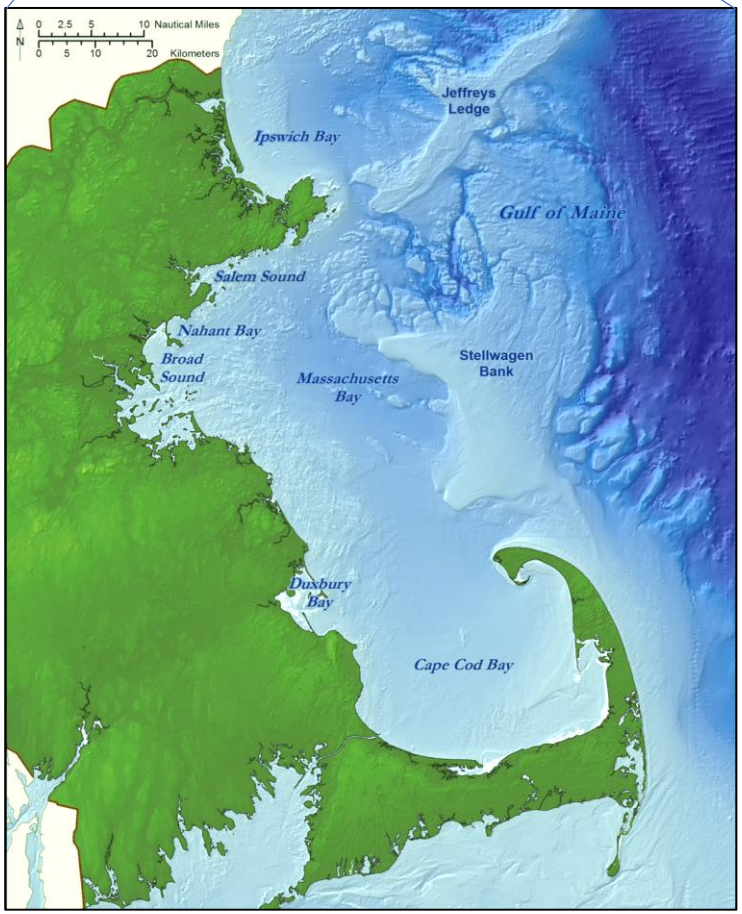
Application of BCG Model and Ecosystem Service Indicators to Assess Condition and Set Restoration Targets

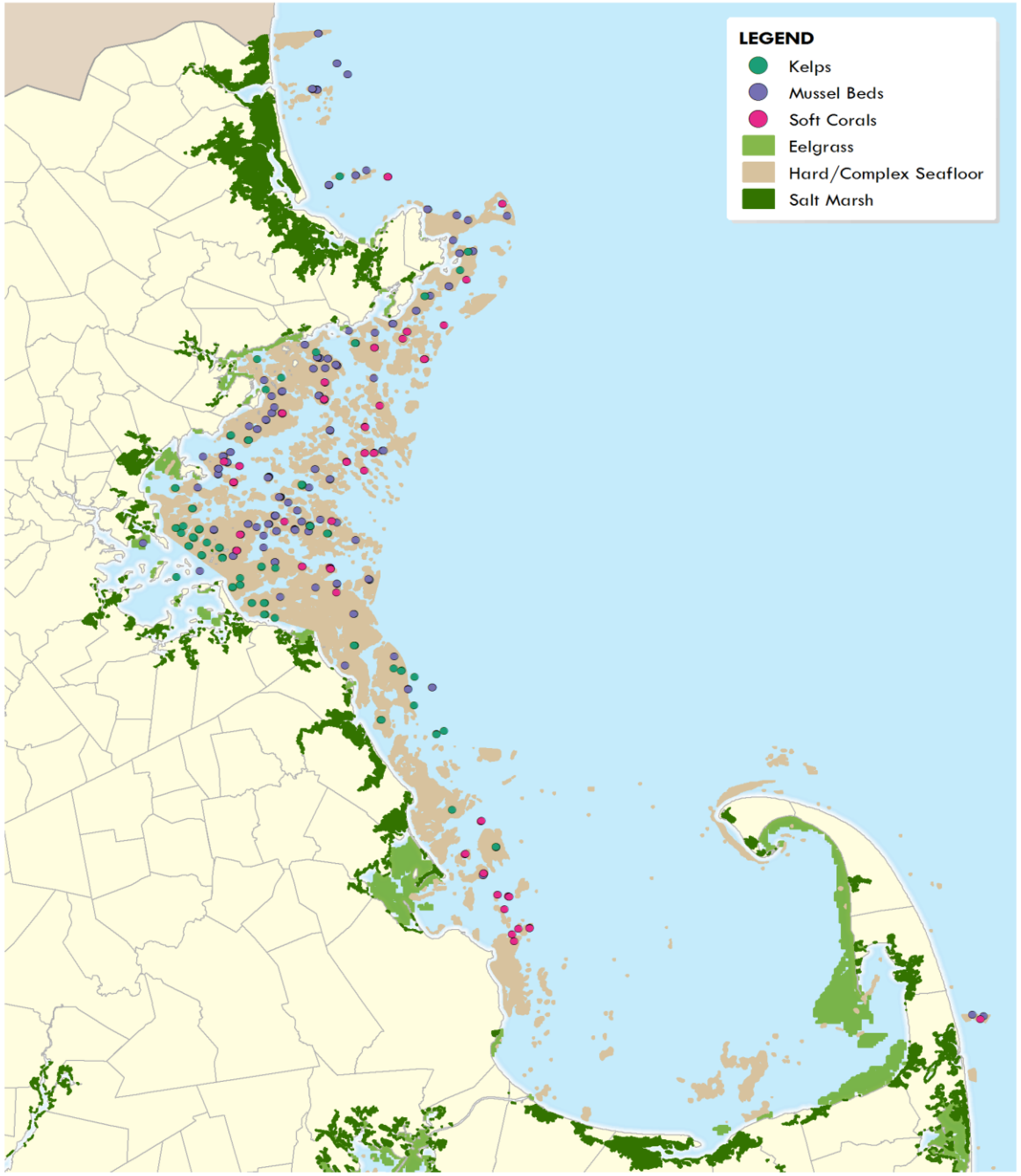
Prassede Vella, Massachusetts Bays National Estuary Program

