# Coastal Climate Adaptation Projects

## as a result of
## Community Resiliency Planning
## and
## Municipal Vulnerability Preparedness

# The Essex Experience

**ECAN Conference**
**October 2018**

Hurricane Sandy cost Massachusetts $375 million

# Dept. of Interior Hurricane Sandy Resiliency Grants Program, 2014

**"Community Risk Reduction through Comprehensive Community Resiliency Enhancement for the Great Marsh Ecosystem"**

## Project Components:

- Native Marsh Vegetation Restoration (eelgrass, invasive plant control), Dune Restoration, Sediment and Hydrology Modeling, Barriers to Flow Prioritization, and **Community Resiliency Planning**

## Planning Project Area: Great Marsh Communities

- Salisbury, Newbury, Newburyport, Essex, Ipswich, Rowley & Gloucester

## Community Resiliency Planning Objectives:

- Assess overall community vulnerability as well provide focused assessments of **highly vulnerable high-priority community assets** through a comprehensive and integrated approach.
- Identify operationally **feasible, site-specific adaptation strategies** that serve to reduce risk.
- **Engage communities** as we work together to lay a framework for future implementation of on-the-ground adaptation strategies.

# Community Resiliency Planning

## Tasks To Be Completed (primarily coastal impacts)

1. Develop community climate vulnerability assessments
2. Conduct comprehensive public outreach & engagement
3. Publish an Adaptation Plan & Implementation Roadmap

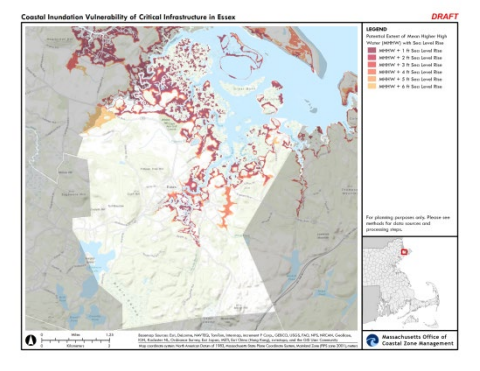
# Town of ESSEX

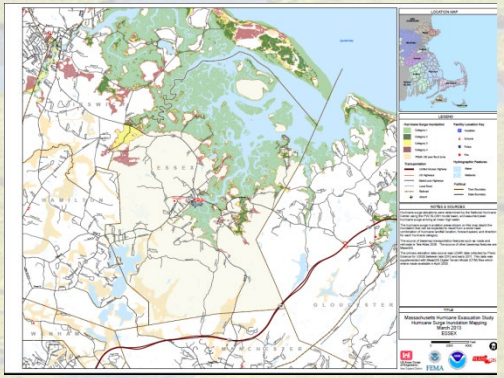
# Essex

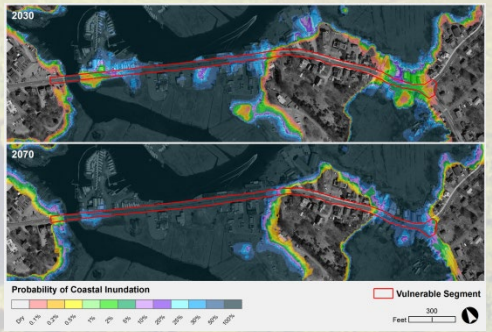
- 16 sq. miles of which 48% is forested and 34% is Great Marsh
- 3504 residents
- Majority of infrastructure located along Rt 133/ Main St Causeway spanning salt marsh and Essex River
- Causeway is a critical transportation corridor

# High-Priority Assets Identified By The Essex Resiliency Task Force

| High-Priority Assets Identified By The Essex Resiliency Task Force | | |
|---|---|---|
| **Priority Asset** | Location | Hazard Type |
| **Main Street Causeway & Woodman's Beach** | 74 Main St. to 166 Main St. | Flooding |
| **Eastern Avenue at Ebben Creek** | 81 Eastern Ave to 97 Eastern Ave | Flooding |
| **Conomo Point Rd** | All of Conomo Point Rd | Flooding |
| **Crane Beach (tip of point)** | | Erosion |
| **Farnham's Restaurant culvert** | 88 Eastern Ave | Flooding |
| **Eastern Ave and Grove St** | Intersection of Eastern Ave and Grove St | |
| **Richdale's Gas Station** | 156 Main Street | Flooding |
| **Ball fields (high school baseball) and playground** | behind Town Hall | Flooding |
| **Landing Road culvert** | Alewife Brook crossing off of Western Ave | Flooding |
| **Apple Street culvert** | near Andrews Street | Flooding |






