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## MEMORANDUM

**TO:** Dean Peschel  
**FROM:** John Hall, Bill Hall, Ben Kirby  
**DATE:** October 26, 2016  
**RE:** Annual Variation in Eelgrass Cover by Region in Great Bay

The spatial variability of eelgrass cover in Great Bay Estuary has been identified as an area for assessment by the peer review panel that evaluated the draft numeric nutrient criteria for the Estuary. This memorandum presents an evaluation of eelgrass spatial variability in Great Bay based on the mapping data provided by Dr. Fred Short for the period from 1986 through 2013. These data were provided as ArcGIS polygons illustrating the areas of measurable eelgrass growth as determined from aerial photography. Each polygon identifies the location of the bed and its associated acreage.

The bathymetry of Great Bay reveals the estuary's drowned ancient river beds (see Figs. 1, 2). Typical patterns of eelgrass cover are separated by these deep channels, where eelgrass cannot grow. As such, these channels made convenient boundaries to analyze eelgrass cover variability in distinct geographic regions of Great Bay. These regions, of approximately equal area, were designated East, South, and West sectors (see Fig. 3). Individual ArcGIS polygons were categorized by geographical sector to evaluate annual change in eelgrass cover for each of the sectors. The total eelgrass area for each sector was summed and plotted by year to visualize localized variations in eelgrass coverage (see Fig. 4).

Eelgrass cover in the West sector has ranged from 815-540 acres over the period from 1990-2013. Eelgrass in this sector has remained relatively stable, with several downturns followed by recovery. The declines in 1995 and 2002 totaled approximately 25% and 30% of the pre-decline cover. Since 2006 this sector has had the most eelgrass cover of the three sectors. In 2006, when the other two sectors experienced a dramatic decline, the West sector remained stable and may have increased slightly. The reduced cover in 2002-2003, when the sector was reduced to its minimum cover, was attributed to an outbreak of wasting disease.

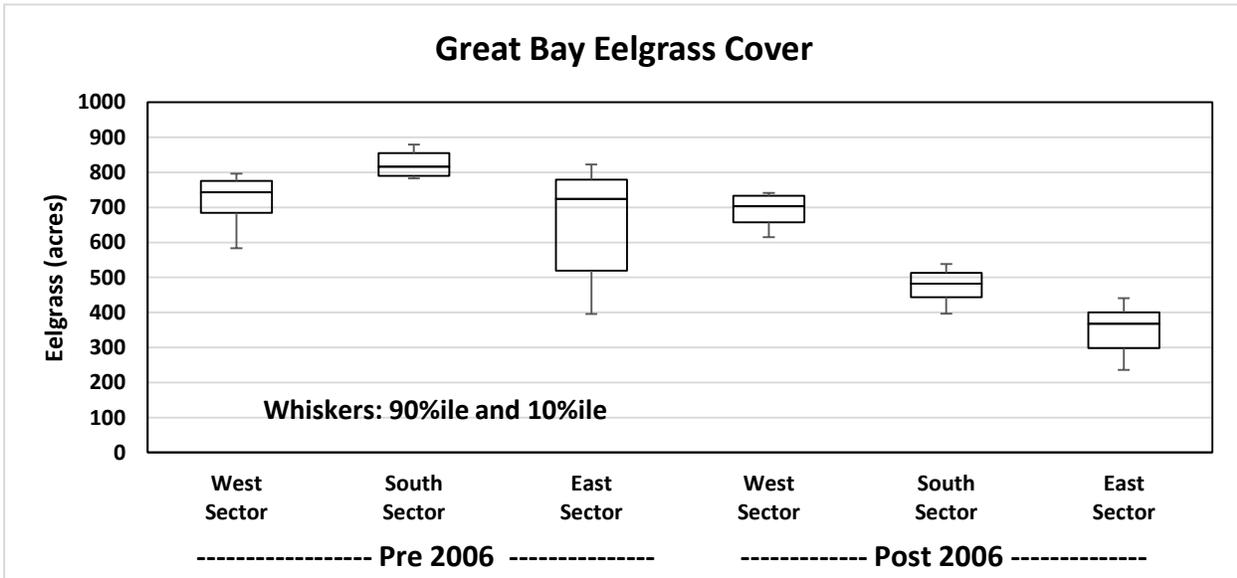
Eelgrass cover in the South section has ranged from 885-300 acres over the period of record (1990-2013). Eelgrass cover was very stable from 1990-2005, ranging from 750-885 acres. In 2006, the South sector experienced a steep decline to 300 acres (~60% loss), coinciding

