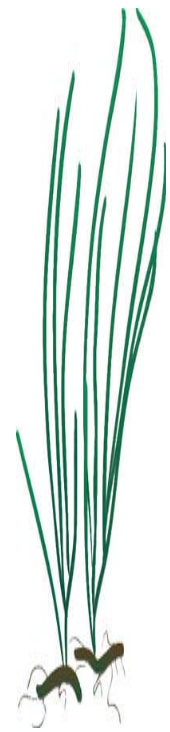
Summary
Maine/NH Eelgrass Collaborators Meeting
Thursday Jan. 22, 9 am – 3 pm
MDI Biological Laboratory: Dahlgren Hall on Old Bar Harbor Road
Salisbury Cove, ME



Scientists and others interested in eelgrass conservation in Maine and New Hampshire came together to share work in progress and discuss future directions for eelgrass research and restoration in Maine.

Attendees: Seth Barker, consulting eelgrass mapper, Angie Brewer, DEP, Matt Craig, Casco Bay Estuary Partnership, Jane Disney, MDI Biological Laboratory, president, Frenchman Bay Partners, Karen James, MDI Biological Laboratory, Bev Johnson, Bates College, George Kidder, MDI Biological Laboratory, Sandra Lary, USFWS, Hilary Neckles, USGS, Fred Short, University of New Hampshire, John Sowles, consulting pilot and photographer, Terry Towne, Maine Coast Heritage Trust, Bob DeForrest, Maine Coast Heritage Trust, Frenchman Bay Partner executive committee member, Rob Wilpan, selectman, Town of Sorrento and municipal liaison, Frenchman Bay Partners, Chris Petersen, College of the Atlantic and vice president, Frenchman Bay Partners, Jeremy Bell, The Nature Conservancy, Chris Heinig & Stephen Karpiak, MER consulting, Kim Payne, environmental consultant, Normandeau, Joe Payne, retired, Friends of Casco Bay, Bay Keeper, Duncan Bailey, MDI Biological Laboratory, Anna Farrell, Maine Conservation Corps, MDI Biological Laboratory.

Goals:

- share existing information among different coastal areas with extensive eelgrass loss
- identify fruitful cross-site collaborations and comparisons
- discuss short-term (2015 field season) and long-range science needs to ensure sustainable eelgrass habitat in our bays and estuaries

Presentations: There were six presentations by researchers from Maine and New Hampshire

1. **Possible Causes of Eelgrass Loss in Frenchman Bay, ME**

Jane Disney, Anna Farrell, George Kidder, MDI Biological Laboratory, Salisbury Cove, ME

Eelgrass decline since 1996 and nearly total eelgrass loss from upper Frenchman Bay at the end of 2012 with no apparent recovery during the 2013 growing season prompted researchers to look at a variety of parameters that might be affecting eelgrass (see maps below). Outer Frenchman Bay areas did not suffer the same losses, and were used as comparison sites.

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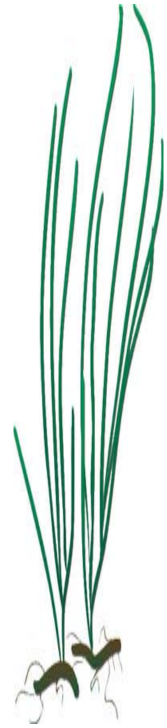

Eelgrass data provided by Maine DMR

Parameters compared between multiple sites in both areas included: abundance of invasive green crabs, genetics of invasive green crabs, water quality, eelgrass density, eelgrass biomass, tensile strength and composition of eelgrass. Results of studies showed:

- There were no correlations between abundance of green crabs and eelgrass biomass or density.
- Both northern and southern varieties of invasive green crabs were present in areas where eelgrass was lost and areas where eelgrass was not lost. There was no correlation between eelgrass density and percentage of green crabs of northern origin.
- The tensile strength of eelgrass varied at different sites around Frenchman Bay, as did plant density and biomass.
- The amount of nitrogen in the water column correlated with the amount of nitrogen in plant tissue as well as biomass of plants.
- Although nitrogen varied significantly between some sites in upper and outer Frenchman Bay, nitrogen levels did not always correlate with areas of eelgrass loss.