Fresh water

# Main Street Causeway, Essex

(Example)

## VULNERABILITIES:

- Tidal flooding
- Storm surge flooding


# Main Street Causeway

# Short-Term and Long-Term Strategies

**Short-term Strategies (now - 2030)**

- Create live video feed showing the Causeway so residents and travelers can go online and see in real-time if it's flooded/impassable. Track and monitor flow beneath Causeway.
- Convene Essex Causeway working group (business owners and others) to begin considering long-term impacts and viability. Include representatives from local businesses, regional and state partners, and town officials.

**Long-term Strategies (2030 - 2070)**

- Raise road several feet at least and establish flow under roadway to restore hydrology and increase natural resiliency of marsh; investigate feasibility of a bridge.
- Incorporate climate projections into long-term infrastructure and business planning, including road maintenance and utilities running along the road.
- Ultimately if the road is to be raised substantially, some businesses will need to relocate; start business owner engagement early in the process (partial planned retreat).

# Regional Adaptation Strategies & Recommendations for the Great Marsh (from Great Marsh Adaptation Plan, 2017)

- Best Practices
- Natural and Nature Based Strategies
  - Use living shorelines to stabilize shoreline edges, where appropriate
  - Explore construction of offshore shellfish reefs and beds to attenuate wave energy, reduce erosion, and improve water quality
  - Protect and restore barrier beaches and dunes through renourishment and revegetation
  - Explore opportunities to beneficially reuse dredged material
  - Restore subaquatic vegetation
  - Restore degraded salt marshes
  - Facilitate marsh migration
  - Ensure and restore connectivity of river and coastal systems
  - Enhance land conservation efforts
- Gray Infrastructure and Retrofits
- Land Use Planning and Policy
- Outreach and Engagement

# Municipal Vulnerability Preparedness Workshop
# Town of Essex, MA

April 2018

## Town of Essex
## Community Resilience Building

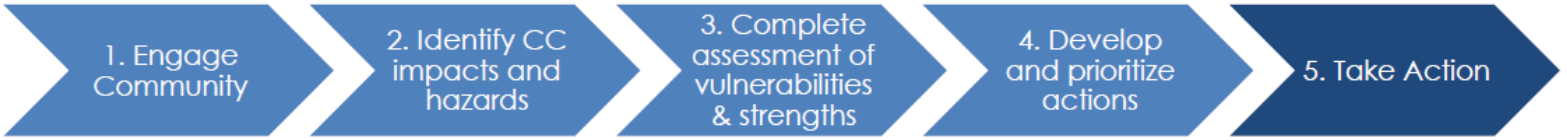
- led by Ipswich River Watershed Association
- all day workshop with data, science, presentations, and discussions
- 35 attendees
- 3 small discussion groups
- facilitated by staff from MassAudubon, MAPC and MBP

# Commonwealth of Massachusetts

## Executive Office of Energy and Environmental Affairs

## Municipal Vulnerability Preparedness Program

***State and local partnership to build resiliency to climate change***




The Municipal Vulnerability Preparedness (MVP) program helps communities in Massachusetts to:

- Define extreme weather and natural and climate related hazards
- Identify existing and future vulnerabilities and strengths
- Develop and prioritize opportunities to take action to reduce risk and build resilience

# Community Resiliency Building Workshop Matrix

## Step 1: We identified the Top 4 Hazards for Essex

Coastal storm surge & sea level rise

Inland flooding

Extreme cold/winter storms/snow

Heat/fire/drought

**Community Resilience Building Workshop Risk Matrix**

H-M-L priority for action over the Short or Long term (and Ongoing)
V = Vulnerability S = Strength

| Features | Location | Ownership | V or S | Coastal Flooding | | | | H - M - L | Short Long Ongoing |
|---|---|---|---|---|---|---|---|---|---|
| **Infrastructural** | | | | | | | | | |
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| **Societal** | | | | | | | | | |
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| **Environmental** | | | | | | | | | |
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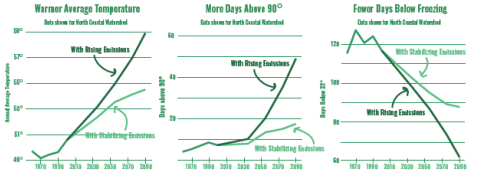
# Climate Change

