Chapter 4.5

Benthic chlorophyll measurements in the Maryland Coastal Bays

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Abstract

Benthic chlorophyll was measured as part of the National Coastal Assessment Program in 2002 at 124 sites (Figure 4.5.1) and 2003 at 152 sites (Figure 4.5.2). This data shows that benthic microalgae or micro-phytobenthos play a significant role in the Coastal Bays and may even be greater than water column plankton biomass in some areas. Recommend benthic algae sampling (biomass and community species composition) should be incorporated in monitoring and research efforts.

Introduction

Benthic microalgae are single-celled microscopic plants (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 (a measure of quantity) of benthic microalgae can be important in determining the total effect on the water column of the microalgal communities' growth and decay. Benthic microalgae may make up a large proportion of the total biomass of estuarine microscopic plants (McComb and Lukatelich 1986) and have been found to be up to 17% of the total production in a European estuary (de Jong and de Jonge 1995) and the most productive marine plants 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 benthic microalgae. These include; season, irradiance, concentrations of N, P and Si, 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 benthic microalgae 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 benthic microalgae 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 (1995) reported that primary production was more or less equally distributed between the surficial millimetre 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 2002 at 124 sites (Figure 4.5.1) and 2003 at 152 sites (Figure 4.5.2).

Management Objective: None currently

Benthic Chl Indicator: None currently

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 **2002** three replicate samples for benthic chlorophyll were collected at 124 sites. For benthic Chlorophyll, a small sample (approximately 5 cm^2) from the top one centimeter of sediment collected via a Van Veen grab sampler was scooped into a 50 ml centrifuge tube. The sample was kept on ice in the dark while on board, and frozen at the end of the day pending analysis. Samples were analyzed at the Chesapeake Biological Laboratory (CBL) according to the fluorometric method of Strickland & Parsons (1972).

In **2003**, three replicates were collected at 152 benthic chlorophyll samples were taken from the top one centimeter of the sediment and collected with a 60 cm^3 syringe (2.5 cm diameter), transferred to a centrifuge tube and kept on ice in the dark while on board. Subsequently frozen until later analysis.

Results

The mean bay-wide, active benthic chlorophyll was 30.48 mg/m^2 in 2002 (number of sites = 99 due to QA issues) and 37.73 mg/m^2 in 2003 (number of sites = 152).

Assawoman Bay
2002 The mean bay-wide summer time benthic chlorophyll was 22.85 mg/m^2 with a standard deviation of 12.7. The minimum value observed was 9.9 mg/$m^2$and maximum observed value was 44.86 mg/m^2.

2003: The mean bay-wide summer time benthic chlorophyll was 34.7 mg/$m^2$with a standard deviation of 25.7. The minimum value observed was 13.8 mg/m^2 and maximum observed value was 122.45 mg/m^2.

Isle of Wight Bay
2002: The mean bay-wide summer time benthic chlorophyll was 30.48 mg/$m^2$with a standard deviation of 13.3. The minimum value observed was 13.3 mg/$m^2$and maximum observed value was 52.5 mg/m^2.

2003: The mean bay-wide summer time benthic chlorophyll was 67.8 mg/$m^2$with a standard deviation of 61.2. The minimum value observed was 6.4 mg/m^2 and maximum observed value was 259 mg/m^2.

St. Martin River
2002: The mean bay-wide summer time benthic chlorophyll was 19.6 mg/$m^2$with a standard deviation of 9.5. The minimum value observed was 10.6 mg/$m^2$and maximum observed value was 48.5 mg/m^2.

2003: The mean bay-wide summer time benthic chlorophyll was 30 mg/$m^2$with a standard deviation of 22.5. The minimum value observed was 12.7 mg/m^2 and maximum observed value was 84.4 mg/m^2.

Sinepuxent Bay
2002: The mean bay-wide summer time benthic chlorophyll was 73.9 mg/$m^2$with a standard deviation of 67.5. The minimum value observed was 11.1 mg/m^2 and maximum observed value was 195.6 mg/m^2.

2003: The mean bay-wide summer time benthic chlorophyll was 51.5 mg/m^2 with a standard deviation of 46.6. The minimum value observed was 10.8 mg/m^2 and maximum observed value was 177.2 mg/m^2.

Newport Bay
2002 The mean bay-wide summer time benthic chlorophyll was 22.5 mg/m^2 with a standard deviation of 18.2. The minimum value observed was 9.1 mg/m^2 and maximum observed value was 83.7 mg/m^2.

2003 The mean bay-wide summer time benthic chlorophyll was 20.6 mg/m^2 with a standarad deviation of 11.4. The minimum value observed was 11 mg/m^2 and maximum observed value was 70 mg/m^2.

Chincoteague Bay
2002 The mean bay-wide summer time benthic chlorophyll was 38.69 mg/$m^2$with a standarad deviation of 29.5. The minimum value observed was 12.4 mg/m^2 and maximum observed value was 128.3 mg/m^2.