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with a period of high rainfall and regional flooding. Over the next three years, eelgrass cover increased to 560 acres. Since 2009, eelgrass cover has declined to 500 acres or less. An inspection of the annual eelgrass maps shows that an area along the coast which previously supported eelgrass has remained barren since 2006 (see Figs. 5, 6). The area of this hole was estimated in ArcGIS to be 150 acres. Eelgrass maps from 1996 and 1998-2005 indicate that this area was previously covered by eelgrass (see Figs. 3, 7). The prolonged period of no eelgrass cover since 2006 suggests that the area may no longer be suitable as eelgrass habitat.

The East sector has fluctuated widely throughout the period of record, ranging from 850-205 acres. Eelgrass cover in this sector was relatively stable in the early 1990s, when eelgrass cover averaged about 800 acres. This period of stability has been followed by rapid change beginning in 1999 with eelgrass cover experiencing steep declines or rapid recovery during subsequent years. The periods of decline have been most severe in this sector, with eelgrass losses exceeding 40% in 2000, 2003 and 2007. As with the South sector, this sector experienced a sharp decline in 2006. An area devoid of measurable eelgrass appeared in 2006 (see Fig. 5). This hole covers approximately 15 acres and may represent an area no longer suitable as eelgrass habitat.

As discussed above, there has been significant variability in the eelgrass cover for the three sectors. Figure 6 illustrates this variability for the period prior to 2006 and the period following 2006.



**Figure 6: Sector Eelgrass Cover Before (1986, 1990-2005) and After (2007 – 2013) 2006**

A statistical evaluation of the sector performance prior to and after 2006 shows that the West Sector had not changed significantly over the two period, while the South Sector and the East Sector experienced significant declines in eelgrass cover (Table 1).

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**Table 1 – Sector Performance Evaluation**

Sector	Average Eelgrass Cover (acres)		ANOVA Probability
	1986; 1990 – 2005	2007 – 2013	
West Sector	716.7	689.8	0.46
South Sector	824.4	467.5	< 0.0001
East Sector	642.9	350.2	0.0005

