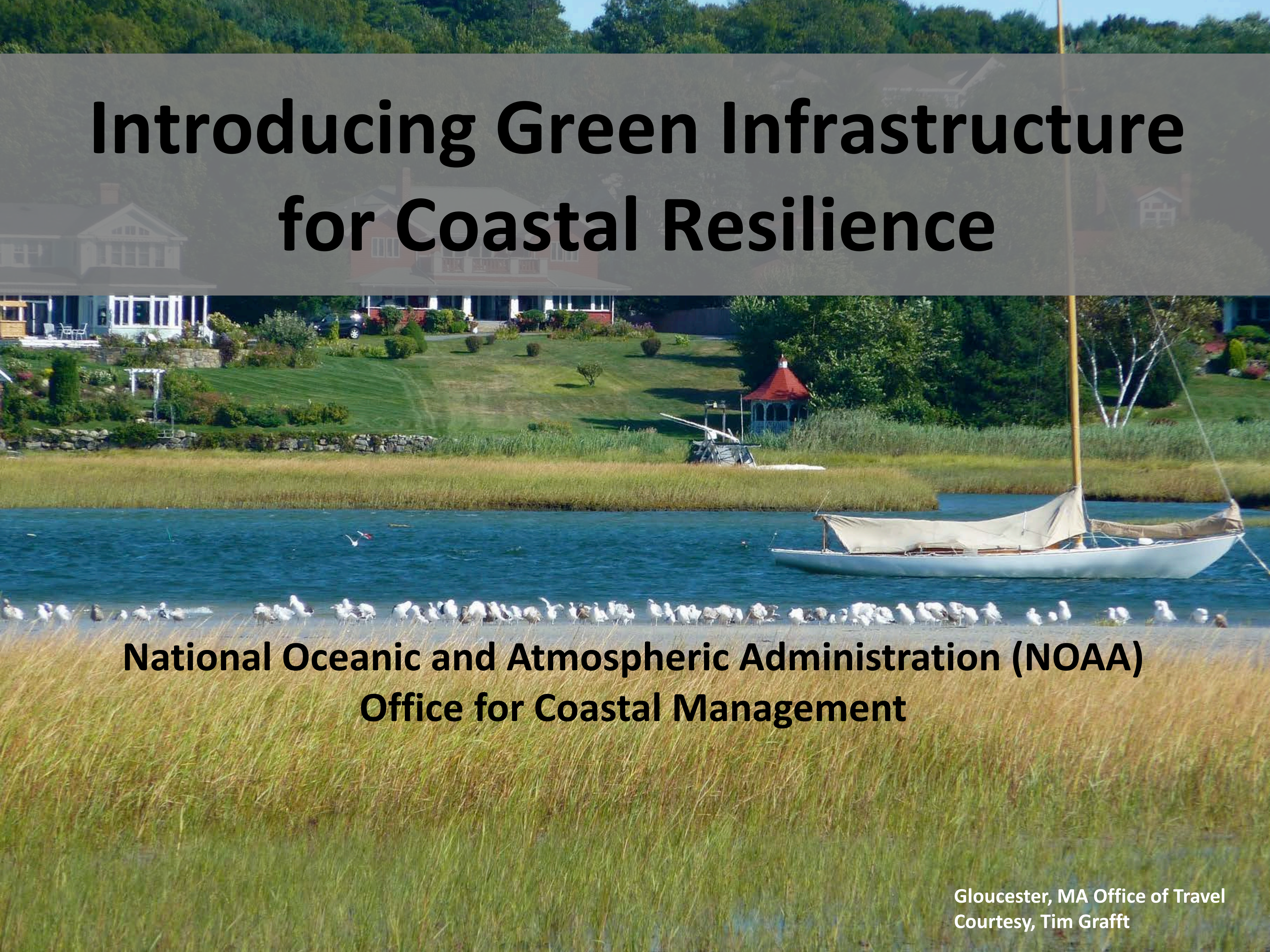
Introducing Green Infrastructure for Coastal Resilience



National Oceanic and Atmospheric Administration (NOAA)
Office for Coastal Management

Gloucester, MA Office of Travel
Courtesy, Tim Grafft

What Is "Resilience"?

Introducing Green Infrastructure for Coastal Resilience

Course Objectives

Introducing Green Infrastructure for Coastal Resilience

Participants:

- Recognize green infrastructure terms and concepts that contribute to community resilience
- Understand ecological, economic, and societal benefits of green infrastructure
- Understand the wide variety of contexts and scales of approaches
- Understanding of how green infrastructure fits into existing planning processes, tips on engaging stakeholders, and potential funding opportunities
- Identify local green infrastructure activities and experts with additional information and resources

Course Outline

Introducing Green Infrastructure for Coastal Resilience

1. Green Infrastructure Concepts and Principles
2. The Practice of Green Infrastructure
3. Implementing Green Infrastructure

A Quick Hello!

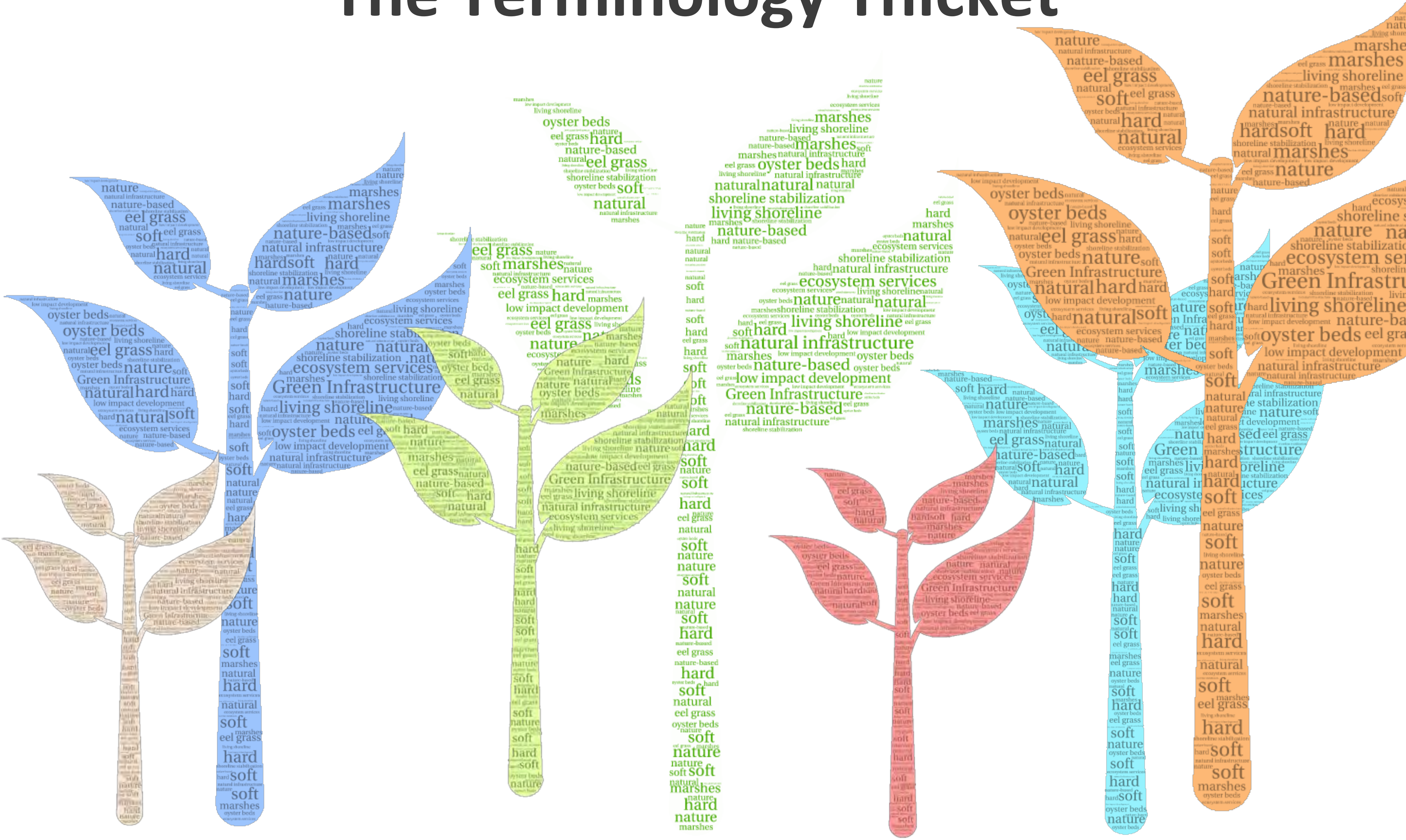
- **Name**
- **Affiliation**
- **One Word** you think of when you hear the term "Green Infrastructure"

Section 1

Green Infrastructure Concepts and Principles

Parker River National Wildlife Refuge, Newburyport
Courtesy, Fish and Wildlife Service

The Terminology Thicket



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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Foundations of Green Infrastructure

Green Infrastructure Concepts and Principles

Landscape Architecture

1860s

Landscape Ecology

1930s

Design with Nature

1960s

Conservation Biology

1970s

Clean Water Act

1970s

Foundations of Green Infrastructure

Green Infrastructure Concepts and Principles

Landscape approach?

