dimensions A. Width____.____ B. Height____.____ C. Substrate/Water Width____.____ D. Water Depth____.____

Outlet Drop to Water Surface____.____ Outlet Drop to Stream Bottom____.____ E. Abutment Height (Type 7 bridges only)____.____

L. Structure Length (Overall length from inlet to outlet)____.____ — OUTLET ELEVATION____.____

INLET

Inlet Shape 1 2 3 4 5 6 7 FORD UNKNOWN REMOVED — INLET ELEVATION____.____ (pp. 32-39)

Inlet Type PROJECTING HEADWALL WITH SQUARE EDGE HEADWALL WITH GROOVED EDGE HEADWALL WITH SQUARE EDGE AND WINGWALLS HEADWALL WITH GROOVED/BEVELED EDGE AND WINGWALLS MITERED TO SLOPE OTHER NO INLET TREATMENT

Inlet Grade (Pick one) AT STREAM GRADE INLET DROP PERCHED CLOGGED/COLLAPSED/SUBMERGED UNKNOWN

Inlet Dimensions A. Width____.____ B. Height____.____ C. Substrate/Water Width____.____ D. Water Depth____.____

ADDITIONAL CONDITIONS

Slope %_____ Slope Confidence HIGH LOW — Internal Structures NONE BAFFLES/WEIRS SUPPORTS OTHER_____ (pp. 20-21, 40-50)

Structure Slope Compared to Channel Slope HIGHER LOWER ABOUT THE SAME

Structure Substrate Matches Stream NONE COMPARABLE CONTRASTING NOT APPROPRIATE UNKNOWN

Structure Substrate Type (Pick one) NONE SILT SAND GRAVEL COBBLE BOULDER BEDROCK UNKNOWN

Structure Substrate Coverage NONE 25% 50% 75% 100% UNKNOWN

Physical Barriers (Pick all that apply) NONE DEBRIS/SEDIMENT/ROCK DEFORMATION FREE FALL FENCING DRY OTHER

Severity (Choose carefully based on barrier type(s) above) NONE MINOR MODERATE SEVERE

Water Depth Matches Stream YES NO-SHALLOWER NO-DEEPER UNKNOWN DRY

Water Velocity Matches Stream YES NO-FASTER NO-SLOWER UNKNOWN DRY

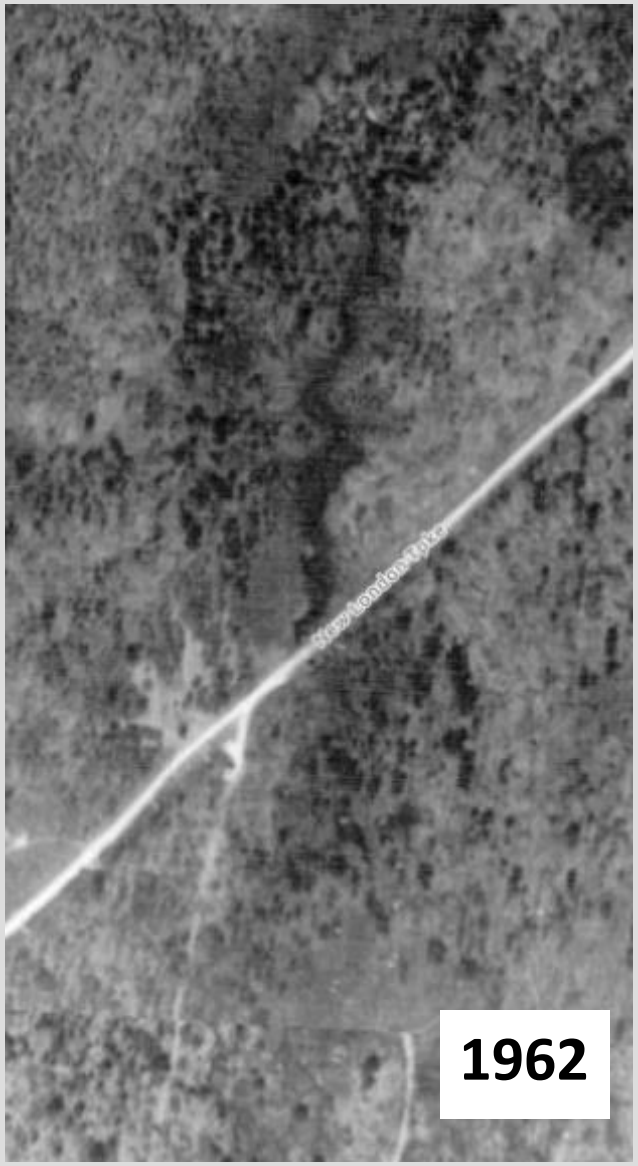
Dry Passage through Structure? YES NO UNKNOWN — Height above Dry Passage_____

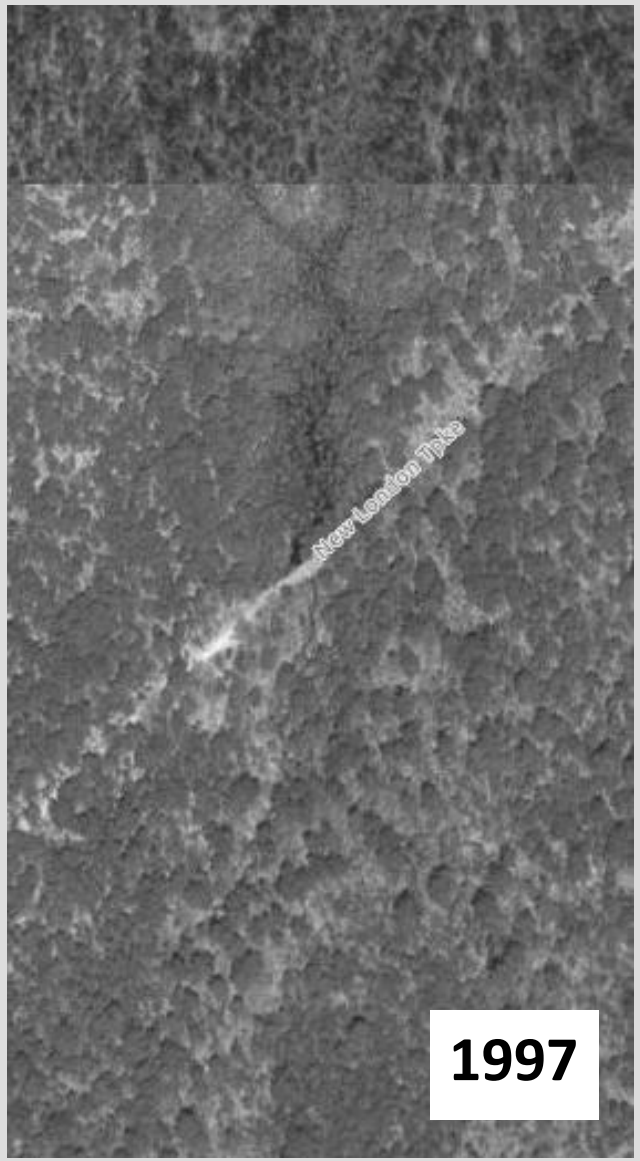
STRUCTURAL CONDITION ASSESSMENT (pp. 52-66)

	INLET					OUTLET				
	Adequate	Poor	Critical	Unknown	N/A	Adequate	Poor	Critical	Unknown	N/A
Cross Section Deformation										
Barrel Condition/ Structural Integrity										
Footing Condition										
Level of Blockage										
Buoyancy or Crushing										
Invert Deterioration										
Joints and Seams Condition										
Longitudinal Alignment										
Headwall/Wingwall Condition										
Flared End Section Condition										
Apron/Scour Protection Condition										
Armoring Condition										
Embankment Piping										

Undersized Culverts

Stream and Wetland Alterations

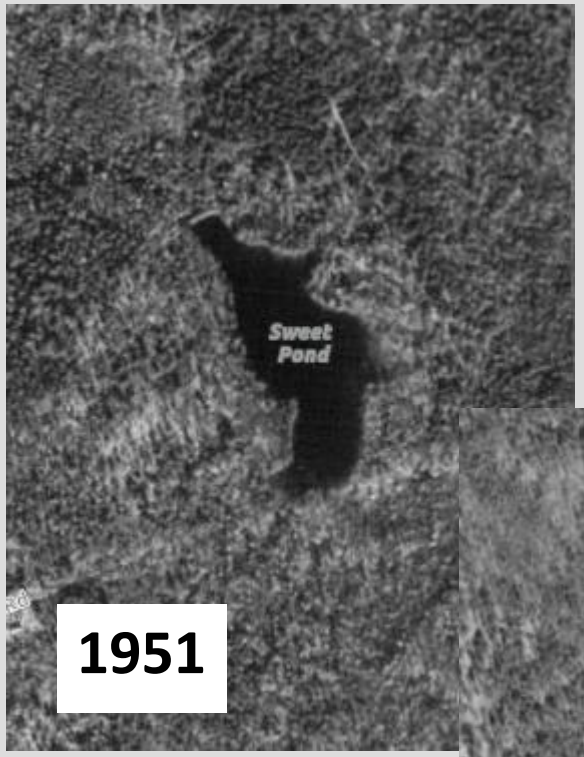




Culverts and Road-Stream Crossings

Sweet Pond Dam - Example

Fluctuating Water Levels



1951

1981

2008

2018

2024

Micro Catchment Analysis

69.13°F

74.48°F

66.37°F

68.60°F

63.59°F

71.46°F

Summer Average Temperature (June, July, August)

Summary

- Many historic dams throughout New England are not mapped or documented by local or state agencies
- Historical aerial images can be used to identify dams and other barriers to aquatic organisms
- Even small unassuming structures can cause reverberating impacts to stream systems
- Field verification can confirm the presence the severity of the impacts of the structures
- Aerial imagery is a good tool to identify restoration projects that may have gone unnoticed

Thank You!

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Special thanks to Rhode Island Chapter of Trout Unlimited, RI Water Resources Board, RI Department of Environmental Management, U.S. Fish and Wildlife Service and the National Fish and Wildlife Foundation who helped support this project.

BSC GROUP

Building Climate Resilience through Ecological Restoration

Planning for Climate Resilience &
Turning Plans into Action
SNEP SYMPOSIUM June 2024

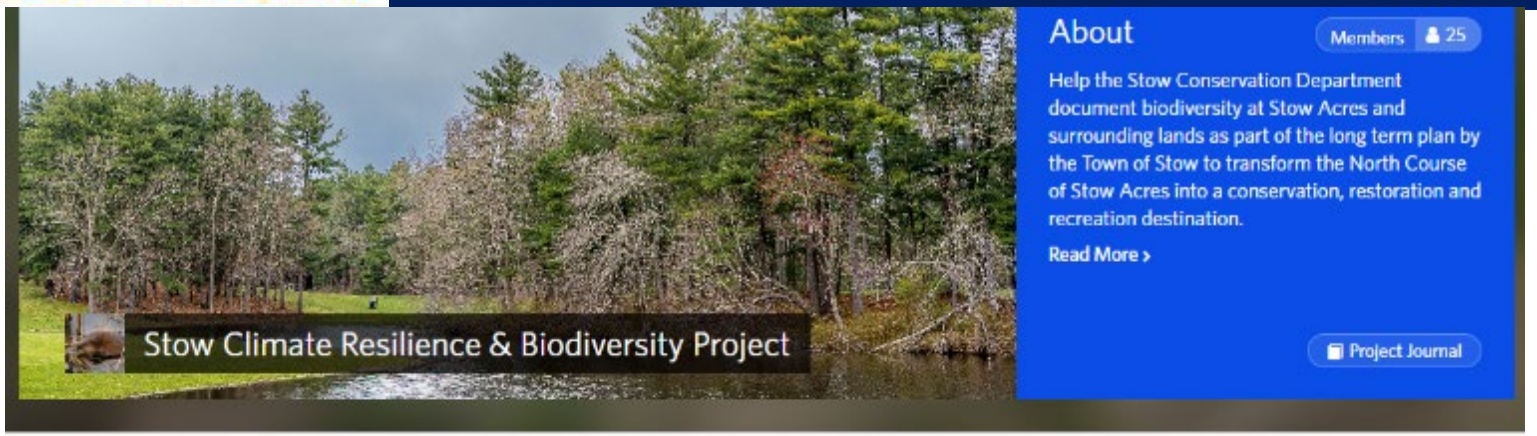
Pallavi Kalia Mande
Director of Climate Resilient Design,
BSC Group

Climate Resilient Master Plan for Stow Acres

Listening to Public Input

- Survey
- Fall Fest
- Senior Forum
- Nashoba Students
- Open House @ Pompo
- User Group Forum
- On-line Mapping Tool
- Working Group Meetings
- Walks/Golf Cart Tours… …and more

Citizen Science with iNaturalist



About

Members 25

Help the Stow Conservation Department document biodiversity at Stow Acres and surrounding lands as part of the long term plan by the Town of Stow to transform the North Course of Stow Acres into a conservation, restoration and recreation destination.

Read More >

Project Journal

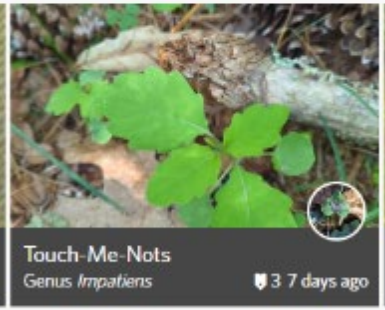
Overview | 381 OBSERVATIONS | 212 SPECIES | 179 IDENTIFIERS | 60 OBSERVERS | Stats