Next Steps: A variety of transplant methods proved to be successful in Frenchman Bay prior to the 2012-2013 loss. Green crab density appeared to be lower in 2014 than in 2013, although a different trapping regime was employed in each year. Eelgrass restoration projects with and without protective crab fencing were put in place in summer 2014. These areas will be evaluated in 2015. Comparisons between sites that did and did not experience eelgrass loss will continue.

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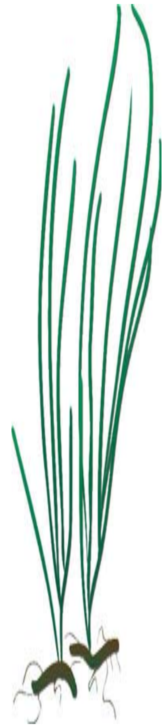

2. **A Comparison of Eelgrass Distribution at Green Crab Study Sites in Casco Bay, Maine 2013-2014:**
Seth Barker and John Sowles, independent consultants, formerly, Maine Department of Marine Resources

Composite images were made using aerial photos that allowed for comparisons of percent cover at a variety of sites in 2013 and 2014. There was an overall loss in eelgrass area, predominantly at Little Chebeague Island, and a shift in percent cover of eelgrass between the two years, from mostly 70-100% cover to mostly 10-40% cover. In the table below: 1= >0-10%, 2=>10-40%, 3=>40-70%, 4=>70-100%.

2014	0	1	2	3	4	Total Area (ha)
Broad Cove	0.02	5.73	28.69	6.90	13.80	55.14
Cousins Island		9.04	14.73	12.56	2.85	39.18
Little Chebeague Island		2.58	10.08	1.44	18.47	32.57
Mackworth Island		2.19	14.50	16.17	2.87	35.73
Widgeon Cove		12.14	1.94	3.28	0.46	17.82
Total Area (ha)	0.02	31.69	69.95	40.35	38.43	180.44

2013	0	1	2	3	4	Total Area (ha)
Broad Cove	0.02	7.44	11.71	8.72	29.51	57.40
Cousins Island		1.79	0.77	16.08	21.82	40.46
Little Chebeague Island	0.37	0.63	13.98	4.39	24.91	44.27
Mackworth Island		2.31	4.24	1.76	27.50	35.81
Widgeon Cove	0.02		14.30	4.31	0.66	19.29
Total Area (ha)	0.41	12.17	45.00	35.26	104.40	197.23

3. **Casco Bay Eelgrass Environmental Controls: Green Crabs and Light Availability.**
Angela Brewer, Division of Environmental Assessment, Bureau of Land & Water Quality, Maine DEP

Research on Eelgrass, Green Crabs, and Light Availability showed:

- Within-season and between-sediment type patterns of green crab abundance, carapace width, and sex ratio vary based on site.
- Total green crab abundance per season and mean crabs caught per trapping event were greatest at Mackworth Island (above threshold for impact?) and least at Widgeon Cove

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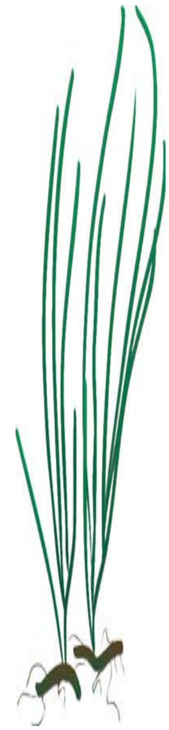


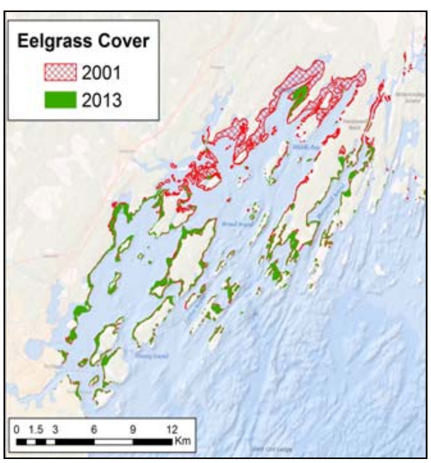
- Little Chebeague green crab data were the most different from other sites; it had the fewest green crabs, most large males—perhaps because the location was adjacent to deeper water?