Essex and the North Coastal Watershed

Our climate is regulated by "greenhouse gases (GHGs)" that trap heat, including carbon dioxide, methane, and nitrous oxide. In the past century, the combustion of fossil fuels, our primary energy source in the age of industrialization, has increased the concentration of GHGs in the atmosphere, which has caused global temperatures to rise. If people stabilize GHG emissions, global temperatures may rise more slowly. If emissions continue increasing at the same rate, we can expect more extreme changes in the climate.

## Higher Temperatures




## As the climate changes, Essex can expect...

### More Large Storm Events

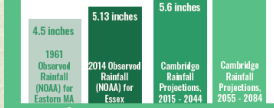
In addition to increasing annual precipitation, climate change will bring more large storm events.

This will lead to more stormwater flooding, as most stormwater drainage has been sized to 1961 standards.

10-year, 24 hour storms refer to the 24-hour rainfall total for the biggest storm expected in a 10-year period.

**Storm drains built for 1961 standards will be inadquate**

Expected size of a 10-year, 24-hour storm




### More Annual Precipitation

**But less in the summer and fall...**

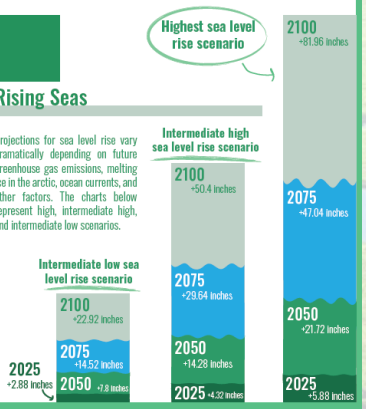
While total annual rainfall and large rainfall events are projected to increase, summer and fall rain is projected to decrease slightly.

**And more frequent droughts...**

Due to the combined effects of earlier snowmelt, less rain, and higher temperatures, summer and fall droughts may become more frequent.

### Rising Seas

Projections for sea level rise vary dramatically depending on future greenhouse gas emissions, melting ice in the arctic, ocean currents, and other factors. The charts below represent high, intermediate high, and intermediate low scenarios.




Sources:
BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World; Massachusetts Department of Fish and Game; Massachusetts Department of Environmental Protection: MassGIS (Bureau of Geographic Information); National Land Cover Database (NLCD)

# Essex

## Social Vulnerability

Social vulnerability refers to social, economic, demographic, or health factors that may make groups of people less resilient to climate change impacts. Certain vulnerabilities tend to be correlated; for example, older adults are more likely to have a disability and live alone than younger adults.

Our strategies for adapting to a changing climate should protect these populations in addition to our natural and built environment.

## Who is most at risk from climate change impacts?

**People who may be more susceptible to negative health effects:** These can include older adults, young children, pregnant women, people with disabilities, and people with pre-existing health conditions, as they are more likely to be physically vulnerable to the health impacts of extreme heat and poor air quality caused by climate change. Individuals with physical mobility constraints, such as people with disabilities and seniors, may need additional assistance with emergency response.

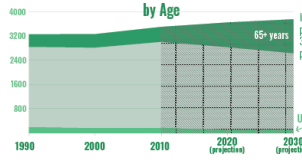
**People who may have more difficulty adapting to, preparing for, or recovering from extreme weather events:** Socioeconomic characteristics such as income and race can influence vulnerability to climate change. Low-income people are often more susceptible to financial shocks, which can occur after extreme weather and which can impact financial security and the ability to secure safe shelter and meet medical needs. Social isolation can also influence vulnerability, as it limits access to critical information, municipal resources, and social support systems. People at the most risk for social isolation include those living alone and people with limited English language proficiency.

**People who live or work in vulnerable locations:** Historic or predicted floodplain, urban flooding locations, areas prone to wildfire, heat islands, neighborhoods prone to power outages. Outdoor workers, first responders, those working in hot indoor environments.

### Older Adults and Young Children

Adults over 65 and children under 5 are more likely to develop health problems on very hot days or during heat waves. Older adults are also more likely to have disabilities or mobility contraints and may need additional assistance during emergencies. They are also more likely to live alone than younger adults.

