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Frederick T. Short

University of New Hampshire, Jackson Estuarine Laboratory, fred.short@unh.edu

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Eelgrass Distribution in the Great Bay Estuary for 2014

A Final Report to

The Piscataqua Region Estuaries Partnership

submitted on 22 January 2016

by

Dr. Frederick T. Short
University of New Hampshire
Jackson Estuarine Laboratory
85 Adams Point Road
Durham, NH, 03824
fred.short@unh.edu

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Executive Summary

Headlines for 2014:

- The Great Bay Estuary **gained** 12% in eelgrass distribution from 2013 to 2014.
- Great Bay itself experienced a 16% **increase** in eelgrass distribution from 2013 to 2014.
- Eelgrass biomass in Great Bay **increased** 8% between 2013 and 2014.
- But in Portsmouth and Little Harbors, eelgrass distribution **decreased** 14% from 2013 to 2014.

Long-term story, the eelgrass decline since 1996:

- The Great Bay Estuary has **lost 44%** of its eelgrass distribution.
- The Great Bay itself has **lost 41% of its eelgrass distribution and 79%** of its eelgrass biomass.
- Little Bay and the Piscataqua River have **lost 94%** of their eelgrass distribution.
- Portsmouth and Little Harbors have **lost 54%** of their eelgrass distribution.

Eelgrass in the Great Bay Estuary gained in areal distribution between 2013 and 2014. In Great Bay, where the majority of 2014 eelgrass gains were seen, shallow new beds of eelgrass seedlings were largely responsible for the increased eelgrass area and biomass. Total eelgrass area in Great Bay was 1466 acres (16% increase) with an 8% gain in biomass. Areal gains outpaced biomass gains because eelgrass seedlings and young plants are typically low in biomass. Nuisance macroalgae and epiphytes continued to proliferate in 2014, especially in Great Bay. As in 2013, there was no eelgrass in Little Bay in 2014. The patchy 4-acre eelgrass area in the Piscataqua River grew more dense but was still less than 30% cover overall. In Portsmouth and Little Harbors, including the Back Channel, eelgrass continued to decline with eelgrass distribution down 14% from 2013, to 150 acres.

Despite the gains seen in 2014, the long-term trend of eelgrass loss continues (Figure 2) and it will take much larger and longer-term increases in eelgrass area and biomass to represent true recovery of the habitat. To put this in perspective, the gains of 2014 do not even make up for the losses in eelgrass seen between 2012 and 2013. In the Great Bay Estuary, eelgrass distribution has declined 44% since 1996. Great Bay itself has lost 79% of eelgrass biomass in that same time, down from 1630 tons in 1996 to 348 tons in 2014.

Worldwide, the main causes of seagrass decline are increased nitrogen and sediment loading. Also, loss of eelgrass leads to increases in the nitrogen available in the water column. Furthermore, eelgrass loss leads to greater resuspension of sediments, which in turn leads to decreasing water clarity.

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. 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 and improves water clarity, removing both nutrients and suspended sediments from the water column; its roots and rhizomes bind and hold sediments in place, thereby reducing turbidity. Historically, eelgrass has been the primary habitat in the Great Bay Estuary, for many decades covering the most area of any of the three major habitats: eelgrass, salt marsh, and mud flat. Eelgrass in the Great Bay Estuary is a vital resource to the State of New Hampshire's marine environment, and eelgrass habitat is essential to the health of the estuary (Trowbridge 2006, Short 2014). The present report describes and interprets the eelgrass distribution, percent cover and biomass data collected in 2014 for the Great Bay Estuary. The report was written for the Piscataqua Region Estuaries Partnership (PREP), and covers the entire Great Bay Estuary, from the Atlantic Coast to the Great Bay, and including the estuarine portions of the tributaries.

Seagrasses are an indicator of estuarine and coastal health worldwide (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 its health status acts 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. Eelgrass change can be measured at the plant population level or by examining 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 through declining biomass (Beem and Short 2009);
- increase in nitrogen enrichment through the eelgrass-based NPI (Nutrient Pollution Indicator, Lee et al. 2004) as well as through increased nuisance seaweeds (Nettleton et al. 2011) and epiphyte cover on eelgrass blades;
- and status and health of the estuary through scientific monitoring of eelgrass distribution, percent cover, and biomass changes (SeagrassNet Monitoring Program, as described in Short et al. 2006, 2014).