- Mean K_d (or down-welling diffuse attenuation coefficient) was similar between sites (variable depths) with exception of Widgeon Cove (shallow site) (K_d is the rate of attenuation of downward visible light (400-700 nm) with depth. The more light that has attenuated at a particular depth, the less that is available for eelgrass to photosynthesize.)

- There may have been a cumulative impact of high green crab abundance and low light at Mackworth Island.

4. Eelgrass Change in Casco Bay, Maine

USGS: *Hilary A. Neckles, USGS, Angie Brewer, Maine DEP, Mike Doan, Friends of Casco Bay, Curtis Bohlen, Matt Craig, Bev Bayley-Smith, Casco Bay Estuary Partnership, Sandra Lary, USFWS, John Lichter and Sabine Berzins, Bowdoin College, John Sowles, Seth Barker, Consulting map experts.*



Extensive eelgrass loss took place in Casco Bay between 2001 and 2013 (see map at left from mapping data provided by MDMR for 2001 distribution, MDEP and CBEP for 2013 distribution).

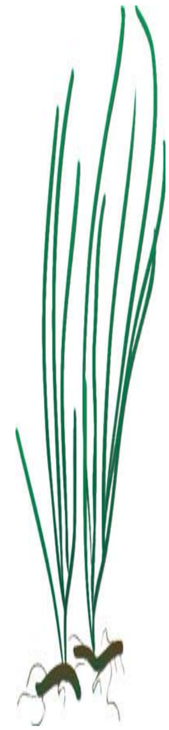
Questions asked:

- Is eelgrass loss continuing?
- What are the direct and indirect causes of change in eelgrass abundance?
- Is the influence of green crabs enhanced or mitigated by environmental characteristics?

Approach: We measured the seasonal change (June to September) in eelgrass percent cover and canopy height along eight shore-parallel transects established in a range of sedimentary environments.

What was found along established transects in different areas:

- Eelgrass percent cover increased from June to September along six out of eight transects. The only transects showing a decrease (Mackworth Island) or constant



(Cousins Island transect in coarse sediments) percent cover despite an increase in canopy height were the transects with the highest overall crab abundance

- In addition, the three transects showing “anomalies” in seasonal change in percent cover (i.e., decrease at Mackworth Island; no change at one Cousins Island transect; and small increase in cover at one Little Chebeague Island transect) were characterized by the greatest percentage of very coarse (> 2mm) sediment particles.

New questions that arose:

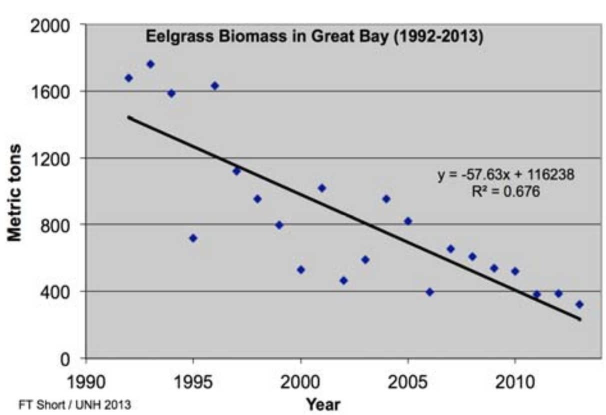
- Is there an interactive effect of sediment type and green crabs on eelgrass? (Data point in the opposite direction of what was predicted; eelgrass in fine sediments was thought to be more susceptible to green crab damage.)
- Could there be a direct influence of sediment nutrient availability in fine sediments in terms of eelgrass resilience to green crab damage?

For the future:

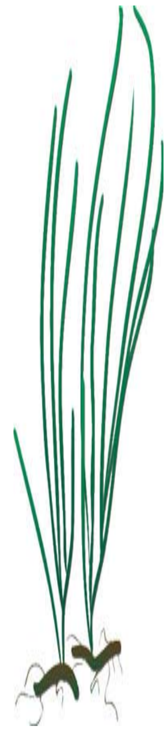
- Very fine sediments and high organic content in upper reaches does not hinder growth (Widgeon Cove)
- Light availability is favorable for eelgrass restoration in shallow zones of Casco Bay; eelgrass restoration is likely possible in the absence of green crabs

5. Status of Eelgrass in the Lamprey and Great Bay Watersheds
Fred Short, Jackson Estuarine Laboratory, University of New Hampshire

Significant declines in eelgrass over the last several decades (see graph below) have been shown to be linked to nitrogen overloading in watersheds.