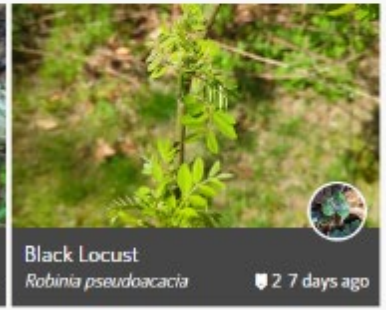
Recent Observations

View All


Alder Buckthorn
Frangula alnus
1 7 days ago


RG
American Dog Tick
Dermacentor variabilis
2 7 days ago


Touch-Me-Nots
Genus *Impatiens*
3 7 days ago


Black Locust
Robinia pseudoacacia
2 7 days ago


Most Observations
ksferra 61
ntepper 40


Most Species
ksferra 46
ntepper 31


Most Observed Species
Sensitive Fern 8
Fringed Polygala 7


8 observations
Sensitive Fern
Onoclea sensibilis


7 observations
Fringed Polygala
Polygaloides paucifolia

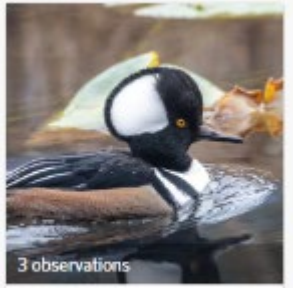

6 observations
Canadian Bunchberry
Cornus canadensis

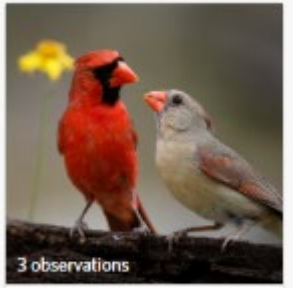

5 observations
Eastern White Pine
Pinus strobus


5 observations
Sweet Pepperbush
Clethra alnifolia


5 observations
Wood Anemone
Anemonoides quinquefolia


4 observations
Partridgeberry
Mitchella repens


3 observations
Hooded Merganser
Lophodytes cucullatus

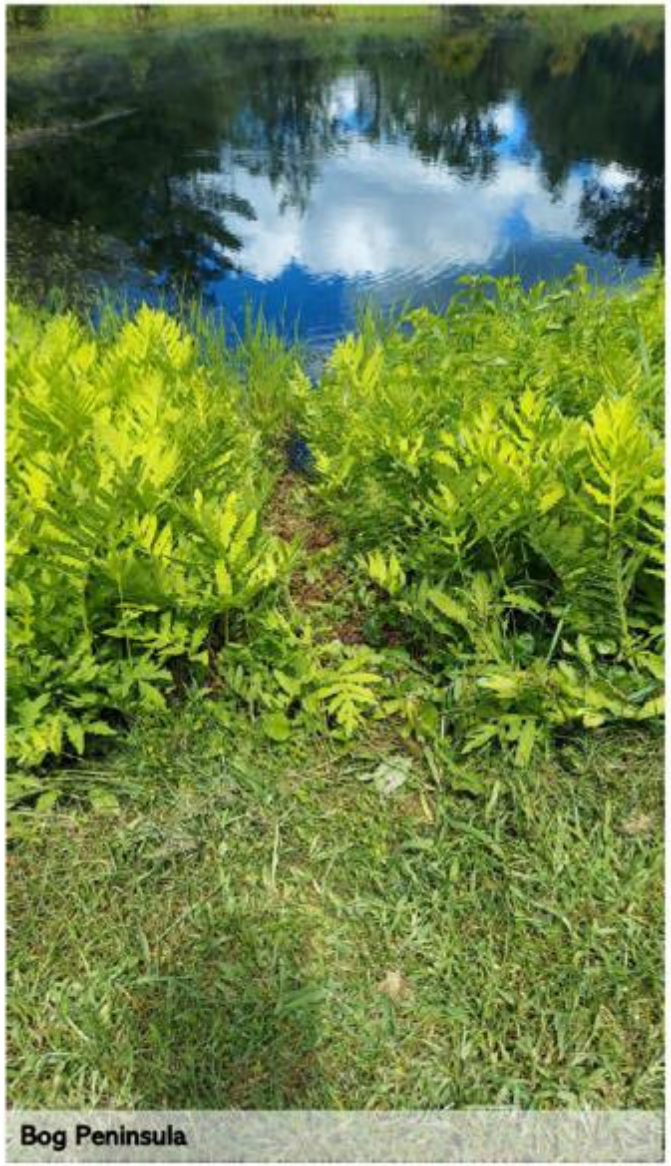

3 observations
Northern Cardinal
Cardinalis cardinalis

PLAY STOW ACRES

BSC GROUP

Primary Ecological Features on Site

Existing Conditions Documentation


Bog Peninsula

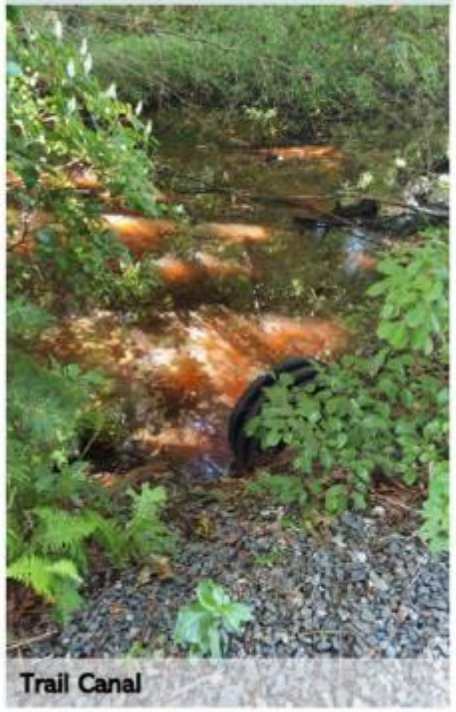

Canal Margins


Dogbone Pond


Driving Range

Driving Range Back


Driving Range


Trail Canal

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Primary Ecological Features on Site

Existing Conditions Documentation


Driving Range


Canal Margins


Algae Pond


Beaver Lodge


Wetland behind Range


Wetland


Near Vernal Pool

PLAY STOW ACRES

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Proposed Ecotypes at Stow Acres


1 Cedar Swamp


2 Spruce Bog


3 Nature-Play/Education


4 Rookery


5 Upland Meadow


6 Vegetative Wetland


7 Riverbank Restructure


8 Eco-Restoration


9 Food Forest


10 Recreation Picnic & Pollinate

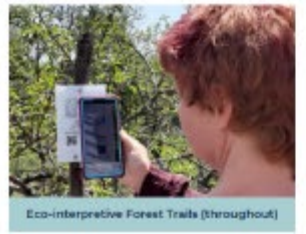

11 Swimming Hole


12 Pond Restoration/Recreation


13 Interpretation Center/Site Office


14 Habitat Integration & Drainage


15 Passive Recreation Fields


Eco-interpretive Forest Trails (throughout)


Trail Based Recreation (throughout)

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Existing Invasive Species at Stow Acres

Asiatic bittersweet

Autumn olive

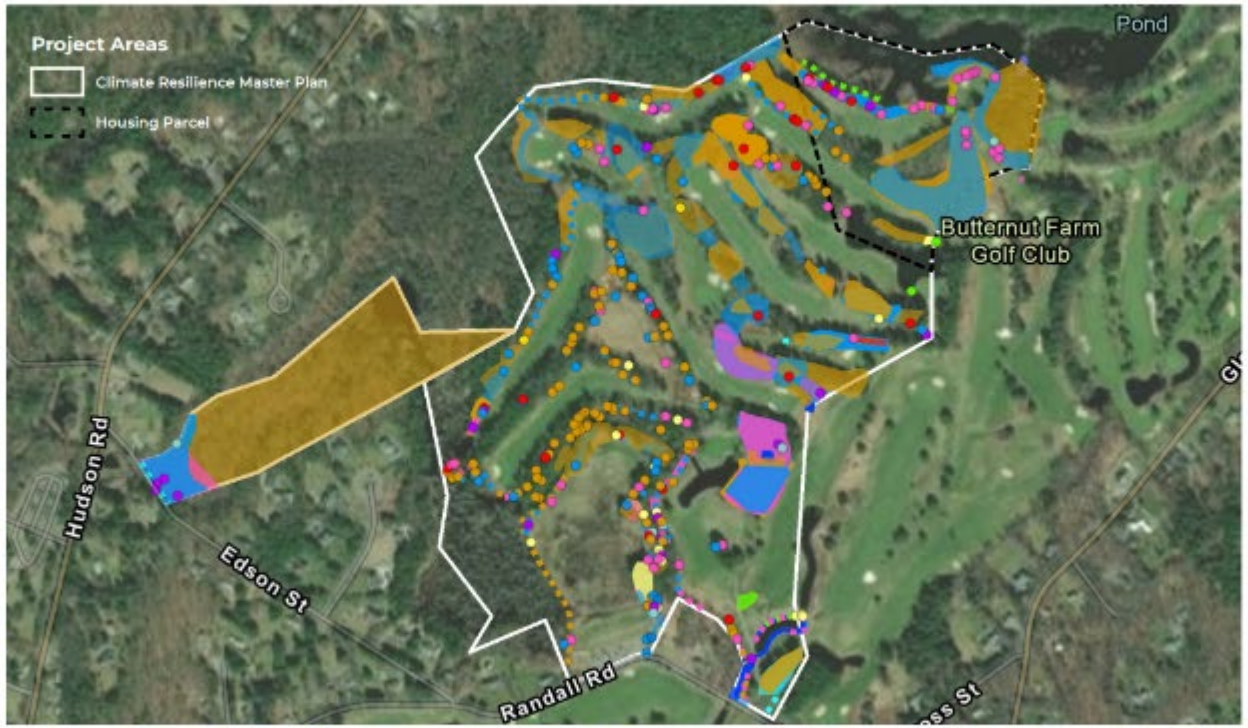
Benghal dayflower

Black locust

European buckthorn; glossy buckthorn

Garlic mustard

Morrow's honeysuckle



Multiflora rose

Purple loosestrife

Reed canary-grass, ribbon grass

Invasive Species

- Asiatic bittersweet
- Autumn olive
- Benghal dayflower
- Black locust
- European buckthorn; glossy buckthorn
- Garlic mustard
- Morrow's honeysuckle
- Multiflora rose
- Purple loosestrife
- Reed canary-grass, ribbon grass

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Proposed Ecological Restoration Master Plan

Master Plan showing Areas of Ecological

- 5 Restoration Area / Food Forest
- 8 Wetland Restoration
- 9 Wetland Stream Buffer Restoration
- 10 Observation Deck / Overlook
- 11 Landscape Buffer Along Housing
- 17 Rookery
- 18 Turtle Nesting
- Proposed Park Driveway
  Driveway Option B
- Proposed Accessible Paths
- Proposed Nature Trails
- Open Water
- Reforestation / Conservation Area
- Open Meadow Restoration Area

PLAY STOW ACRES

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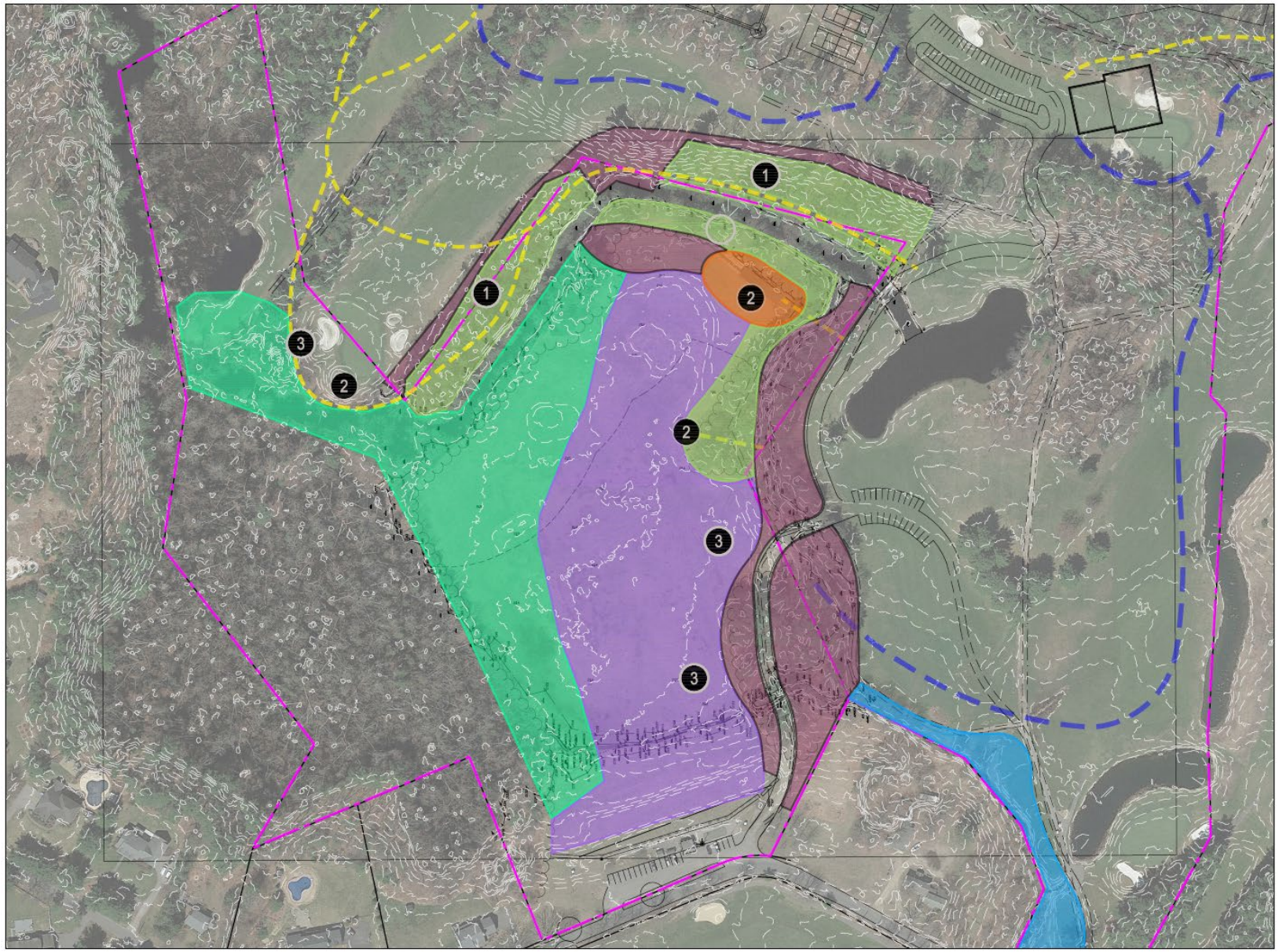
Proposed Wetland Restoration Concept



STREAM RESTORATION WITH NATIVE PLANTING

PRESERVE HEALTHY SOIL AND PLANT COMMUNITY

SCRUB / SHRUB SWAMP - REMOVE FILL AND RECREATE PIT AND MOUND CHARACTERISTICS TO MATCH ADJACENT SWAMP

ADD SHRUBS AND HERBACEOUS PLANTINGS TO RESTORE UNDERSTORY PLANT COMMUNITY - INVASIVE SPECIES MANAGEMENT AS NECESSARY

UPLAND AREA FOR ACCESS AND OVERLOOK

WET MEADOW - LIGHT GRADING AND SCARIFYING TO REDUCE COMPACTION AND IMPROVE SEED CONTACT TO SOIL

1 NATURE TRAIL

2 SEATING AREA / OVERLOOK / INTERPRETIVE SIGNAGE

3 WILDLIFE NESTING FEATURES

PLAY STOW ACRES

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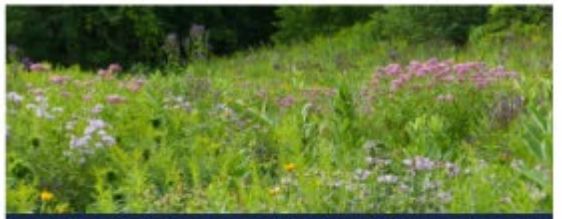
Proposed Wetland Restoration Elements

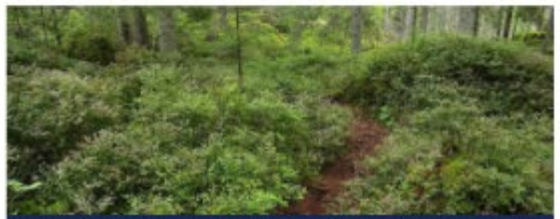
WHY RESTORE WETLANDS?