**Essex Recent and Projected Population by Age**

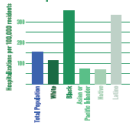



In 2030, seniors are projected to be almost 30% of Essex's total population.

### People with Health Conditions

People who are already in poor health are more likely to be harmed by hot weather and resulting poor air quality.

**Massachusetts Asthma Hospitalizations**




### People Living Alone


As of 2010, approximately 30% of Essex households consisted of someone living alone.

About one-third of people living alone were over 65.

### Communities of Color

Particular racial or ethnic groups may also be more likely to have certain social vulnerabilities than others. For example, Black and Latino populations have a much higher rate of asthma hospitalizations than other groups.

**Essex is becoming more diverse...**

**Although over 96% of the town's population is white...**

**11x** African American population increase since 190

**Populations of color have increased since 1990.**

**2.5x** Asian population increase since 1990

**3x** Latino population increase since 1990

### Low Income Households

Households that earn low incomes are more susceptible to financial shocks triggered by extreme weather, which can cause long-lasting financial insecurity and can make it hard to secure safe shelter, sufficient food, and medical care.

**29.6%** ± 8% Households in Essex that are low-income

*A four-person household earning less than $54,200 is considered low-income

### People Who Work Outside

People who primarily work outside, such as parcel delivery people, construction workers, or farmers, may be at added risk from extra exposure to high heat and poor air quality.

Sources:
American Community Survey (ACS) 2012-2016; United States Census 1990, 2000, 2010; MAPC Projections; Massachusetts Department of Public Health Asthma Data, 2008-2012

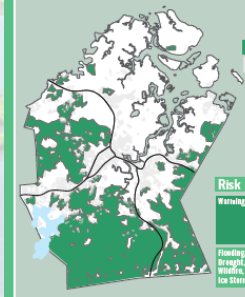
# Essex

## Natural Resources

Natural Resources lessen climate impacts by absorbing and storing carbon dioxide and by serving vital protective functions. Forests, open space, wetlands, rivers, and streams protect drinking water quality and quantity, provide flood control, and give relief from extreme heat. Healthy ecosystems are more resistant to stresses from a changing climate and better able to protect against heat and flooding.

### Trees

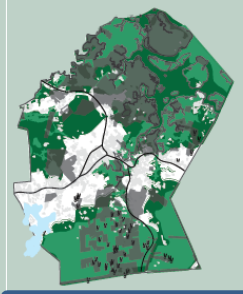
Trees are important in mitigating the impact of heat waves. According to the EPA, suburban areas with mature trees are 4-6 degrees cooler than new suburbs without trees. Shaded surfaces can be 25-40 degrees cooler than the peak temperatures of unshaded surfaces. Trees also absorb remarkable quantities of precipitation. Research has shown that a typical medium-sized tree can intercept as much as 2,380 gallons of rain per year (USDA Forest Service).




| Risk | Impact |
|---|---|
| Warming | Expected to shift forest type from Maple-Birch-Beech forest to Oak-Hickory forest similar to New Jersey.<br>New pests and diseases |
| Flooding, Drought, Wildfire, Ice Storms | Weaken and damages trees |

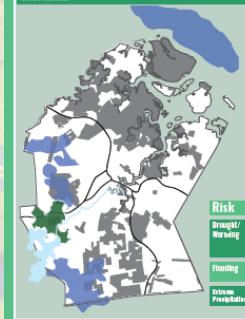
### Terrestrial Resources

The areas of Core Habitat and Critical Natural Landscape in Essex demonstrate a contiguous track of exemplary ecosystems that weave a fabric of resilience. These areas can endure climate change stressors to continue to provide important ecosystem services such as flood control, clean water, clean air, species diversity, and cooling temperatures. They also sequester and store carbon dioxide. Vernal pools, or small seasonal wetlands, are crucial habitats for species such as salamanders.




### Freshwater Resources

Essex contains, healthy, intact freshwater wetland systems that sustain critical ecosystem functions in climate change. These ecological assets protect drinking water quality and quantity, provide flood control, and maintain overall ecosystem health for climate resilience.