Upgrades by wastewater treatment facilities have led to reductions in nitrogen loading. Continued reductions will be necessary to be able to restore eelgrass meadows in the



Lamprey and Great Bay watersheds. On-going eelgrass monitoring is planned to assess the effects of nutrient reductions.

What can we all do to ensure that eelgrass can survive in our bays?

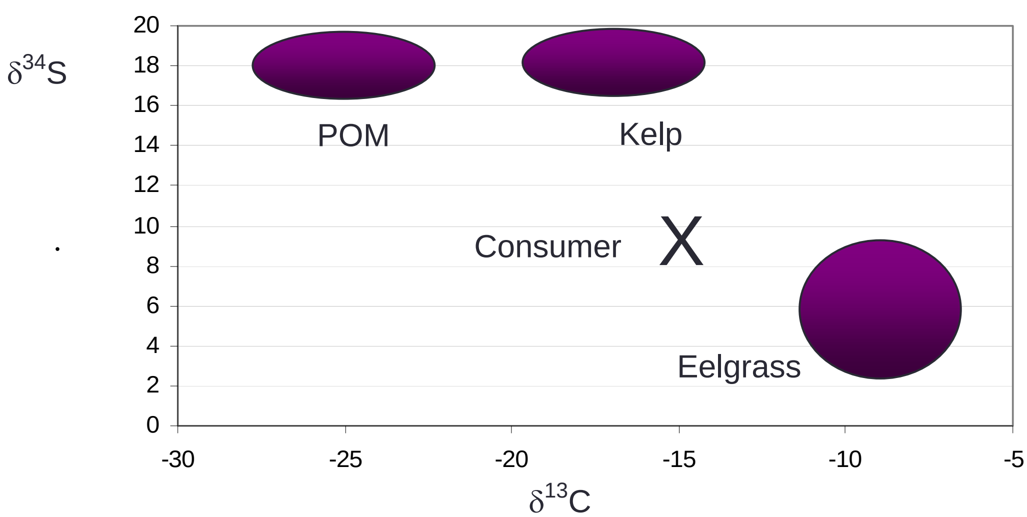
- Advocate for waste water treatment facility upgrades
- Advocate for reducing atmospheric N
- Advocate to reduce non-point runoff
- Support science for estuarine restoration
- Carry the message: the problem and the solutions

6. Organic matter derived from eelgrass: Where does it go and why do we care?
Bev Johnson: Geology Department, Bates College, Lewiston, Maine

1. Some of the organic matter derived from eelgrass ends up in the food chain. This has been revealed by looking at the stable carbon, nitrogen and sulfur isotopic composition of an animal's tissue, which reflects the stable isotope composition of diet.

- Carbon and sulfur isotopes can reveal primary production at the base of food web.
- Nitrogen isotopes can reveal trophic level of an organism.

The stable carbon and sulfur isotope composition of primary producers, such as eelgrass, kelp, and phytoplankton are different from each other (see purple fields in the graph below). The isotope composition of these primary producers is passed on to the tissues of consumers. Thus, it is possible to determine the source of organic matter at the base of an organism's diet by analyzing the isotopic composition of the organism's tissue. **In the schematic below, the consumer (represented by the X) has a diet that relies on eelgrass, kelp and phytoplankton as its isotopic ratio falls between the three primary producers.**



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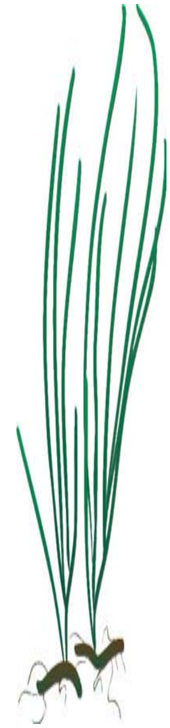

Isotopic analysis of archaeological fish bones provides valuable paleoecological information. Comparisons of the isotope composition of flounder bones from ancient shell middens and modern flounder bones in Penobscot Bay reveal a shift in flounder diet fueled largely by organic matter derived from eelgrass between 4500 and 400 years ago to a diet fueled almost entirely by macroalgae at some point post 1674 AD. This relatively recent shift to increased macroalgae fueling the base of the nearshore foodweb indicates a major loss of eelgrass habitat and a shift in baseline conditions at some point after colonization by western Europeans.