Over two decades ago, in 1989, there was a dramatic decline in eelgrass distribution 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). Since the partial recovery from the 1989 crash, the greatest extent of eelgrass in the GBE was observed in the year 1996. The declines in eelgrass biomass seen since 1996 are not a result of wasting disease. Worldwide, anthropogenic nitrogen loading and increased sedimentation are the main causes of seagrass loss (Orth et al. 2006).

A downward trend in eelgrass continues, showing losses of eelgrass distribution and biomass in the Great Bay itself and Estuary-wide since the modern maximum of 1996, with a 44% loss overall since then in distribution. Eelgrass biomass, representative of eelgrass habitat functions and values, is down 79% in Great Bay itself since 1996.

The University of New Hampshire has created digitized eelgrass distribution information for the Great Bay Estuary for the years 1999-2013 and these are now in the PREP database. *Ruppia maritima* was not observed in 2014 and is not reported here. Below, I report on the eelgrass distribution and cover class information for the year 2014 in the Great Bay Estuary, based on aerial photography and subsequent ground truthing carried out in August and September of 2014.

Project Goals and Objectives

UNH has now completed the 2014 eelgrass mapping project under contract to PREP. The project goal, and the objective of the contract, was to map eelgrass distribution by cover class in the Great Bay Estuary for 2014 based on aerial photography and ground truth, as well as to report on eelgrass biomass.

The final work products are ArcInfo shapefiles of eelgrass distribution throughout the Great Bay Estuary for 2014, including all necessary documentation/metadata for the ArcInfo files, and this final report describing the results of the findings for 2014.

Methods

The methods for this project followed the procedures specified in the approved QA Project Plan (Short and Trowbridge, 2010). Biomass estimate methods are described on Page 238 of the "Final Environmental Data Report December 2012: Technical Support Document for the 2013 State of Our Estuaries Report" (PREP 2012).

The present report describes and interprets the eelgrass distribution, percent cover and biomass data collected in 2014 for the Great Bay Estuary. "Distribution" refers to acres of estuary where eelgrass is present; that is, there is at least 10% cover of eelgrass. "Biomass" refers to an estimate of the dry weight of eelgrass in the estuary (in tons), including above and below ground plant matter.

Results and Discussion

The shapefiles containing the eelgrass distribution data for 2014 have been provided to the PREP Coastal Scientist by email and are available through NH Granit (granit.unh.edu) or through the NH DES "Eelgrass Viewer" at:

<http://nhdes.maps.arcgis.com/apps/webappviewer/index.html?id=2792e57da2704867b164c17aee2dc43e>

Metadata for the shapefiles is as follows:

Codes for cover classes:

10 to 30% cover = P (Patchy or sparse)

30 to 60% cover = H (Half)

60 to 90% cover = SB (Some Bottom)

90 to 100% cover = D (Dense)

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

Between 2013 and 2014, there was 12% increase in eelgrass distribution in the Great Bay Estuary (Figure 1), largely as a result of new beds forming in the shallow fringes of Great Bay (see Table 1). Great Bay itself showed a gain of 16% eelgrass distribution, with a smaller gain of 8% in eelgrass biomass. The former eelgrass bed in Little Bay, which disappeared in 2013, did not recover in 2014. One site in the Piscataqua River retained patchy eelgrass across an area of 4 acres in 2014. Between 2013 and 2014, there was a 14% loss of eelgrass distribution in Portsmouth Harbor. Eelgrass distribution and biomass in 2014 in the Great Bay Estuary remained low compared to 1996 levels.

