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Eelgrass/Macroalgae Discussion Primer for TAC Activities 2016-2017

Piscataqua Region Estuaries Partnership

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Eelgrass/Macroalgae Discussion Primer for TAC Activities 2016-2017

October, 2016

This document was discussed at the October 28th Technical Advisory Committee meeting; please visit the website below to access the notes from that meeting. These notes contain caveats and suggested improvements to the primer.

<http://prepestuaries.org/prep-technical-advisory-committee/>

The issue of eelgrass and macroalgae in the Great Bay Estuary (GBE) is extremely important and complex. The purpose of this document is to clarify issues and questions to make for a more productive and informed discussion. (Note: I refer to “eelgrass” because it is, by far, the dominant species of seagrass in the GBE. *Ruppia maritima* (widgeon grass) has been found in the Oyster River and may be present elsewhere.)

Note that this Primer is a “Draft” and may be updated as the PREP Technical Advisory Committee (TAC) discussions occur over the coming year. Please check the Title Page to make sure you have the latest version.

The Primer focuses on the following subjects:

- Biomass versus presence/absence
 - Using 1996 as a “reference” year and the issue of an agreed upon baseline
 - Causes of Eelgrass Decline: Worldwide and Great Bay Estuary
 - Epiphytes
 - Macroalgae
- **Biomass versus Presence/Absence**
- PREP eelgrass reports have generally been about “distribution,” that is, cover of eelgrass. As long as an area has 10% eelgrass, then it is classified as being “present.” (Eelgrass cover below 10% cover is difficult to detect with aerial photography.)
 - The eelgrass distribution data are available through NH Granit (granit.unh.edu) or through the NH Department of Environmental Sciences “Eelgrass Viewer” at:

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

- In addition to this parameter, it’s important to know how the biomass of eelgrass is changing, because the ability of an eelgrass bed to function depends on how many shoots are in a given area, how long those shoots are, how extensive the root systems are under the sediment, etc.
- For those who want to know more about how biomass is calculated, please see page 238 of the PREP Data Report (PREP 2012), which accompanied the 2013 State of Our Estuaries Report. Below is the critical paragraph on these methods:
 - “In addition to mapping eelgrass bed boundaries, each eelgrass bed was assigned a density based on visual observation: partial (10-30% cover), half (30-60% cover), some bottom (60-90% cover) and dense (90-100% cover) (UNH, 2010). The ArcGIS Identity tool was used to calculate the area of eelgrass coverage in each density class in the different sections of the Great Bay Estuary. The biomass of eelgrass was calculated by assuming a shoot density for each density class: partial (25 g/m²); half (55 g/m²); some bottom (85 g/m²); and dense (250 g/m²). The total area of eelgrass in each density class was multiplied by the shoot density for the class to calculate the biomass for that class. The total biomass (in units of metric tons or 1000 kilograms) was calculated by summing the biomass from each density class of eelgrass.”

- It is critical that the community understand how these biomass assessments are done, how variability in the data are handled, etc. PREP will work through the Technical Advisory Committee process to address these questions.

– **Executive Summary; the “1996” issue.**

- Often, in conversations about eelgrass in the Great Bay Estuary, one hears references and comparisons to what the conditions were in 1996. Is 1996 the “baseline” for eelgrass? (“Baseline” refers to our best assessment of the earliest record of a certain resource, so that changes can be measured against some “starting point.”)
- The 1996 level of 2900 acres is currently the PREP restoration goal listed in its Comprehensive Conservation Management Plan (CCMP). 1996 is used because it represents the peak level (2900 acres) of eelgrass since the 1990’s, and because that was the first year that georectified imagery was used.
- It’s important to know that we only have complete maps (including Great Bay, Portsmouth Harbor, the tributaries, etc.) of the Great Bay Estuary for the following years:

| Year | Acreeage of Eelgrass for Great Bay Estuary |
|--------------------|--|
| 1981 | 3200.4 |
| 1996 | 2900 |
| 1999 | 2464.8 |
| 2000 | 2287.2 |
| 2001 | 2747.1 |
| 2002 | 2151.7 |
| 2003 | 2002.7 |
| 2004 | 2369.7 |
| 2005 | 2511.6 |
| 2006 | 1626.6 |
| 2007 | 1495.9 |
| 2008 | 1626.4 |
| 2009 | 1893.0 |
| 2010 | 1896.7 |
| 2011 | 1890.7 |
| 2012 | 1817.1 |
| 2013 (Fred Short) | 1449.9 |
| 2013 (Seth Barker) | 1683.6 |
| 2014 | 1621.4 |
| 2015 (draft) | 1497.5 |