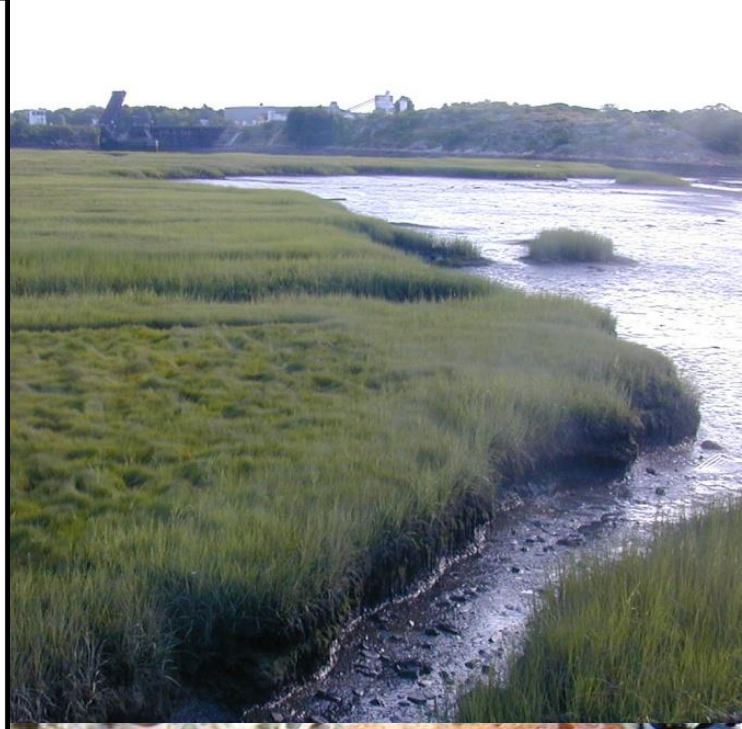
Emily Shumchenia, E&C Enviroscape

Massachusetts Bays NEP is a large, diverse, and complex estuary

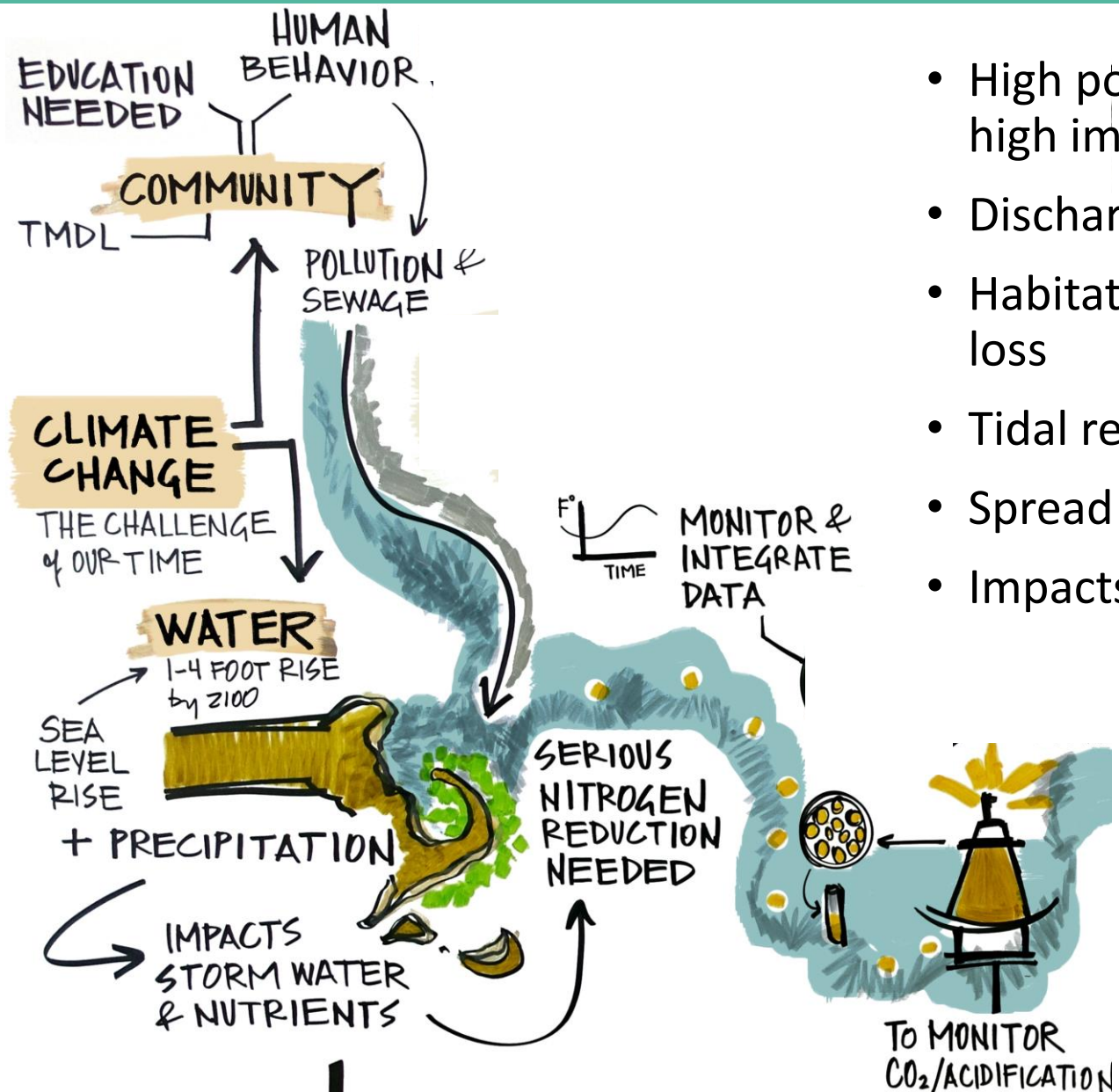


- Comprises three major Bays across 1650 mi^2
- 1100 miles from Salisbury to Provincetown
- Outer edge defined by Stellwagen Bank
- Receives input from 7000 mi^2 watershed area
- Merrimack River >7000 $ft^3\ s^{-1}$
- 1.7 million people in 50 coastal communities

