Chapter 4.5

Benthic Microalgae in the Maryland Coastal Bays

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Abstract
Benthic microalgae was measured as part of the National Coastal Assessment Program in 2010 at 25 sites (Figure 4.5.1). The results show that benthic microalgae play a significant role in the Coastal Bays and may even exceed water column plankton biomass in some areas. It is recommend that benthic microalgae sampling (biomass and community species composition) should be incorporated in monitoring and research efforts.

Introduction

Benthic microalgae, BMA, are single-celled microscopic photosynthetic organisms (primarily diatoms, dinoflagellates, and cyanobacteria) that inhabit the top 0-3 cm of the sediment surface and are sometimes referred to as microphytobenthos (MPB). Benthic chlorophyll is an indicator of the microalgal biomass on the sediment surface. This is the primary food resource available to benthic grazers such as shellfish and numerous finfish species (Lower Cape Fear River Program 2004).

The chlorophyll biomass (mg/m^2, a measure of quantity) of benthic microalgae can be important in determining the total effect of the microalgal community on the water column. BMAmay make up a large proportion of the total biomass of estuarine microscopic photosynthesizing organisms (McComb and Lukatelich 1986), have been found to be up to 17% of the total production in a European estuary (de Jong and deJonge 1995) and the most productive marine primary producers in an Australian estuary (Moreton Bay: see p164 Dennison and Abal 1999). A number of factors have been shown to influence the establishment and productivity of BMA. These include; season, irradiance, concentrations of nitrogen, phosphorus and silicon, tidal range, sediment type, and precipitation (Brotas and Catarino 1995; Carruthers 2004).

The surficial layer of sediments is a zone of intense microbial and geochemical activity and of considerable physical reworking. The vertical distribution of BMA is the net effect of the opposing actions of migration to the sediment surface by motile organisms and mixing which tends to produce a uniform distribution in the surface layer.

The variability in vertical distribution may be confounded by considerable horizontal patchiness (MacIntyre *et al*. 1996). Distributions of viable BMA have been found to extend into the mixed layer of 15 mm (MacIntyre and Cullen 1995) and more than 0.5 cm into surface sediments (de Jong and Colijn 1994). MacIntyre and Cullen (1995) reported that primary production was more or less equally distributed between the surficial millimeter of benthos and the overlying water and that vertical distributions of chlorophyll *a* in sediments, varied by up to four times over scales of 1 to 10 mm (MacIntyre and Cullen, 1995). Chlorophyll *a* concentrations in the 0-1 mm layer of sediment varied by up to 8 times on three successive days (MacIntyre and Cullen 1995; Deeley and Paling 1999).

Data Sets

Benthic chlorophyll was measured as part of the National Coastal Assessment Program in 2010 at 25 sites (Figure 4.5.1). Each site was the average of triplicate samples.

Management Objective: None

Benthic Chlorophyll Indicator: None

Data Analysis

Although the sediment may contain non-viable phytoplankton cells, which have sunk out of the water column, only those algal cells that are viable (able to grow) in the sediment have been presented here (reported as active chlorophyll).

In 2010, three replicates were collected at 25 benthic chlorophyll sites in the Coastal Bays. A small sample was taken from the top one centimeter of the sediment and collected with a 60 cm^3 syringe (2.5 cm diameter), immediately transferred to a centrifuge tube and kept on ice in the dark. Samples were subsequently frozen until later analysis (Grinham et al. 2007). Samples were analyzed at the Chesapeake Biological Laboratory according to the fluorometric method of Strickland & Parsons (1972).

To convert concentration to an integrated water column chlorophyll values were multiplied by the mean depth, 1.5 m, assuming a well mixed water column.

Results

The mean coastal bay-wide, active benthic chlorophyll a was 35 mg/m^2 in 2010 (number of sites = 24) with a standard deviation of 22. The minimum was 5.3 while the maximum active benthic chlorophyll *a* observed was 204. Highest abundances were in Isle of Wight and Sinepuxent Bays. These results are in line with data collected between 2002-2006 (Table 4.5.2).

Table 4.5.1 Average water column chlorophyll *a* (CHL) by bay segment (2010-2012 chl status, April-Nov) compared to average active benthic chlorophyll *a* (summer 2010).