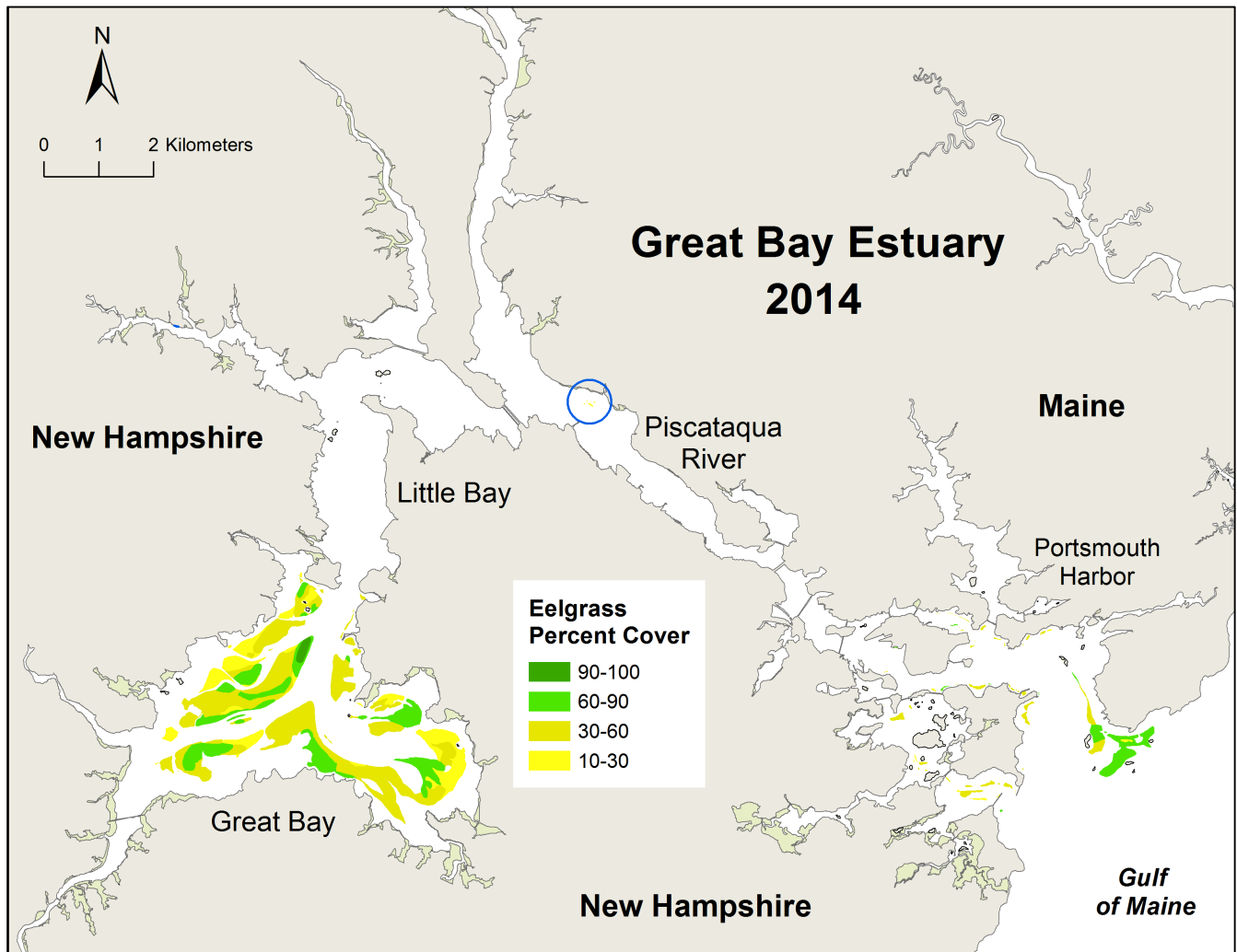


Figure 1. Eelgrass distribution in the Great Bay Estuary based on aerial photography from September 12, 2014 and ground truth surveys. Note blue circle around the patchy 4-acre eelgrass area in the Piscataqua River.

Table 1. Eelgrass distribution for different components of the Great Bay Estuary, going back to 1996, the peak year for eelgrass distribution since mapping began in 1984 (Short et al. 1986). (Data from F. T. Short, UNH, partially funded by PREP since 2004).