SCRUB / SHRUB SWAMP


SCRUB / SHRUB SWAMP


WET MEADOW


WET MEADOW


NATURE TRAIL

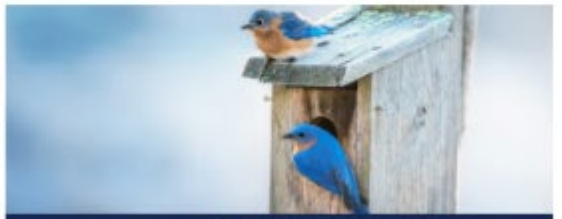

WETLAND OVERLOOK


TRAIL SIGNAGE


ROOKERY


WILDLIFE NESTING


WILDLIFE NESTING


WILDLIFE NESTING


WILDLIFE NESTING

Existing Driving Range

Proposed Wetland Restoration

Existing Forested Area

Proposed Area for Nature Play

PLAY STOW ACRES

BSC GROUP

Existing Upland Trail and Lawn/Golf Course Area

PLAY STOW ACRES

BSC GROUP

Proposed Upland Trails and Active Recreation Area

Existing Golf Course with Sand Traps

PLAY STOW ACRES

BSC GROUP

Proposed Turtle Nesting Area, Wetland & Board Wall

PLAY STOW ACRES

BSC GROUP

Existing Upland Lawn/Golf Course and Forested

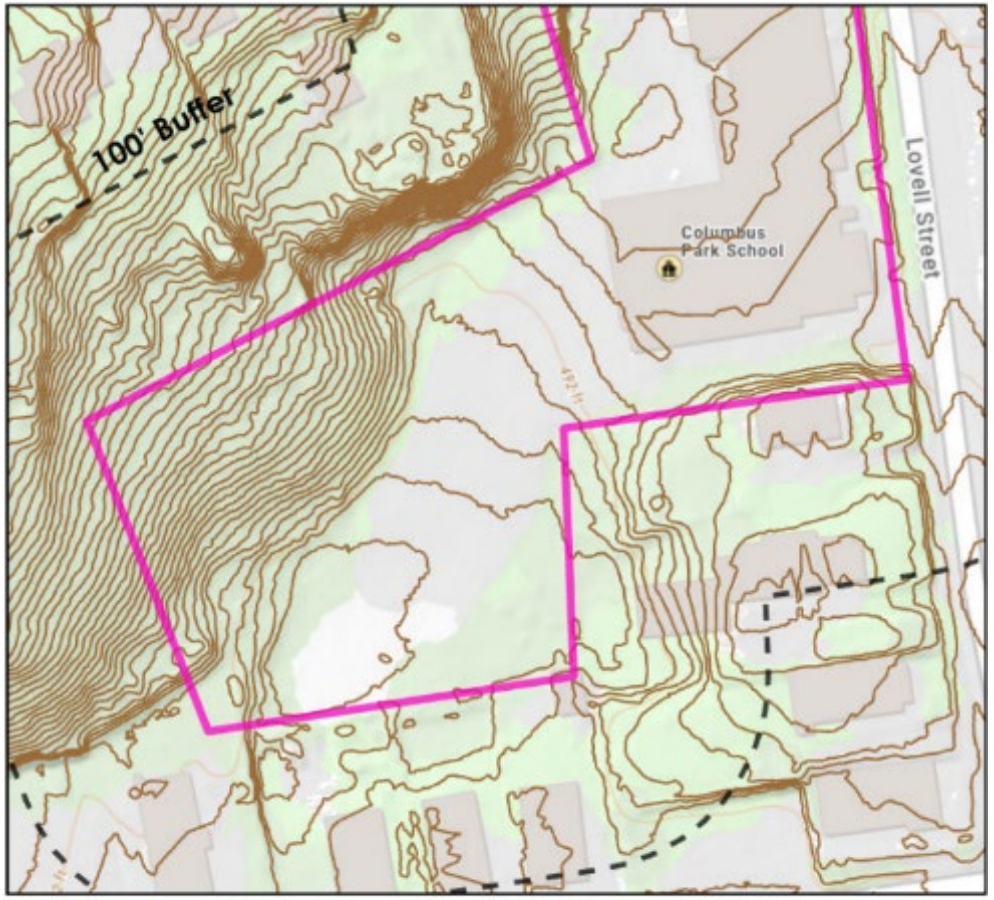
PLAY STOW ACRES

BSC GROUP

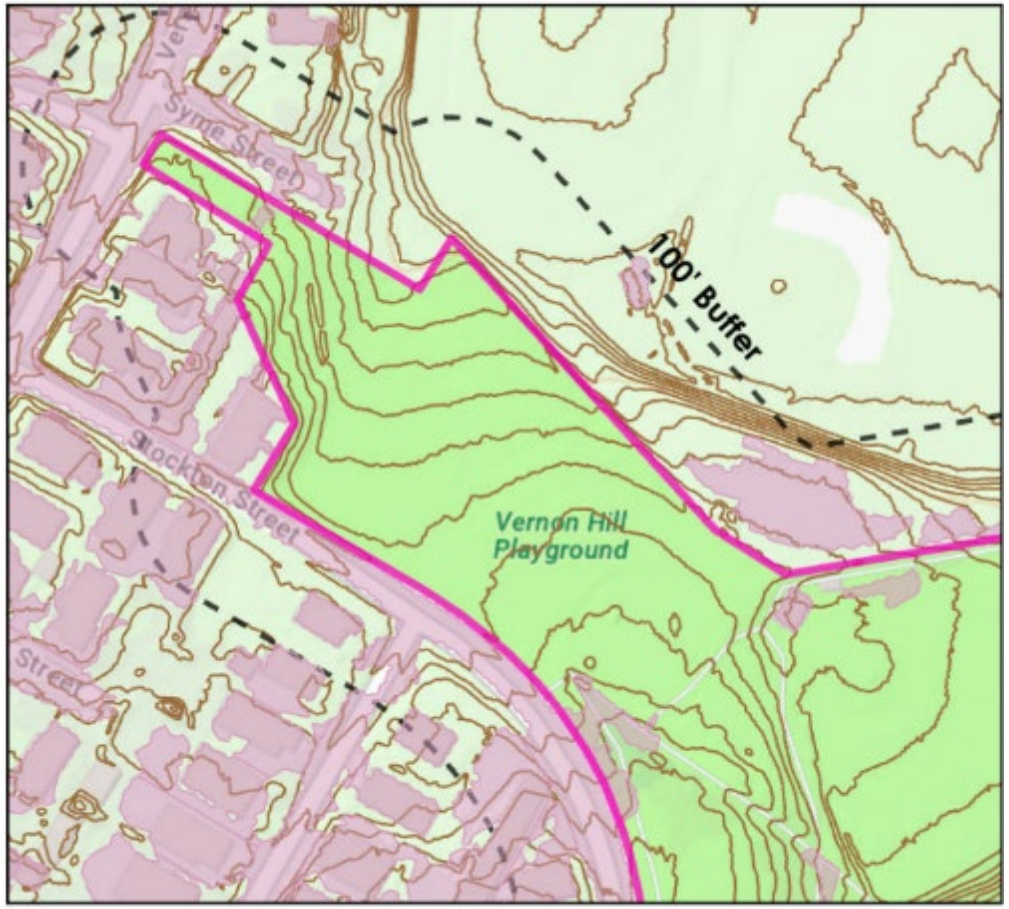
Proposed Food Forest and Open Meadow Area

Worcester Miyawaki Forests & Cool Pockets

- CoolPockets Pilot Projects in Worcester



1 Columbus Park School Site



3 Vernon Hill Playground Site

CoolPockets at ColumbusPark

Columbus Park Elementary School Site

•The CoolPocket design will be for the play area yard behind Columbus Park Elementary School, adjacent to the parking lot.

•The existing site could benefit from alternatives to asphalt for the play areas, with enhanced shade tree plantings, shade structures, and cooling surfaces integrated throughout the site.

CoolPockets at ColumbusPark

CoolPockets at ColumbusPark

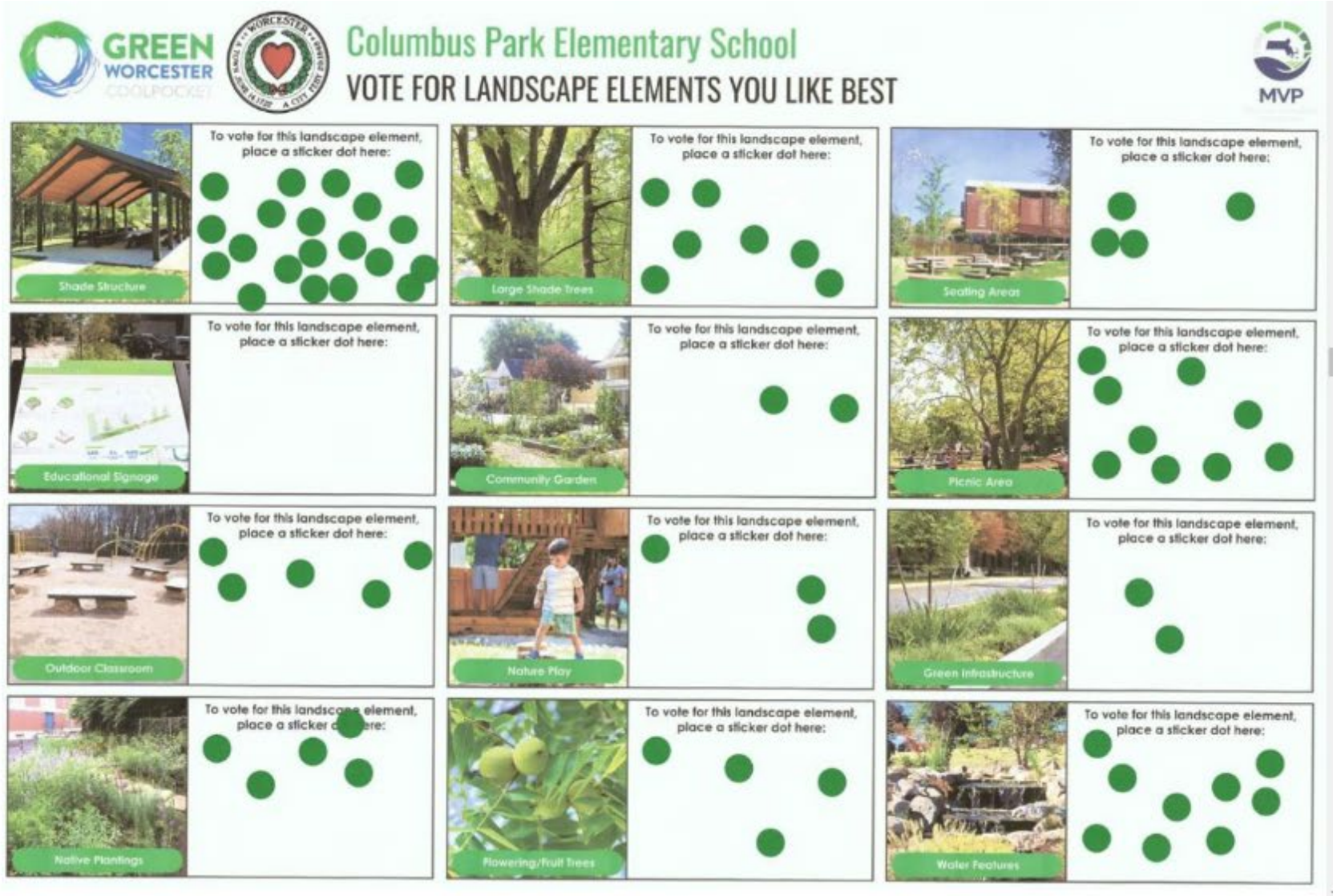
Columbus Park Elementary School CoolPocket Design Workshop

We worked with the school administration to design a class activity – a workshop - for 6th grade students. This workshop gave students the chance to share their ideas on various green infrastructure elements they'd like to see incorporated into the CoolPocket design at the school. Students worked in groups to design their own CoolPockets using cut out images of landscape elements.

CoolPockets at ColumbusPark

Another activity at the workshop was a dot voting exercise. Students voted for their favorite design elements by placing sticker dots next to them. The results included:

- Shade Structures (53)
- Picnic Area (20)
- Nature Plan (17)
- Water Feature (17)
- Large Trees (16)
- Outdoor Classroom (13)
- Fruit/Flowering Trees (11)
- Community Garden (6)
- Seating (6)
- Green Infrastructure (5)
- Native Plantings/Pollinator Garden (3)
- Educational Signage (3)



CoolPockets at ColumbusPark

Columbus Park Elementary School Concept Design

The Columbus Park Elementary School Concept Design incorporates several ideas from the workshop, including:

- Backpack and Coat Hangers
- Turf Soccer Field
- Memorial Tree
- Pervious Paving for Sports Play Areas (e.g. basketball court, volleyball court)
- Shade Structures
- Rain Garden and Bioswales
- Nature Play
- Informal Play with Paint Markings (e.g. hopscotch)
- Shaded Picnic Areas
- Community Garden
- Outdoor Classroom with a Pollinator Garden