Site-level approach?

Applicability across Scales

Green Infrastructure Concepts and Principles

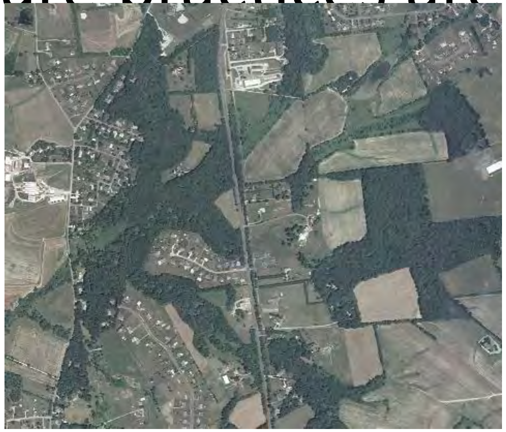
Landscape and watershed

Commun[ity]
and sit[e]

Importance of Context

Green Infrastructure Concepts and Principles

Green infrastructure practices are context sensitive.



Rural → Urban

Coastal ← Upland

Why Green Infrastructure?

Green Infrastructure Concepts and Principles

Coastal Shoreline Counties

Population

123.3 million

Coastal Shoreline County population in 2010.

39%

Percent of the U.S. population that resides in Coastal Shoreline Counties in 2010.

34.8 million

Coastal Shoreline County population change from 1970 to 2010, a 39% increase.
(U.S. average 52%)

10 million

Projected population change in Coastal Shoreline Counties from 2010 to 2020, an 8% increase.
(U.S. average 10%)

Humpback Whale National Marine Sanctuary. Credit: Fiona Langenberger

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Figure 3 | Population Change in Coastal Shoreline Counties: 1970-2010

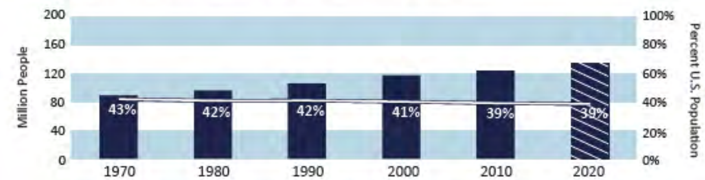
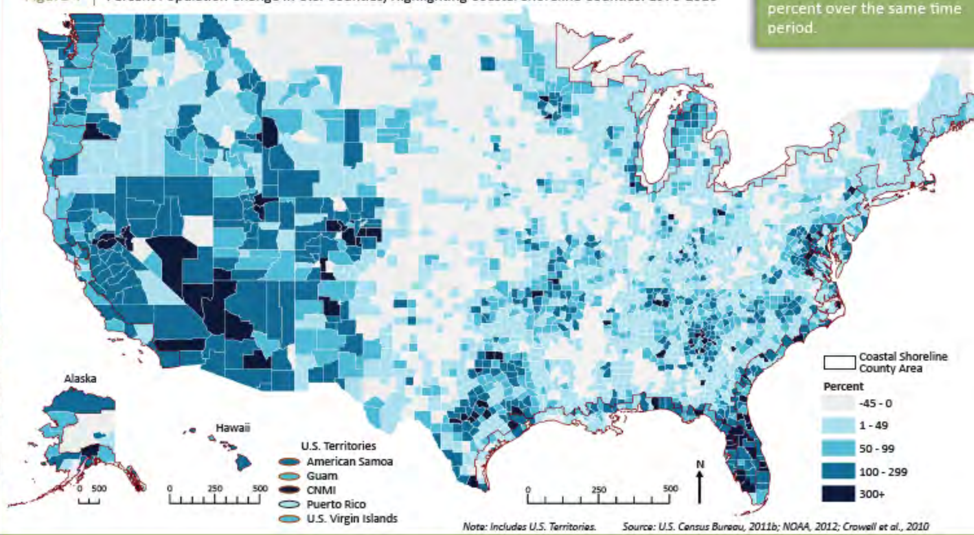


Figure 4 | Percent Population Change in U.S. Counties, Highlighting Coastal Shoreline Counties: 1970-2010



Note: Includes U.S. Territories. *Source: U.S. Census Bureau, 2011b; NOAA, 2012; Crowell et al., 2010*

The Bottom Line

In 2010, 123.3 million people, or 39 percent of the nation's population lived in Coastal Shoreline Counties. Population growth in these counties occurred at a lower rate than the nation as a whole from 1970 to 2010. The population in Coastal Shoreline Counties increased by 34.8 million people, a 39 percent increase, while the nation's entire population increased by 52 percent over the same time period.

NOAA's National Coastal Population Report

Why Green Infrastructure?

Green Infrastructure Concepts and Principles


Collins Cover, Salem
Courtesy, Elizabeth Hollin


Hurricane Sandy
Courtesy, Brian Birke


Hurricane Sandy
Courtesy, Brian Birke

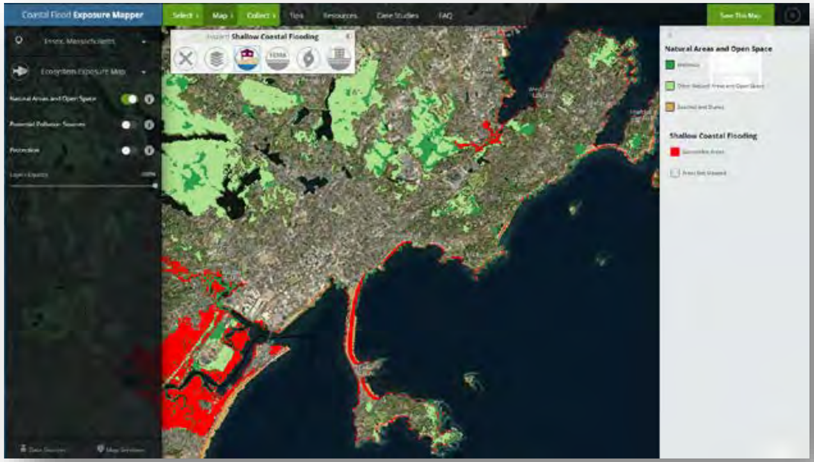
Why Green Infrastructure?