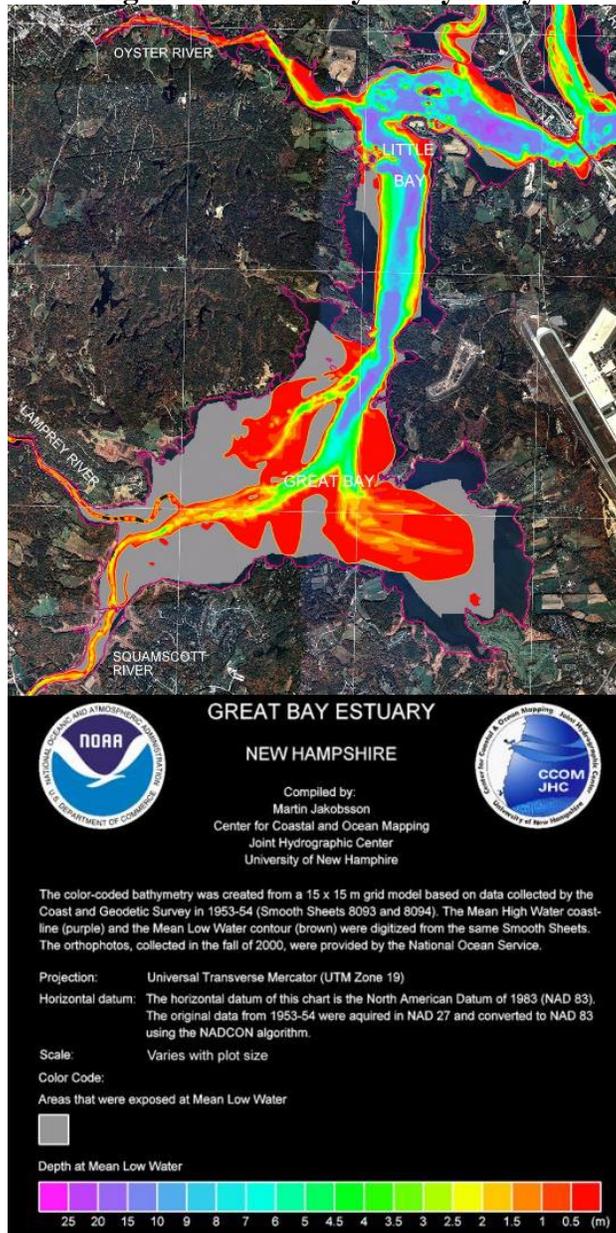
## Conclusions

Prior PREP SOE Reports have focused on water quality as a primary cause for eelgrass declines in Great Bay Estuary. This assessment demonstrates that eelgrass declines in Great Bay are primarily localized to the southern and eastern sections of the Bay. Any assessment evaluating eelgrass decline needs to address the spatial pattern of losses illustrated above.

The analysis also shows that several areas of Great Bay that previously supported continuous measurable eelgrass cover over a 16 year period (1990 – 2005) now have not reported measurable eelgrass cover for 8 continuous years (2007 – 2013). This observation has several ramifications. First, in identifying a baseline level of eelgrass cover in Great Bay, these areas should be subtracted out since they no longer appear able to support measurable eelgrass cover. Secondly, the areas without measurable eelgrass cover are adjacent to or surrounded by areas of eelgrass cover. Given the proximity of the eelgrass present and eelgrass absent areas, it is doubtful that water quality is responsible for the observed eelgrass loss. These areas should serve as a focus point to determine why eelgrass can no longer establish itself. Once this cause is determined, its influence in other areas of the Bay can be assessed.

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Figure 1: Great Bay Bathymetry



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Figure 2: Great Bay - August 8, 2006 (Google Earth)



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Figure 3: Great Bay Sectors (Map of 1996 Eelgrass)