| Year | Great Bay | Little Bay | Oyster River | Piscataqua River | Portsmouth Harbor | Little Harbor | Total for Great Bay Estuary |
|------|-----------|------------|--------------|------------------|-------------------|---------------|-----------------------------|
| 1996 | 2503 | 33 | 14 | 33 | 238 | 74 | 2894 |
| 1997 | 2305 | - | - | - | - | - | - |
| 1998 | 2398 | - | - | - | - | - | - |
| 1999 | 2130 | 26 | 0 | 12 | 238 | 53 | 2459 |
| 2000 | 1945 | 8 | 0 | 13 | 256 | 63 | 2285 |
| 2001 | 2392 | 11 | 0 | 22 | 262 | 48 | 2735 |
| 2002 | 1795 | 4 | 0 | 18 | 262 | 65 | 2145 |
| 2003 | 1627 | 14 | 0 | 35 | 262 | 58 | 1996 |
| 2004 | 2042 | 14 | 0 | 21 | 204 | 70 | 2349 |
| 2005 | 2175 | 26 | 0 | 25 | 227 | 55 | 2507 |
| 2006 | 1321 | 12 | 0 | 23 | 213 | 54 | 1623 |
| 2007 | 1245 | 0 | 0 | 6 | 194 | 44 | 1489 |
| 2008 | 1395 | 0 | 0 | 4 | 176 | 44 | 1619 |
| 2009 | 1701 | 0 | 0 | 6 | 151 | 32 | 1890 |
| 2010 | 1722 | 0 | 0 | 4 | 125 | 44 | 1895 |
| 2011 | 1624 | 48 | 0 | 7 | 123 | 34 | 1836 |
| 2012 | 1599 | 35 | 0 | 7 | 136 | 38 | 1813 |
| 2013 | 1266 | 0 | 0 | 7 | 150 | 26 | 1448 |
| 2014 | 1466 | 0 | 0 | 4 | 125 | 25 | 1620 |

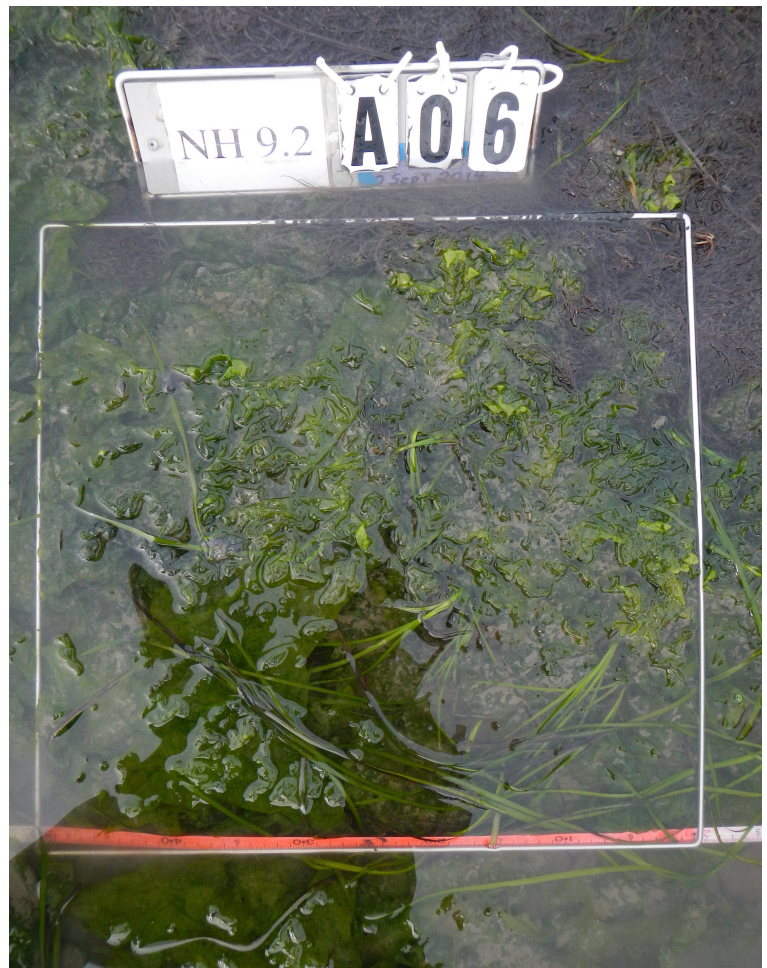
- indicates not mapped

Eelgrass has disappeared throughout much of its previous range in the Estuary: large areas of the Estuary that supported eelgrass in the 1980s and 1990s no longer have any eelgrass. **The Estuary has lost 44% of its eelgrass area since 1996. As of 2014, Great Bay itself lost 79% of its eelgrass biomass since 1996.** Photo 1 (below), exemplifies a common sight in the Great Bay in 2014: excessive nuisance seaweed growth and greater epiphyte loads on eelgrass leaves. Due to the loss of the eelgrass “filter” function, more suspended sediments occur, especially in Great Bay, where they collect on eelgrass leaf blades.