Green Infrastructure Concepts and Principles

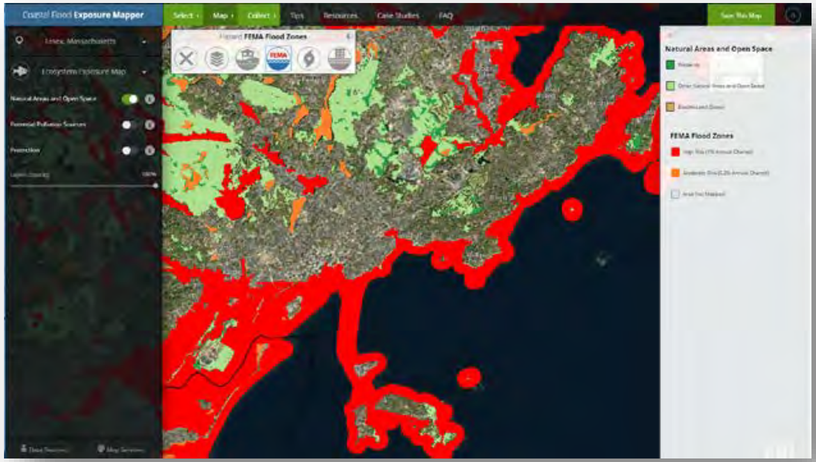
Courtesy, Adam Whelchel, TNC

Exposure to Coastal Hazards

Green Infrastructure Concepts and Principles



Shallow Coastal Flooding



FEMA Flood Zones

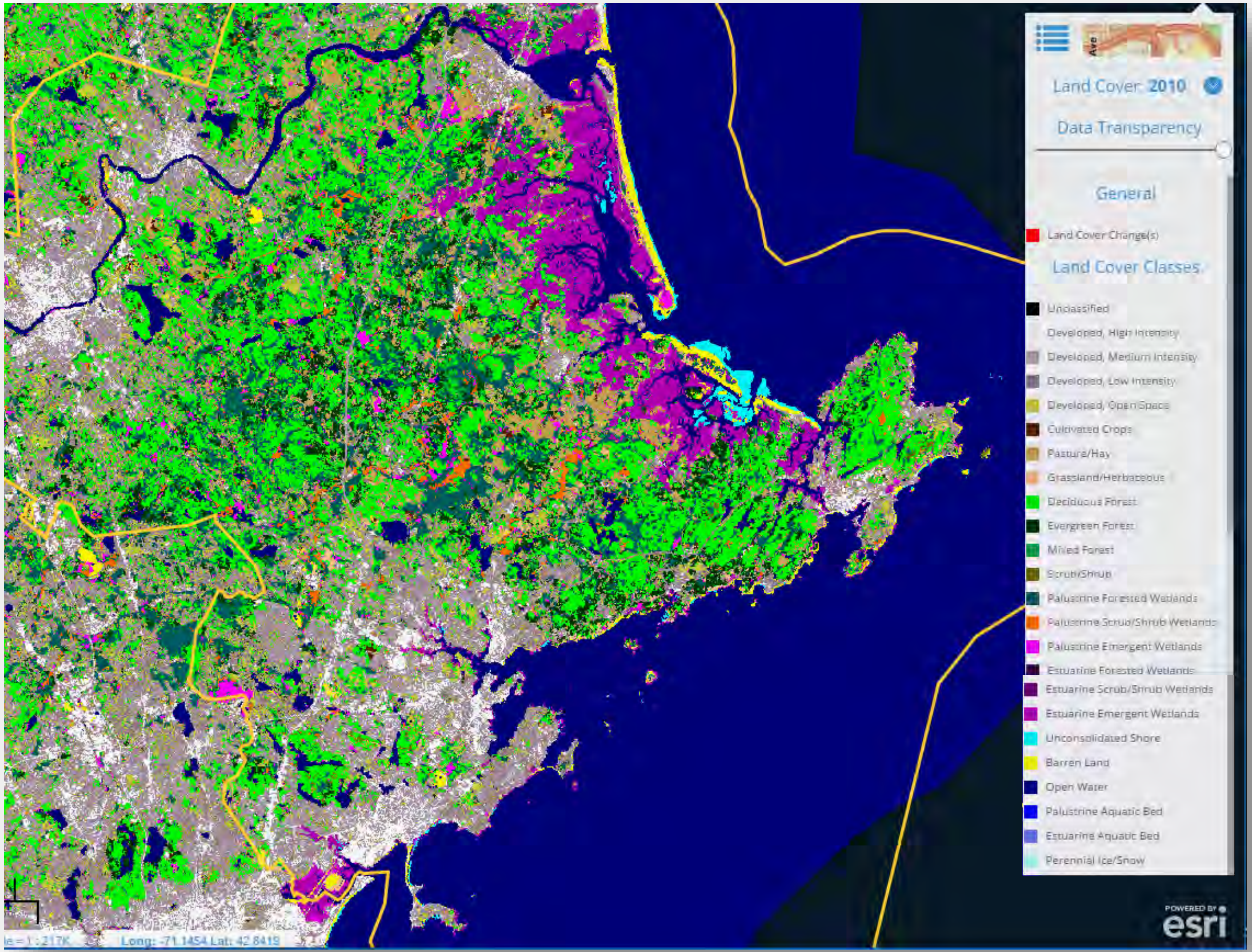
Storm Surge

Sea Level Rise

coast.noaa.gov/digitalcoast/tools/flood-exposure

Visualizing Land Cover

Green Infrastructure Concepts and Principles



coast.noaa.gov/digitalcoast/tools/lca

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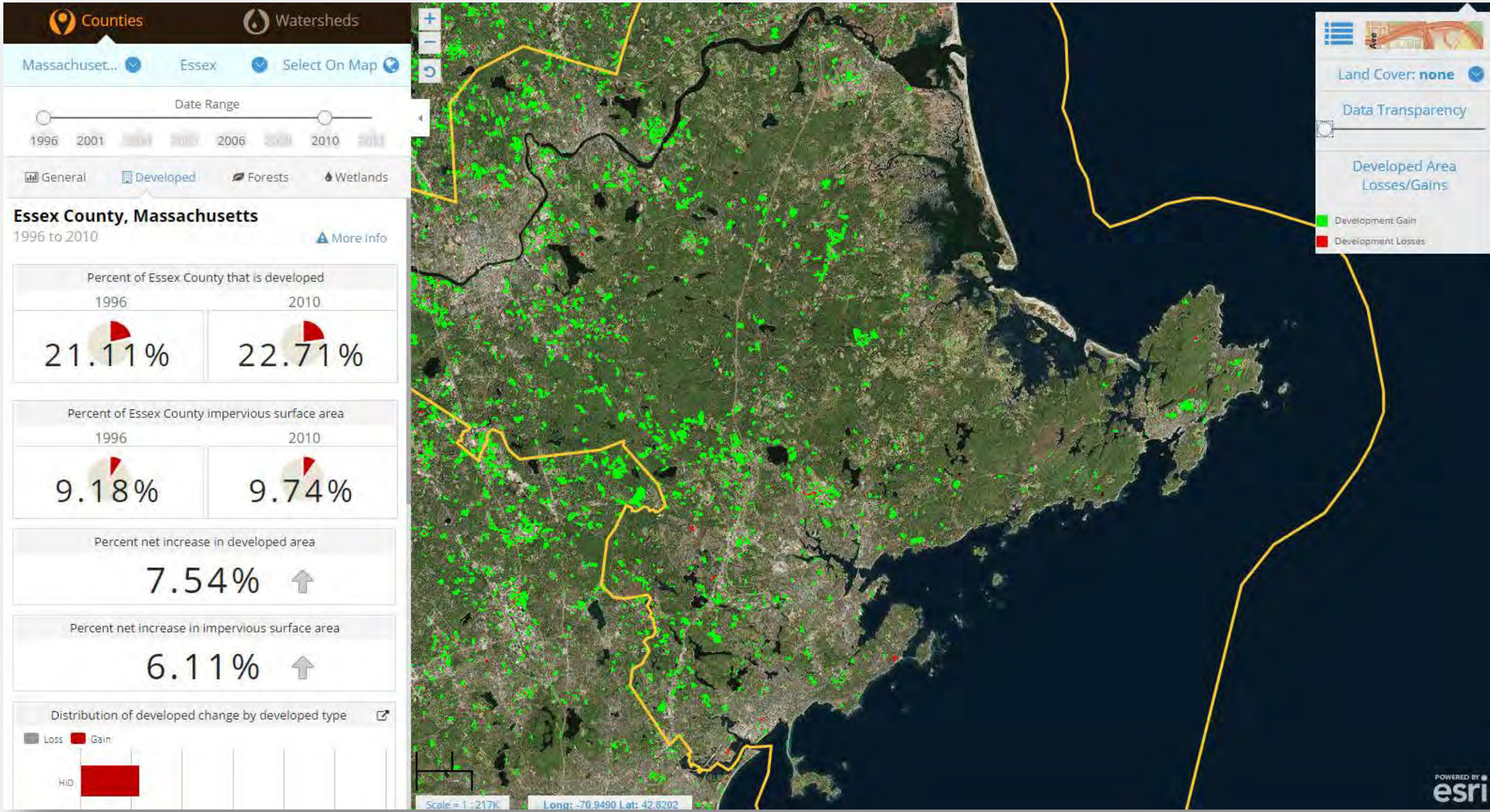
Visualizing Land Cover

Green Infrastructure Concepts and Principles



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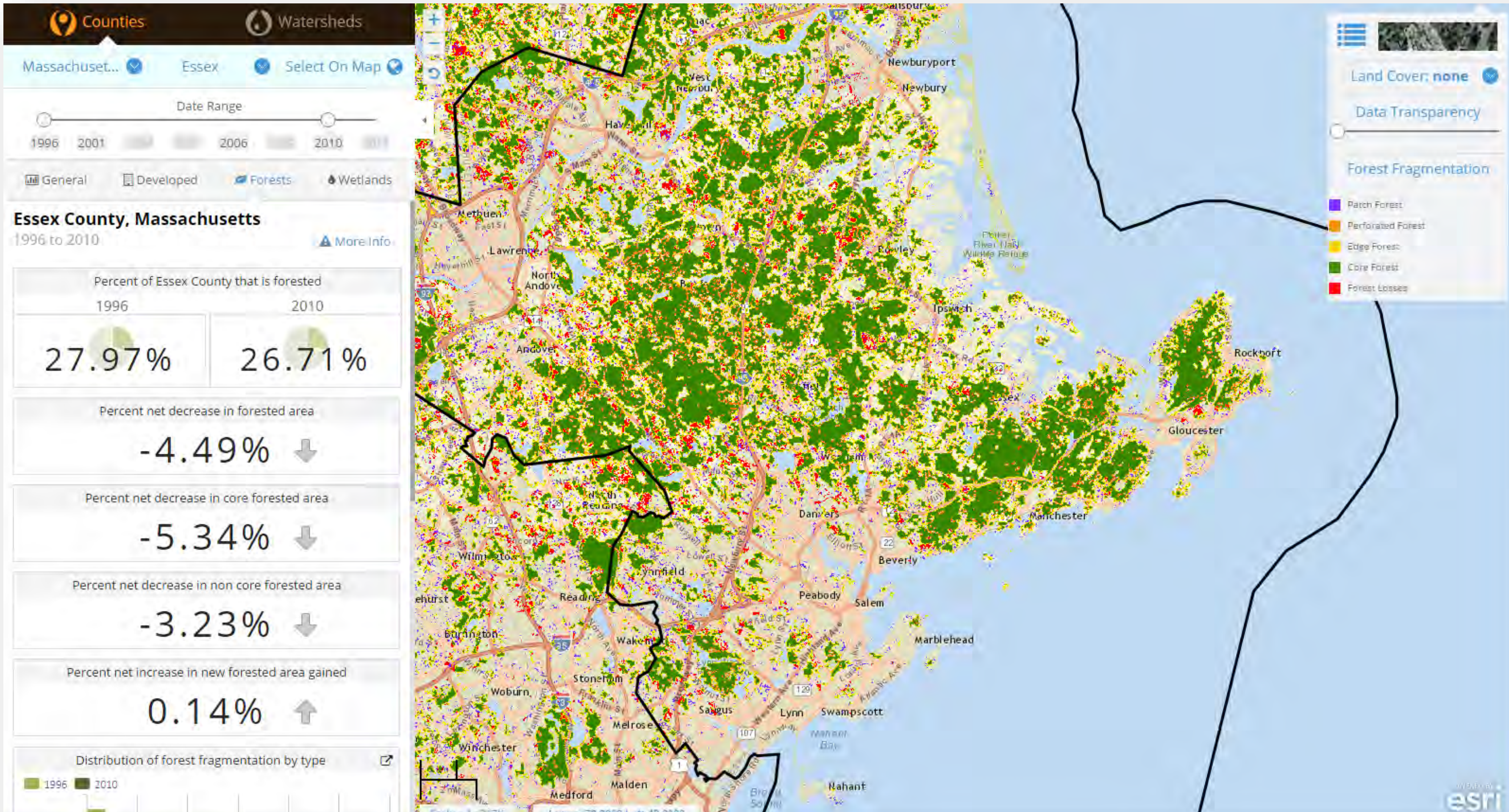
Visualizing Land Cover