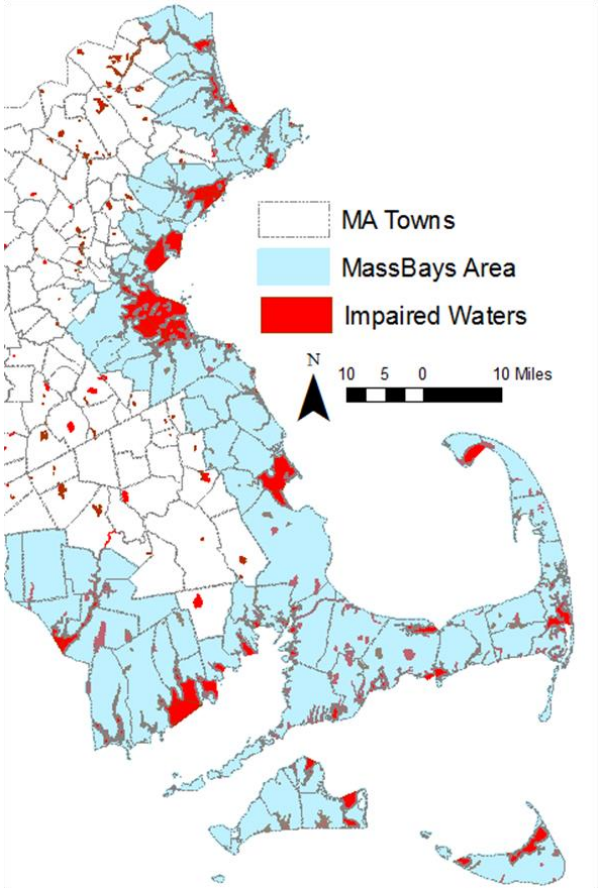

LEGEND
Kelps
Mussel Beds
Soft Corals
Eelgrass
Hard/Complex Seafloor
Salt Marsh
0 Nautical Miles 8
0 Kilometers 15
Data sources: MA Board of Underwater Archaeological Resources, MA Department of Environmental Protection, MA Division of Marine Fisheries, MA Office of Coastal Zone Management, National Oceanic & Atmospheric Administration, U.S. Geological Survey
Map coordinate system: North American Datum of 1983, Massachusetts State Plane Coordinate System, Mainland Zone (FIPS zone 2001), meters



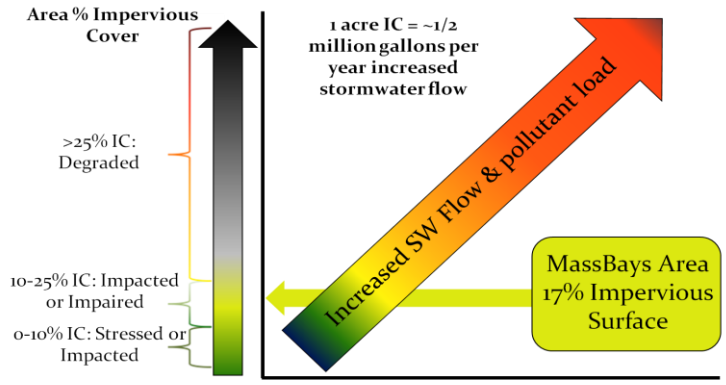
Estuaries are where the most difficult environmental challenges take place



- High population density = high impervious surface
- Discharge of pollutants
- Habitat fragmentation and loss
- Tidal restrictions
- Spread of invasive species
- Impacts of climate change



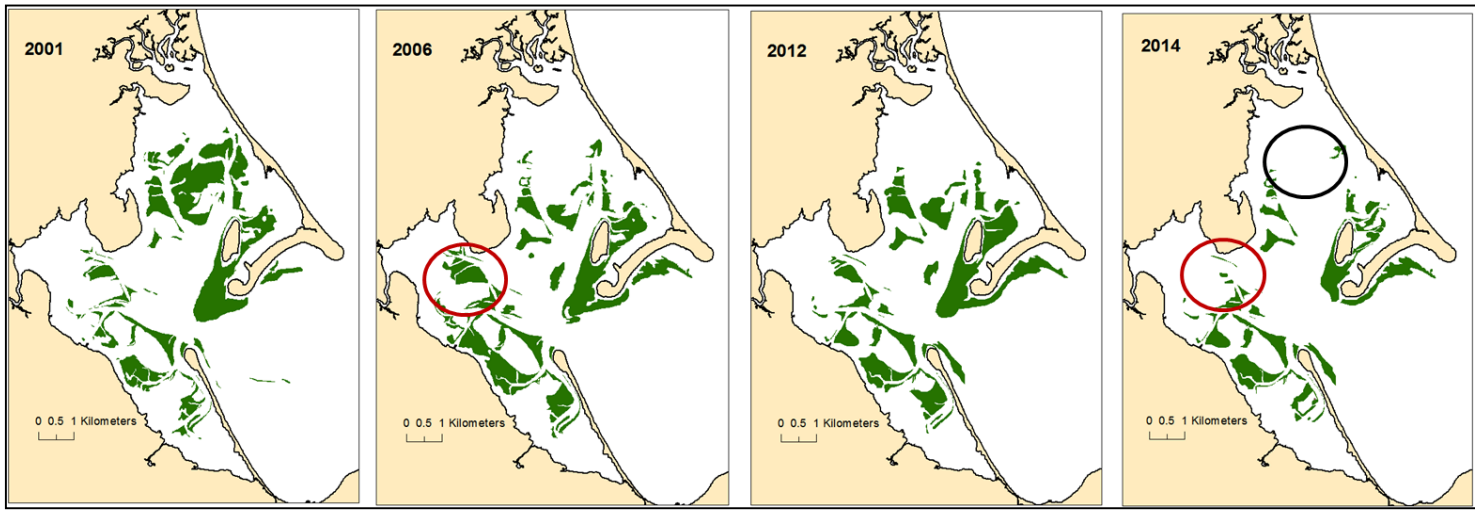
Stormwater Pollution



Stormwater runoff is causing waterbody impairments from N and bacteria.