In Great Bay itself, eelgrass distribution increased 16% from 2013 to 2014, while eelgrass biomass increased 8%. These gains partially offset the losses of distribution and biomass from the year before. The increases occurred in shallow fringing areas of Great Bay, mostly via new eelgrass seedlings. Gains in eelgrass distribution outpaced new biomass, typical of new area created by seedlings. (See DES “Eelgrass Viewer,” url above.)

The eelgrass acreage in Great Bay itself is now 59% of what it was in 1996, the peak year of recent times. In 2014, there was only one remaining area in Great Bay supporting high eelgrass density (90 – 100% cover). Nuisance seaweeds, largely comprised of the invasive species, *Gracilaria vermiculophylla*, as well as *Ulva lactuca*, continued to proliferate. In 2012, an increased epiphyte load on eelgrass leaves was noted, which continued in 2013 and persisted in 2014. Epiphyte loading further stresses eelgrass by shading the leaves and by causing retention of sediment on the eelgrass leaf surface. Wasting disease was present in Great Bay in 2014 at fairly low levels and did not strongly impact eelgrass during the year.

Photo 1:
Great Bay monitoring photograph.
Quadrat sampling in the mid-bay bed, taken 2
September 2014, showing a frequent sight:
Ulva lactuca and *Gracilaria vermiculophylla*
overgrowth of the eelgrass (*Zostera marina* L.)
meadow. (SeagrassNet 2014)



In the northwest part of Great Bay, near Adams Point, the eelgrass bed west of Seal Rock had largely the same area as 2013. Along the Adams Point shoreline, the fringing beds re-vegetated between 2013 and 2014. The distribution of eelgrass on the flat surrounding the Footman Islands was similar to 2013 but with deep-edge regression in 2014 and extensive *Gracilaria* intermixed with the eelgrass. The eelgrass island seen for years near the main channel and east of the Footman Islands, after showing decline for several years, was gone in 2014. On the western side of Great Bay in the mid-bay bed, eelgrass was similar to 2013 with some expansion into shallow areas and a great deal of *Ulva*. At the mouth of the Lamprey River, there was a sparse eelgrass bed reestablished by an extended area of seedlings. In the southern Bay, eelgrass showed increases in density on the Squamscott River side and losses in density in the central portion, with distribution similar to 2013. Between 2013 and 2014, Greenland Bay experienced abundant eelgrass seedling recruitment, yielding new eelgrass acreage although this was somewhat offset by losses in central and northern Greenland Bay. The eelgrass bed east of Nannie’s Island diminished from previous years with a great deal of *Ulva* and *Gracilaria* and high levels of eelgrass flowering. Along the eastern side of Great Bay, eelgrass expanded south of Thomas Point at the shallow edges of the beds. North of Thomas Point, the shallow eelgrass bed largely disappeared in 2014, except for a fringe along the channel. Eelgrass in eastern Great Bay was heavily epiphytized.