Green Infrastructure Concepts and Principles



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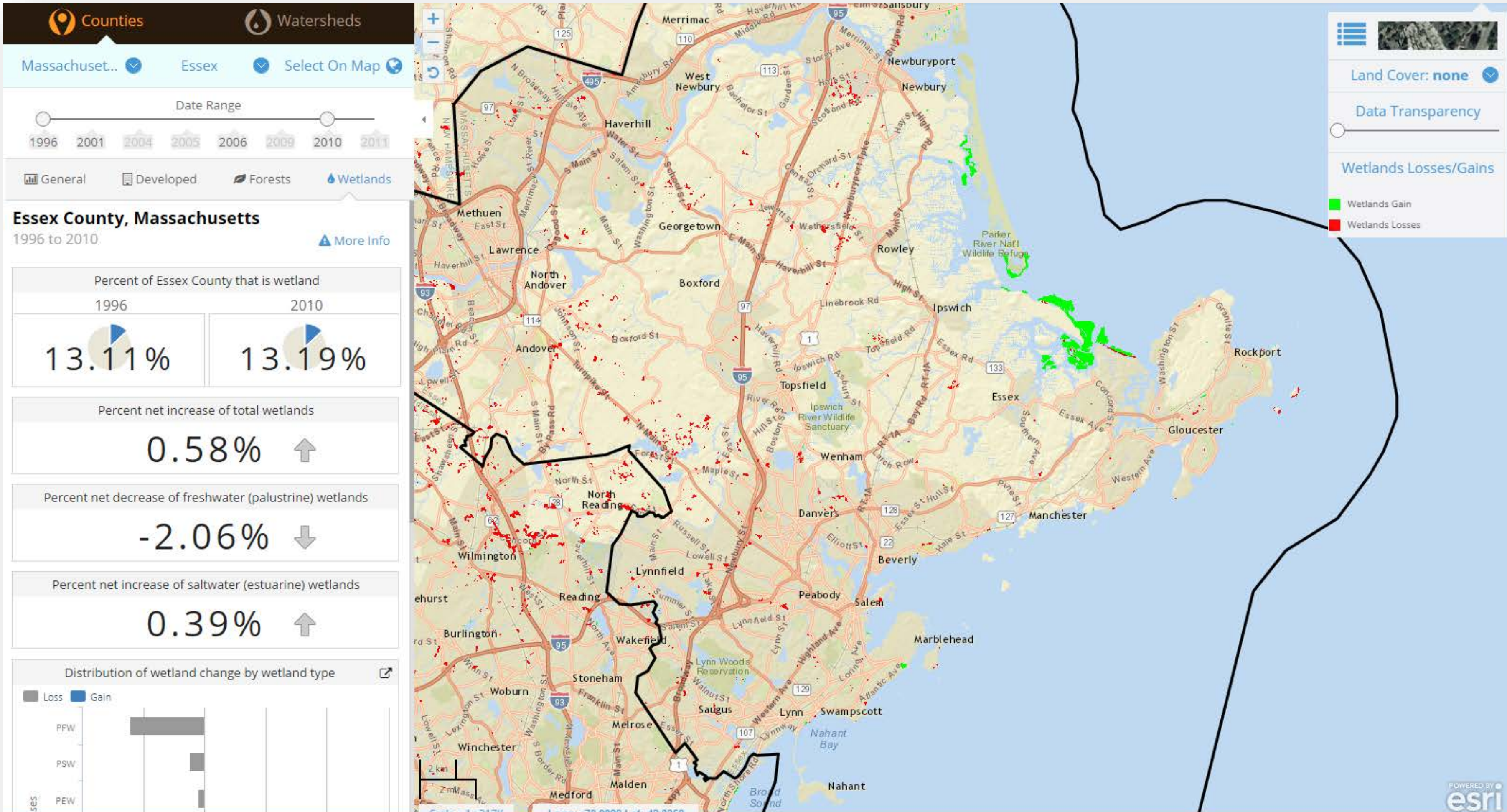
Visualizing Land Cover

Green Infrastructure Concepts and Principles



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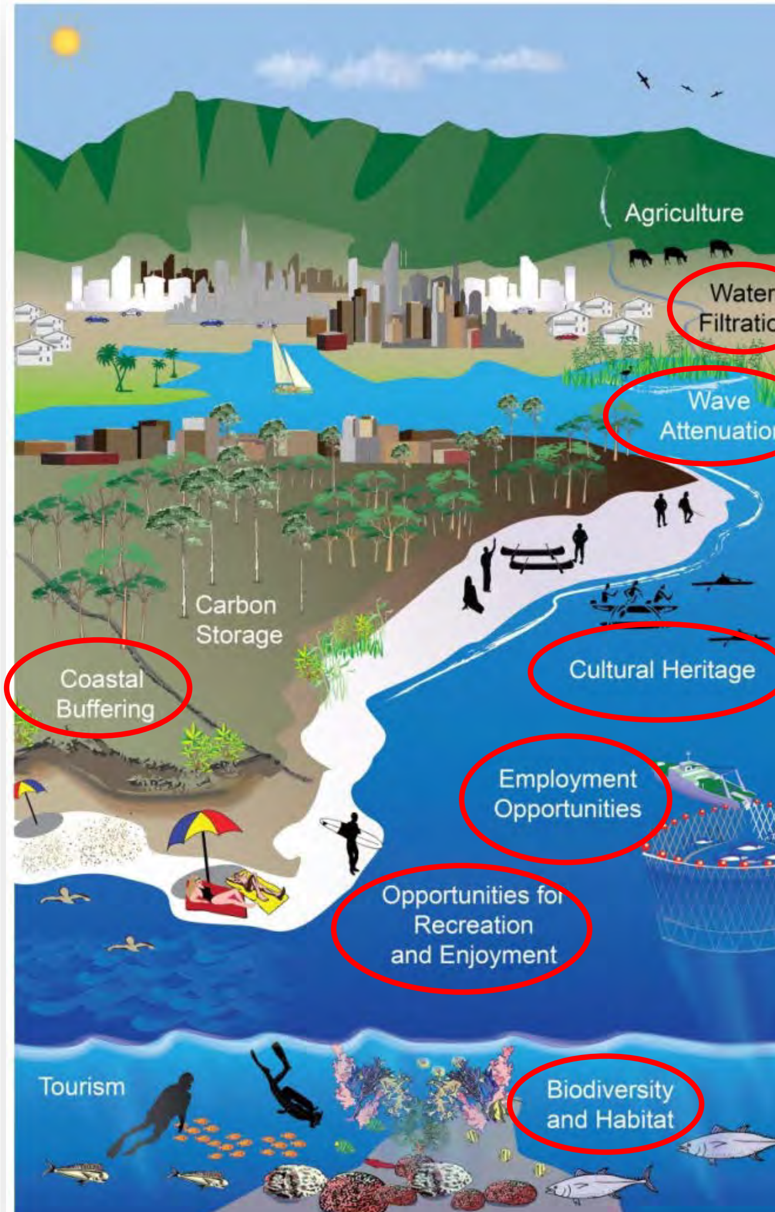
Ecosystem Services

Natural ecosystems provide multiple benefits to people, including food and water production, improved air and water quality, and recreation and spiritual inspiration.

Multiple Benefits

- Environmental
- Societal
- Economic



Who's Benefit

A wide variety of stakeholders stand to benefit. Engaging stakeholders is an essential part of understanding the benefits and how they are valued by people.