Shade Structures

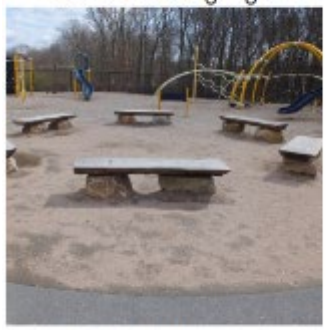

Large Shade Trees


Seating Areas


Educational Signage


Community Garden


Picnic Area


Outdoor Classroom


Nature Play

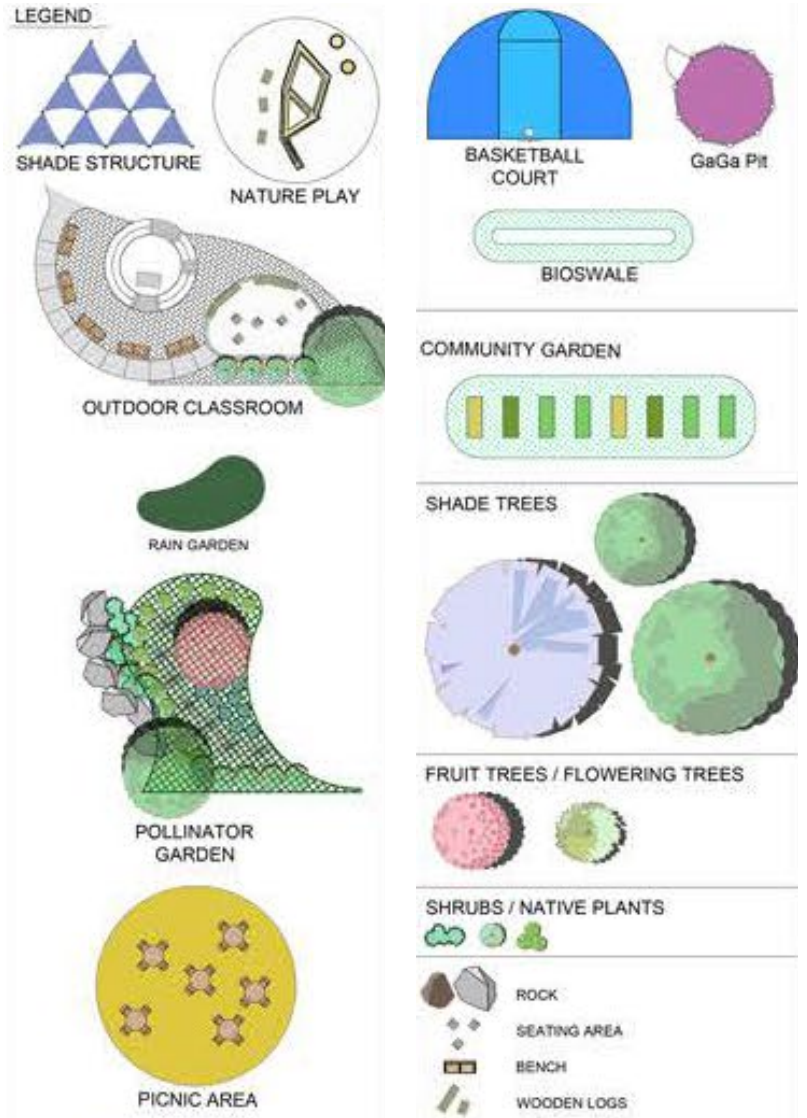

Raingarden


Native Plantings


Flowering/Fruit Trees


Water Features

CoolPockets at ColumbusPark



CoolPockets at ColumbusPark

Educational Signage

Community Garden

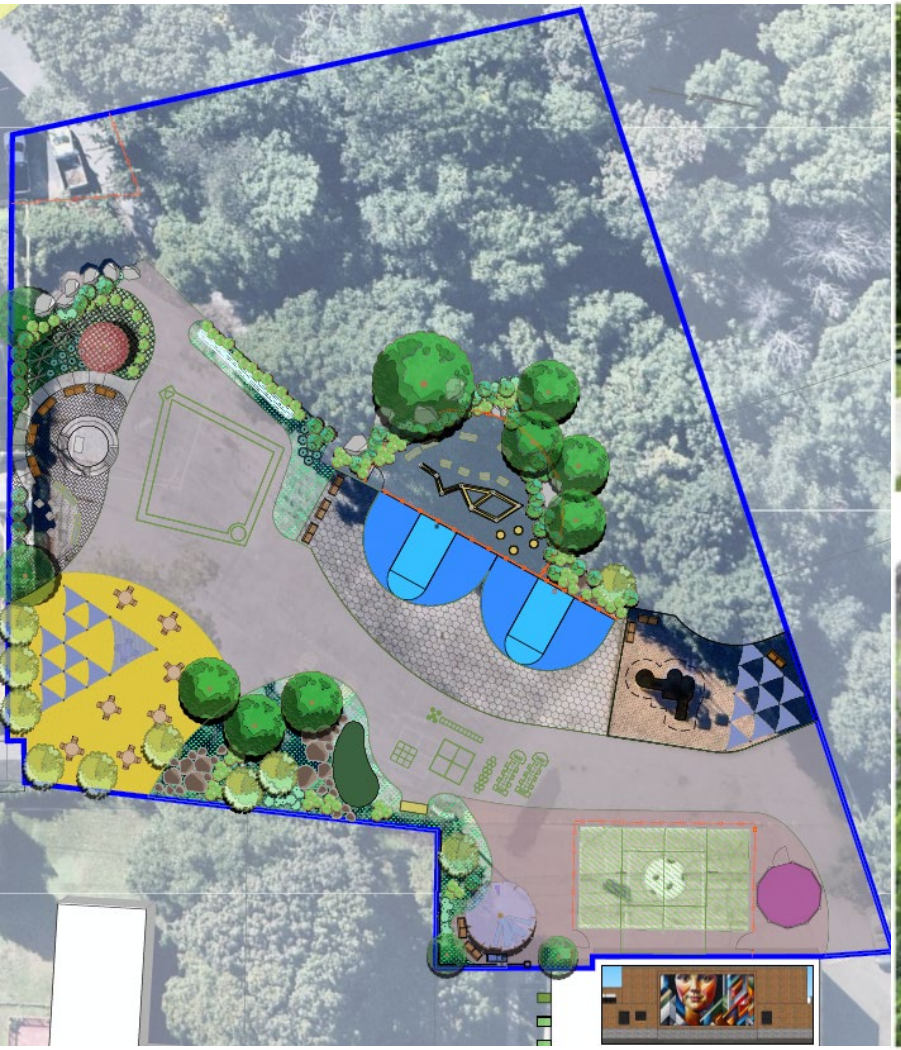
Picnic Area

Outdoor Classroom

Nature Play

Raingarden

CoolPockets at ColumbusPark



Shade Structures

Large Shade Trees

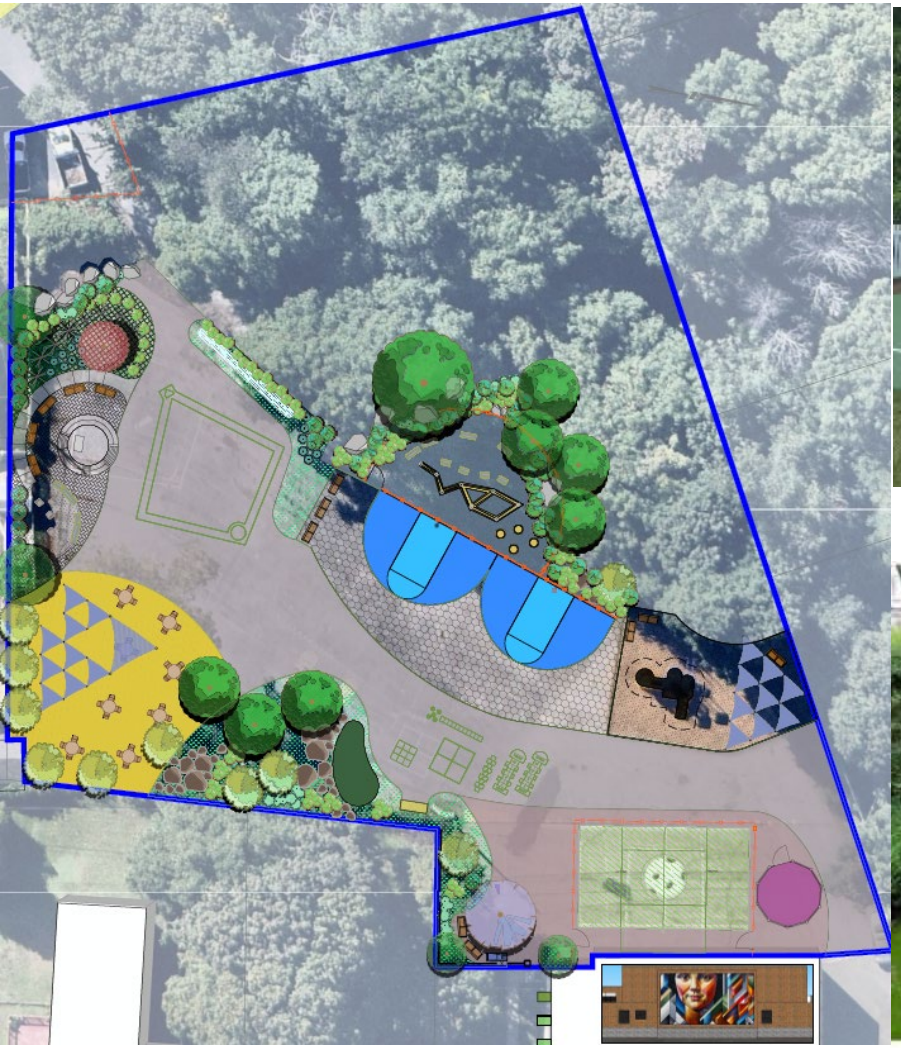
Seating Areas

Native Plantings

Flowering/Fruit Trees

Water Features

CoolPockets at ColumbusPark



Pervious Tile Basketball Court

Permeable Turf Field in Park

Pervious Pavers with Grass

Permeable Turf for Soccer Field

Permeable Turf for Play Structure

Permeable Turf w/ Water Feature

CoolPockets at ColumbusPark

Bioswale for Stormwater Runoff

Bioswale for Stormwater Runoff

Shade Canopy for Play Structure

Rain Garden for Stormwater Runoff

Shade Canopy for Seating Area

Shade Canopy for Play Structure

CoolPockets at ColumbusPark

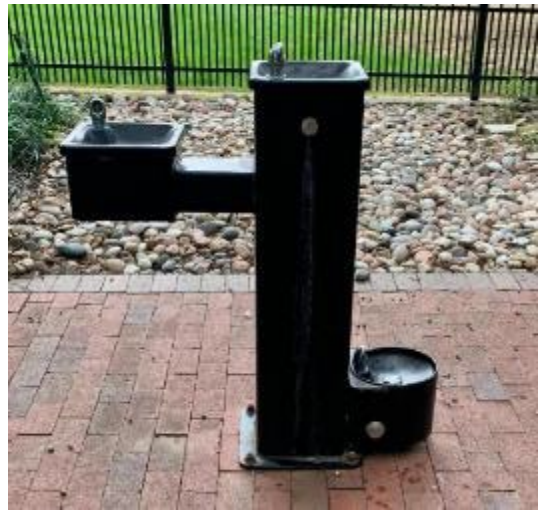
Structure for Water Mist Spray

Structure for Water Mist Spray

Water Fountain with Bottle Filler

Splash Pad with Water Spray

Structure for Water Mist Spray



Water Fountain with Dog Bowl

CoolPockets at ColumbusPark

CoolPockets at ColumbusPark

CoolPockets at ColumbusPark

CoolPockets at ColumbusPark

CoolPockets at ColumbusPark

McGrath Lot
Miyawaki Forest

GREEN WORCESTER
MIYAWAKI FOREST

MVP
Municipal Vulnerability Preparedness

The City of WORCESTER

What is a Miyawaki Forest?

Miyawki Forests are small, dense, layered urban plantings in city niches that grow vigorously and help to cool heat islands, improve biodiversity, and foster climate resilience. Worcester's 2024 pilot builds on experience of other municipalities in Massachusetts, the U.S., and worldwide.

McGrath Lot Site

Worcester's first Miyawaki forest will be situated at the McGrath Parking lot behind the Worcester Public Library, adjacent to the YMCA.

For more information and to learn how to participate, please visit our project website:
tinyurl.com/MiyawakiForests

McGrath Parking Lot

Current McGrath Lot

1 Year Growth

5 Year Growth

Mature Growth Overtime

GREEN WORCESTER
MIYAWAKI FOREST

McGrath Lot Miyawaki Forest

Forest Growth & Succession

- The forest will cover 6,400 square feet, buffering sound from nearby streets and railroad tracks, and greening the view of the parking lot.
- Using a biomimicry model of expedited succession, the forest will imitate natural disturbance patterns to accelerate growth and biodiversity.
- Volunteers and city staff will monitor the forest's growth to ensure balance and promote the development of key species, using strategies that expedite the forest's ability to attain qualities of an old-growth forest.
- Clark University students and faculty will monitor changes in surface temperature before planting and as the forest grows, to measure and assess the forest's impact on cooling the parking lot heat island.

GREEN WORCESTER
MIYAWAKI FOREST

On The Ground Photos

McGrath Lot Site Planting Day

MVP
Municipal Vulnerability Preparedness













Plumley Village Miyawaki Forest

GREEN WORCESTER MIYAWAKI FOREST

MVP Municipal Vulnerability Preparedness

The City of WORCESTER

What is a Miyawaki Forest?

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Plumley Village Site

Worcester's second Miyawaki forest will be situated at the southeastern corner of Plumley Village, adjacent to a playground.

For more information and to learn how to participate, please visit our project website:
tinyurl.com/MiyawakiForests

Current Plumley Site

1 Year Growth

5 Year Growth

Mature Growth Overtime

GREEN WORCESTER
MIYAWAKI FOREST

Plumley Village Miyawaki Forest

Forest Growth & Succession

- The forest will cover 10,000 square feet, buffering sound from the highway.
- Using a biomimicry model of expedited succession, the forest will imitate natural disturbance patterns to accelerate growth and biodiversity.
- Volunteers and city staff will monitor the forest's growth to ensure balance and promote the development of key species, using strategies that expedite the forest's ability to attain qualities of an old-growth forest.
- Clark University students and faculty will monitor changes in surface temperature before planting and as the forest grows, to measure and assess the forest's impact on cooling the playground heat island.

GREEN WORCESTER
MIYAWAKI FOREST

On The Ground Photos

Plumley Village Site Planting Day

MVP
Municipal Vulnerability Preparedness












What we do to our environment…
…we do to ourselves
Thank You & Questions!

KAREN BEATTIE
VICE PRESIDENT OF SCIENCE & STEWARDSHIP
NANTUCKET CONSERVATION FOUNDATION

JULIANNE BUSA, PHD, PWS
SENIOR RESILIENCE SCIENTIST
FUSS & O'NEILL, INC.

Fresh From the Field

Diverse Wetlands and Climate Refugia

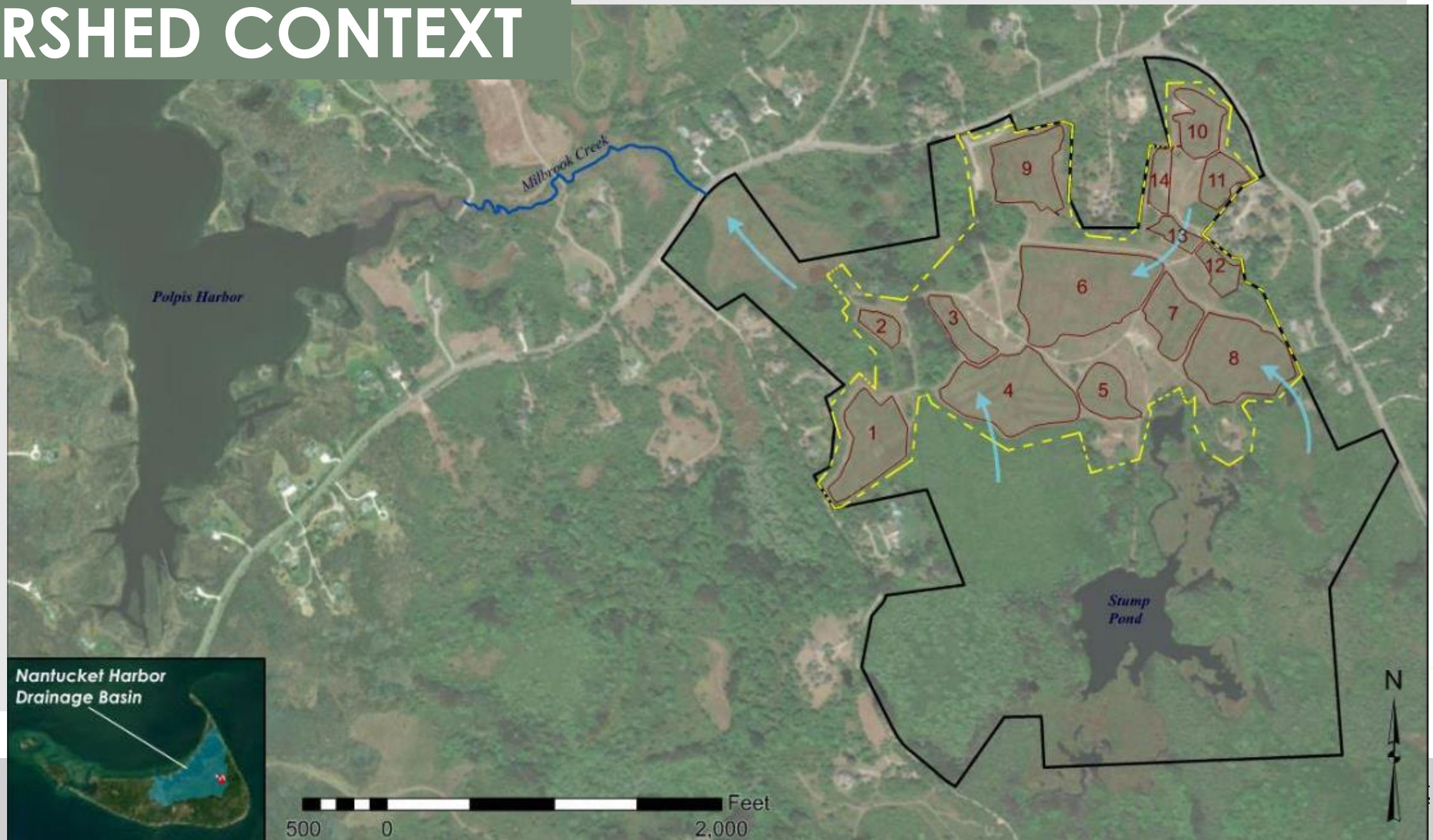
INSIGHTS FROM THE *JUST COMPLETED* FIRST PHASE OF A 40-ACRE CRANBERRY BOG RESTORATION ON NANTUCKET

PRESENTATION OVERVIEW

SETTING THE STAGE
- EXISTING CONDITIONS
- CLIMATE as CONTEXT
- WATER QUALITY QUESTIONS

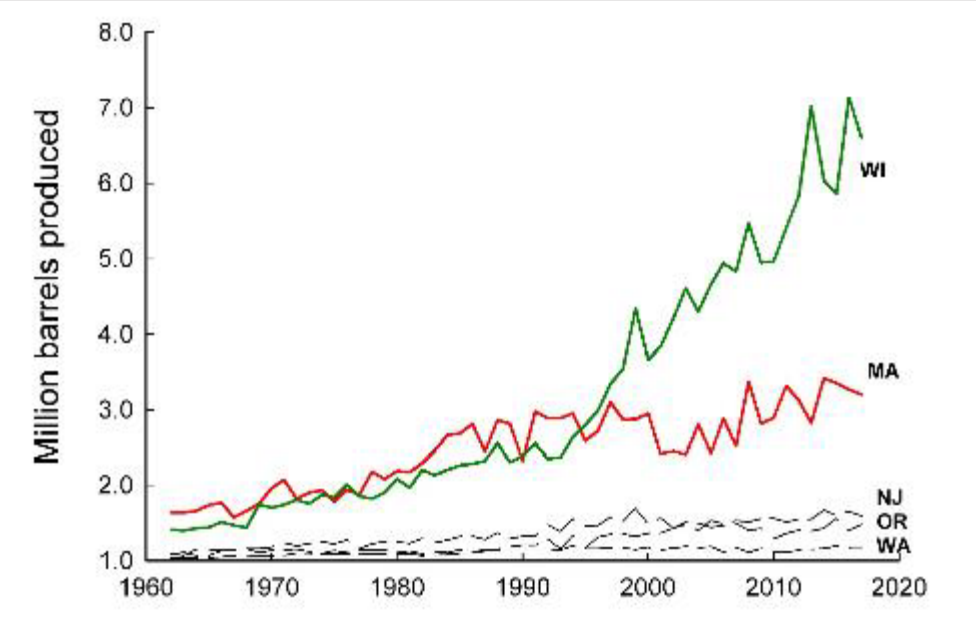
IMPLEMENTATION INSIGHTS
- DESIGN + FIELD MODS → REALITY
- EMBRACING COMPLEXITY/ENCOURAGING ACCESS
- ITERATE, ITERATE, ITERATE, (MONITOR), ITERATE
- SWEET BOGGY SUCCESS