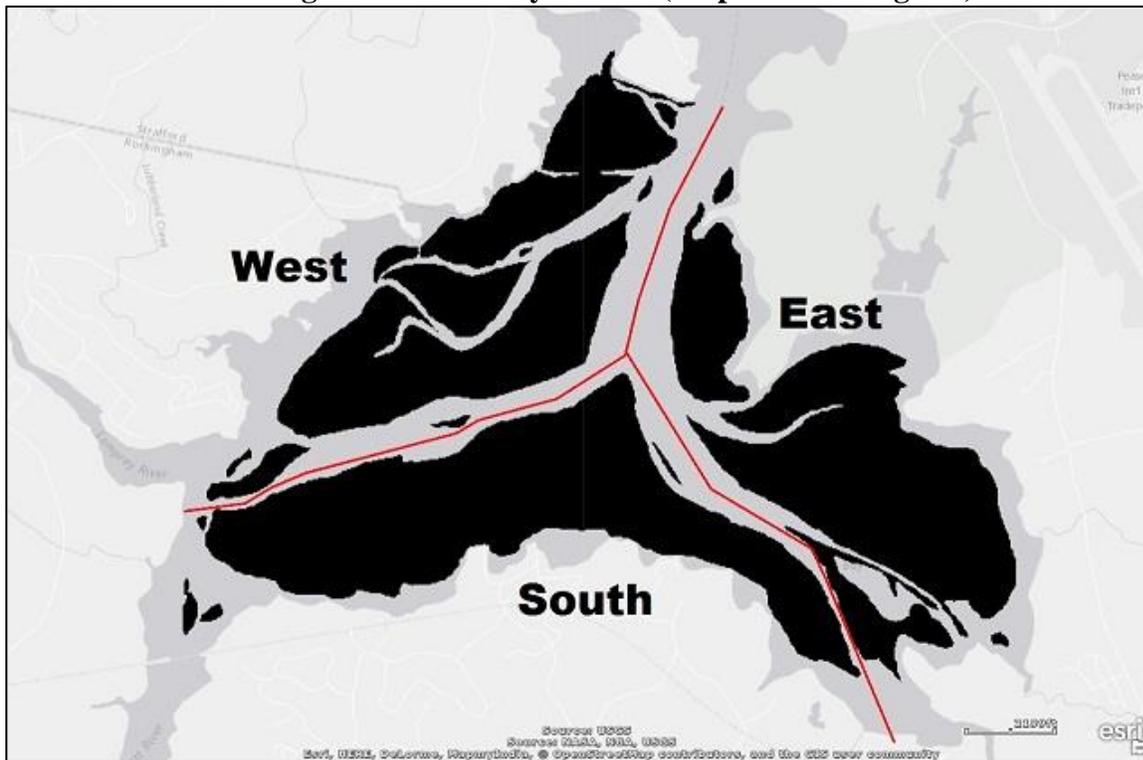
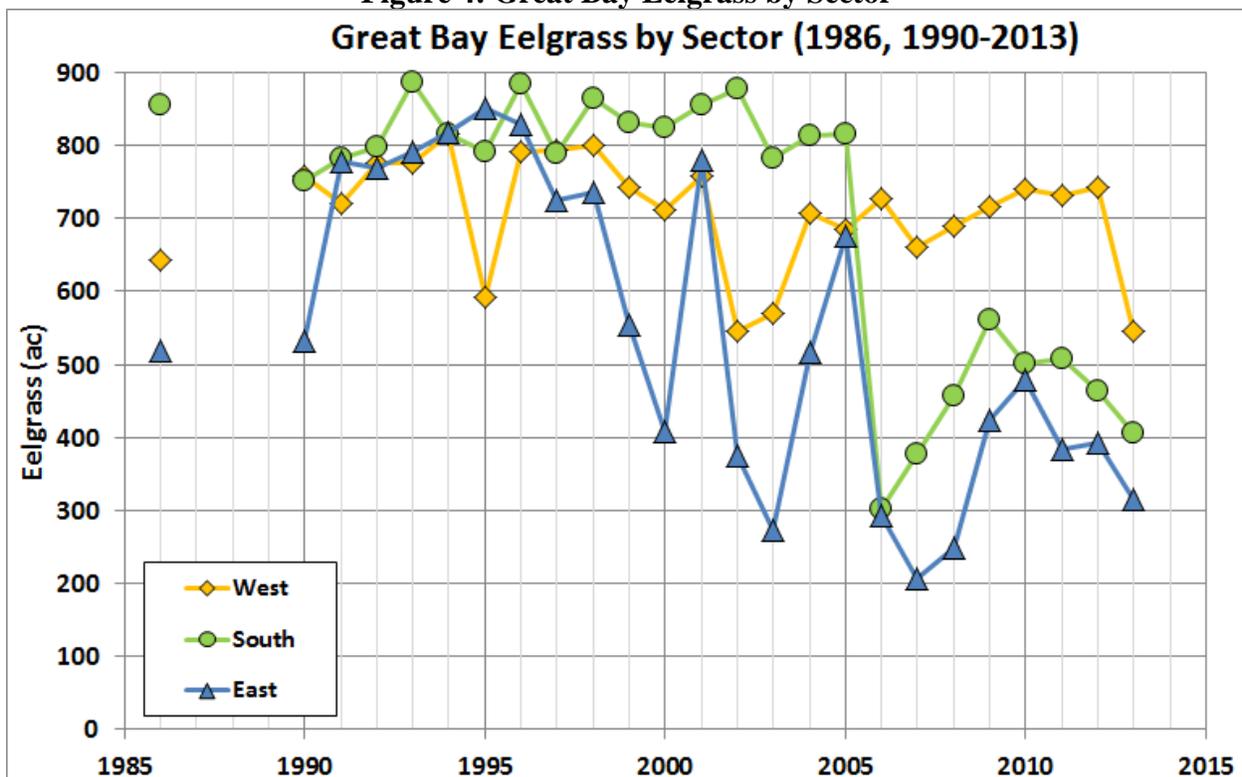
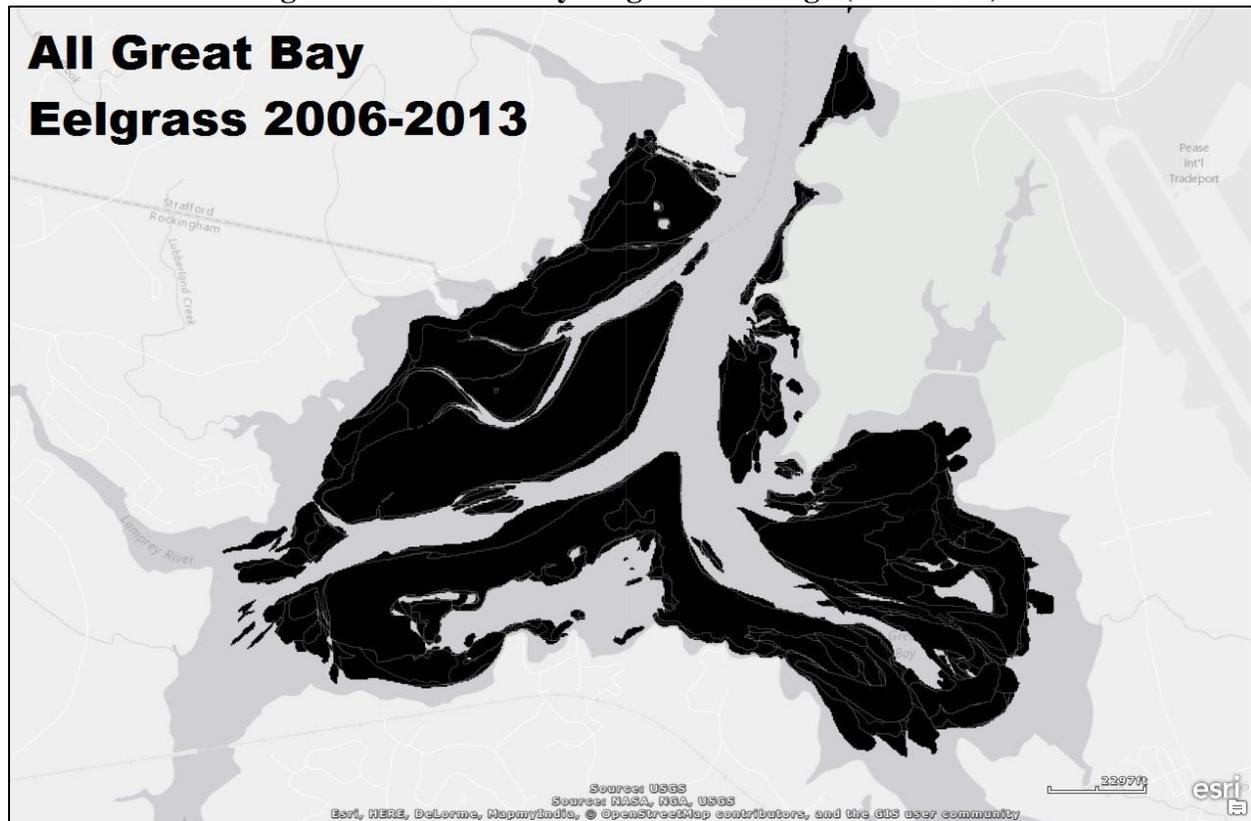


Figure 4: Great Bay Eelgrass by Sector



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Figure 5: All Great Bay Eelgrass Coverage (2006-2013)



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Figure 6: Southern Sector Eelgrass Hole (Google Earth, June 29, 2010)



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Figure 7: All Great Bay Eelgrass Coverage (1998-2005)