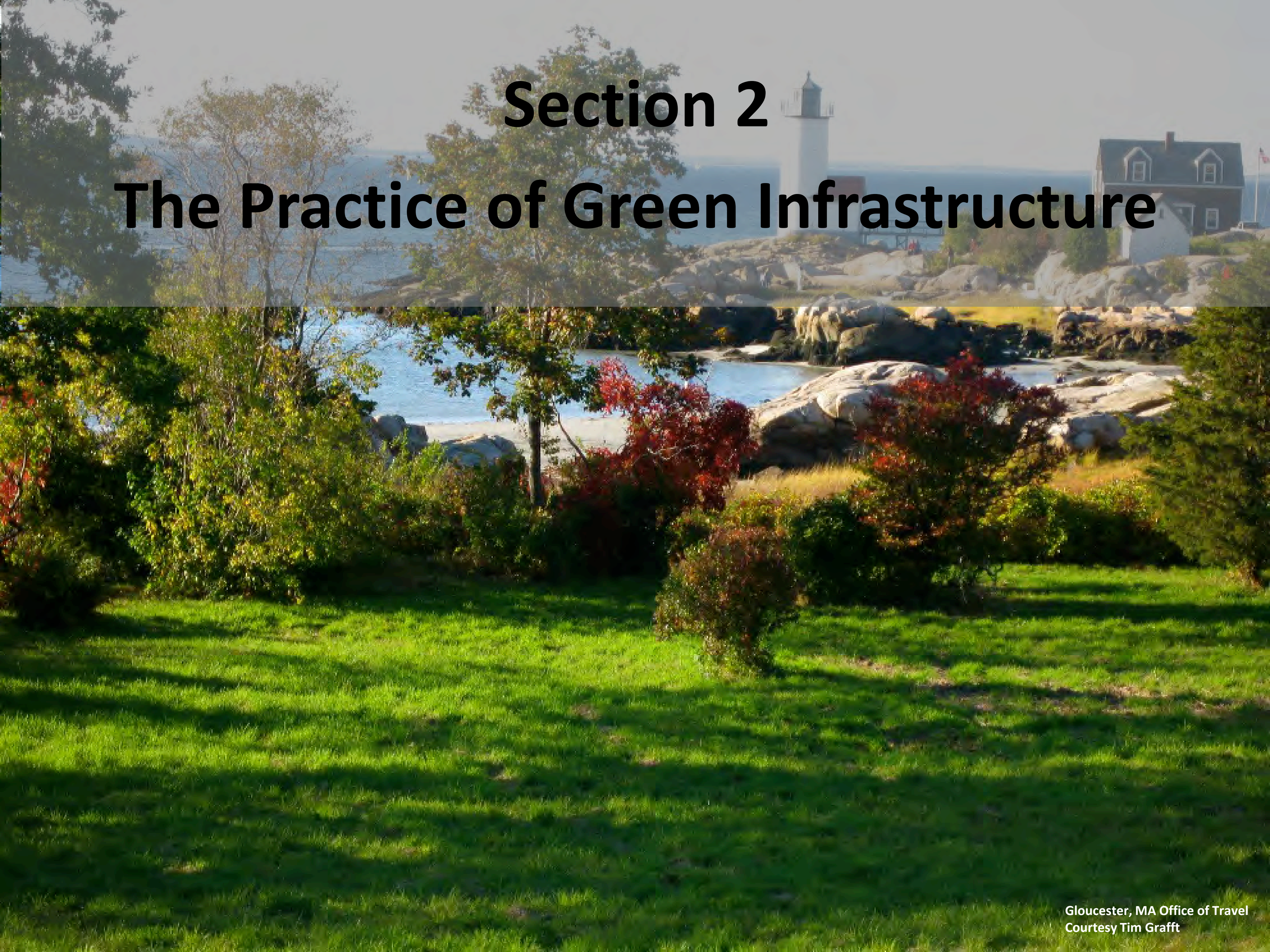
Table Discussion 1

Green Infrastructure Concepts and Principles

What coastal hazard issues is your community experiencing? (e.g., flooding, stormwater runoff)

Section 2

The Practice of Green Infrastructure



Gloucester, MA Office of Travel
Courtesy Tim Grafft

Planning Concepts

The Practice of Green Infrastructure

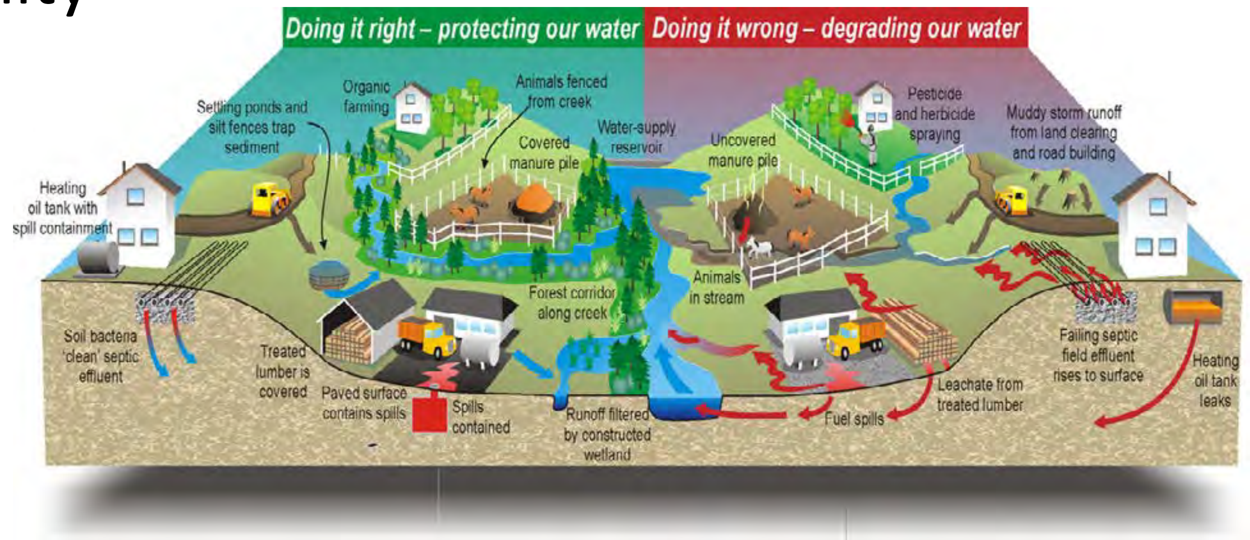
- Approach will depend on the ***scale*** you are addressing
- All practices, regardless of scale, use ***ecosystem services*** to acquire maximum benefits
- Design methods are repeatable and grounded in ***science***
- ***Context*** is important

Design Concepts

The Practice of Green Infrastructure

Successful green infrastructure practices incorporate

- Multi-functionality
- Resilience
- Sense of place
- Return on investment



Green Infrastructure in Practice

The Practice of Green Infrastructure

Landscape and watershed

Commu

and si

Landscape Design Concepts

The Practice of Green Infrastructure

	BETTER	WORSE
Area		
Proximity		
Connectivity		

Landscape and Watershed Approaches and Resilience

The Practice of Green Infrastructure

- Recent study* on flood reduction during Hurricane Sandy showed:
  - Coastal wetlands saved more than $625 million in flood damages
  - Where they exist, coastal wetlands reduced damages by more the 10% on average
  - In Ocean County, NJ wetland conservation can reduce average annual losses by more than 20%

*Coastal Wetlands and Flood Damage Reduction: Using Risk Industry-Based Models to Assess Natural Defenses in the NE USA, 2016.

Community and Site Design Concepts

The Practice of Green Infrastructure

- Natural areas and open spaces should serve multiple functions (e.g., recreation, stormwater storage, filtration)
- Connect people to open areas through greenways and trails
- Preserve or mimic the natural hydrological functions of a site or drainage area
- Use urban streetscapes to provide ecosystem benefits in urban areas

Community and Site Approaches

The Practice of Green Infrastructure

Urban Forestry

- Trees provide enormous environmental, economic, and societal benefits
- Develop a tree planting program designed to maximize benefits
- To the extent possible, protect existing forested areas, particularly large specimen trees

Community and Site Approaches

The Practice of Green Infrastructure

Green Streets

- Key linking component in green infrastructure network
- Design dependent on local conditions but generally include
  - Alternative street widths
  - Swales
  - Bioretention
  - Permeable pavements
- Provides multiple benefits

Philadelphia Water Department

Coos Bay, Oregon

Community and Site Approaches

The Practice of Green Infrastructure

Environmental Site Design

- Place the site in context to greater community
- Preserve and enhance natural features
- Mimic or enhance existing hydrology
- Minimize impervious cover
- Key component of low impact development (LID)

TrockWorks Architectural Services

Community and Site Approaches

The Practice of Green Infrastructure

Low Impact Development Practices

Bioretention (Infiltration and Filtering)

- Rain gardens
- Bioswales
- Stormwater planters

Green Roofs (Storage and Evapotranspiration)

- Blue roofs
- Cisterns

Permeable Pavements (Infiltration)

- Porous asphalt/concrete
- Grass or gravel pavers
- Pavers

Community and Site Approaches and Resilience

The Practice of Green Infrastructure

- Many studies on the effectiveness of these practices for
  - Reducing the heat island effect
  - Improving water quality
  - Recharging groundwater
  - Providing societal benefits

- For LID, flood reduction is a 'co-benefit'
  - City of Portland, OR reduced peak flow of stormwater runoff by 93%, cooling costs by 27%, and heating costs by 15%.