N load from impervious cover within MassBays >100,000 lb (45,359 kg)/yr (2015).

Eelgrass loss in Duxbury Bay - 72% 1995-2014



How will MassBays meet these challenges?

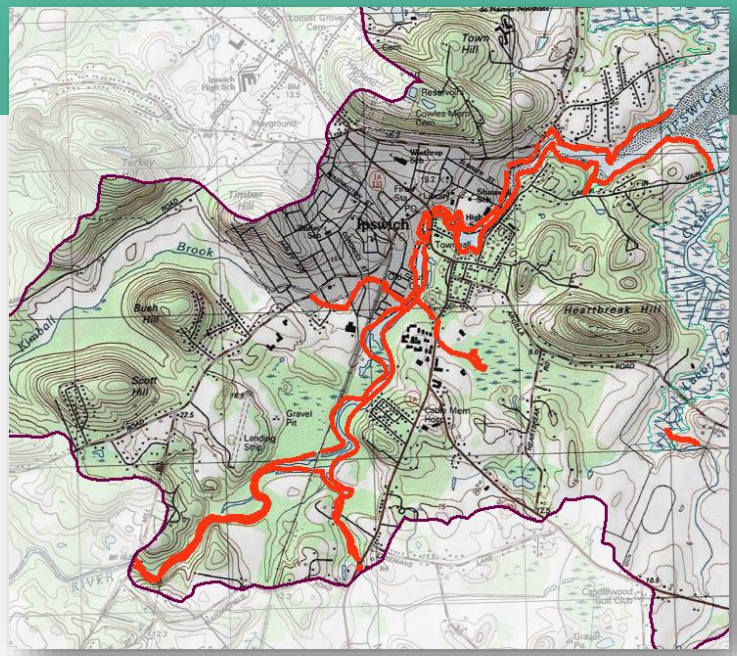
- Identify valued ecosystems to address stakeholder concerns
- Establish target conditions for embayments
- Track spatial and temporal changes in ecological conditions
- Support local action to improve environmental conditions

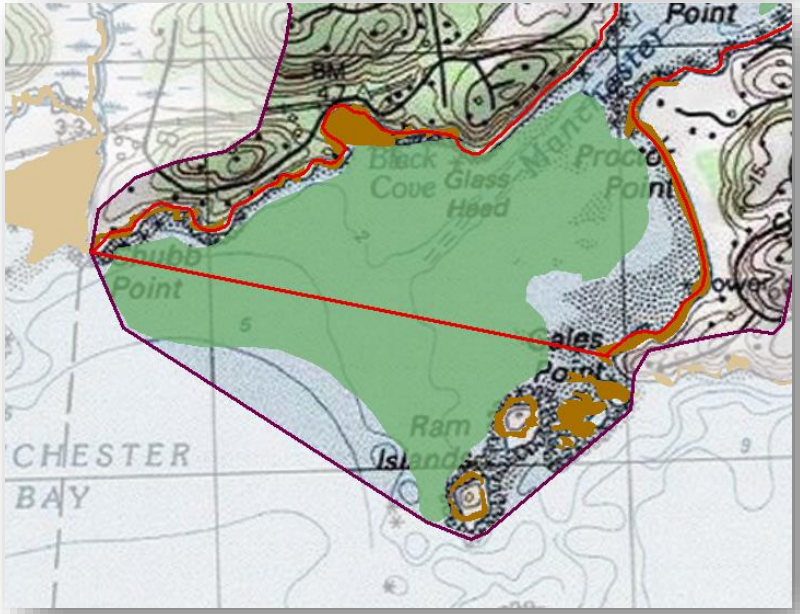
What is the overall outcome?

Targets for future embayment conditions that will guide and inform implementation of the management plan across the region.