- Note that the table above has all of the various zones combined into one column for the whole GBE. DES uses different zones than the ones in PREP’s eelgrass reports. This is an issue that must be addressed in the TAC meetings eventually.
- While PREP has a restoration goal of 2900 acres, DES uses a different benchmark, based on data from 1990 and a composite from the years 1948, 1962 and 1980/81.

- Obviously, the establishment of an agreed upon “baseline” and restoration goals is complicated and warrants continued discussion.
- Causes of Eelgrass Decline: Worldwide and Great Bay Estuary
- Orth et al (2006), in an article entitled, “A Global Crisis for Seagrass Ecosystems,” state: “In all regions, the environmental effects of excess nutrients or sediments are the most common and significant causes of seagrass decline, and result in small to very large areas of seagrass being lost. The direct influence of other organisms (e.g., brown tides, urchin overgrazing, and disease) has also led to large-scale losses and, when acting in concert with suspended sediments and nutrients, can accelerate the trajectory of seagrass loss for the area in question.”
 - A table in the article also lists the following factors as important but having a less significant impact (that is, when looked at across many cases; in individual estuaries, these other factors can be very significant.) These factors include: “sea level rise, high temperature, herbivory, introduced species and bioturbation.”
 - The causes of eelgrass loss in the Great Bay Estuary has been debated for several years, with some experts pointing to nutrient loading as the most influential factor and others pointing to significant rain events that bring in light attenuating substances. In 2014, the Municipal Coalition and NH DES co-organized an expert Peer Review (Bierman et al 2014) panel to evaluate the validity of numeric nutrient criteria established by DES in 2009 (Trowbridge 2009), based on the data in that report.
 - Of the four peer reviewers, one was a seagrass specialist. That reviewer concluded that “the DES weight of evidence does not support the conclusion that excess nitrogen was the primary factor that caused the decline of eelgrass and the inability of eelgrass to repopulate specific areas.”
 - PREP has noted at earlier meetings that the Peer Review is an important document that should continue to be referenced. Some clarifying statements about the review are in order:
 - The focus on the Peer Review was on the validity of using Numeric Nutrient Criteria in a regulatory context. That is different from PREP’s mission of trying to understand changes in the ecosystem and potential stressors at a broader level.
 - PREP also believes it’s important to be clear about the Peer Review findings that “the DES weight of evidence does not support the conclusion that excess nitrogen was the primary factor that caused the decline of eelgrass and the inability of eelgrass to repopulate specific areas.”
 - It would be possible to interpret this statement as meaning that “nitrogen isn’t an important factor” in eelgrass loss. That is, in PREP’s view, not scientifically accurate, for the following reasons.
 - There are two reasons the “weight of evidence” might not support a certain conclusion: 1) there isn’t enough data; 2) the data clearly contradict the conclusion.
 - PREP’s interpretation—supported by conversations with two of the four peer reviewers is that, in this case, the first reason is more relevant. That is, the Peer Review felt more data was required to state that nitrogen was the primary factor in eelgrass loss.

- Also, the focus of the Peer Review was whether nitrogen was the “primary” factor in eelgrass loss. PREP, on the other hand, is interested in the secondary, tertiary, etc. factors as well. Why? Because sometimes, management actions can only target stressors other than the primary stressor.