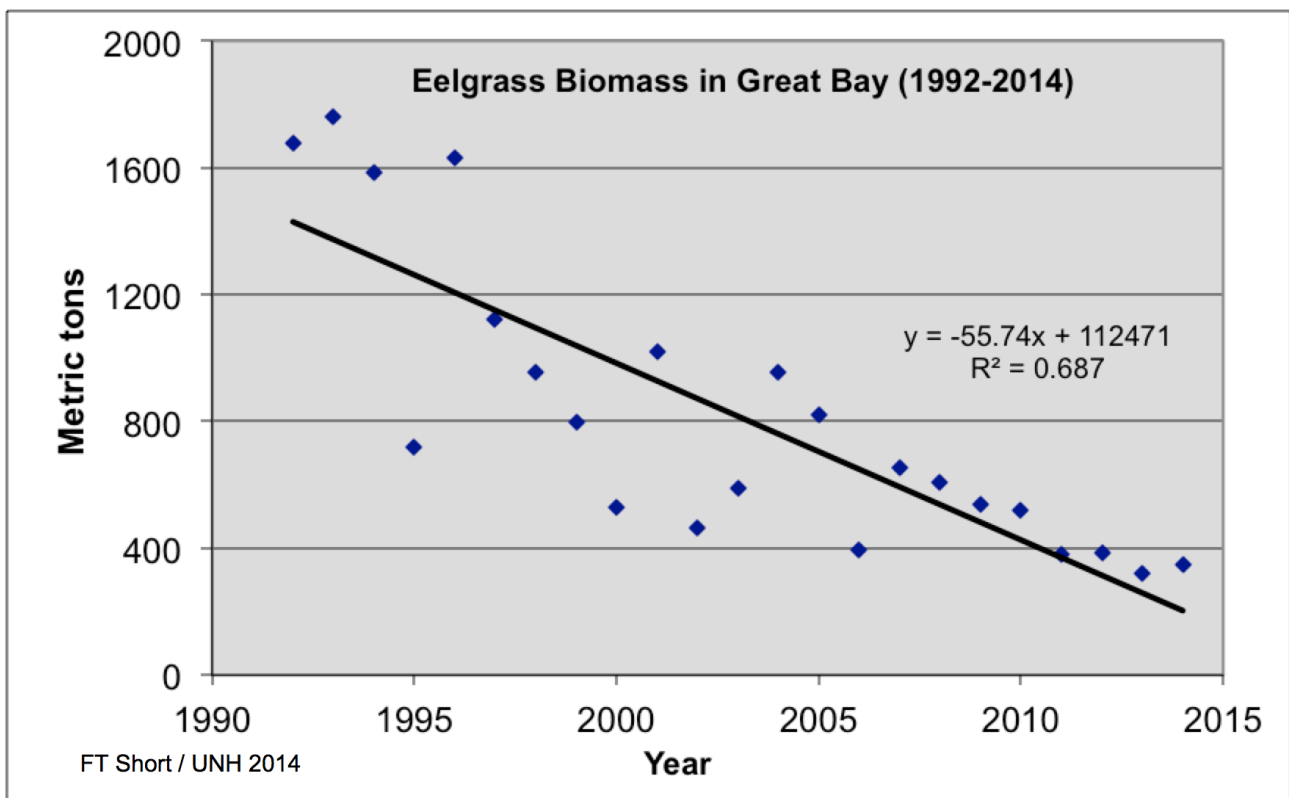


Figure 2. Downward trend in annual eelgrass biomass in Great Bay from 1992 through 2014, including the increase of 2014 which does not substantially alter the trend.

In Little Bay, the eelgrass beds along the eastern shoreline and in Welch Cove completely disappeared in 2013. There continued to be no eelgrass in Little Bay in 2014.

In the Piscataqua River, the patchy eelgrass area adjacent to Adlington Creek, Maine, covered an area of 4 acres. The eelgrass bed in this location is growing denser over time but is still less than 30% cover.

In Portsmouth and Little Harbors (including Gerrish Island, Back Channel, and Odiorne Point), eelgrass distribution from 2013 to 2014 decreased 14%. Most of the decline occurred in Little Harbor, but there were also reductions in eelgrass distribution along the Maine coast off Gerrish Island. The only area showing some eelgrass increase was in the channel confluence at the mouth of Sagamore Creek. Eelgrass distribution in the Portsmouth Harbor area has decreased 54% since 1996.

2014 represents a slight improvement for eelgrass in the Great Bay Estuary over 2013, mostly seen in Great Bay itself as seedlings expanded into new shallow areas of the Bay. More extensive flowering of eelgrass plants in the Bay, a response to the highly stressed conditions, is providing more seed, resulting in expanding beds of eelgrass seedlings. 2014 was also a year with good growing conditions for eelgrass: fairly low rainfall, lots of sunshine, and few major storms. While it is very good to see an increase in eelgrass distribution in Great Bay, the slight uptick of 2014 does not compensate for the losses that occurred between 2012 and 2013. The long-term trend for eelgrass in the Great Bay Estuary is still downward, with a 44% loss of eelgrass distribution since 1996 and a 79% loss of eelgrass biomass in Great Bay since 1996.

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