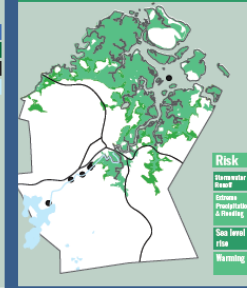



| Risk | Impact |
|---|---|
| Drought/ Warming | Seasonal no-flow/ low-flow, reduced absorption capacity, diminished fish habitat, algal blooms, low dissolved oxygen, reduced drinking water supply |
| Flooding | Impaired waters, toxic exposure, contaminant loading |
| Extreme Precipitation | Scouring impaired waters, sewer overflows |

### Coastal Resources

Salt marshes and estuaries are complex and highly productive ecosystems generally resilient to wide variations in temperature, salinity, and inundation. Ecological benefits of salt marshes include: floodwater storage, storm surge protection, carbon sequestration/storage, nutrient removal, water quality improvements, and commercial fish and shellfish habitat.

Coastal bays host critical ecosystems for coastal resilience: shellfish growing areas, eel grass meadows, anadromous fish (saltwater fish that spawn in fresh water), and resident and migratory birds, some of which are threatened and endangered.




| Risk | Impact |
|---|---|
| Stormwater Runoff | Threatens to pollute salt marshes |
| Extreme Precipitation & Flooding | Extreme storms threaten to harm salt marshes; flooding increases nonpoint pollution to bays |
| Sea level rise | Persistent salt water inundation to salt marshes |
| Warming | Invasive species migrate to warmer waters; ocean acidification |

Sources:
MassGIS (Bureau of Geographic Information); BioMap2: Conserving the Biodiversity of Massachusetts in a Changing World; Massachusetts Department of Fish and Game; Massachusetts Department of Environmental Protection: MassGIS (Bureau of Geographic Information); National Land Cover Database (NLCD); Trust for Public Land; MAPC; University of Vermont

## Step 2: Important Community Features

***What features and resources in Essex are most VULNERABLE to weather-related impacts?***

- Infrastructure: e.g. buildings, roads, bridges, wells
- Environment/natural resources: e.g. salt marsh, clam beds
- Society/people: e.g. elderly citizens living in flood zones

# Findings: Highest Priority Actions

## Infrastructural Features

1. **Causeway/Route 133 Resiliency Planning**, including Main Street bridge repairs – working with the State and with Business groups
2. **Apple Street –** planning and management so as to keep it a safe and useable alternate transportation route when Causeway/Route 133 floods
3. **Safe Drinking Water** - study of vulnerabilities related to assuring safe and plentiful drinking water in the future
4. **Multi-faceted emergency warning system** for the public

# Findings: Highest Priority Actions

## Environmental Features

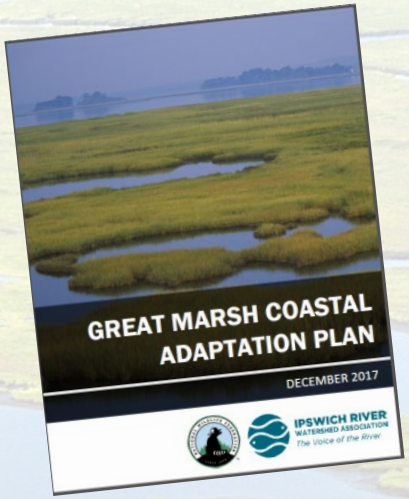
1. **Salt marsh restoration and management –** including protection of shellfish, addressing erosion, study of sediment and movement of sand throughout the marsh)
2. **Mouth of the Essex River –** study of sediment and movement of sand
3. **Beaver management –** plan for municipal stewardship
4. **Chebacco Lake Watershed -** protection of ecosystem, wildlife habitat, and water supply
5. **Forest management**, both public and private lands, and resiliency to address disease and threats of forest fire