– Epiphytes

- It is important to keep track of epiphytes on eelgrass. Epiphytes refer to algae growing on the blades of eelgrass themselves. Too many epiphytes and the eelgrass blades have difficulty photosynthesizing; also, the blades can get weighed down or can be more easily uprooted because of the increased drag.
- Increased epiphytes can be caused by increased nitrogen loading, climate change, and a decrease in “grazers,” small aquatic invertebrates that eat the epiphytes off of the eelgrass beds. Decreases in grazers can occur because of poor oxygen conditions and/or because of an increase in creatures that eat grazers, such as green crabs or fish, or because of poor conditions related to toxic contaminants such as heavy metals, etc.
- Epiphyte assessment is not part of the annual “distribution” reports. However, SeagrassNet monitoring protocols have been implemented in the Great Bay proper—not the rest of the estuary—since 2007, and PREP is hoping to use this data—providing PREP has the funds—to quantify changes in epiphytes in the Great Bay since 2007. SeagrassNet is an internationally recognized protocol for assessing health of eelgrass beds by looking at a suite of important parameters, such as: density of shoots, canopy height, presence/absence of macroalgae and epiphytes, presence of reproductive shoots, and above and belowground biomass.

– Macroalgae

- There have been some quantitative and many anecdotal reports of increased macroalgae in the Great Bay Estuary, but the actual dataset documenting an increase is sparse: for intertidal macroalgae, there are two data points between 1980 and 2009 (PREP 2013)—not including the work begun by Burdick in 2013. The 1980 and 2009 data points come from different researchers, but both involve the same site: Lubberland Creek near the mouth of the Squamscott River in Newmarket, NH. In 1980 there was no macroalgae at the site and in 2009 the site was 40% covered by macroalgae.
- It is important to note that increased algae—both native and invasive—can be caused by various things, such as: increased nutrients and/or climate change as well as other factors.
- Note also that PREP is tracking macroalgae cover in the intertidal areas of the Great Bay Estuary. Later this year, Dr. Burdick and Dr. Mathieson of UNH will present a synthesis of data from 2013 through 2015.
- In addition, Burdick and colleagues are working on reviewing photography going back to the late 70s and assessing changes in intertidal macroalgal percent cover.
- None of the above research, however, covers what is happening in the subtidal (always under water) regions of Great Bay Estuary. It is obvious to anyone who has spent time studying the eelgrass beds that this issue could be quite significant, as there is quite a lot of macroalgae throughout the estuary, including species that were not present in the 90s. More quantitative data is needed.

- It is important to note that, from the surface, the eelgrass can look quite healthy and perhaps even be assessed at “complete” cover, such as in the photo below, taken by Ru Morrison of NERACOOS in early August, 2016.



- However, in recent years, if one snorkels through the eelgrass beds in Great Bay, one often sees—particularly in September and October, thick mats of macroalgae that sit in up to one foot thick carpets down amongst the bottom of the eelgrass blades, impossible to see from the boat. If one uses a boat hook to drag up plant matter in a seemingly healthy eelgrass bed, one very often finds what you see in the photo below, taken by me on October 4, 2016. One can see some eelgrass blades here, but the plant matter is dominated by algae, in particular, a red algae of the genus *Gracilaria*.



- One might think that one could use DES’ “Eelgrass Viewer” and click on the various polygons on the map to find out what percent cover eelgrass was mapped at for certain areas, and then conclude that what isn’t covered by eelgrass is covered by either bare ground or algae. However, that isn’t the case, because the eelgrass and algae co-exist in such a way that it’s possible for there to be complete coverage of both plant types in the same quadrat.

- Once again, PREP is hoping that SeagrassNet data can help shed light on changes in the subtidal with regard to macroalgae, between the years 2007 and 2015. However, this data is restricted to three 50m transects in the Great Bay proper; we do not have SeagrassNet data from other parts of the Great Bay Estuary.
- In addition, PREP and partners need to look at other methods for more rigorously assessing changes in macroalgae distribution and biomass.

The issues of eelgrass and macroalgae are important and complicated. It's possible that this primer will be modified in the coming months to reflect these changes. Please check the "expiration date" of the version you are using to make sure you have the latest version.

Thank you. Kalle Matso, Coastal Scientist, PREP

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