Shoreline Design Concepts

The Practice of Green Infrastructure

- Natural or Nature-Based
  - Dunes and beaches
  - Vegetated features (salt marsh, wetlands, submerged aquatic vegetation)
  - Oyster and coral reefs
  - Barrier islands
  - Maritime forest/shrub communities
- Hybrid
  - Natural and structural features
- Nonstructural
  - Floodplain policy and management
  - Flood proofing

Shoreline Approaches

The Practice of Green Infrastructure

Natural or Nature-based

Dune and Beach Creation

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

Salt Marshes, Wetlands, Vegetation, SAV

- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer
- Increase infiltration

Oyster and Coral Reefs

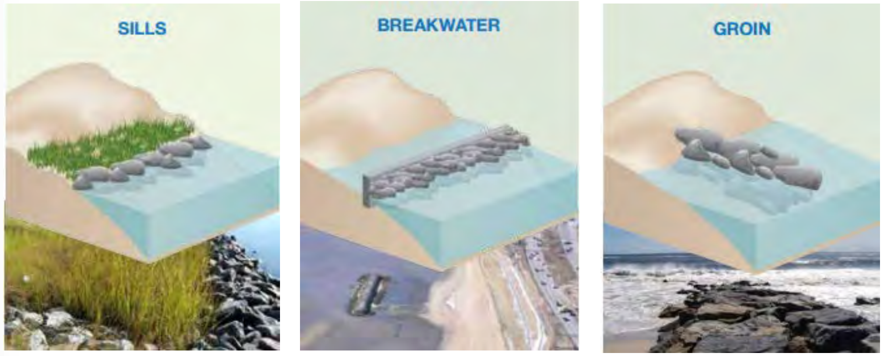
- Break offshore waves
- Attenuate wave energy
- Slow inland water transfer

Shoreline Approaches

The Practice of Green Infrastructure

Hybrid

Courtesy, Tracy Skrabal, NC Coastal Federation



http://sagecoast.org/info/information.html

- Blends both nature-based and structural approaches
- Derives benefit of wave energy dissipation from structural practices
- Derives ecosystem service benefits from nature-based practices

Shoreline Approaches and Resilience

The Practice of Green Infrastructure

- Study* conducted in North Carolina before and after Hurricane Irene showed:
  - Marshes with and without sills are more durable and protected shorelines from erosion better than the bulkheads during the Category 1 storm.
  - 76% of bulkheads were damaged in the storm.
  - No damage occurred to shorelines with or without sills.

Courtesy, Tracy Skrabal, NC Coastal Federation

*Marshes with and without sills protect estuarine shorelines from erosion better than bulkheads during a Category 1 hurricane, 2014

Table Discussion 2

What green infrastructure-related projects are you working on now, or hope to, that contribute to preserving resilience-enhancing ecosystem services in your community? **Record one sentence project description, location, your contact information (put a "P" if it is an existing or planned project and put an "I" if it is an idea).**

Section 3
Implementing Green Infrastructure

Courtesy, Waquoit Bay NERR

Barriers to Green Infrastructure

Implementing Green Infrastructure

Technical and Physical

- Lack of understanding
- Lack of data showing benefits, costs, and so on
- Insufficient technical knowledge or experience
- Lack of design standards, codes, and ordinances

Financial

- Not enough data about costs and economic benefits
- Perceived high costs over short and long terms
- Lack of funding for implementation
- Too much risk – not enough incentives

Legal and Regulatory

- Local rules lacking, conflicting, or restrictive
- State policies
- Property rights issues
- Federal rules can be conflicting

Community and Institutional

- Insufficient information and green infrastructure benefits for political leaders, administrators, staff, developers, builders, and landscapers
- Community and institutional values that underappreciate green infrastructure aesthetics and characteristics
- Lack of interagency and community cooperation

Green Infrastructure Can Inform Planning

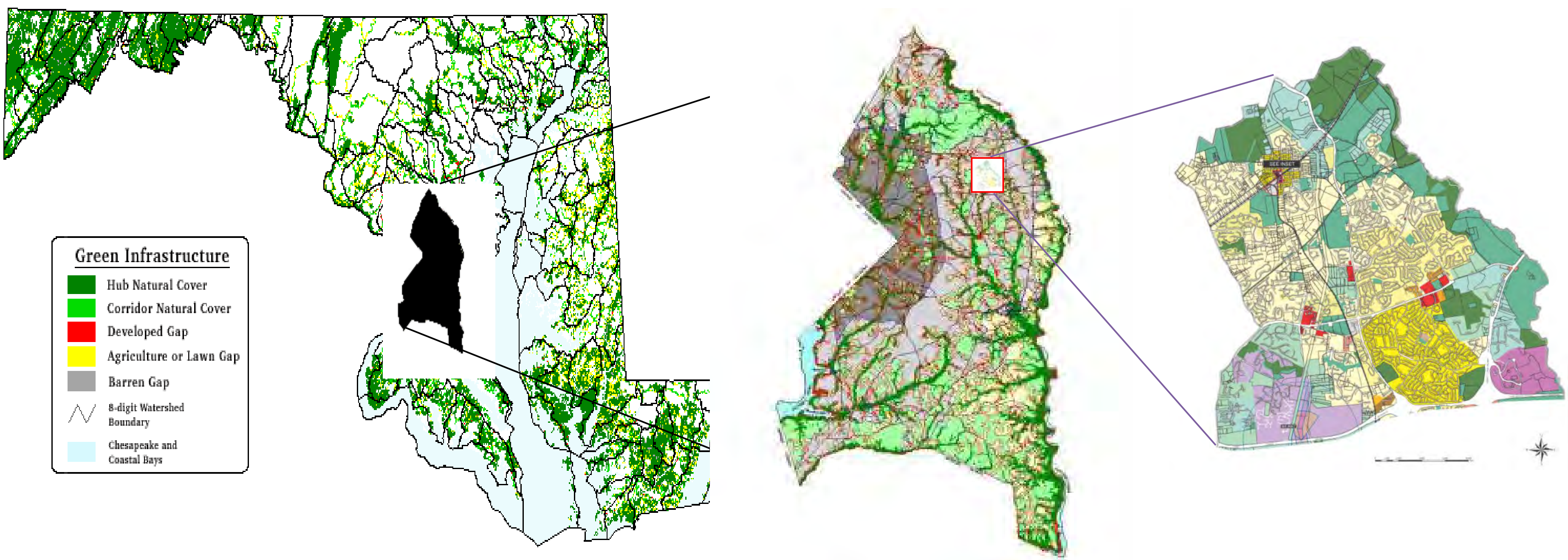
Implementing Green Infrastructure

Incorporate green infrastructure into planning efforts:

- Comprehensive
- Transportation
- Smart growth
- Watershed
- Conservation
- Hazard mitigation
- Stormwater
- Climate change adaptation
- Resilience
- Land use