Watershed	**Water Column CHL (µg/L)**	**Integrated water column CHL (mg/m^2)**	**Benthic CHL (mg/m^2)**
Assawoman	7.60	11.4	24.89
Isle of Wight	11.00	16.5	51.26
St Martin River	22.84	34.26	39.45
Sinepuxent	5.39	8.08	49.13
Newport	19.56	29.34	40.55
Chincoteague	5.30	7.95	24.15

Assawoman Bay – Average active benthic chlorophyll *a* was 24.89 mg/m^2 (n=4) (Table 4.5.1). The standard deviation among replicates at a site ranged from 2.1 – 7.9 mg/m^2. The minimum active benthic microalgae chlorophyll *a* value observed was 11.33 mg/m^2 and maximum observed value was 51.40 mg/m^2 (Figure 4.5.1). Total BMA (active chlorophyll plus pheophytin) biomass ranged 41.37 – 86.21 mg/ m^2.

Isle of Wight Bay – Average active benthic chlorophyll *a* was 51.26 mg/m^2 (n=6) (Table 4.5.1). The standard deviation among replicates at a site ranged from 2.2 – 18.2 mg/m^2. The minimum active benthic microalgae chlorophyll *a* value observed was 9.44 mg/m^2 and maximum observed value was 100.94 mg/m^2 (Figure 4.5.1). Total BMA biomass ranged 25.66 – 204.08 mg/ m^2.

St. Martin River – Average active benthic chlorophyll *a* was 39.45 mg/m^2 (n=3) (Table 4.5.1). The standard deviation among replicates at a site ranged from 1.5 – 10 mg/m^2. The minimum active chlorophyll *a* value observed was 19.27 mg/m^2 and maximum observed value was 80.51 mg/m^2 (Figure 4.5.1). Total benthic microalgaebiomass ranged 61.43 – 188.34 mg/ m^2.

Sinepuxent Bay –The average active benthic chlorophyll *a* was 49.13 mg/m^2 (n=1) (Table 4.5.1). The standard deviation among replicates was 8.7 mg/m^2. The minimum active benthic microalgae chlorophyll *a* value observed was 39.57 mg/m^2 and maximum observed value was 56.72 mg/m^2 (Figure 4.5.1). Total BMA biomass ranged 61.77 – 99.51 mg/ m^2.

Newport Bay – The active average benthic chlorophyll *a* was 40.55 mg/m^2 (n=2) (Table 4.5.1). The standard deviation among replicates at a site ranged from 1.1– 5.7 mg/m^2. The minimum active benthic microalgae chlorophyll *a* value observed was 15.02 mg/m^{2}and maximum observed value was 69.16 mg/m^2(Figure 4.5.1). Total BMA biomass ranged 54.41 – 121.45 mg/ m^2.

Chincoteague Bay – The average active benthic chlorophyll *a* was 24.15 mg/m^2 (n=9). The standard deviation among replicates at a site ranged from 1.6 – 11.3 mg/m^2. The minimum active benthic microalgae chlorophyll value observed was 5.31 mg/m^2 and maximum observed value was 41.33 mg/m^2 (Figure 4.5.1). Total BMA biomass ranged 13.99 – 106.82 mg/ m^2.

Discussion

Benthic microalgae play a significant role in the Coastal Bays and were more abundant than water column plankton biomass in some areas (Table 4.5.1). Interannual variability (Table 4.5.2) may be related to rainfall variations, water clarity differences and associated nutrient loading. Recommend benthic algae sampling (biomass and community species composition) be incorporated into monitoring and research efforts.

This data confirms the hypothesis that benthic microalgae are a major component of the autotrophic biomass throughout the Coastal Bays, with concentrations ranging from 5.3 to 204 mg/m^2. However, abundance was highly variable. Isle of Wight Bay had the highest average benthic microalgae while Chincoteague Bay had the lowest.

Benthic microalgae may have greater abundance than phytoplankton (per unit measure) in some areas of the Coastal Bays. When chlorophyll biomass is integrated over the depth of the water column, the average benthic microalgae biomass is greater. It is likely that benthic microalgae play a significant role in nutrient cycling within sediments, as well as being an important primary producer within the system. Benthic microalgae samples were limited and, due to the spatial and temporal patchiness of these organisms, additional samples would give a more accurate assessment. Further research is required to establish causes of variability and reliable measures of this metric to develop an effective monitoring tool.

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Figure 4.5.1 Distribution of active benthic chlorophyll during the summer of 2010.