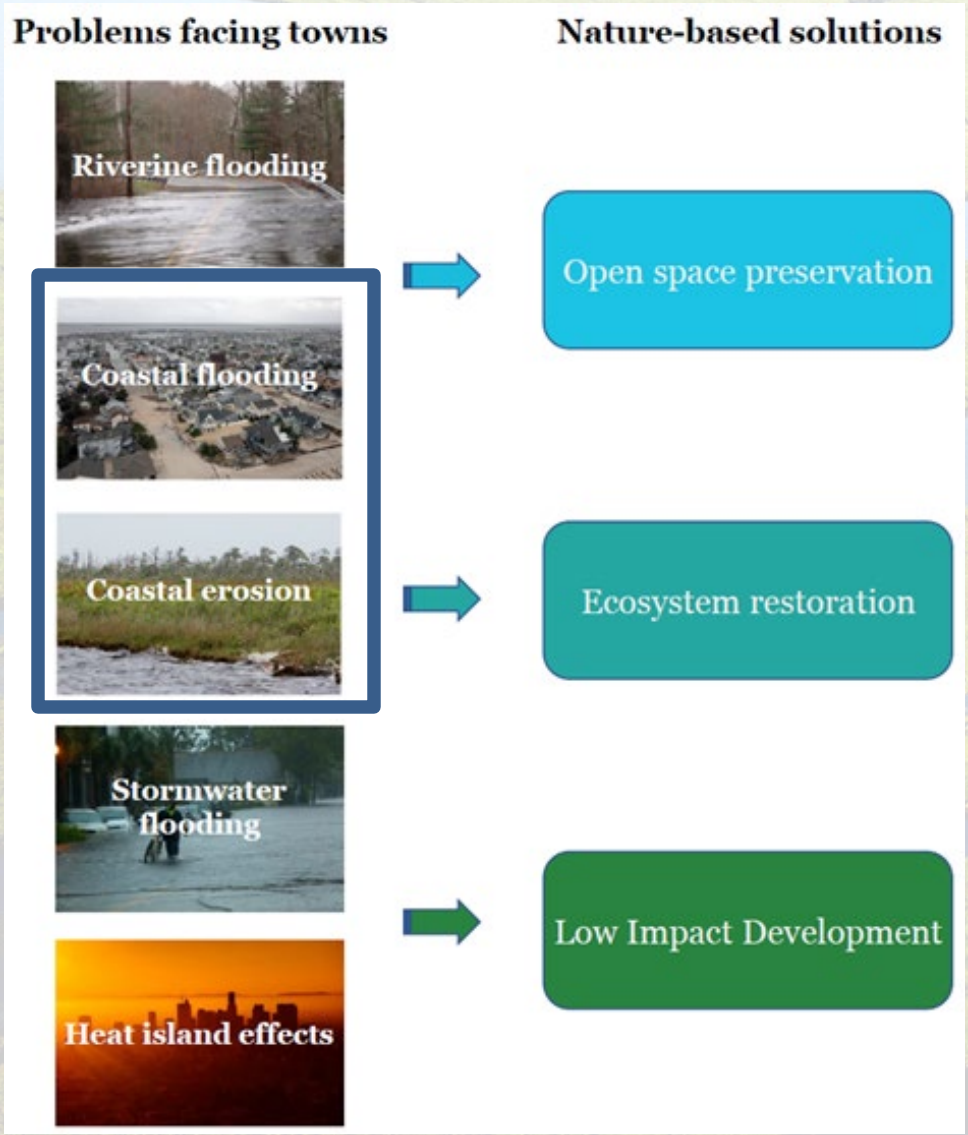
# Findings: Highest Priority Actions

## Societal Features

1. **Municipal outreach & education program**, including Preparedness Training (led by strategic planning committee)
2. **Emergency services & sheltering plan, supplies & communications plan**
3. **Adoption of Great Marsh Adaptation Plan (Sandy Grant)**
4. **Create database of vulnerable citizens**
5. **Business Community & Chamber of Commerce,** education and knowledge sharing, including best practices

# A Menu of Adaptation Strategies




# Step 3: We identified actions to address these vulnerabilities

**For example: Main Street Causeway**

Vulnerabilities:

- Tidal flooding
- Storm surge flooding
- Sea level rise

## STRATEGIES & ACTIONS:

- Causeway reconstruction in 2012
- Emergency vehicles
- Engage business owners
- Green Infrastructure & Low Impact Development
- Explore alternate routes: Apple Street
- Long-term: raise road, move businesses
- **Improve Marsh Resiliency** (first line of defense)

