Detecting and Understanding Threats to Eelgrass in the Gulf of Maine: The Times, They Are A-Changin’

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Detecting and Understanding Threats to Eelgrass in the Gulf of Maine: The Times, They Are A-Changin'
Threats to Eelgrass

- Natural Disturbance
- Indirect Human Impacts: Upland development
- Direct Human Disturbance
- Global Climate Change

- Hydrologic/Physical Alterations
- Chemical Inputs
- Altered Sediment Processes
- Altered Landscape
- Species Introduction

- Biological Structure
- Physical Environment
- Ecosystem Function
Threats to Eelgrass

Natural Disturbance

Indirect Human Impacts: Upland development

Direct Human Disurbance

Global Climate Change

Hydrologic/Physical Alterations

Chemical Inputs

Altered Sediment Processes

Species Introduction

Altered Landscape

Biological Structure

Physical Environment

Ecosystem Function
Watershed Impacts on Coastal Water Quality

Human Population Density

Nitrogen Load

Persons per square mile


USGS SPARROW Model, 2002

Modeled N load, kg yr⁻¹
- < 1x10⁻³
- 1x10⁻³ to 2x10⁻³
- 2x10⁻³ to 5x10⁻³
- 5x10⁻³ to 2x10⁻⁴
- > 2x10⁻⁴
Relative Effects of Nutrient Enrichment and Grazing

Relative Effects of Nutrient Enrichment and Grazing

It’s complicated!

Onward to the Gulf of Maine
Eelgrass Distribution
Gulf of Maine

Seagrass Conservation

Assess resource status

Diagnose causal relationships

Implement management options

Assess resource status

Diagnose causal relationships

Implement management options

Assess resource status

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Threats to Eelgrass

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Trawling and Dragging

Paul Cunningham
Mussel Dragging Causes Severe and Long-lasting Impact

Casco Bay
Maquoit Bay

Independent Recovery Trajectories:
9-11 years to reach 95% cover

Space for time substitution

Spatial simulation model

Seagrass Conservation

Assess resource status

Implement management options

Diagnose causal relationships
Seagrass Conservation

Assess resource status

Implement management options

Diagnose causal relationships

Diagnose causal relationships

Implement management options
Monitoring Challenges:

- Detecting trends before losses are irreversible
- Forecasting changes in distribution and condition
- Predicting changes on large spatial scale
- Efficient and affordable
Hierarchical Monitoring Framework

Decreasing numbers of sites
Decreasing spatial representation
Increasing sample frequency
Increasing number of variables

Tier 3
Intensive monitoring

Tier 2
Regional surveys

Tier 1
Broad inventories and remote sensing

Cape Cod National Seashore

Tier 1 Mapping
- Bed location
- Bed size

Tier 2 Baywide Survey
- Percent cover
- Canopy height

Tier 3 Intensive Measures
- Percent cover
- Canopy height
- Shoot density
- Biomass
- Light, temp, seds

Multiple linear regression model:
Biomass is dependent on Percent cover, canopy height
$R^2 = 0.84$
Threats to Eelgrass

Hydrologic/Physical Alterations

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Indirect Human Impacts: Upland development

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Change in eelgrass in upper Casco Bay: the next two slides are views of the bed at the top of Maquoit Bay.
2001

Hilary Neckles
Eelgrass Destroyed by Invasive European Green Crabs

56% loss of eelgrass area: 3,338 ha to 1,477 ha

Impacts of eelgrass loss on shellfish calcification?
Expanding Populations of Invasive Colonial Tunicates

Carman et al., Management of Biological Invasions, submitted
The Times, They Are A-Changin’...

- It’s even more complicated!
- Existing threats exacerbated by direct and indirect effects of global change
- Long-term sustainability of eelgrass in the Gulf of Maine will demand multi-faceted approaches
Thank you and best wishes for the next 75 years!