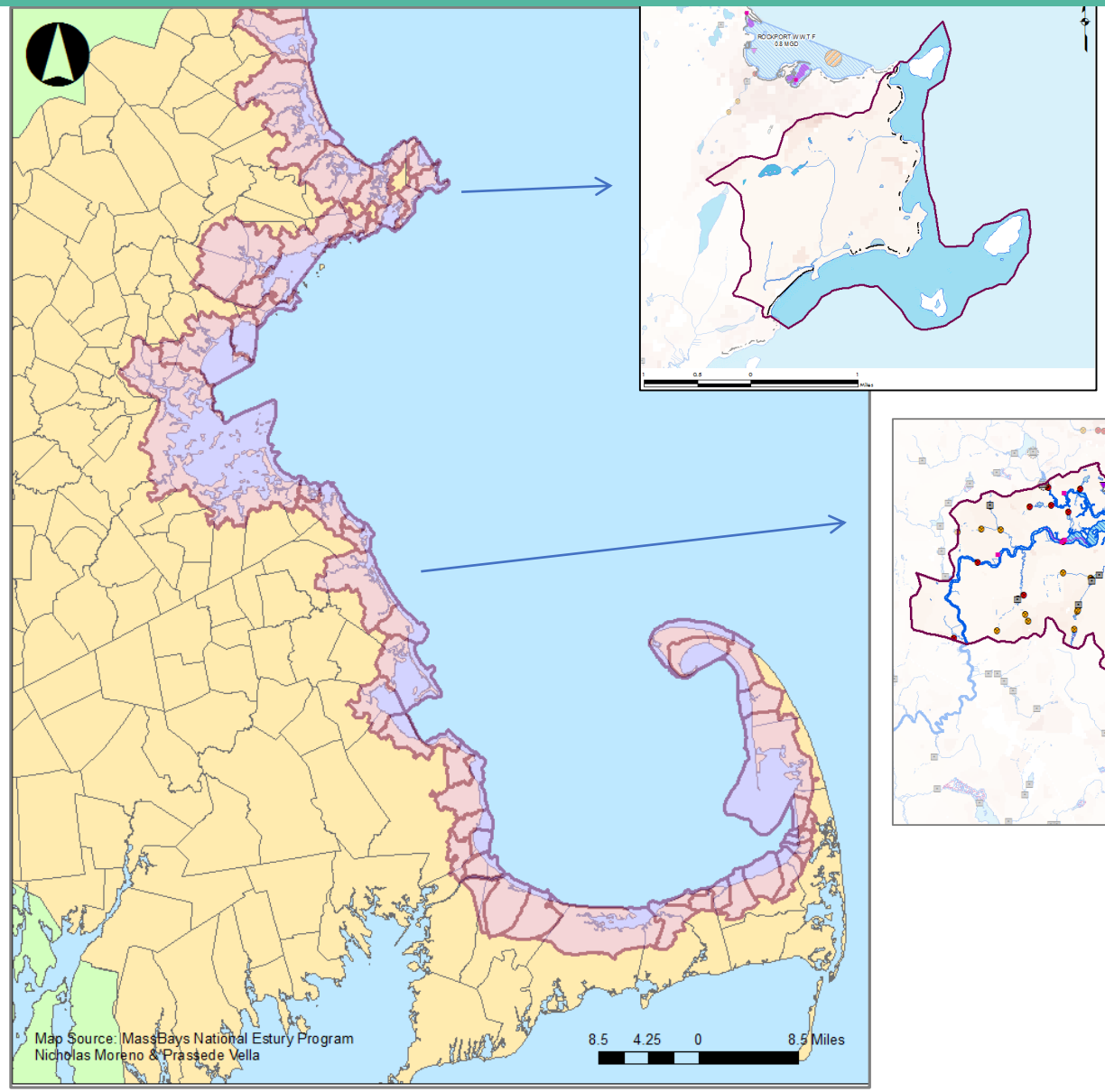
Phase 1: Estuarine delineation and assessment

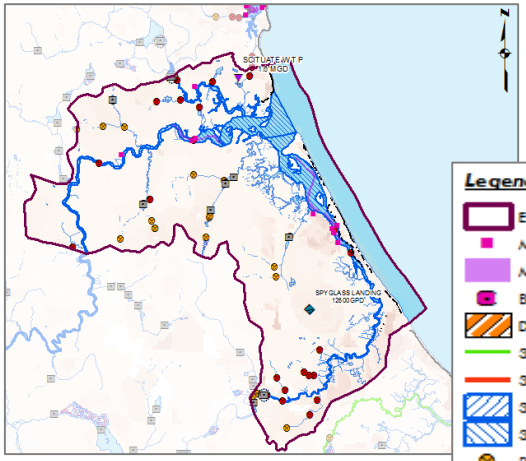
- Identified coastal/estuarine embayments and inter-estuarine areas
- Developed a list of resources and stressors to characterize each assessment area
- Developed interactive maps of each embayment and inter-estuarine area.

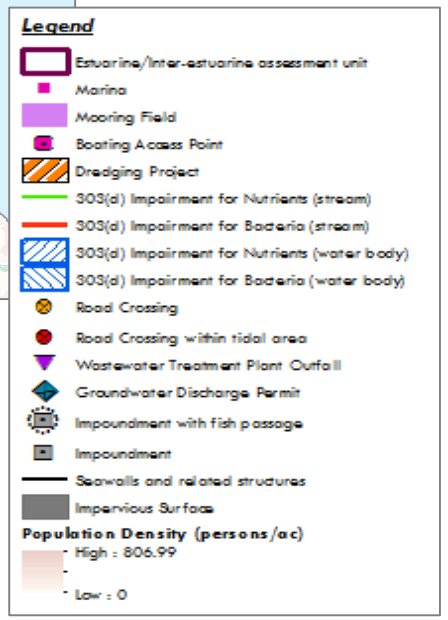




Output: 69 Assessment Areas







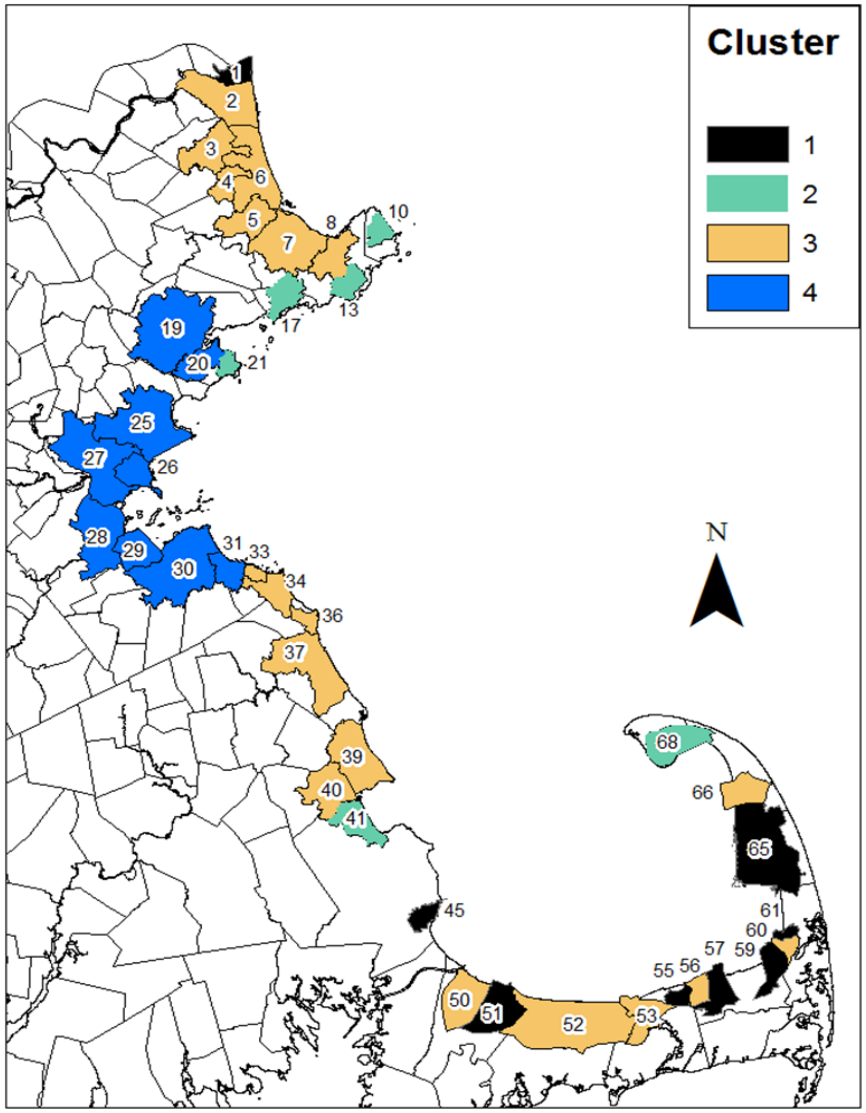
- 47 Embayments
- Rocky shorelines and headlands
- (Barrier) beaches

