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Eelgrass Distribution in the Great Bay Estuary for 2009 : Final Report

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A Final Report to

The Piscataqua Region Estuaries Partnership

submitted by

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Table of Contents

Executive Summary

Eelgrass in the Great Bay Estuary in 2009 was once again present only in Great Bay itself and in Portsmouth Harbor. For the second year in a row, there was no eelgrass in Little Bay or in the Piscataqua River. In 2009, there was a continued loss of eelgrass biomass in Great Bay; there has been a 66.4% loss of biomass in Great Bay since 1996 and distribution is 30% less than in 1996. Although eelgrass distribution in Great Bay itself increased between 2008 and 2009, primarily due to continued expansion from natural seeding of bare areas, the Bay's eelgrass biomass continued to decline as a result of decreases in plant density in existing beds. Nuisance macroalgae in Great Bay continued to proliferate and impact eelgrass by smothering eelgrass shoots and reducing shoot density. In 2009, Portsmouth Harbor experienced a 16% loss of eelgrass distribution since 2008, for a loss of 31% of the Harbor's eelgrass distribution in the past three years, an alarming trend. Although the number of acres of eelgrass has increased, driven by gains in Great Bay, even with these areal gains, biomass is down for the Bay itself and the trends of loss in Portsmouth Harbor of both eelgrass distribution and percent cover continue. Despite the increase in eelgrass distribution in Great Bay Estuary due to the increased seed recruitment in Great Bay, the loss of percent cover and biomass in Great Bay and in Portsmouth Harbor again this year (2008 – 2009) indicate the continuing adverse water quality conditions in the Estuary.

Introduction

Eelgrass (*Zostera marina* L.) is an essential habitat for the Great Bay Estuary (GBE) because it is the basis of an estuarine food web that supports many of the recreationally, commercially and ecologically important species in the estuary and beyond. Also, eelgrass provides food for ducks, geese and swans, as well as food, nursery habitat, and shelter for juvenile fish and shellfish. Eelgrass filters estuarine waters, removing both nutrients and suspended sediments from the water column; its roots and rhizomes bind and hold sediments in place. Eelgrass in the Great Bay Estuary is a vital resource to the State of New Hampshire's marine environment, a habitat that is essential to the health of the estuary (Trowbridge 2006, Short 2009). The present report describes and interprets the eelgrass distribution data collected in 2009 for the Great Bay Estuary.

Seagrasses are an indicator of estuarine health (Orth et al. 2006, Waycott et al. 2009). Rooted in place, eelgrass integrates the influences of environmental conditions that it experiences within an estuarine system and therefore can be read as a barometer of impacts and changes to the estuary. Eelgrass beds alter their distribution and biomass in response to changing water quality, nutrient inputs, and light levels, with change assessable at the plant population level or through differences in plant physiology and chemistry. Using eelgrass as an indicator, one can detect: reduction in water clarity through reduced areal coverage (distribution) in subtidal beds, particularly at the deep edge of eelgrass beds (Rivers 2006, Ochieng et al. 2010) and declining biomass (Beem and Short 2009); increase in nitrogen (N enrichment) through the NPI (Nutrient Pollution Indicator, Lee et al. 2004); and status and health of the estuary through scientific monitoring of eelgrass percent cover and biomass changes (SeagrassNet Monitoring Program, Short et al. 2006).

As of the 2008 mapping, a year before the mapping of eelgrass distribution and cover reported here, eelgrass in the Great Bay Estuary remained at low levels except in Great Bay itself. By 2008, eelgrass had completely disappeared from Little Bay and the Piscataqua River.

Ruppia maritima (called here by its common name, ruppia) was observed in large beds in several of the tributaries of GBE in 2005, but declined in distribution from 2005 to 2008. The beds of ruppia in the Bellamy, Oyster and upper Piscataqua Rivers were gone in 2007 and 2008 except for one large bed in the Bellamy River. Although ruppia is a seagrass and provides some of the functions of an eelgrass meadow, it is an annual plant, its distribution is highly variable from year to year, and its low canopy height (less than 10 cm in these beds) creates different habitat conditions than eelgrass.

Almost two decades ago, in 1989, there was a dramatic decline in eelgrass area in Great Bay itself to only 300 acres (15% of normal levels). The cause of this crash was an outbreak of a slime mold, *Labryrinthula zosterae*, commonly called "wasting disease" (Muelhstein et al. 1991). More recently, the greatest extent of eelgrass in the GBE was observed in 1996 after the beds had recovered from the wasting disease episode of the late 1980s and early 1990s. The decline in eelgrass biomass seen from 1996 – 2008 is not a result of wasting disease, and shows all the signs of being caused by anthropogenic impacts, namely increased nutrient loading and sedimentation. Nutrient loading and sedimentation are the main causes of seagrass loss worldwide (Orth et al. 2006).