Green Infrastructure Can Inform Planning

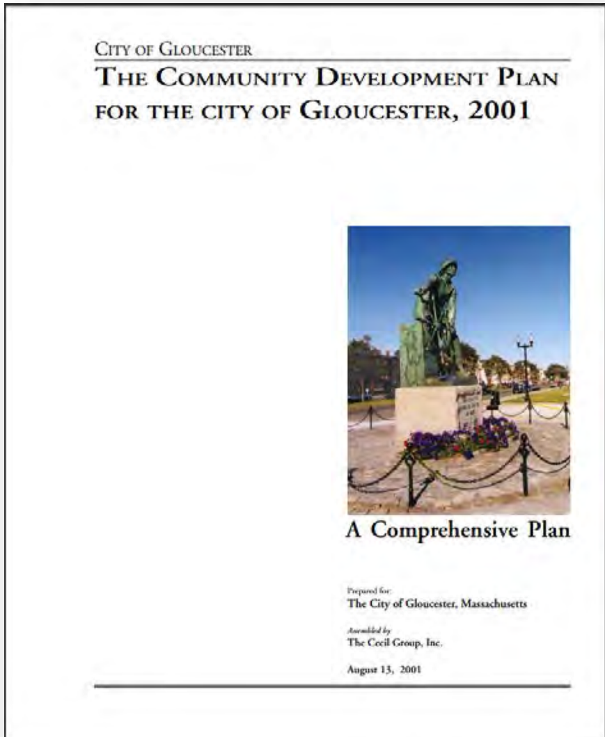
Implementing Green Infrastructure

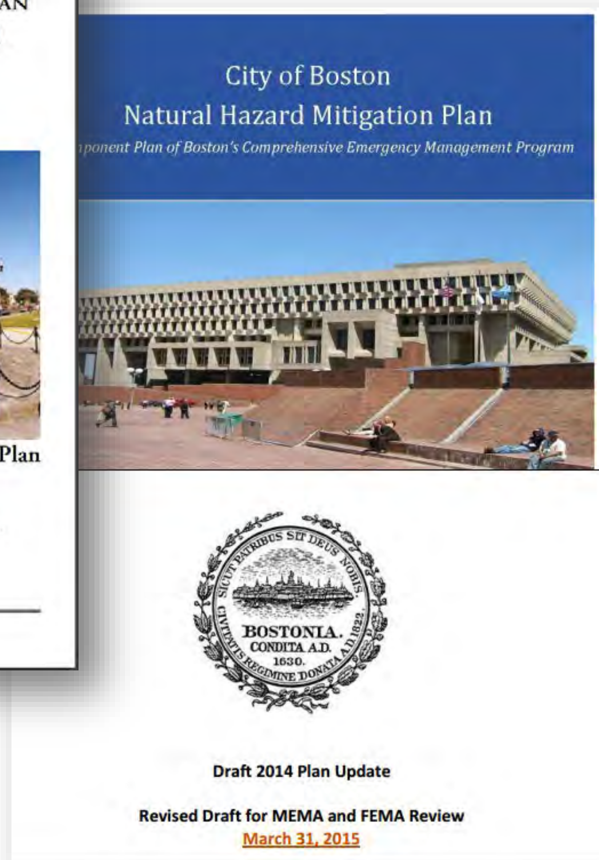


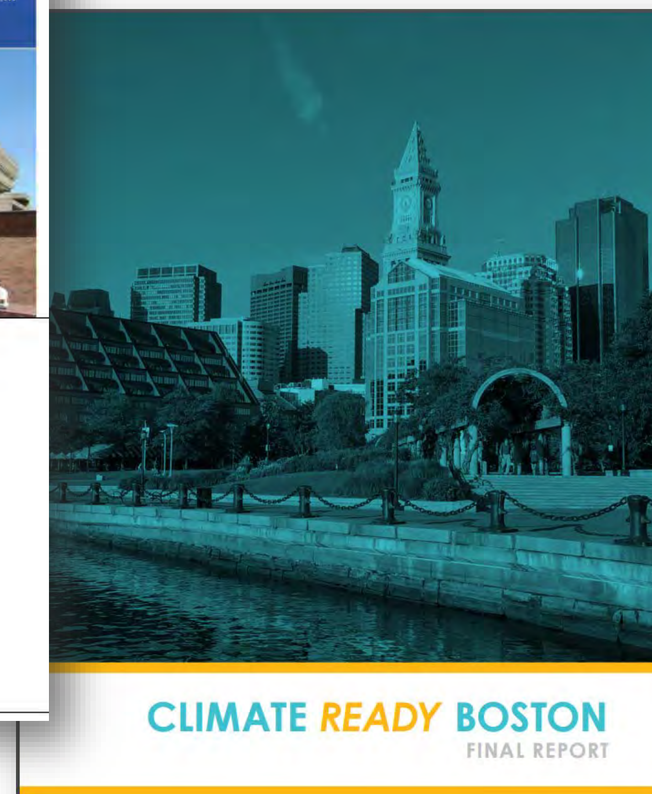
Maryland State Plan **Prince George's County** **Bowie Planning Area**