Phase 2: Identifying embayment types and targets

- Used 47 embayments
- Selected specific resources and stressors
- Modified/standardized datasets
- Developed analytical approach

Output:

- *Comprehensive, relatable database that can be queried*
- *Map of embayment category types*



The next step….

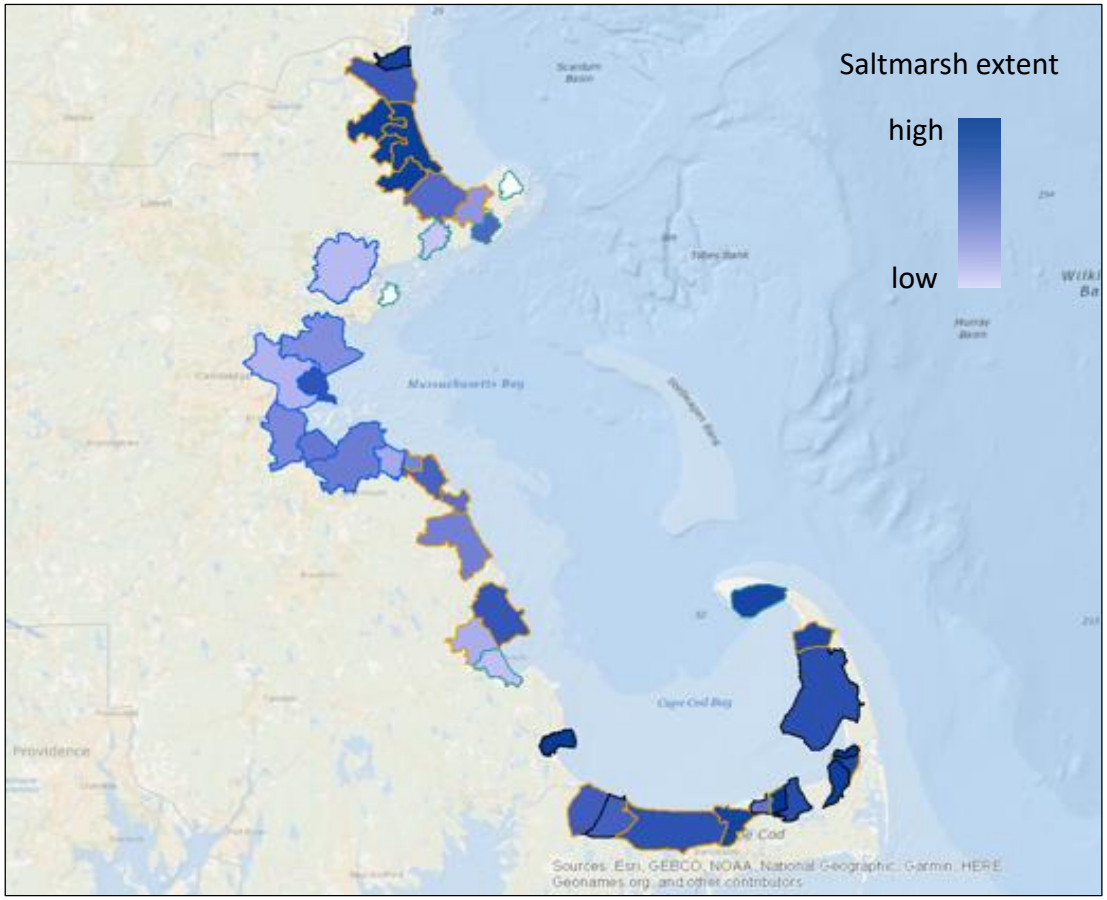
How do we set the targets?

How do we make sure these are the right targets?

How do we measure success?

How might MassBays use BCG?

We have a large database to mine….