The University of New Hampshire has created digitized eelgrass distribution information for the Great Bay Estuary for the years 1999-2008 and these are now in the PREP database. Here, I report on the eelgrass distribution and cover class information for the year 2009 in the Great Bay Estuary, based on aerial photography and ground truthing.

Project Goals and Objectives

UNH has now completed the 2009 eelgrass mapping project under contract to PREP. The project goal, and the objective of the contract, was to map eelgrass distribution in the Great Bay Estuary for 2009 based on aerial photography and ground truth.

The final work product is ArcInfo files of eelgrass distribution throughout the Great Bay Estuary for 2009, including all necessary documentation/metadata for the ArcInfo files, and this final report describing the results of our 2009 findings.

Methods

The methods for this project followed the procedures specified in the approved QA Project Plan (Short and Trowbridge, 2003).

Additionally, in 2009 the edges of eelgrass beds were traced with a Garmin GPSmap 76C and the track was compared to the mapped eelgrass polygons (Appendix, Figure 2). Near-vertical aerial photography was also acquired at 8000 feet to evaluate the potential for rubber-sheeting such photos to the basemap. An oblique photo from 8000 feet is shown in the Appendix in Figure 3.

Results and Discussion

The shapefiles containing the eelgrass distribution data for 2009 have been provided to the PREP Coastal Scientist by email. Metadata for the shapefiles is as follows:

Codes for cover classes:

P = 10 to 30 % cover (Patchy)
H = 30 to 60 % cover (Half)
SB = 60 to 90 % cover (Some Bottom)
D = 90 to 100 % cover (Dense)

Eelgrass cover below 10% cannot be detected in the aerial photography.

Eelgrass distribution in 2009 in the Great Bay Estuary remained low compared to historical cover, with some increased area in Great Bay itself but severe losses in Portsmouth Harbor (Figure 1). The Great Bay experienced a continued biomass loss, despite its increase in eelgrass distribution. In 2009, Little Bay and the Piscataqua River remained devoid of eelgrass. In Portsmouth Harbor (including Little Harbor and the Back Channel), eelgrass distribution declined significantly with concomitant decreases in percent cover of remaining eelgrass areas. Because of its large remaining intertidal eelgrass meadows, Great Bay dominates the areal findings for eelgrass in the estuary overall. Eelgrass has disappeared throughout much of its historic range in the estuary: large areas of the estuary that historically supported eelgrass currently do not, including Little Bay and the Piscataqua River. The greatest loss of eelgrass in the Estuary between 2008 and 2009 occurred in Portsmouth Harbor. ***The estuary presently has 65% of its 1996 eelgrass distribution. Great Bay itself has lost 66.4% of its eelgrass biomass since 1996.*** The overall loss of eelgrass in the estuary is indicative of poor water quality conditions.

In Great Bay itself, eelgrass distribution increased from 2008 to 2009 while eelgrass biomass decreased. The increase in distribution of 306 acres was due to further re-vegetation via seedlings in bare areas of the bay. Eelgrass distribution in Great Bay is at 70% of what it was in 1996, its peak year in recent times. Overall, there was a slight decrease in eelgrass biomass from 2008 to 2009 in Great Bay; a few eelgrass beds in the Bay increased in biomass, but most lost biomass. Expanded eelgrass distribution in 2008 and 2009 in Great Bay was a result of two years of favorable growing conditions (low rainfall, sunny weather) that allowed survival of eelgrass seedlings -- despite the Estuary's degraded water quality conditions -- in intertidal areas not recently vegetated by eelgrass. Even with the significant gain in eelgrass distribution in Great Bay, the reduction in the quality of the beds resulted in continued overall loss of eelgrass biomass within the Bay itself. Wasting disease was present in Great Bay at fairly low levels and was not a contributor to eelgrass biomass declines.

In the northwest part of Great Bay, near Adams Point, there was little change in eelgrass distribution while eelgrass biomass decreased, as in the previous year. On the western side of Great Bay, eelgrass distribution increased slightly with some areas re-vegetating; some beds increased in biomass while others decreased. In the southern Bay, there was a decrease in percent cover throughout much of the bed and nuisance seaweeds persisted. The eelgrass beds off Sandy Point declined in eelgrass percent cover. In the southwest part of Greenland Bay in 2009, percent cover remained roughly the same and there was some increase in eelgrass distribution compared to 2008. In northern Greenland Bay, eelgrass distribution increased slightly with some decrease in percent cover while some beds remained the same. The largest increase in eelgrass distribution in 2009 occurred along the eastern side of Great Bay between Nanny's Island and Thomas Point, where new patchy eelgrass appeared inshore. The existing offshore bed in this area expanded toward shore (eastward) but regressed at the deep edge, showing an overall decrease in biomass.