WATERSHED CONTEXT



CRANBERRY PRODUCTION

CRANBERRY DECLINE IN MASSACHUSETTS



Slide courtesy of Chris Neill

New York Times, October 6, 2016

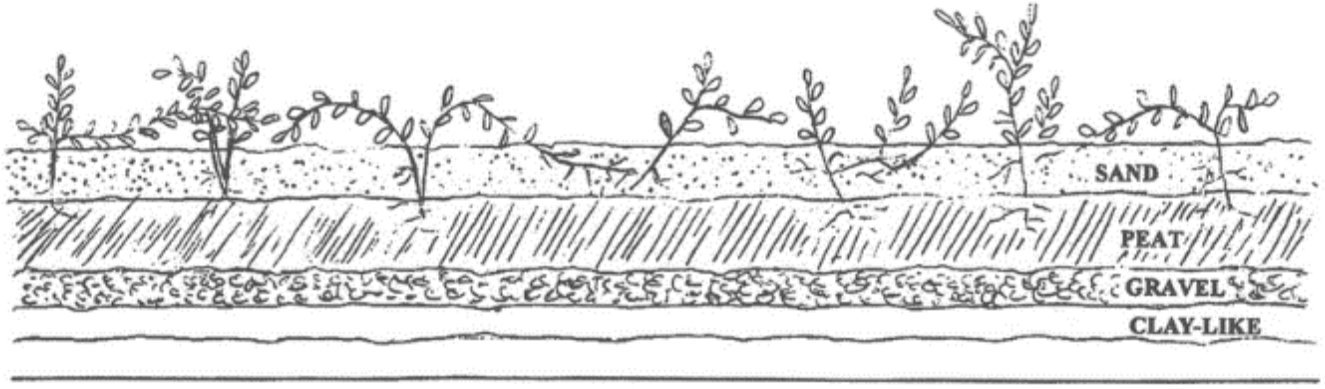
FUSS & O'NEILL

WINDSWEPT BOGS
PRE-RESTORATION CONDITIONS

FUSS & O'NEILL

RETIREMENT

AGRICULTURAL LEGACY

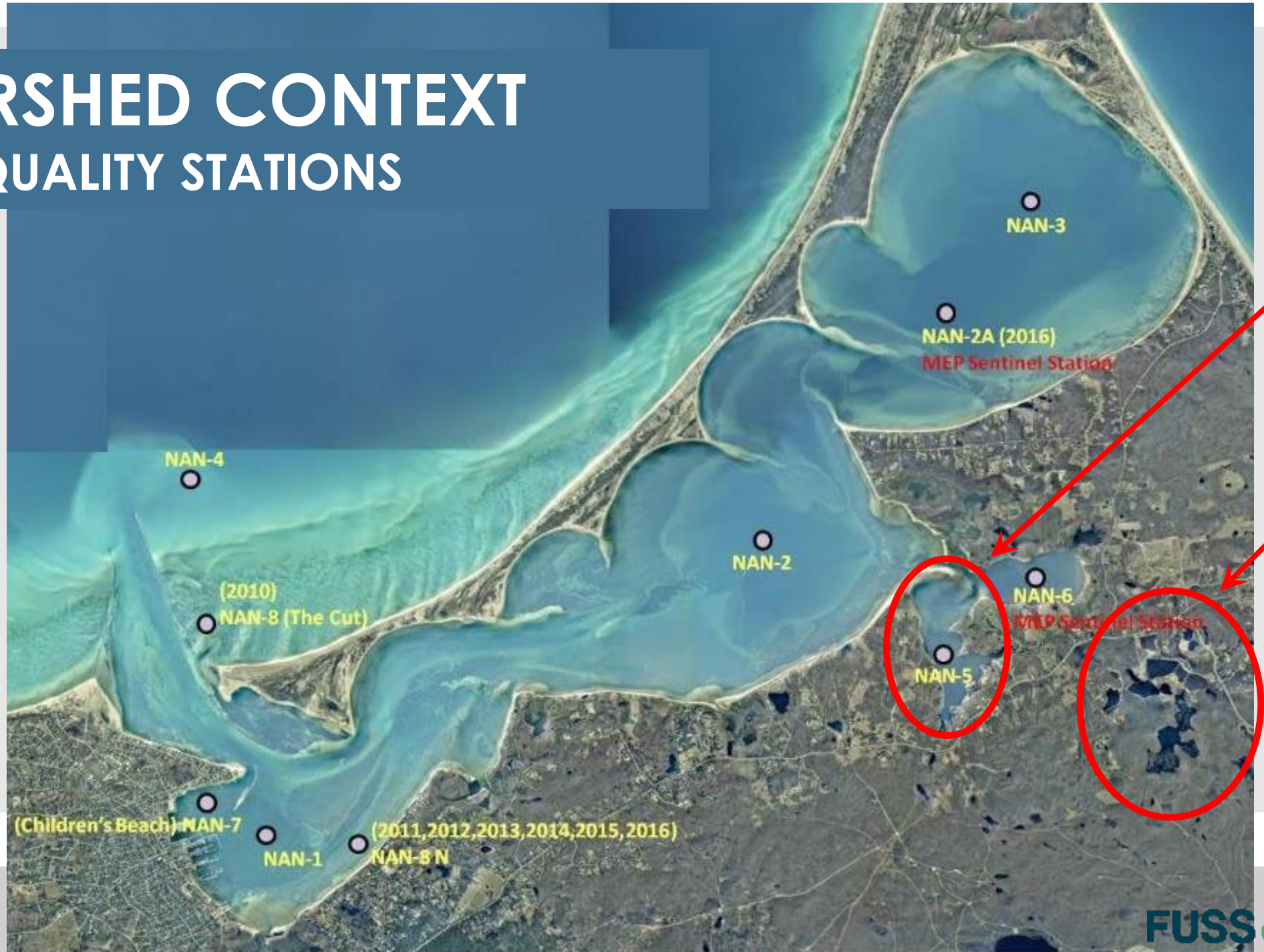


FUSS & O'NEILL

AGRICULTURAL LEGACY

PLACED SAND FILL OVER NATIVE PEAT	LOSS OF FUNCTIONING WETLANDS DOMINANCE BY UPLAND PLANTS
ALTERATION OF HYDROLOGY	DITCHING/BERMS WATER CONTROL STRUCTURES
LANDSCAPE SIMPLIFICATION	LOSS OF BIODIVERSITY LOSS OF ECOSYSTEM SERVICES
PESTICIDE/HERBICIDE RESIDUES	WATER QUALITY CONCERNS
EXCESS NUTRIENTS FROM PAST FERTILIZATION	

WATERSHED CONTEXT
WATER QUALITY STATIONS



POLPIS HARBOR

WINDSWEPT BOGS

FUSS & O'NEILL

WATER QUALITY CONCERNS

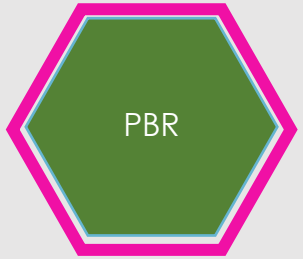
NITROGEN + BACTERIA IMPAIRMENTS

MILLBROOK CREEK → 60-70% of STREAM DISCHARGE N-LOAD to POLPIS HARBOR

CRANBERRY PRODUCTION AS MAJOR CONTRIBUTOR?

REFERENCE WETLANDS

FUSS & O'NEILL



PROCESS-BASED RESTORATION

UNDO HYDROLOGIC ALTERATIONS	HABITAT & HYDRAULIC CONNECTIVITY
RE-ENGAGE GROUNDWATER	ENGAGE BURIED PEAT LAYERS
EXPOSE NATIVE SEED BANK	COST-EFFECTIVE CONSTRUCTION LET NATURE DO THE WORK
SLOW THE FLOW	REDUCE PEAK FLOWS / MITIGATES STORM DAMAGES ALLOW SEDIMENT TO SETTLE OUT FILTER NONPOINT SOURCE POLLUTANTS
FUTURE-FORWARD	PLAN FOR CLIMATE REFUGIA/INLAND MARSH MIGRATION

→ LONG-TERM SELF-SUSTAINING ECOLOGICAL FUNCTION

→ CLIMATE ADAPTATION

FUSS & O'NEILL

PROCESS-BASED RESTORATION

UN-STRAIGHTENING DITCHES

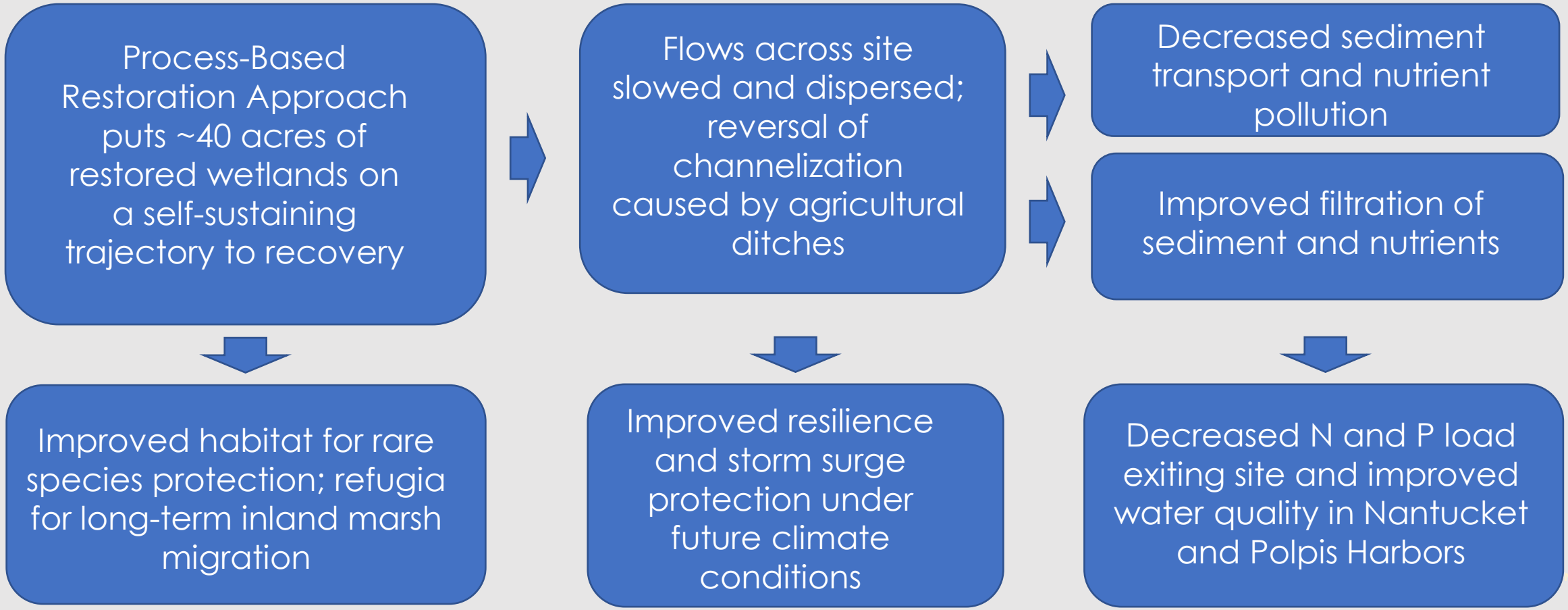
MICROTOPOGRAPHY

PROCESS-BASED RESTORATION

EMBRACING MESSINESS

REMOVING BERMS/ RECONNECTING BVW

WATERSHED HEALTH OUTCOMES/BENEFITS



FUSS & O'NEILL

BOG RESTORATION DESIGN

RESTORED HABITATS

WETTER

DRIER

- HERBACEOUS WETLANDS
- SCRUB-SHRUB WETLANDS
- UPLAND HABITAT
- PROPOSED TRAIL

PLAN LEGEND

1. EXISTING VEGETATED WETLANDS
2. WET MEADOW
3. BERMS REMOVED/PERFORATED TO CONNECT RESTORED BOGS TO EXISTING WETLANDS
4. IRRIGATION DITCHES MODIFIED TO CREATE BROAD, VEGETATED FLOW PATH
5. IRRIGATION DITCH DISCONNECTED FROM BOG TO PREVENT BYPASS FLOW OF SURFACE WATER
6. POCKETS OF DEEP MARSH HABITAT
7. BERMS REMOVED TO CONNECT BOG CELLS
8. FLUMES REPLACED BY "COBBLE RIFFLE" TO DISPERSE FLOW AND MAINTAIN STUMP POND'S WATER LEVEL
9. UPLAND HABITAT "ISLANDS" CREATED FROM SECTIONS OF BERM
10. STUMP POND (TO BE MAINTAINED)
11. EASTERN RESERVOIR (TO BE MAINTAINED)