Ecologically diverse

Highly urbanized > minimal development

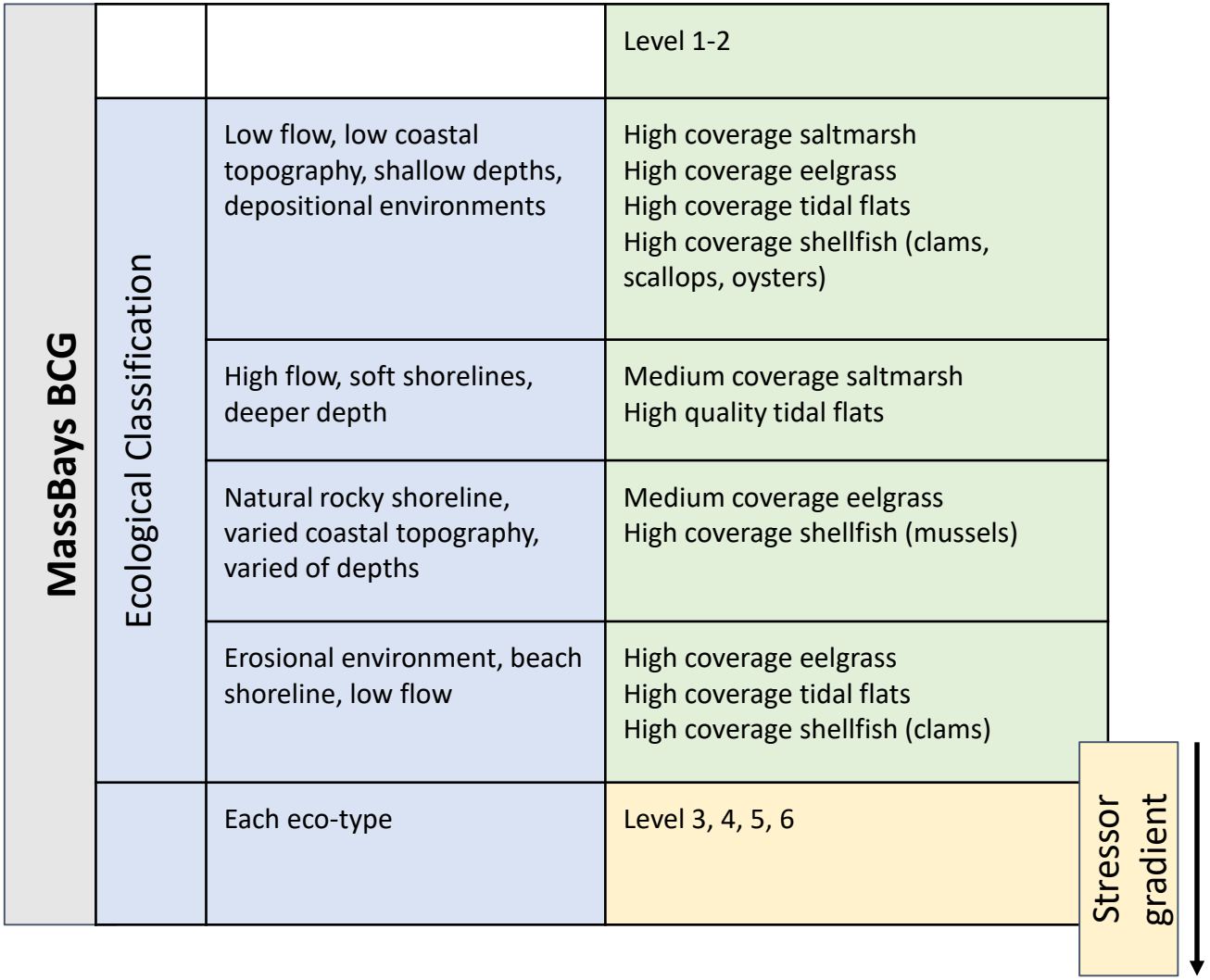
47 estuarine embayments

30-50 possible resource and stressor metrics

Primary attributes of interest (so far) are:

SALT MARSH, EELGRASS, SHELLFISH, TIDAL FLATS

The BCG provides a framework to organize data



Sort and group the 47 embayments by ecological similarity. Physical drivers will influence biological response.

Historical data are used here to articulate minimally-disturbed conditions for each eco-type.

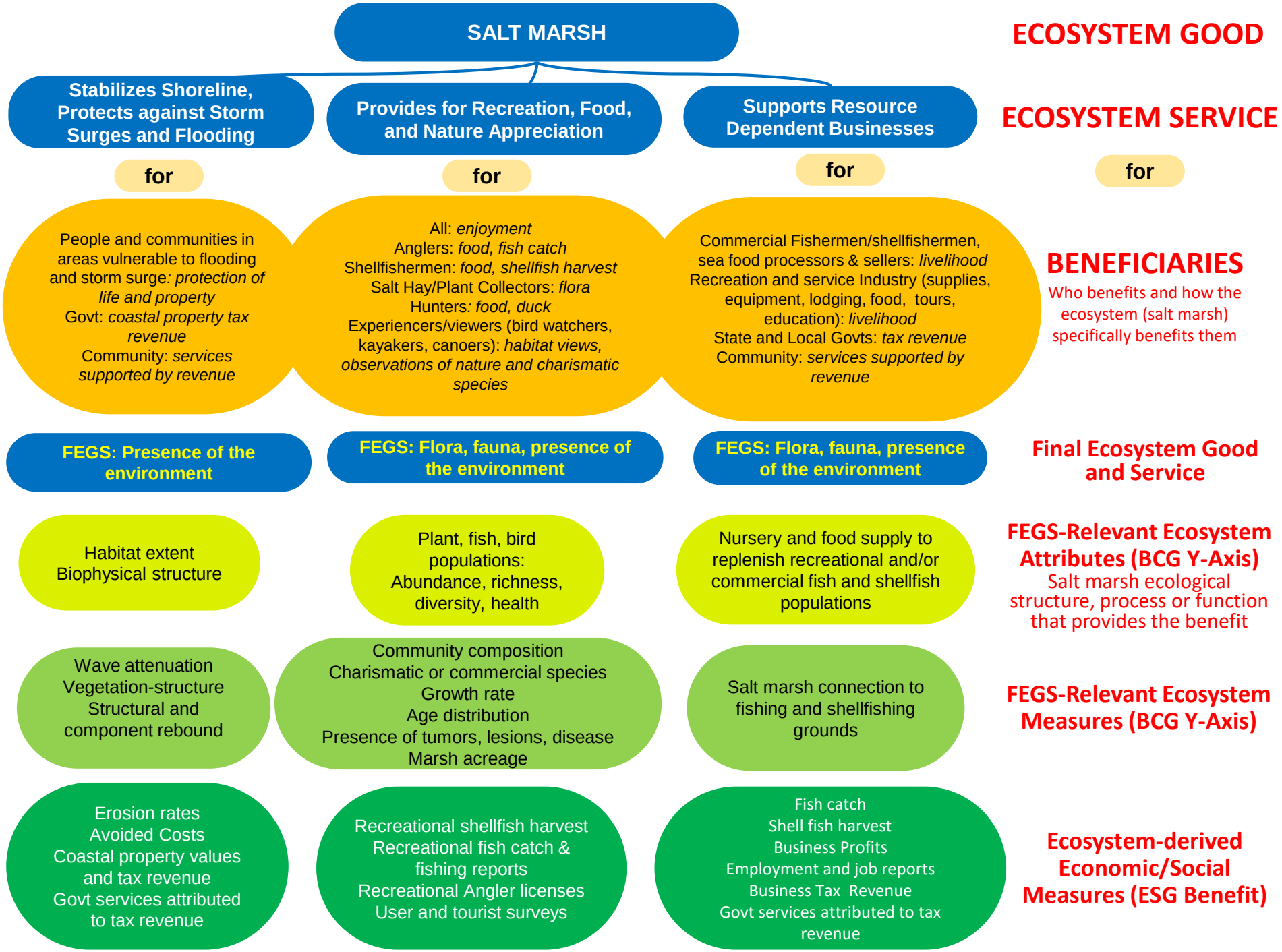
Remaining observational data, plus expert-judgment, are used here to define BCG Levels 3-6 for each eco-type.