2. Some of the organic matter derived from eelgrass is sequestered as "blue carbon".

Blue carbon is a term used to refer to the carbon stored and sequestered in three coastal ecosystems– mangroves, salt marshes and seagrasses. The carbon sequestration rates in blue carbon ecosystems are among the highest in the world. Furthermore, carbon is well preserved in the saturated and anoxic sediments and can build up great carbon stocks over time. Thus, blue carbon ecosystems provide climate change mitigation benefits.

The net climate change mitigation benefits of restoration and conservation projects are determined by improving "baseline" conditions.

First, baseline conditions must be established by monitoring carbon emissions/sequestration and carbon stocks. In this preliminary assessment of carbon sequestration and storage in Maine eelgrass beds, sequestration data are compiled from the literature and preliminary carbon stocks are assessed from sediment core analyses in Maquoit Bay.

In Maine, there are approximately:

- 5600 km Coastline:
- 82 km2 Salt Marsh
- 128 km2 Eelgrass Beds

Preliminary assessment of the annual carbon burial rate for both salt marsh and eelgrass beds in Maine reveals that each ecosystem sequesters approximately 17 Gg C/year. This is approximately equivalent to the annual emissions of about 13,000 cars for each ecosystem. Preliminary assessment of carbon stocks in eelgrass beds in Maine indicates that approximately 1600 Gg C are stored in the upper meter of sediment. This carbon is approximately equivalent to the amount of carbon emitted by 1.2 million cars annually**.**

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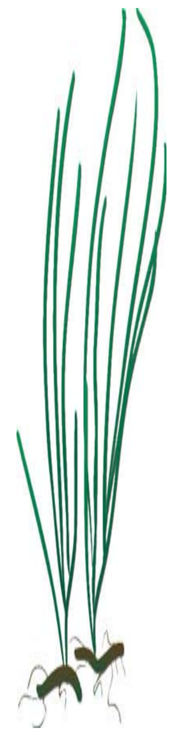


Loss of coastal vegetative habitats results in loss of important ecosystem services:

- habitat and nutrients for commercially important fishery species
- carbon sequestration potential
- erosion control

Conclusions:

- **Organic matter derived from eelgrass matters.**
  - It is important in foodwebs
  - It is important in carbon sequestration and storage

- **Work still to do**
  - Additional sample collection from eelgrass meadows
  - Better assessment of stocks and emissions/sequestration in Maine including areas subject to various degrees of perturbation by
    - - water quality changes
    - - green crab presence
    - - erosion of sediments

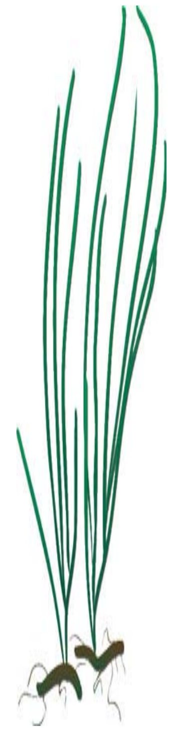
Afternoon Discussion:

After the presentation of work in progress by meeting participants, a discussion of future directions for research and possible collaborative projects ensued.

In Casco Bay, goals are to:
1. restore eelgrass
2. determine factors that control eelgrass loss

John Sowles emphasized that it is important to have good reference sites, some of which can be identified from 2014 work.

It appears that there is a range of sediments that can still support eelgrass. Are green crabs responsible for loss? There is evidence (based on work by Fred Short, Hilary Neckles, and Jane Disney et al.) that green crabs have been destructive in eelgrass habitat in both Casco Bay and Frenchman Bay. There may be factors that make eelgrass susceptible to green crab damage. Fencing appears to help mitigate green crab damage. Fred Short has seen that crabs can be distracted from eelgrass restoration areas by simply setting up a wall with fence material in proximity to the restoration site. Full protective fencing might not be necessary. Fred Short also reported that a fungus, not the protist *Labyrinthula zosterae* that causes wasting disease, may be responsible for some eelgrass loss (this was seen in Great Bay) and may also make it easier for green crabs to destroy eelgrass areas. Karen James may be able to use DNA assisted species identification



techniques to determine if the fungus species is present in different eelgrass areas. There may be other causal agents that we have not yet identified leading to eelgrass loss..