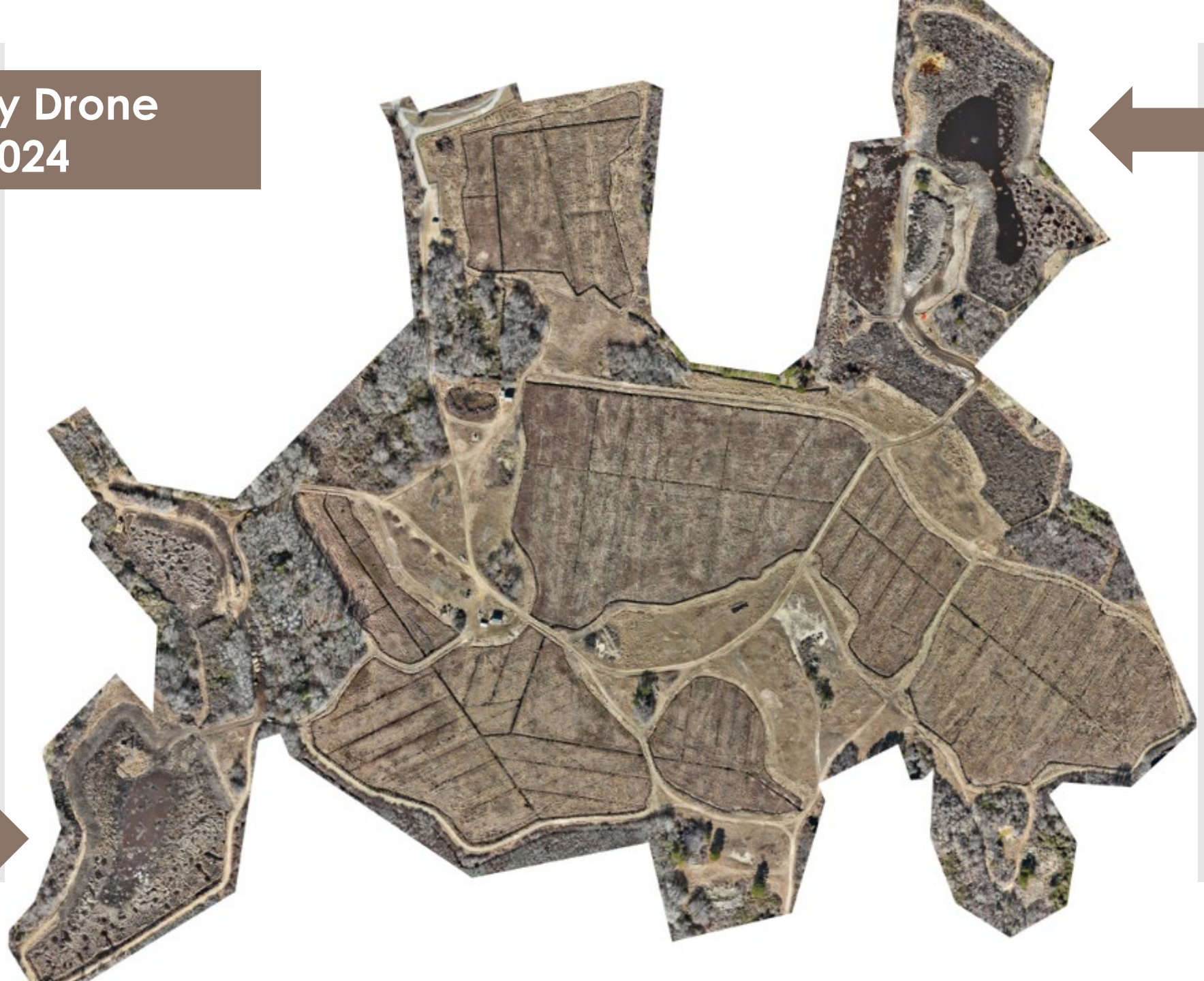
RENDERING: BOG 9

RESTORATION REALITY: BOG 9

FUSS & O'NEILL

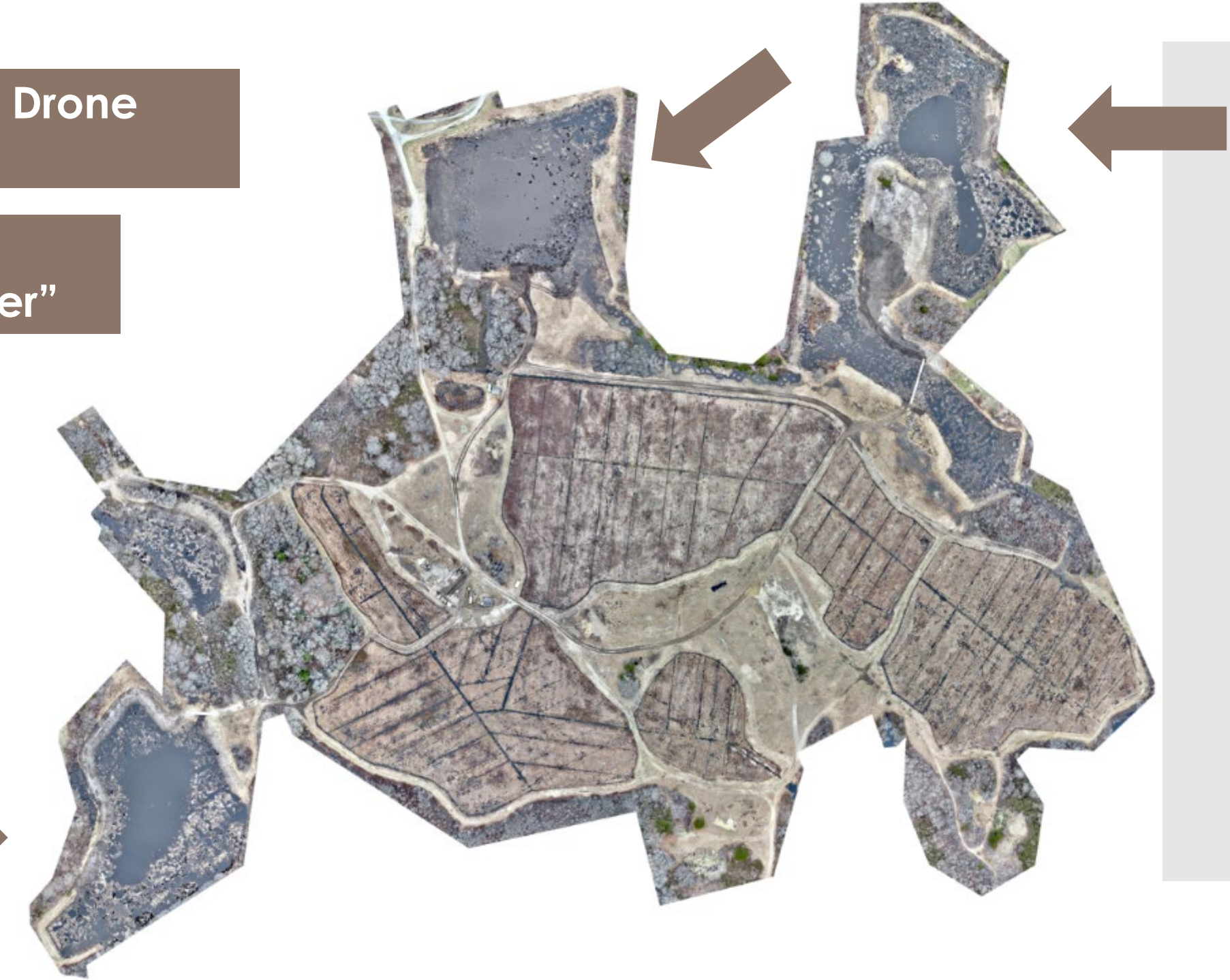
Windswept by Drone
January 6, 2024

Windswept by Drone
February 8, 2024



Windswept by Drone
March 9, 2024

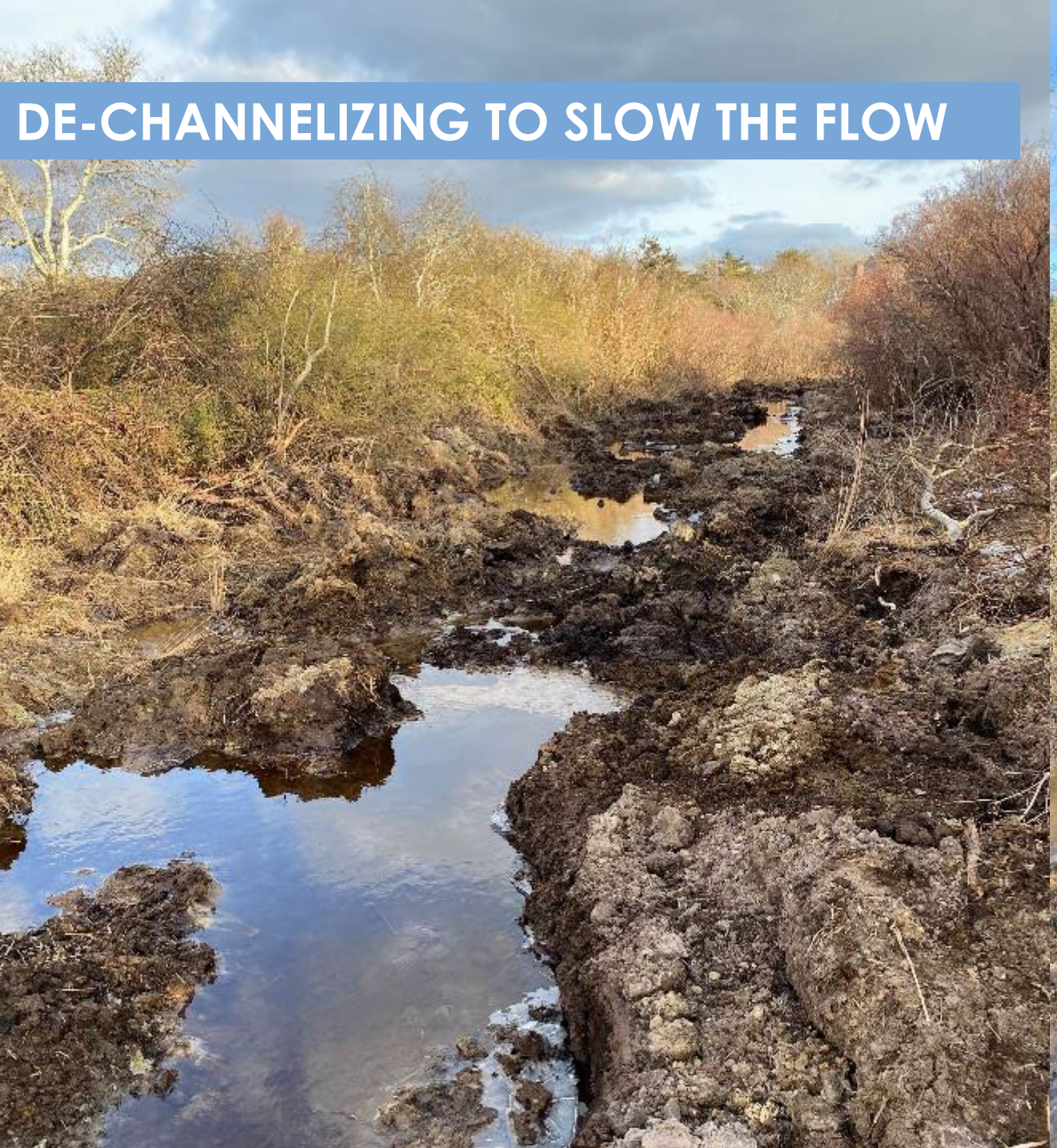
Project Motto:
“Wetter is Better”



Windswept, Un-Bogged? Re-Bogged?
April, 2024

EXTERNAL DITCH → DISPERSED FLOW

DE-CHANNELIZING TO SLOW THE FLOW



SO LONG, INFRASTRUCTURE…

HELLO, HABITAT

HELLO, HABITAT…

MULTI-SCALAR | VERTICAL | HORIZONTAL | WITHIN-BOG | CROSS-BOG

EMBRACING LANDSCAPE DIVERSITY

NEW FAVORITE SPOT

IMPLEMENTATION:
SCIENCE MELDS WITH ART

- TRUE COLLABORATIVE PARTNERSHIP
- DESIGN INTENT → TRANSLATION IN FIELD
- ON-THE-FLY
- INSTANTANEOUS FEEDBACK

MONITOR RESPONSE

- WATER LEVEL
- TIMELAPSE IMAGERY
- SOIL PROFILE DEVELOPMENT
- WATER QUALITY (NUTRIENTS)
- FLOW PATTERNS

ITERATE/ADAPT for PHASE 2

NERD OUT IN THE MUD. SHARE THE STORY

MAKE HEADLINES*!


The Boston Globe

FOR MIGRANTS IN MASS., THE STRUGGLE GOES ON

House lines up behind a possible TikTok ban

Despite need, primary care harder to find

In emotional times, security on alert at shelters

Doomed cranberry bogs get new life in climate fight

Doomed cranberry bogs get new life in climate fight

By Erin Douglas
GLOBE STAFF

NANTUCKET — Sinking their boots deeper into the thick, black muck, scientists oohed and aahed among themselves. The object of their affection: a field of upturned mud.

"This is so beautiful," said Beth Lambert, director of the Massachusetts Division of Ecological Restoration.

The mess at the century-old Windswept Cranberry Bog on Nantucket could be beautiful come summer when plants return. But right now?

"It kind of looks like a bomb has

century of farming and restore the land to its native wetland ecosystem. Wetlands reduce the impacts of sea level rise and coastal erosion by acting as a sponge that can absorb flood waters. They can also mitigate climate change by storing carbon dioxide, a greenhouse gas. Both make them a key strategy for the state's battle to adapt to and fight climate change.

The soil at what was once a 231-acre organic cranberry bog is being upturned, removed, and jumbled as part of the wetland restoration project supported by a $1 million grant from the US Fish and Wildlife Service. The total

Jeremy Sanders worked on a walkwa
in Nantucket that is becoming wetla

A10 The Region

Doomed cranberry bogs get new life in climate fight

Cranberry farming requires cold temperatures and ice, and both are in short supply as winters rapidly warm across New England.

* front page

FUNDERS + PARTNERS

The Windswept Bog Wetland Restoration Project is funded in part through grants from the Massachusetts Department of Fish and Game Division of Ecological Restoration, the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, Southeast New England Program, Restore America's Estuaries, and the Richard King Mellon Foundation.

COMING SOON: PHASE 2, NOV. 2024

QUESTIONS?

JULIANNE BUSA, PHD, PWS

SENIOR RESILIENCE SCIENTIST

JBUSA@FANDO.COM

413.333.5469

NANTUCKET CONSERVATION FOUNDATION

FUSS & O'NEILL

Protecting Buzzards Bay's Coast from Sea Level Rise

Pilot project with restoration management actions implemented across >70 acres on 3 sites. Completed 2023

Gene Albanese Ph.D.
Senior Conservation Ecologist
SE MA, Cape & Islands

Mass Audubon

Partners & Support

- Save The Bay
- Dartmouth Natural Resources Trust
- NOAA
- Ducks Unlimited
- Wareham Land Trust
- U.S. Fish and Wildlife Service
- Bristol County Mosquito Control

Mass Audubon

Goals

- Increase capacity of coastal ecological communities to recover (resilience) & transition (e.g., inland migration) from the forecasted impacts of climate change & sea-level-rise
- Recover and enhance process, function & native biodiversity by mitigating the legacy impacts of anthropogenic change
- Leverage partnerships, education & outreach expertise to promote & share knowledge

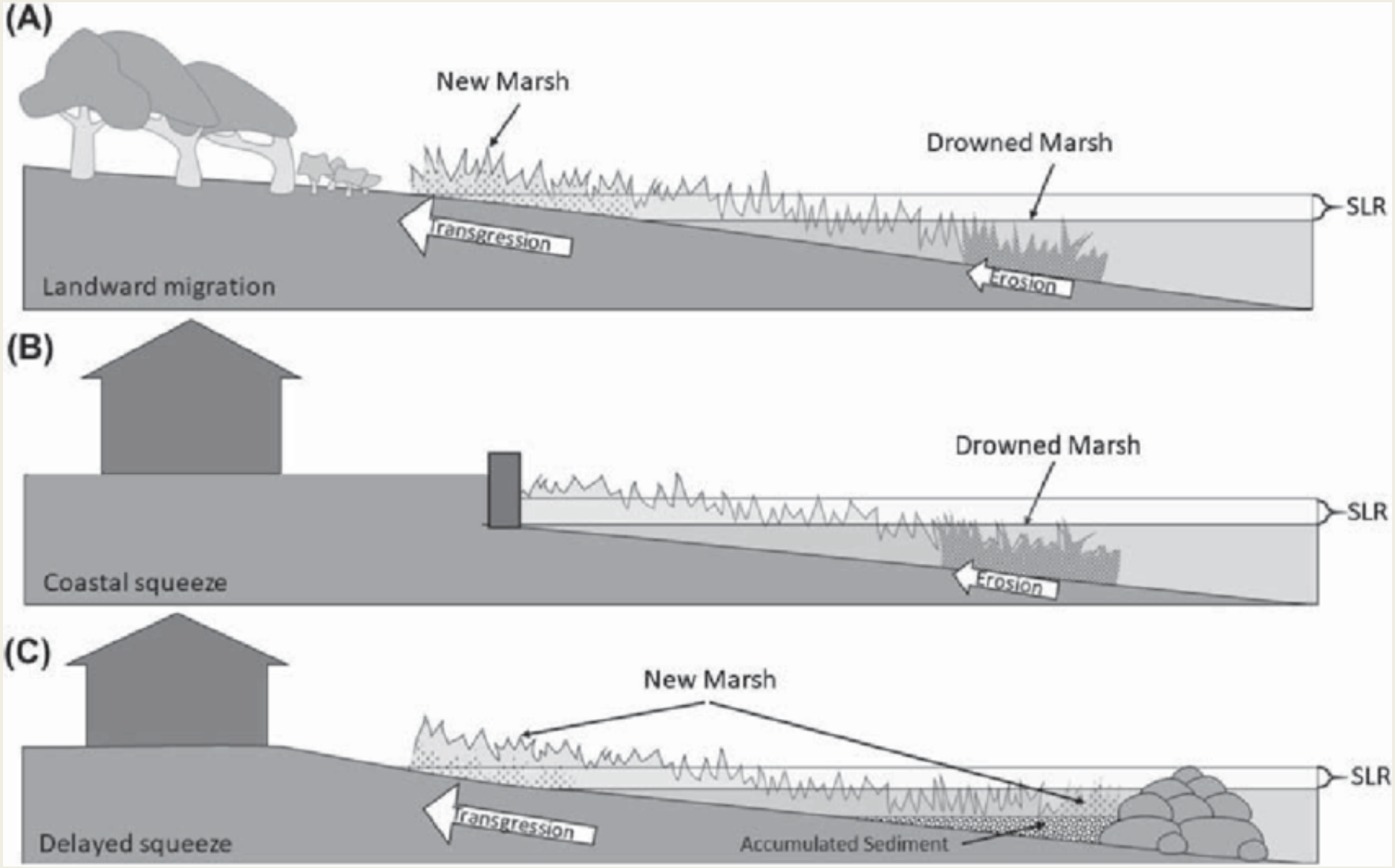
Mass Audubon

Resistance: Increase saltmarsh lifespan

Resilience: Remove coastal hard infrastructure & reduce threats to increase diversity

Transition: Facilitate inland saltmarsh migration

Facilitating Coastal Wetland Transgression



Adopted from Coastal Wetlands, C. Perillo et. al. 2019

Saltmarsh Tidal Hydrology Restoration

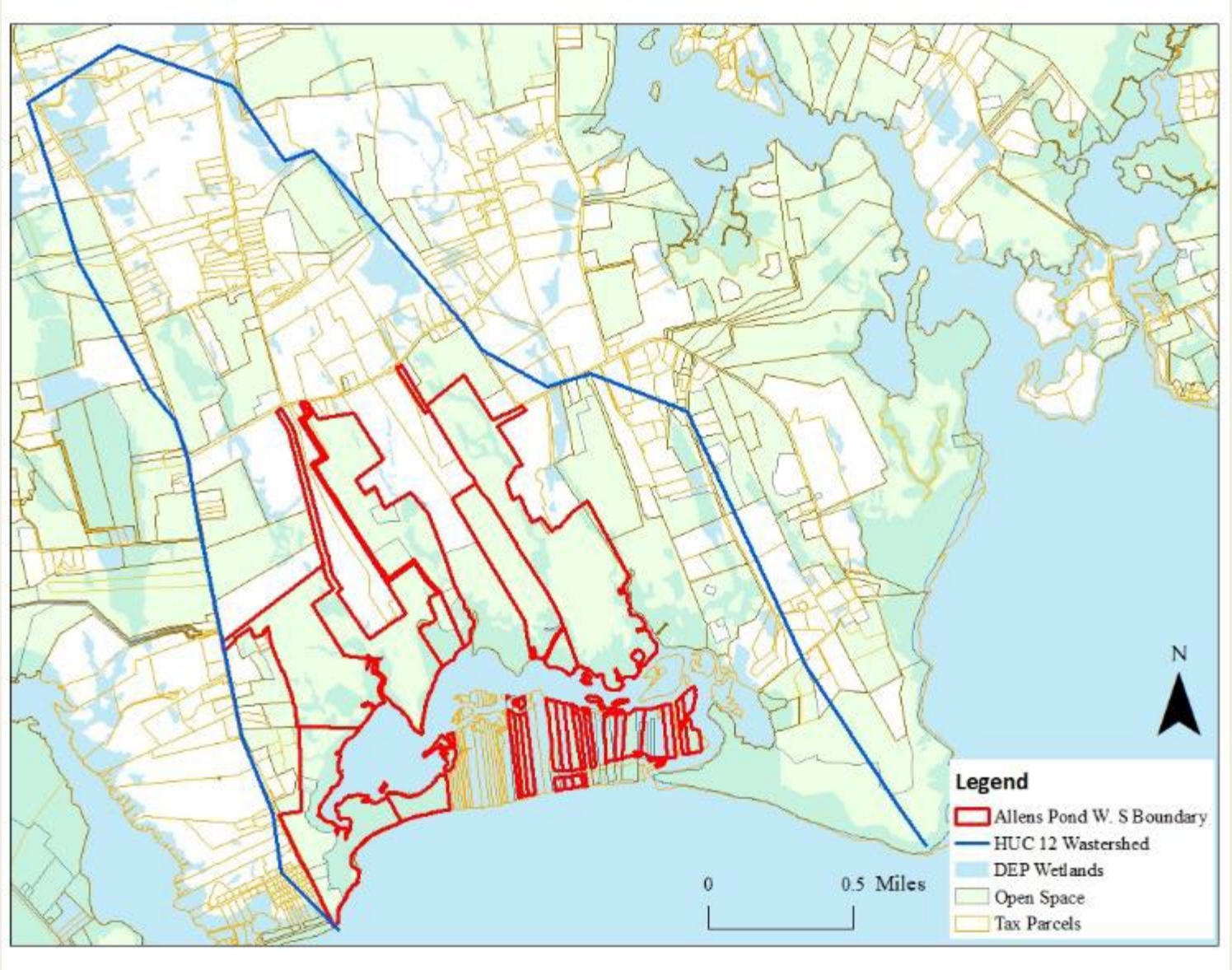
- Mitigating legacy impacts of historic land use practices & SLR
  - Dewatering & revegetating ponding areas
  - Removing tidal restrictions e.g., stones, debris