This sounds like a complicated table…

How can this information be conveyed to the public?

The MassBays cares about:

- Shellfish
- Salt marsh health
- Beach erosion
- Climate change impacts
- Water quality
- Stormwater pollution


SALT MARSH
ECOSYSTEM GOOD
Stabilizes Shoreline, Protects against Storm Surges and Flooding
Provides for Recreation, Food, and Nature Appreciation
Supports Resource Dependent Businesses
ECOSYSTEM SERVICE
for
for
for
for
People and communities in areas vulnerable to flooding and storm surge: protection of life and property
Govt: coastal property tax revenue
Community: services supported by revenue
All: enjoyment
Anglers: food, fish catch
Shellfishermen: food, shellfish harvest
Salt Hay/Plant Collectors: flora
Hunters: food, duck
Experiencers/viewers (bird watchers, kayakers, canoers): habitat views, observations of nature and charismatic species
Commercial Fishermen/shellfishermen, sea food processors & sellers: livelihood
Recreation and service Industry (supplies, equipment, lodging, food, tours, education): livelihood
State and Local Govts: tax revenue
Community: services supported by revenue
BENEFICIARIES
Who benefits and how the ecosystem (salt marsh) specifically benefits them
FEGS: Presence of the environment
FEGS: Flora, fauna, presence of the environment
FEGS: Flora, fauna, presence of the environment
Final Ecosystem Good and Service
Habitat extent
Biophysical structure
Plant, fish, bird populations:
Abundance, richness, diversity, health
Nursery and food supply to replenish recreational and/or commercial fish and shellfish populations
FEGS-Relevant Ecosystem Attributes (BCG Y-Axis)
Salt marsh ecological structure, process or function that provides the benefit
Wave attenuation
Vegetation-structure
Structural and component rebound
Community composition
Charismatic or commercial species
Growth rate
Age distribution
Presence of tumors, lesions, disease
Marsh acreage
Salt marsh connection to fishing and shellfishing grounds
FEGS-Relevant Ecosystem Measures (BCG Y-Axis)
Erosion rates
Avoided Costs
Coastal property values and tax revenue
Govt services attributed to tax revenue
Recreational shellfish harvest
Recreational fish catch & fishing reports
Recreational Angler licenses
User and tourist surveys
Fish catch
Shell fish harvest
Business Profits
Employment and job reports
Business Tax Revenue
Govt services attributed to tax revenue
Ecosystem-derived Economic/Social Measures (ESG Benefit)

Salt marsh

	BCG y-axis attributes	BCG y-axis numeric decision rules	FEGS Environment: Salt marsh Beneficiary: Property owners
BCG Level	**FEGS-relevant ecological attributes (narrative)**	**FEGS-relevant ecological measures (quantitative)**	**Ecosystem-derived economic/social measures (quantitative)**
Level 1/2	Abundant, dense, and healthy saltmarsh in many places	Saltmarsh extent: between A and B acres saltmarsh per km shoreline Wave attenuation: between X and Y wave heights	Coastal property values and tax revenue: Maximum; highest ever
Target Condition Level 3	Abundant, dense, and healthy saltmarsh in most places; thin and/or poor quality saltmarsh in other places	Saltmarsh extent: between B and C acres saltmarsh per km shoreline Wave attenuation: between Y and Z heights	Coastal property values and tax revenue: Really high
Level 4	Thin and/or poor quality saltmarsh in many places	Saltmarsh extent: even fewer acres saltmarsh per km shoreline Wave attenuation: little attenuation	Coastal property value and tax revenue: Average
Existing Condition Level 5	Sparse saltmarsh	Saltmarsh extent: almost no saltmarsh per km shoreline Wave attenuation: almost no attenuation	Coastal property value and tax revenue: Low
Level 6	No saltmarsh	Saltmarsh extent: zero saltmarsh per km shoreline Wave attenuation: No attenuation	Coastal property value and tax revenue: Coastal properties are a liability

Together, BCG and ESG communicate the consequences of MassBays environmental degradation and restoration

- Provide methods to convert qualitative characteristics of ecosystem condition (BCG) and ecosystem service production (ESG) to quantitative measures.
  - Then used to set quantitative targets and thresholds and to assess condition of coastal systems relative to those thresholds.

- ESG is a means for stakeholders to connect changes in ecosystem condition (BCG) to changes in ecosystem service production and may be valuable for other applications, including evaluating restoration success and conducting resource damage assessments.

Thank you!

Questions?