In Little Bay and the Piscataqua River there was virtually no eelgrass in 2009, similar to 2008. No evidence of eelgrass was seen from aerial surveys or photography. Ground truth efforts revealed a few scattered eelgrass seedlings at one site in the Piscataqua River near Adlington Creek. The restored bed in the Bellamy River is gone as of 2009. All of the eelgrass transplanted for the New Hampshire Port Mitigation Project of 1993-95 and the eelgrass beds that served as reference sites for this project have been lost (Beem and Short 2009). The loss of eelgrass in Little Bay and the Piscataqua River represents a decrease of 318 acres since the 1981 historical map, a severe loss of habitat and of the critical connecting corridor of vegetation between Great Bay and Portsmouth Harbor. The ruppia seen in previous years in the upper Piscataqua River and other rivers was absent in 2009.

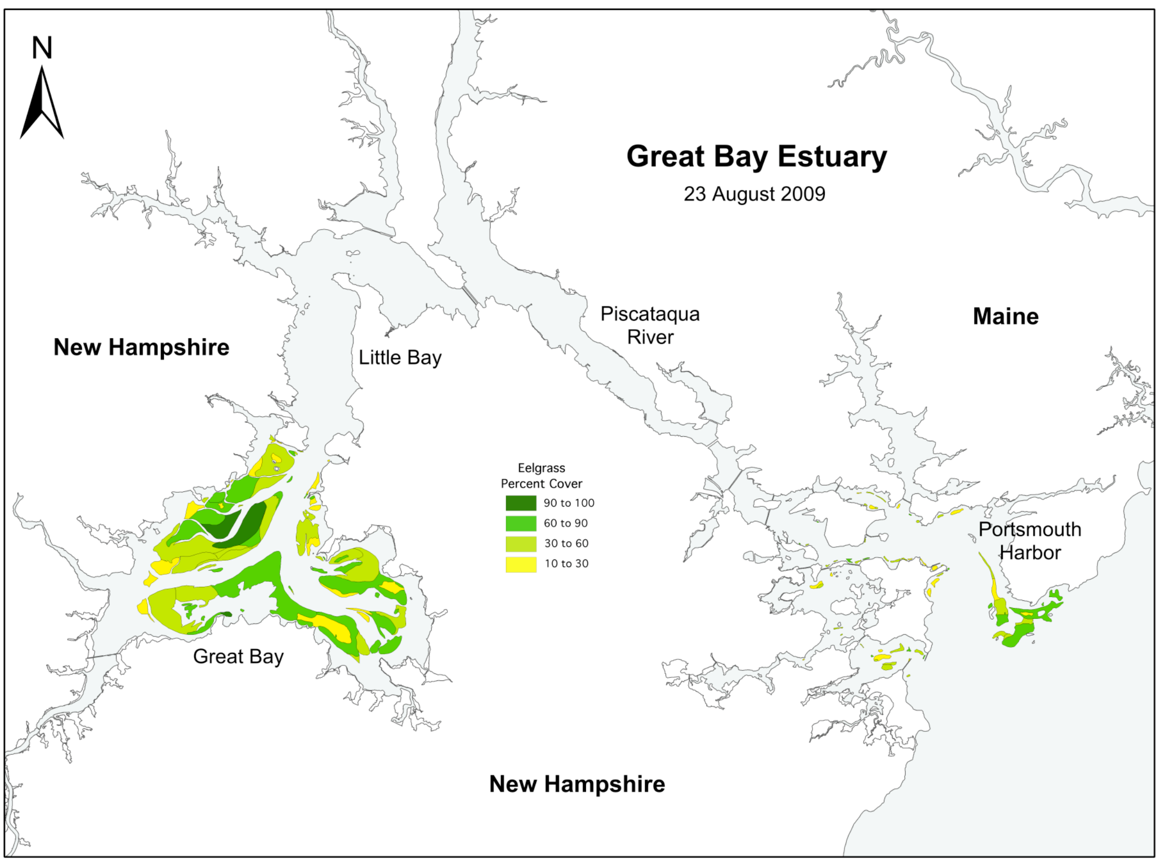

Figure 1. Eelgrass distribution for the Great Bay Estuary based on aerial photography from 23 August 2009 and ground truth surveys.

In Portsmouth Harbor (including Little Harbor and Back Channel), eelgrass distribution and percent cover declined markedly in 2009. Most of the eelgrass beds in this area showed reduction in both distribution and percent cover. The loss of eelgrass distribution in the Portsmouth Harbor region since 2008 stands at 16%, with a 31% loss since 2006. The majority of eelgrass losses occurred at the mouth of Portsmouth Harbor and in Little Harbor in deep, sub-tidal beds, although percent cover decreased in many of the eelgrass beds throughout the area. The small eelgrass beds in upper Portsmouth Harbor seaward of the Memorial Bridge on both the New Hampshire and Maine sides, lost between 2006 and 2007, have not re-appeared. Eelgrass wasting disease levels were low throughout the area. The former eelgrass meadow between Gerrish and Fishing Islands in Portsmouth Harbor was still impacted by Canada goose grazing (Rivers and Short 2007) and remained below detection limits.