Saltmarsh Tidal Hydrology Restoration

Ditch vs. Runnel & Peat Island

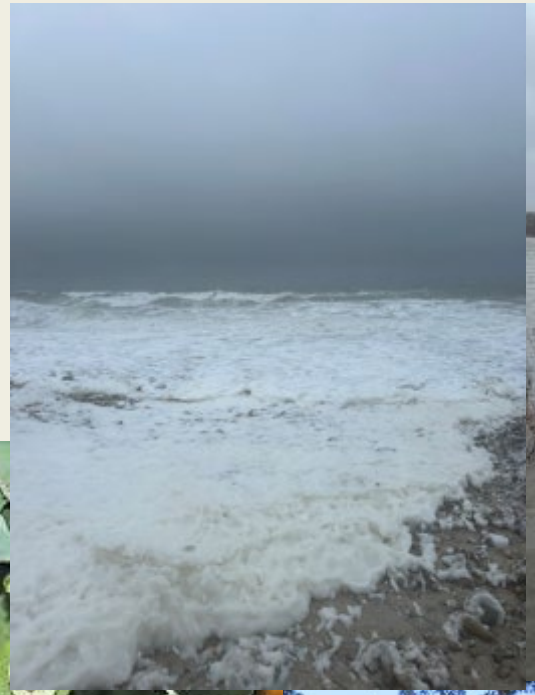
Allens Pond Coastal Pond Watershed

- 3.5 sq. mile watershed
- Great Pond w/managed inlet and 4 freshwater drainages
- APWS 611ac., OVFR 60ac., CR 295 ac.
- Pond 165ac. Saltmarsh 160ac., Coastal dunes & beach 108ac.
- Micro tidal system
- MTR = 0.96 ft.
- Tidal Prism ~65M gallons



Allens Pond, Biodiversity Hotspot

Threats

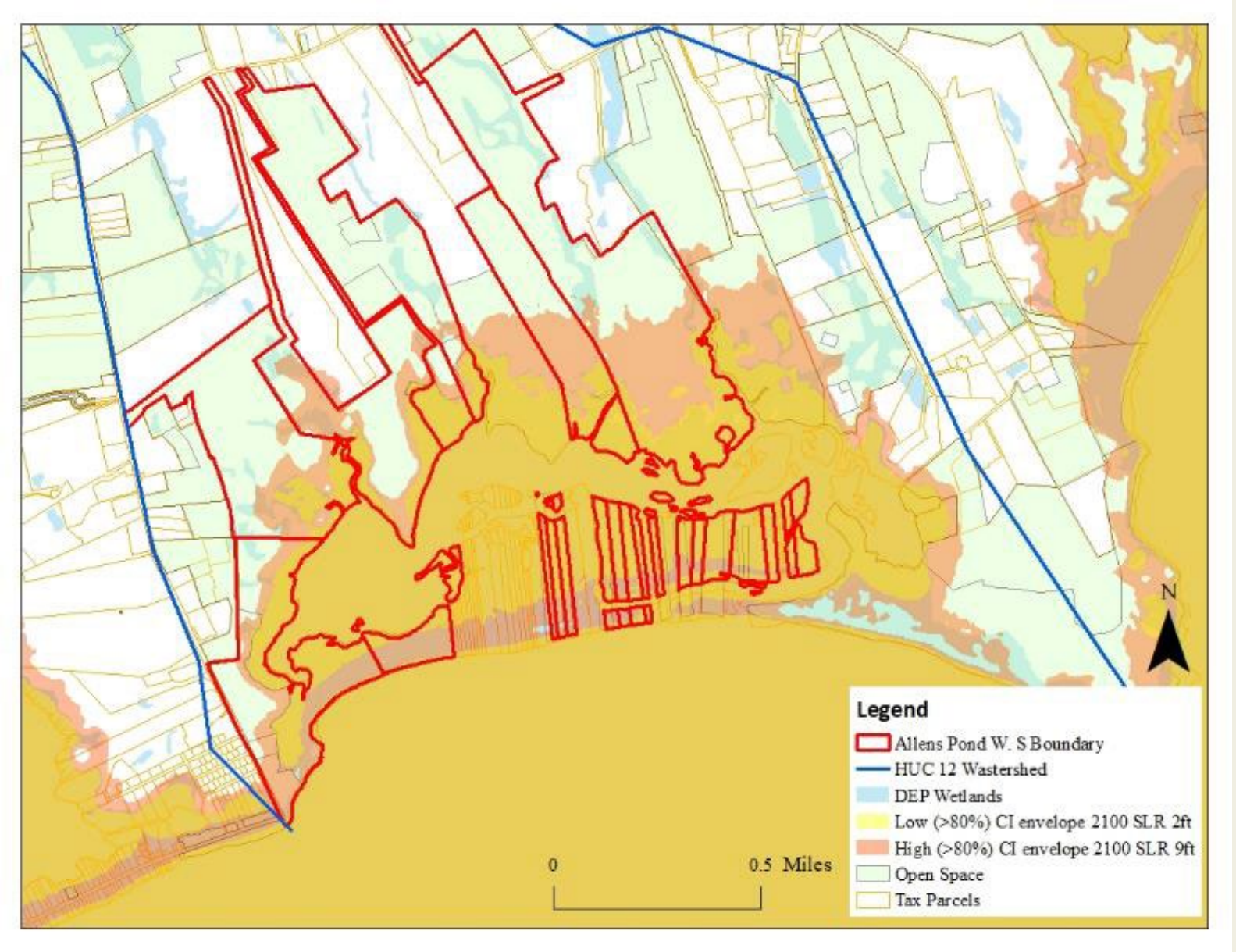



buzzards
BAY
COALITION
Allens Pond
Bay Health Index (5-year average)
43
AP1
AP2
Little Beach
Google

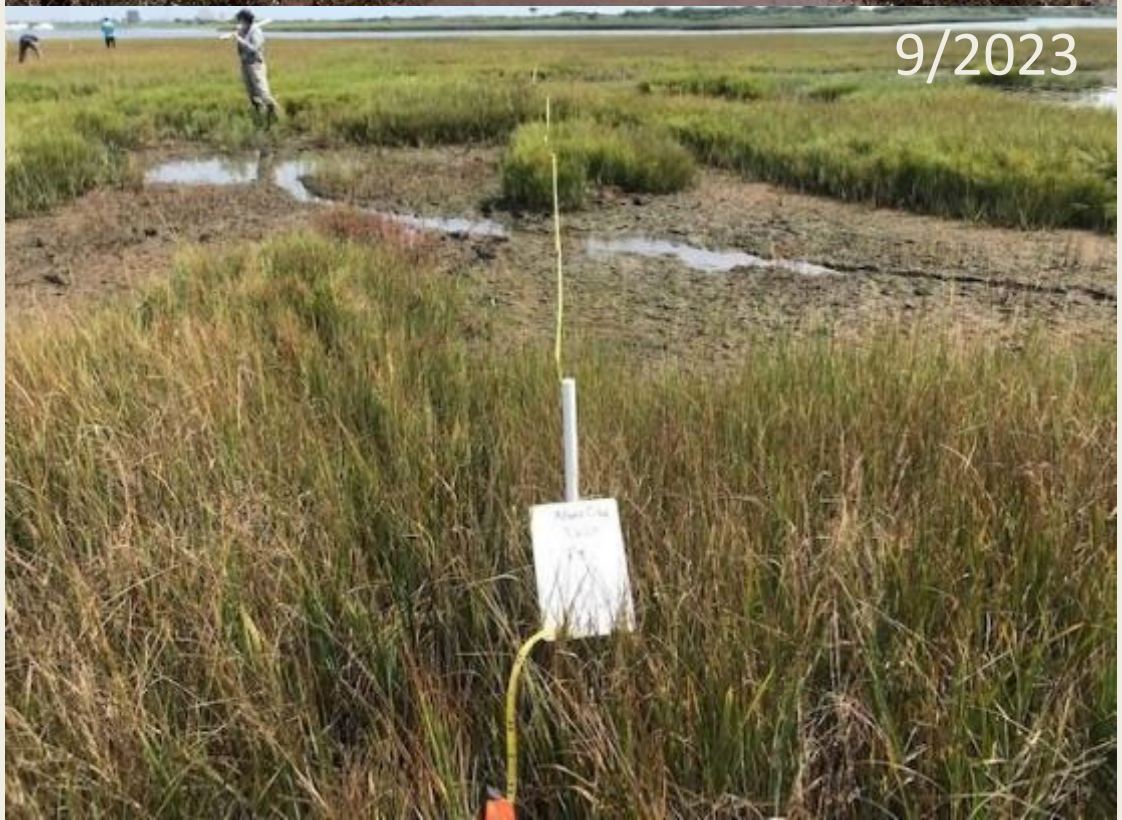
Allens Pond, Dartmouth, MA

1938

SLR & Saltmarsh Inland Migration

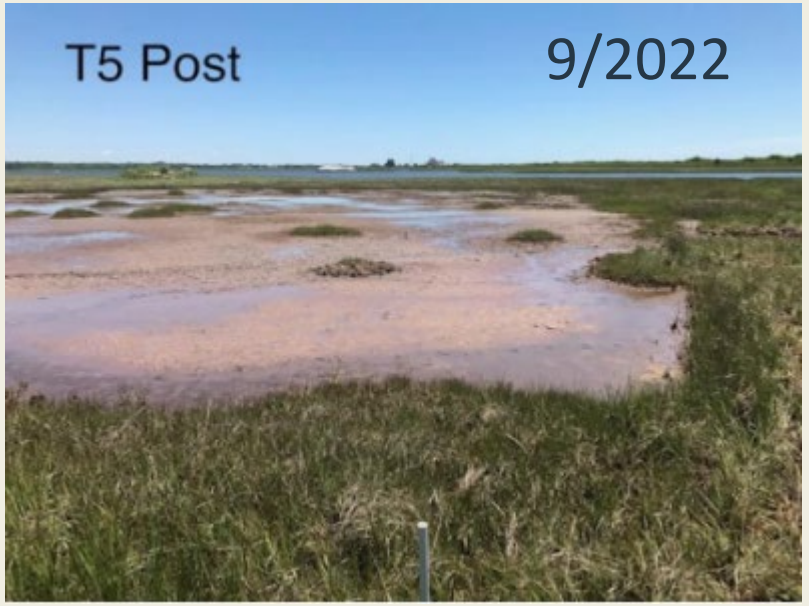


Saltmarsh Surface Tidal Hydrology Restoration, Dewatering & Revegetating Ponding Areas

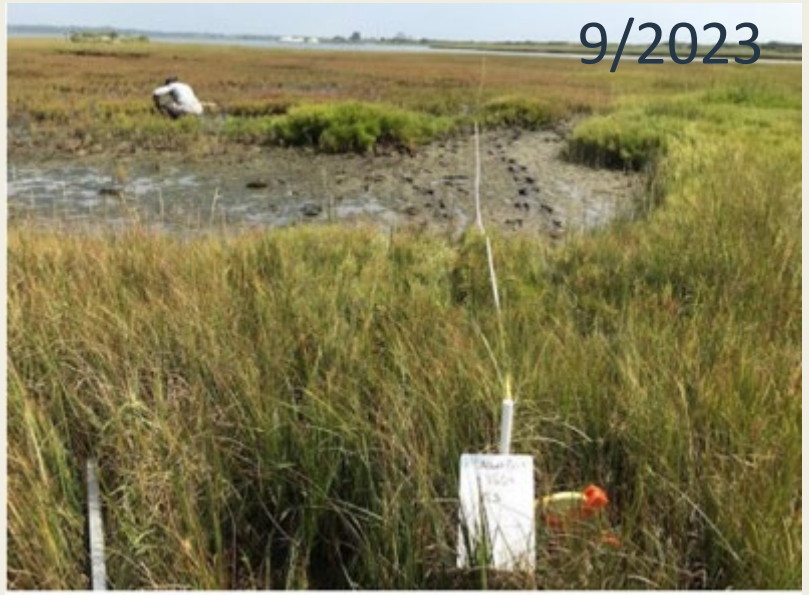


Mass Audubon


5/2022


T5 Post
9/2022


9/2023


9/2023

Saltmarsh Surface Tidal Hydrology Restoration

9/2022

9/2023

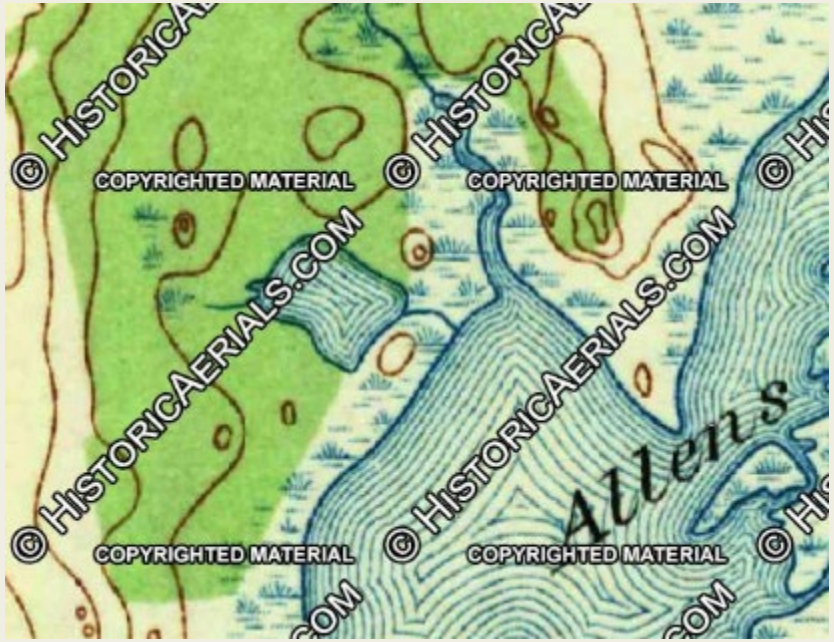
Saltmarsh Tidal Hydrology Restoration, Removing Tidal Restrictions