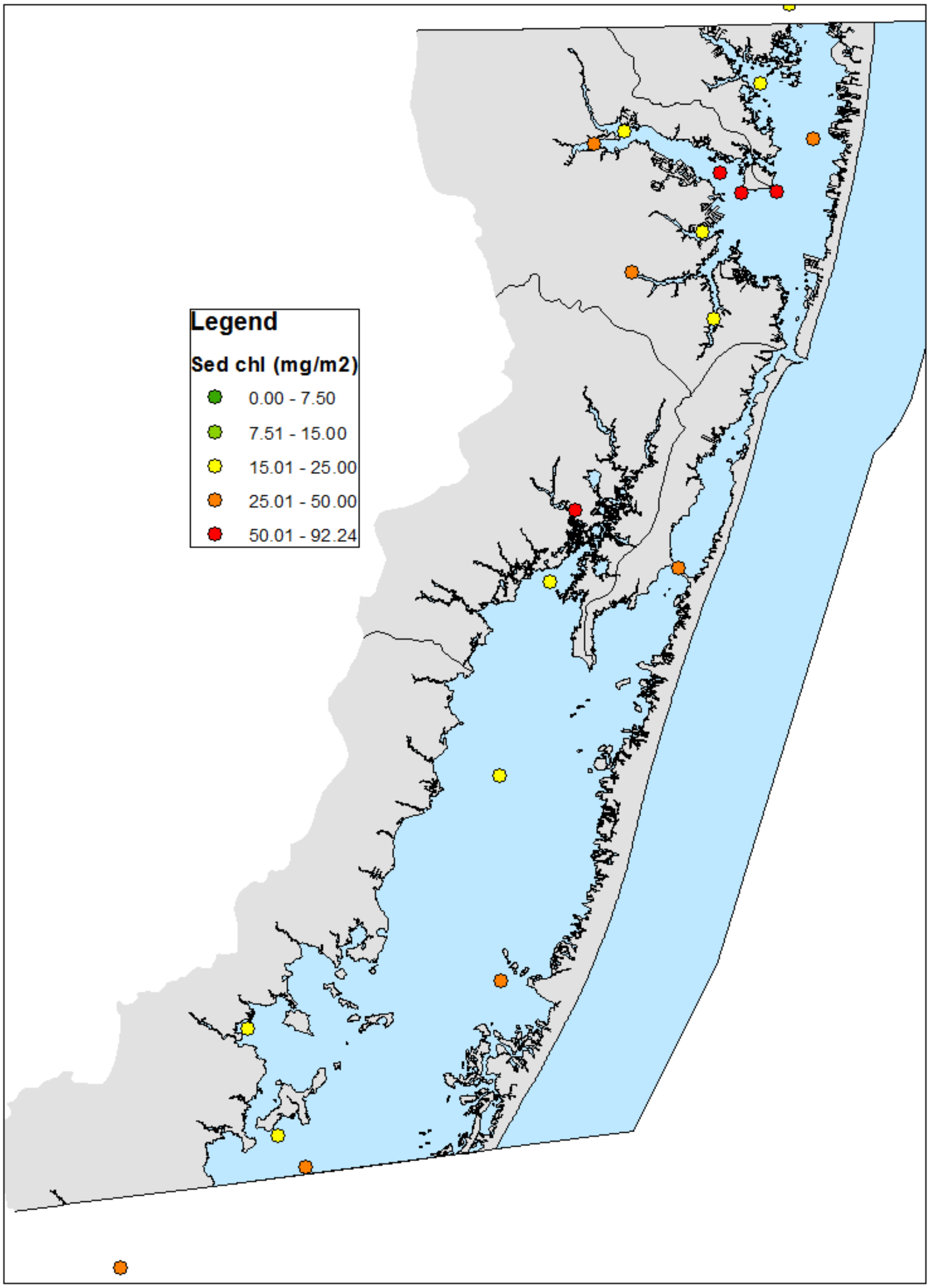

Table 4.5.2 Average benthic chlorophyll and range in the Maryland Coastal Bays, 2002-2010.

			TOTAL sediment chl a (mg/m2)			**ACTIVE sediment chl a (mg/m2)**		
Year	**N**	**reps**	min	max	**Average**	min	max	**Average**
2002	76	3	27	267	**73.8**	10	236	**31.6**
2003	152	3	10	312	**78.8**	0	294	**37.7**
2004	40	10	11	450	**77.1**	0	337	**32.4**
2005	20	8	22	317	**79.4**	6	224	**31.6**
2006	20	8	14	189	**57.1**	7	77	**20.4**
2010	25	3	47	150	**81.31**	12	92	**34.9**