# MVP Top Recommendations to Improve Resilience

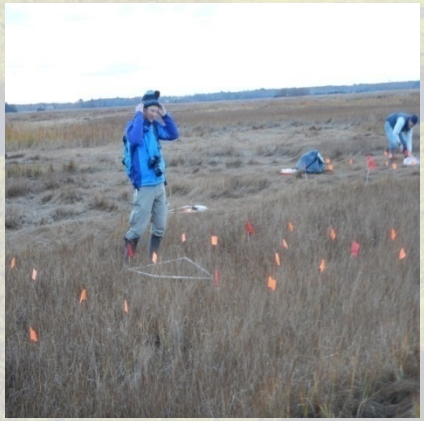
1. Salt Marsh Restoration and Management – Multiple strategies are underway and should be continued and enhanced to *restore and protect the Essex salt marsh*. These strategies may include: **addressing erosion of degraded marsh banks by building mussel reefs and other strategies;** studying the movement of sand and sediment throughout the marsh; land protection for marsh migration; **exploring opportunities to beneficially reuse dredged material**; study and exploration of the development of oyster/mussel beds; invasive species removal; planting eel grass to help with **wave attenuation during storms**; using green infrastructure to reduce stormwater pollution so as to keep shellfish beds open and healthy; and more.

2. Mouth of the Essex River Study and Management – Efforts should continue to work with partners to study and better understand the movement of sediment at the mouth of the Essex River and throughout Essex Bay, including analyses of channel and creek hydrology, marsh platform elevation changes and response to sea level rise, marsh bank

3. Management of Inland Flooding
4. Chebacco Lake watershed Protection
5. Forest Protection and Management
6. Regulatory Issues

# Ongoing Great Marsh Resiliency Projects

- Eelgrass Restoration (& green crab control)
- Barrier Beach Dune Restoration
- Marsh Drainage Restoration
- Marsh Bank Erosion
  - Living Shorelines (TLP, Mussel Bed Restoration)
- Hydrology, Salinity, and Sediment Modeling
- Restoring Native Marsh Platform Vegetation through Invasive Species Management
  - *Phragmites australis*
  - Perennial Pepperweed
- Essex River Dredging Project (ACOE)



# MVP Action Grant Awards in the Great Marsh

| | | |
|---|---|---|
| **Essex** | **Feasibility Study for an Essex Bay Living Shoreline (mussel reef study)** | **$15,000** |
| **Essex (and Great Marsh communities)** | **Documenting Effects of a Large-Scale, Natural Sediment Event on Salt Marsh Resiliency in the Great Marsh Estuary: Assessing Applicability for Potential Salt Marsh Management Strategies in Massachusetts (TLP)** | **$60,000** |
| Gloucester | Watershed and Water Supply Vulnerability, Risk Assessment and Management Strategy | $107,044 |
| Newburyport | Wastewater Treatment Plant Climate Resilience | $122,695 |
| **Newbury (and Great Marsh communities)** | **Assessing storm energy reduction by the vegetated salt marsh platform in Newbury, MA: a background to enhancing natural protection by the living shoreline (native vegetation)** | **$225,840** |

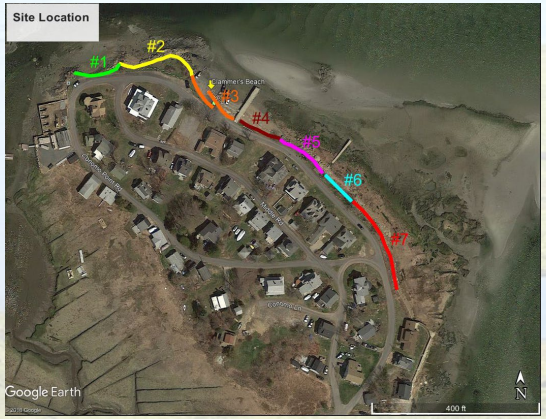
Mapping Marsh Vegetation in Newbury

# Nature-Based Projects Funded through MVP Action Grants that Benefit the Town of Essex

- Attenuation of SLR/Storm Surge through Marsh Vegetation (Newbury)
- Thin-layer Placement of Sediment on the Marsh (Essex)
- Mussel Reef Assessment (research), (Essex)

Robust regrowth of marsh grasses was the dominant result noted during field evaluations of the sediment event (left) but isolated patches of repressed growth were noted at each site (right).

# Seawall Assessment, Conomo Point




- Increased Storm Surge to the marsh and Conomo Point
- Resulting from loss of portion of barrier beach protecting Essex Bay(Crane Beach)
- $65,000 from Dam and Seawall Grant (EEA)

Peter Phippen
Town of Essex
MassBays National Estuary Program
Eight Towns and the Great Marsh Committee
Merrimack Valley Planning Commission
Great Marsh Resiliency Partnership

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