Recommendations

1. Increase efforts to lower nitrogen loading to the Great Bay Estuary (GBE) to improve water clarity and reduce nuisance seaweeds throughout the estuary.

2. Throughout the GBE watershed, accelerate the implementation of sediment retention structures to reduce the direct sediment input to the estuary that contributes to elevated turbidity.

3. Secure funding for eelgrass research in GBE including investigations of the deep edge, Nutrient Pollution Indicator, and N isotope studies in order to examine trends and current status.

4. Continue annual monitoring of eelgrass in the Great Bay Estuary to detect trends in eelgrass itself and as an indicator of estuarine health.

5. Update the conversion of eelgrass percent cover to biomass through field surveys.

6. Restore eelgrass in Little Bay and the Piscataqua, Oyster and Bellamy Rivers.

7. Conduct quantitative monitoring of the wasting disease in the Great Bay Estuary.

8. Institute best management practices in the Great Bay Estuary to reduce boating and mooring impacts to eelgrass.

9. Create an improved map of potential eelgrass habitat for the Great Bay Estuary and use it in planning estuarine development to avoid impacts to areas where eelgrass could grow if water clarity were improved.

10. Avoid both actual and potential eelgrass habitat when siting construction projects, other habitat restoration activities, or boat moorings and docks in the estuary.

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Appendix

GPS track of boat survey lines along the edges of eelgrass beds in Great Bay demonstrates the accuracy of the eelgrass mapping (Figure 2). Slight deviations from the edge of the bed as mapped occurred due to 1) wind pushing the boat off the edge of the bed, 2) difficulty in seeing the deep edge in turbid water at the channel, and 3) GPS points collected immediately after leaving the edge of the bed. The eelgrass beds in Great Bay are easily seen by the dark continuous areas in an oblique aerial photograph taken from 8000 feet (Figure 3). The near-vertical aerial photography at 8000 feet is distorted by the Earth's curvature, the parallax of the camera lens, and the angle of the photograph to a degree that direct mapping of eelgrass from these photos was not possible.

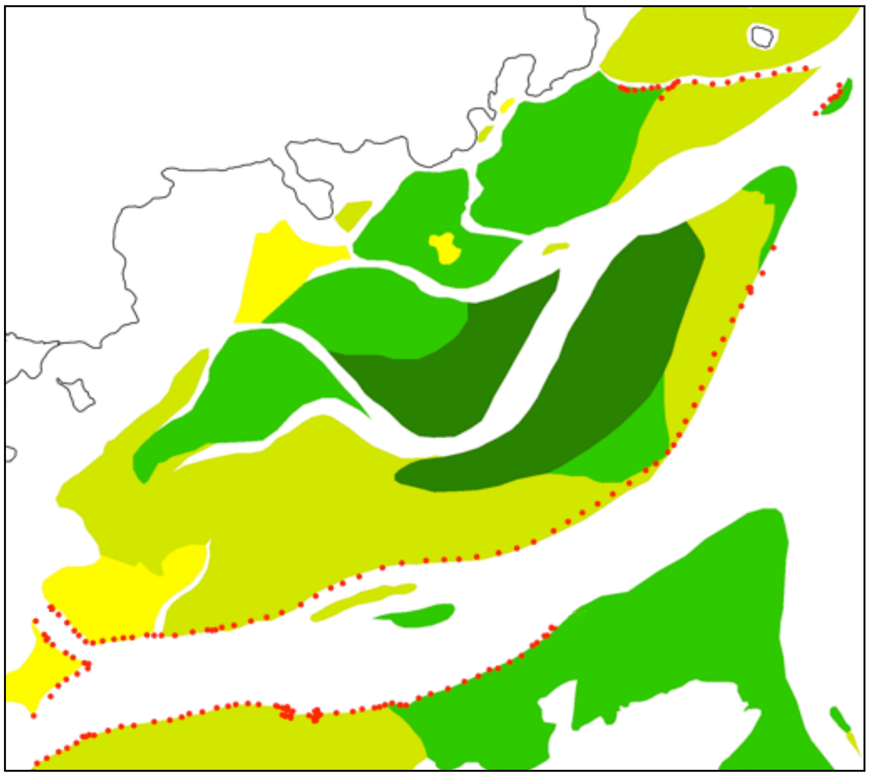

Figure 2. Eelgrass beds in Great Bay, NH: the red dots show the GPS points collected as the boat skirted the edge of the eelgrass beds.

Figure 3. Aerial photo of Great Bay from 8000 feet, showing the dark pattern of eelgrass beds throughout the Bay, 23 August 2009.