Hilary Neckles suggested that we pilot eelgrass restoration in Casco Bay, and set up a replicate project in Frenchman Bay. We would use natural areas for comparison. Areas identified as ideal for eelgrass restoration would be based on certain parameters, such as

- Green crab abundance
- Light availability
- Carbon and sulfides in the sediment

We would need to set up Standard Operating Procedures for both groups to follow. We would have to establish whether we would use whole plants or seeds. Then decide on a planting technique. We would need to control for green crabs and monitor light availability. We discussed the use of HOBO sensors. If they are calibrated in the air, then they might be useful.

We had a discussion on whether using HOBO sensors or a PAR profile would be best. We also discussed how best to measure turbidity. Some groups use a LI-COR meter. Water quality variables to assess might include:

- N
- P
- Si
- Temperature
- Dissolved Oxygen
- Salinity
- pH
- Transparency
- Chlorophyll a

Maura Thomas in David Townsend's Laboratory at University of Maine has been analyzing Casco Bay and Frenchman Bay nutrients over the years and it would be good to stay consistent with that.

Then there would have to be routine checking of restoration sites--perhaps using GoPro® cameras. Monitoring parameters could include percent shoot survival, leaves/shoot, plant length, etc.

We discussed whether doing comparison restoration projects help us get at the question of why we are losing so much eelgrass.

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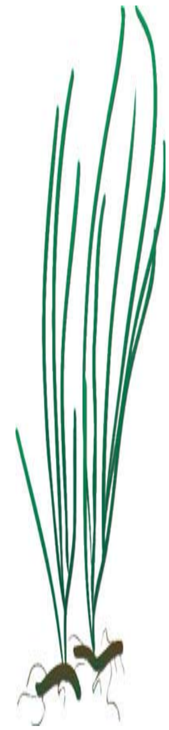

The subject of pesticide and herbicide applications on yards and golf courses came up. Do we know how much of an impact this can have on eelgrass? Laurie Osher tried to look at this in Taunton Bay, but was not able to come to a definitive conclusion. We had a brief discussion of progress made in the Casco Bay area to reduce impacts of chemical fertilizers on lawns. Joe Payne worked with the Maine Board of Pesticide Control. He found out that Weed and Feed like products are re-formulated every year. So it would be difficult to experiment on effects of a particular formula etc. Friends of Casco Bay did a public education campaign, and have reduced use of fertilizers in the watershed as a result.

We found out about the State Wildlife Action Plan from Matt Craig. Eelgrass is drawing more interest in the state. The State Wildlife Action Plan committee may be looking at the interface with coastal systems. Clair Enterline, Maine DMR, is a good contact for more information.

Fred Short found that advocating for reductions in nitrogen, working with municipalities and state government, and helping to turn around the nitrogen loading happening at waste water treatment facility outfalls, were successful endeavors that needed to continue.

Perhaps the function of this group is to advocate for eelgrass conservation and restoration. It may be good to connect with folks from Beginning with Habitat. And to contribute to the State Wildlife Action Plan.

The Ocean Acidification Task Force Report also mentions eelgrass, as it can mitigate impacts of changing ocean pH by taking up CO_2 during photosynthesis.

Final decisions were not made on next steps in terms of restoration and research. Each group is proceeding with research; we will communicate by e-mail and follow-up on collaborative plans for summer 2015.

Bev Johnson would like tissue samples while folks are out in the field this summer for her on-going stable isotope food web work.

Jane Disney offered to write up meeting notes. We may create and submit a press release throughout the state on this meeting, the collective findings of researchers regarding eelgrass loss in the state of Maine, coupled with emerging information on changing food webs, and potential impacts on a variety of ecosystem services. We can cite the State Wildlife Action Plan and the Ocean Acidification Task Force Report as evidence that eelgrass should be conserved in the Gulf of Maine.