Removing Barriers & Restoring Connectivity

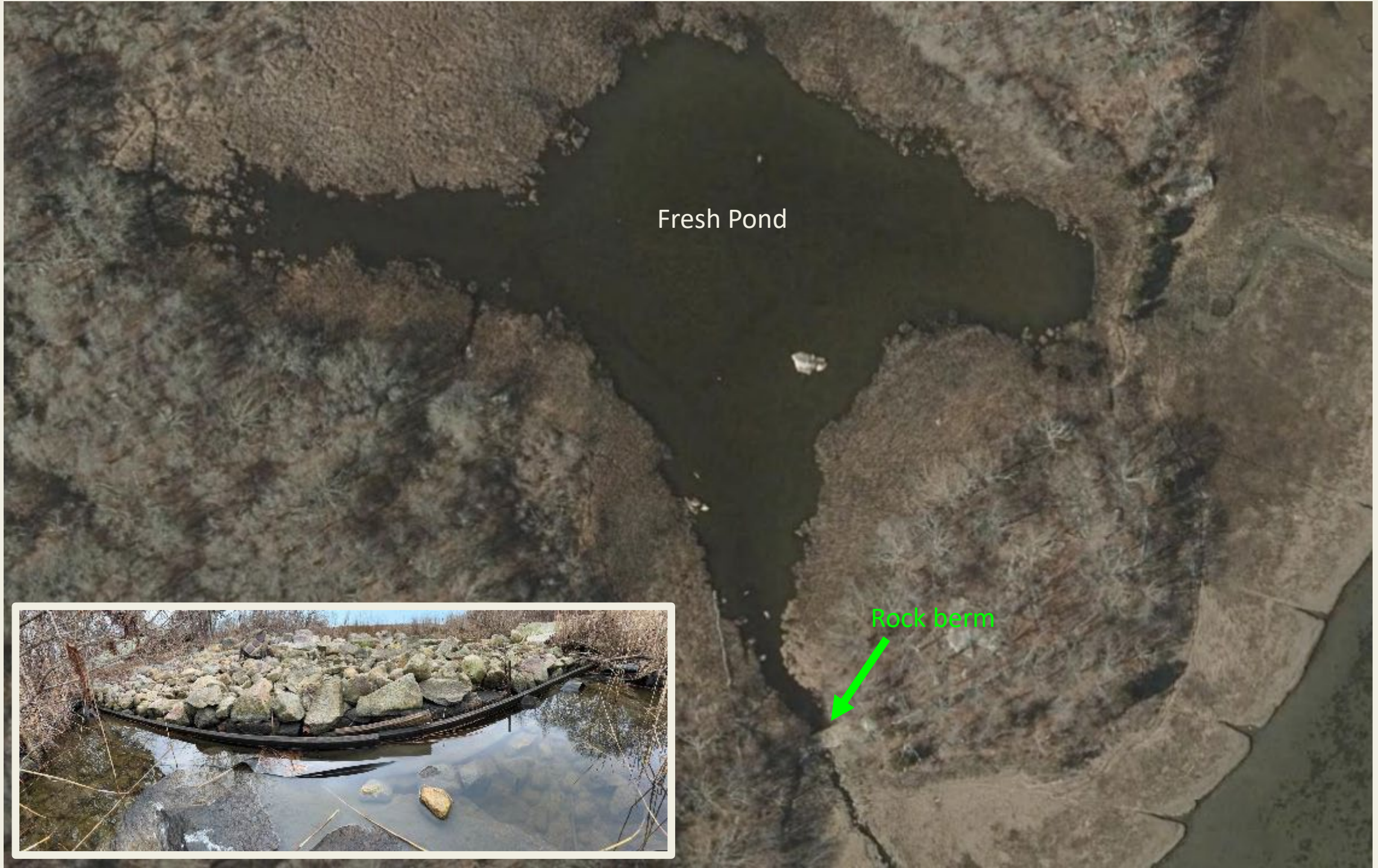
1930

1938

1942



Mass Audubon


Fresh Pond
Rock berm

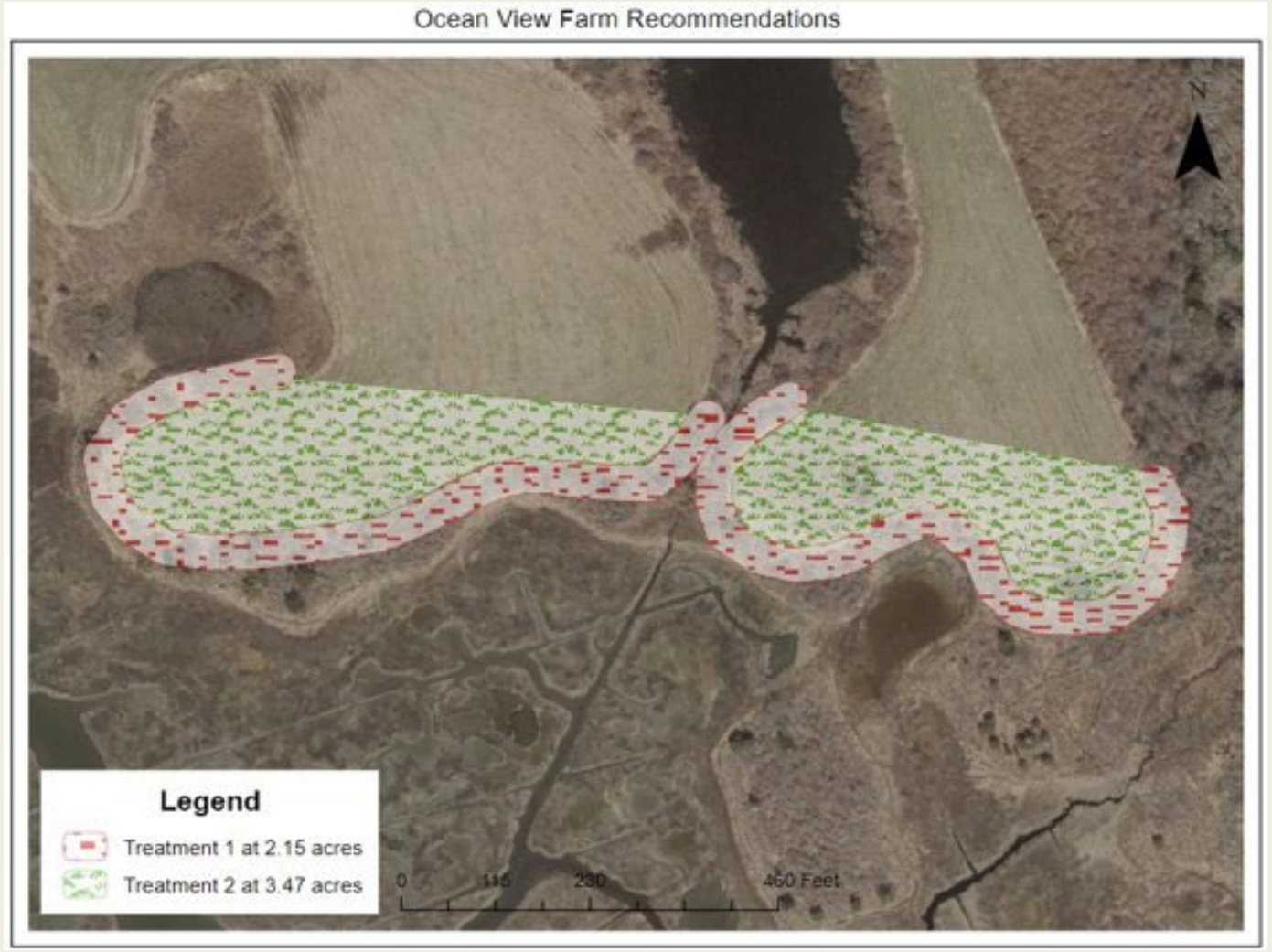
Removing Barriers & Restoring Connectivity

5/23

11/23

Facilitating Saltmarsh Inland Migration

DNRT's Ocean View Farm



Facilitating Saltmarsh Inland Migration

Mass Audubon


1/2021


2/2021


7/2022


2/2021

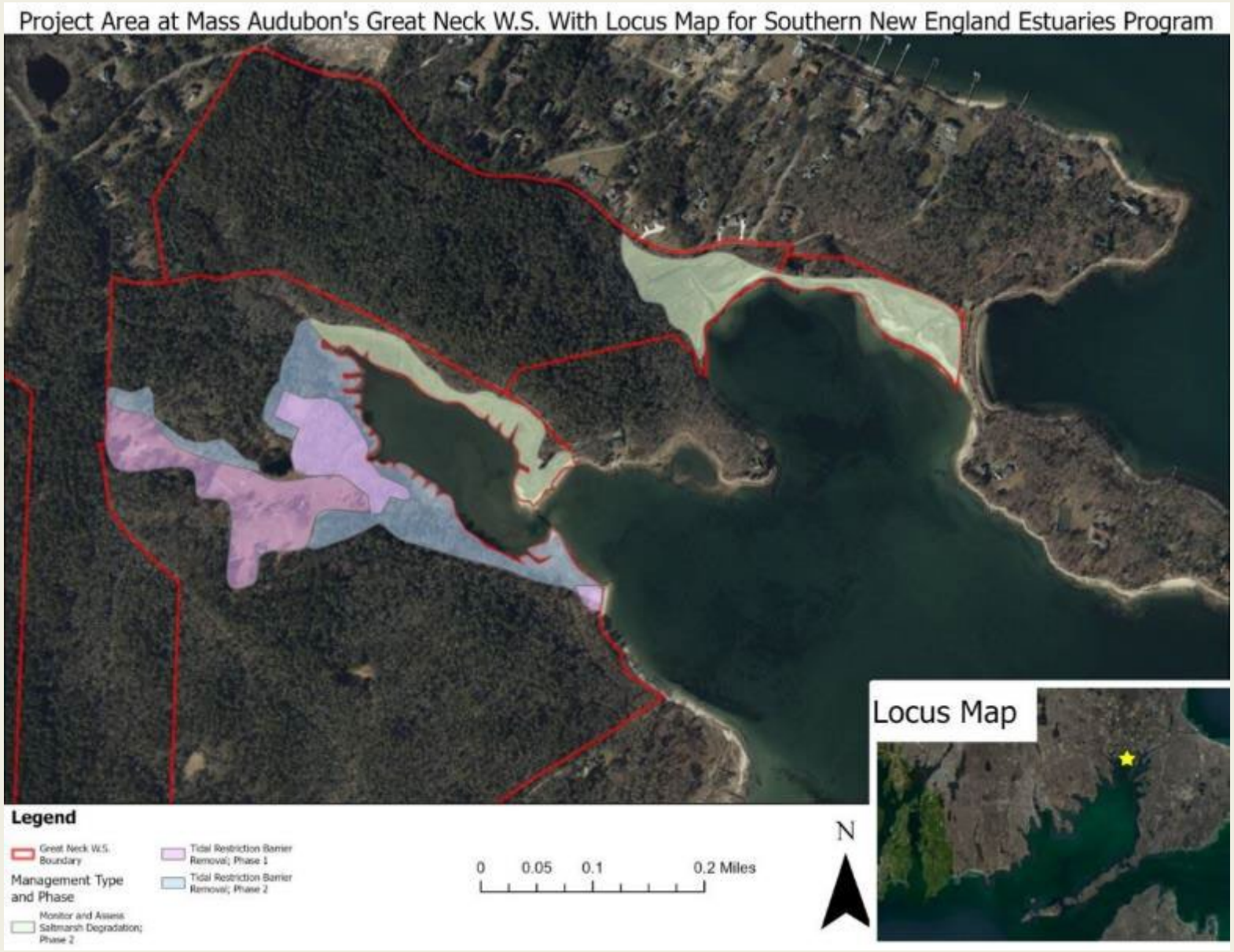

7/2022


7/2023


7/2023

Great Neck W.S., Wareham

- 219ac.
- 110 ac. added in 2020
- Five buildings removed & > 25ac. restored since 2020



Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Mass Audubon

Facilitating Saltmarsh Inland Migration, Removing Infrastructure and Biological Barriers

Mass Audubon

Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Mass Audubon


11/2020


6/2021


7/2023

Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Mass Audubon


1/2022


1/2022


6/2023


10/2023

Facilitating Saltmarsh Inland Migration, Removing Infrastructure & Biological Barriers

Research, Monitoring & Knowledge Sharing

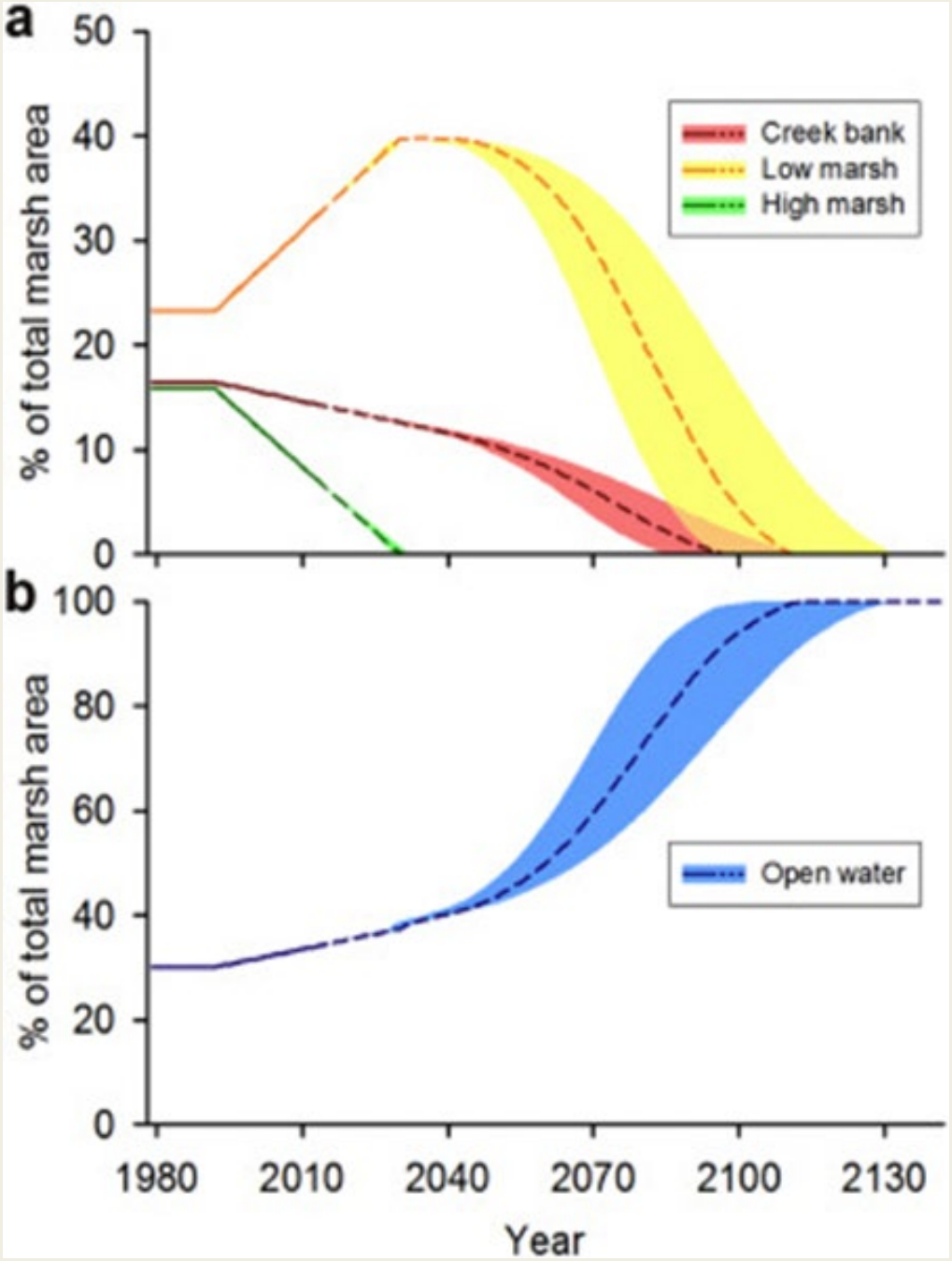
Education & Outreach Programs

- Over 120 volunteers directly supported restoration management
- >3000 Students in Fall River, New Bedford & Wareham
- >5000 People engaged through outreach programs

Next Steps

- 2023 SNEP Stormwater & Natural Infrastructure Grant
  - Over 190 acres across 4 sites in Dartmouth & Wareham, MA
  - Allens Pond, Ocean View Farm, Great & Cromesett Neck's
    - Remove tidal restrictions & barriers to inland saltmarsh migration
    - Restore low-lying upland areas & saltmarsh tidal hydrology
    - Peer-to-peer knowledge sharing workshops
    - Public outreach programs
    - Continue and expand research, monitoring & planning
    - Propose Allens Pond inlet & beach management plan

Mass Audubon


a
50
40
30
20
10
0
% of total marsh area
Creek bank
Low marsh
High marsh
b
100
80
60
40
20
0
% of total marsh area
Open water
1980
2010
2040
2070
2100
2130
Year