What are some of the dominant coastal habitats?

<table>
<thead>
<tr>
<th>Salt Marshes</th>
<th>Rocky Intertidal Shore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seagrass Beds</td>
<td>Shellfish Reef</td>
</tr>
<tr>
<td>Coral Reefs</td>
<td>Mangrove Swamp</td>
</tr>
<tr>
<td>Mudflats</td>
<td>Barrier Beach/Dune Systems</td>
</tr>
</tbody>
</table>

**Why?**

1) Physical forces (wind, tides) interact with internal process to support a negative feedback system.

2) The result is a recognizable ecosystem that has ecological functions and human values.
Conceptual Model of Salt Marsh Processes

Figure 4. Conceptual model of salt marsh (Cahoon and Lynch [http://www.pwrc.usgs.gov/set/]).
Surface Elevation Tables (SETs) and Marker Horizons Established . . . and Measured
Salt marshes are among our most productive and valuable ecosystems

- Plants support food webs
- Secondary production
- Plant structure for habitat
- Support of biodiversity
- Protection from flooding
- Protection from coastal erosion
- Removal of sediments & excess nutrients
- Aesthetic, Recreational & Educational values
- Self-sustaining ecosystems
- Long term carbon storage
The Case for Building Salt Marshes into Living Shorelines

- Loss of 30% of historical salt marshes
- Future for marshes is not bright - SLR/CC
- Salt marshes and peat develop slowly as sea levels rise – most marshes are over 1,000 years old
- Created marshes erode EVEN if shoreline protected
  - 1993 salt marsh creation lost 20% of area in five years in North Mill Pond
- Salt marshes protect, survive and heal following storms
  - Gittman et al. 2014
THE SALT MARSH SQUEEZE

Marsh migration + Shoreline stabilization = salt marsh squeeze

From Kirsten Howard, NHCP
Local Living Shoreline Projects

Coastal Habitat Restoration Team: Burdick, Moore, Grizzle, Eberhardt, Ashcraft, Ballestero and Technicians and Students

University of New Hampshire
COASTAL HABITAT
CHART

PROJECT SITES
- UNH Dune
- UNH Marsh
- Other Marsh
Challenges of northern shoreline projects

• Low light
• Short growing season
• Large tidal range
• Ice
Ranges of Options

**Green - Softer Techniques**

**VEGETATION ONLY** - Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.

**EDGING** - Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.

**SILLS** - Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.

**Coastal Structures**

**BREAKWATER** - (vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.

**REVETMENT** - Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.

**BULKHEAD** - Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

Guidance for Considering Use of Living Shorelines, NOAA 2015
SAGE, 2016, Natural and structural measures for shoreline stabilization

Mill Pond Way berm removal, North Mill Pond, Portsmouth, NH
SAGE, 2016, Natural and structural measures for shoreline stabilization

Brewster Street Mitigation on North Mill Pond (Stantec)
North Mill Pond at Brewster St. Mitigation 2016

Pre-existing
Fill to Designs Grades
Plant With Plugs
Final Product
Winter Can Be Cruel
Marsh built in South Mill Pond 2001, Portsmouth, in front of seawall and behind sill constructed from existing rocks on site.

SAGE, 2016, Natural and structural measures for shoreline stabilization
Two Case Studies: Living Shoreline Marshes with Sills

1) Cutts Cove, Portsmouth
   – Designed as restoration of salt marsh
   – Approach is to partially remove rip-rap wall
   – Sill provides a ‘climate ready’ feature for 2060

2) Wagon Hill Farm, Durham
   – Designed to stop erosion
   – Also restores damaged salt marsh
   – Sill provides erosion resistant edge and ‘climate ready’ feature; TBZ allows for marsh migration
Rip Rap Armor at Cutts Cove
Tides and existing marshes in Cutts Cove
Proposed Cutts Profile
Cutts Profiles and Ecosystems

- Existing Rip-rap Profile
- Tidal Buffer Zone
- Upper Low and High Marsh
- Rock Sill
- Lower Low Marsh

Distance from mudflat (ft)

Elevation NAVD (ft)
Tides and existing marshes in Cutts Cove

- Mudflat
- Low Marsh
- High Marsh

Elevation NAVD (ft)

Distance from mudflat (ft)

Tidal Buffer Zone

Rock Sill

Upper Low and High Marsh

Lower Low Marsh

High Marsh

Low Marsh

Mudflat
Construction Sequence

Clear and Grub

Flatten rip-rap wall and build stone edge

Backfill with sandy silt to elevation
Planting and Maintenance
Measures of Success

• Monitoring
  – Erosion
  – Plant establishment and growth
  – Animal use of habitat

• Maintenance
Pre-restoration Fish Sampling
Case Study #2: Wagon Hill Farm
Change from 1992 to 2015
Wagon Hill Farm Issues and Data Collection

Potential Causes of Erosion

- Waves
- Increased foot /pet traffic
- Decreased light
- Increased Sea Level
- Ice Damage
- Plant disease or herbivory
- Lack of Sediment supply
- Eroded shoreline promotes erosion cycle
- Stormwater

Data Collection

[to eliminate potential causes and inform design]

- High intensity water levels
- Wildlife cameras
- Light meters
- Water level recorders
- Wildlife cameras
- Observations
- Trial structure
- Erosion pins
Setting Erosion Pins
Foot Traffic and Boat Waves
Light can be a big issue for plants from 2009 to today.
Potential First Phase - Plan

- Large, existing stone to be tied-in to existing marsh to be fronted by end sill; wrap sill around side.

- Existing tidal marsh area to be used as reference line for proposed offsets and example of how to construct tidal marsh.

- Rocks and boulders to keep edge of tidal marsh zone in place and promote growth.

- Intermediate buried coir log to help hold grade.

- Staked coir log roll.
Profile Type 1

LARGE STONE BREAKWATER
TO HELP HOLD GRADES AND
CREATE CUSPATE AREAS
Conclusions

• Recognize limited growing season
• Difficulty increases with tidal range and physical exposure to shear stress from waves and ice
• Be aware of conditions that can reduce success: shade and animals (geese, crabs, snails, people)
• Consider management (including people management) at the landscape scale
Thank You!