Comprehensive, Hazard Mitigation, and Climate Adaptation Planning

Implementing Green Infrastructure

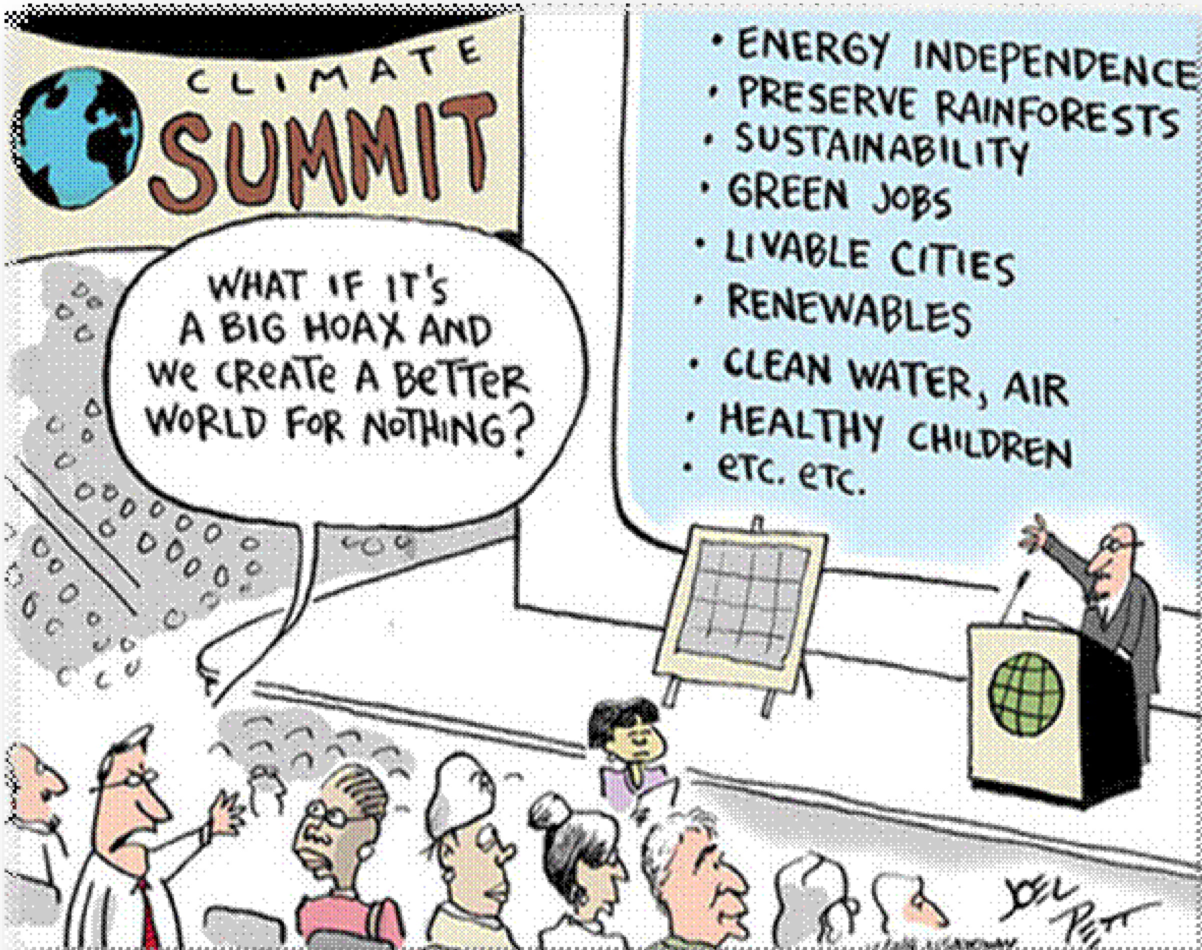






Multiple Benefits

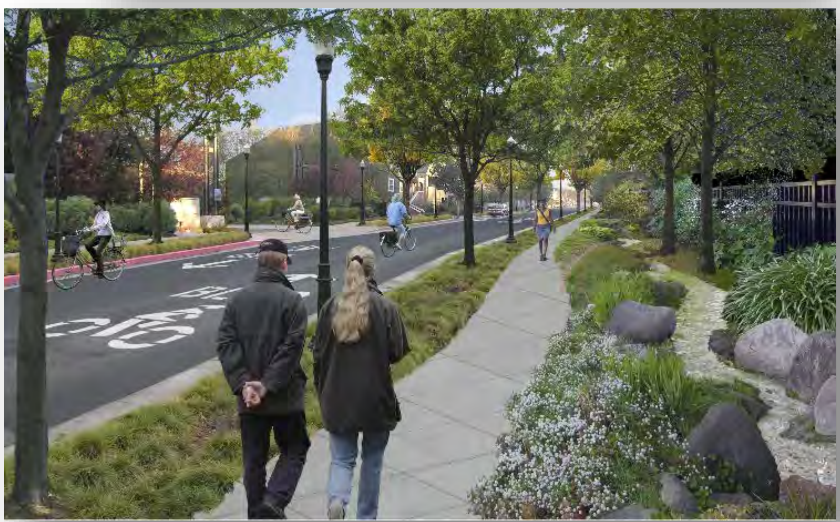
Implementing Green Infrastructure



Engaging Stakeholders

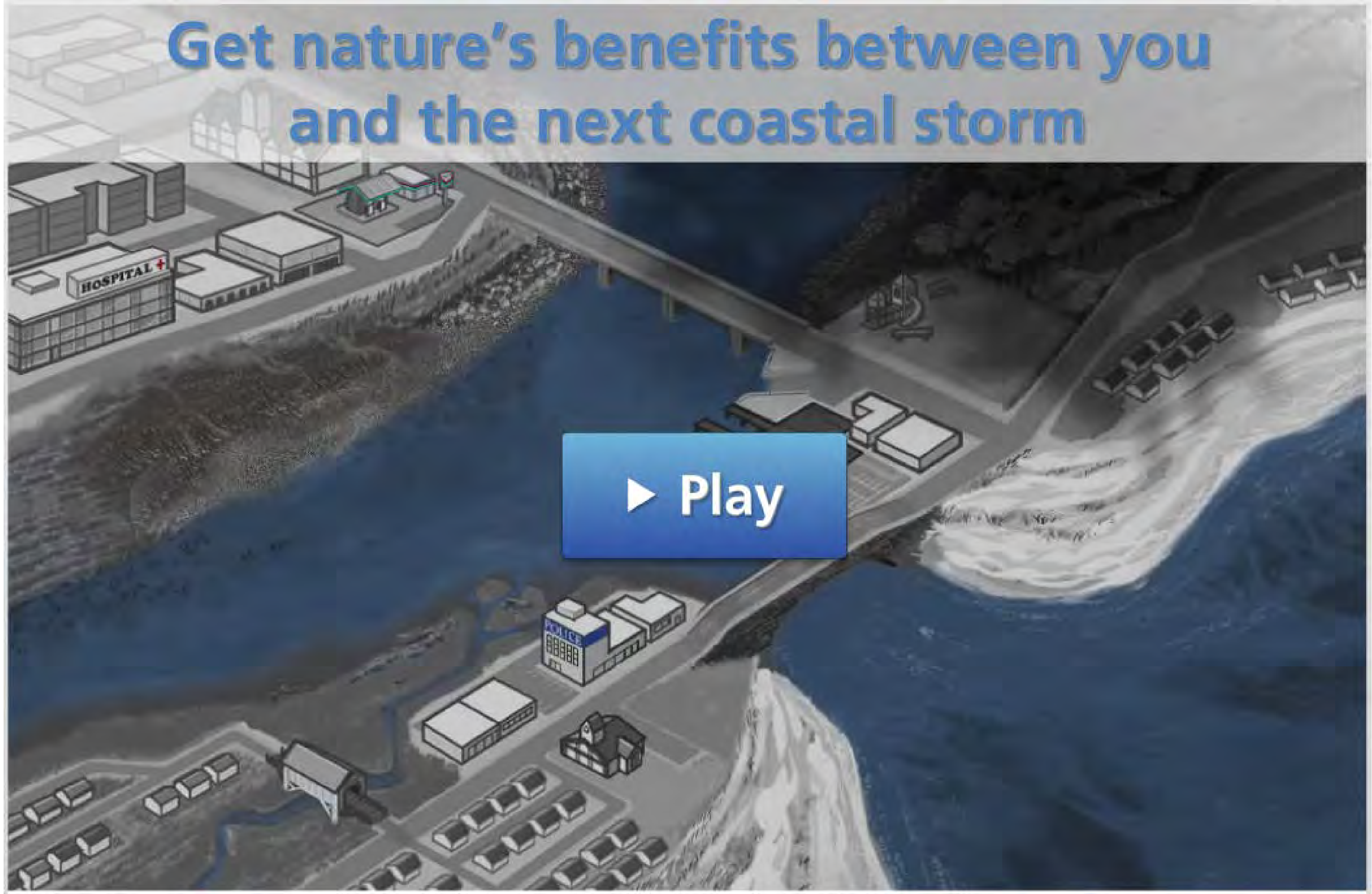
Implementing Green Infrastructure

- Have a plan
- Speak to their interests, not yours
- Explain the hazard risk and offer solutions
- Use multiple ways to communicate



Engaging Stakeholders

Implementing Green Infrastructure



Engaging Stakeholders

Implementing Green Infrastructure

Put Green Infrastructure between Your Community and the Next Coastal Storm.

There are many benefits.

Tidal and Forested Wetlands
- Slow waves
- Filter and clean floodwaters
- Provide food and jobs

Green Streets
- Capture and clean stormwater
- Beautify streets and encourage economic development
- Provide pedestrian-friendly walkways

Oyster and Coral Reefs
- Slow storm surge
- Provide food
- Clean water

Sand Dunes
- Buffer waves as a first line of defense
- Build economy through tourism

Open Space and Parks
- Store floodwaters and recharge aquifers
- Increase property values

Urban Trees
- Reduce runoff and absorb floodwaters
- Shade and cool homes and businesses
- Provide clean air and water

Living Shorelines
- Slow waves and reduce erosion
- Protect property

Office for Coastal Management
Digital Coast

See the reverse of this page to learn more.

Here's What You Can Do to Protect Your Community.

Green infrastructure can have multiple functions and cost less than using only gray infrastructure.

Conserve Existing Natural Areas

Natural areas such as wetlands, dunes, and vegetated shorelines absorb storm surge waves, reducing damage to nearby homes and roads.

How do we know it works? A study after Hurricane Sandy showed that areas containing wetlands had less damage than those without. Wetlands prevented an estimated $600 million in property losses.

Increase Your Community's Ability to Absorb Stormwater

- Protect and plant trees.
- Implement other practices such as green streets to keep stormwater from running into sewers, lessening the strain on existing systems.
- Use capital improvement projects as an opportunity to fund stormwater projects.

How do we know it works? The City of Portland, Oregon, used a combination of green roofs, green streets, trees, and rain gardens to reduce the peak flow of stormwater runoff by 93 percent, cooling costs by 27 percent, and heating costs by 15 percent.

Photo: Tracy Skrabal, North Carolina Coastal Federation

Create Natural Shorelines

Create living shorelines using oysters, marsh grass, and other natural materials to absorb wave energy and reduce erosion.

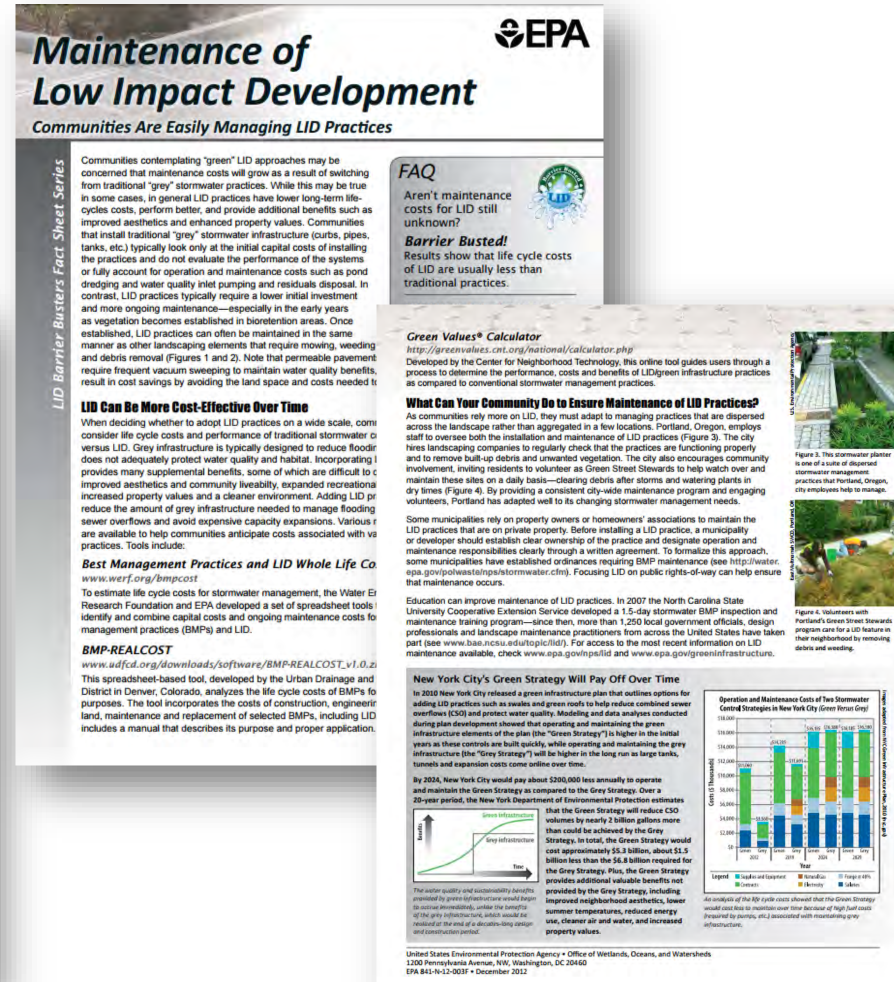
How do we know it works? North Carolina properties that used natural shoreline protection measures withstood wind and storm surge during Hurricane Irene better than properties using seawalls or bulkheads.

To learn more, visit *coast.noaa.gov/digitalcoast/topics/green-infrastructure.*

Office for Coastal Management
Digital Coast

Engaging Stakeholders

Implementing Green Infrastructure



www.epa.gov/green-infrastructure/overcoming-barriers-green-infrastructure

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Funding for Green Infrastructure

Implementing Green Infrastructure

- US Environmental Protection Agency
- NOAA
- Federal Emergency Management Agency
- National Park Service
- National Endowment for the Arts
- US Department of Transportation
- Economic Development Administration
- National Recreation and Parks Association
- Funders Network for Smart Growth and Livable Communities
- Qualified Energy Conservation Bonds

Table Discussion 3

Implementing Green Infrastructure

- **Part 1**: What barriers have you run into around implementing green infrastructure?
- **Part 2**: How can you overcome these barriers?

One Last Thing . . .

***Please* fill out the Evaluation!**

http://bit.ly/2nGhqW6

Thank You!

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