2003 The mean bay-wide summer time benthic chlorophyll was 28.6 mg/m^2 with a standarad deviation of 29.5. The minimum value observed was 8.5 mg/$m^2$and maximum observed value was 161.2 mg/m^2.

Discussion

This data confirms the hypothesis that benthic microalgae are a major component of the autotrophic biomass throughout the MD Coastal Bays, with concentrations ranging from 8.5 to 259 mg/m^2. However, abundance was highly variable even within a sample location.

Benthic microalgae may have greater abundance than phytoplankton in some areas of the Maryland Coastal Bays. Therefore, it is likely that they may play a significant role in nutrient cycling within sediments, as well as being an important primary producer within the system. Further research is required to establish causes of variability and reliable measures of this variability to develop an effective monitoring tool. Assessment of benthic micro-algal species and community composition is also recommended. .

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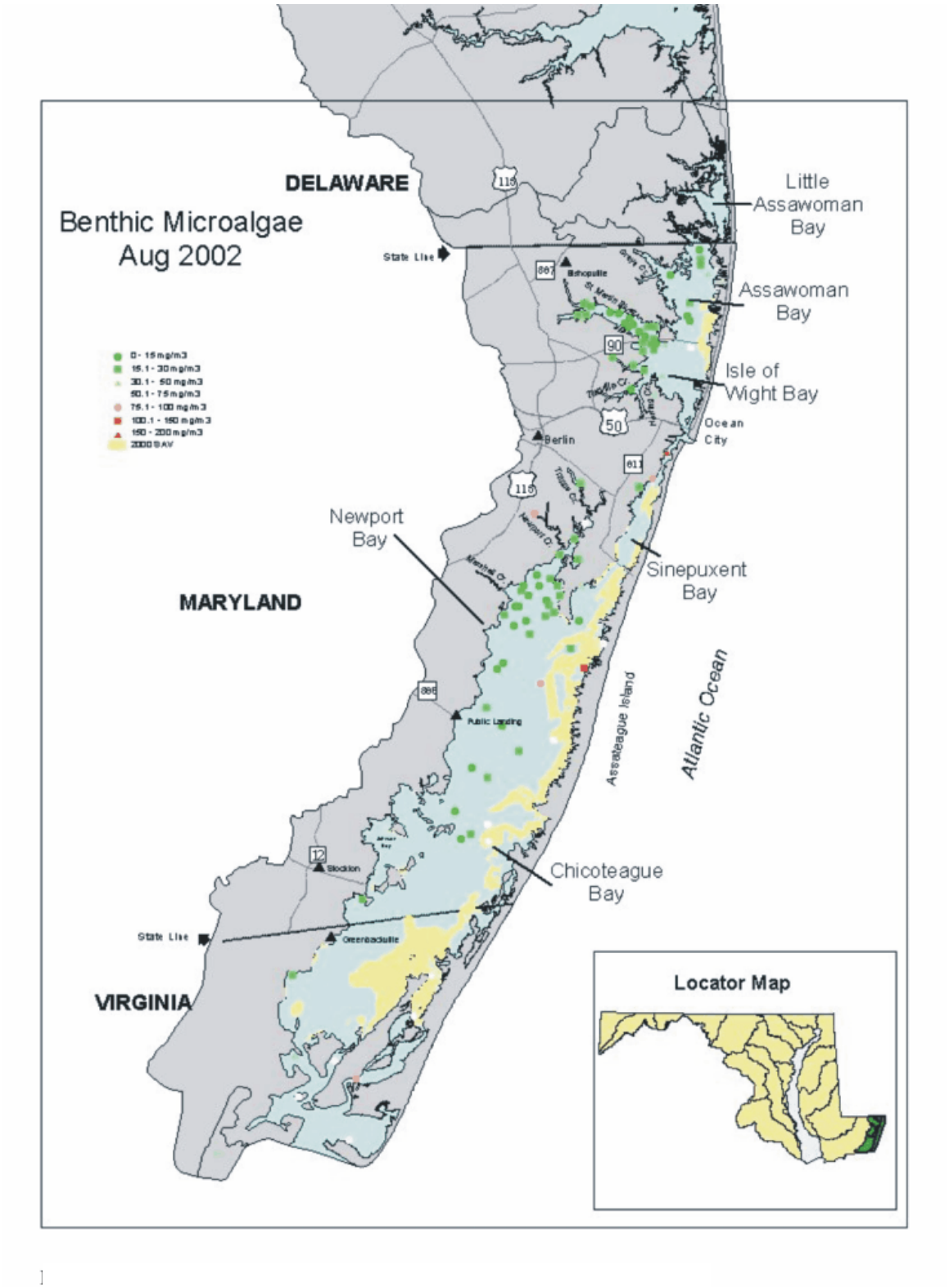

Figure 4.5.1: Benthic chlorophyll distribution during the summer of 2002.

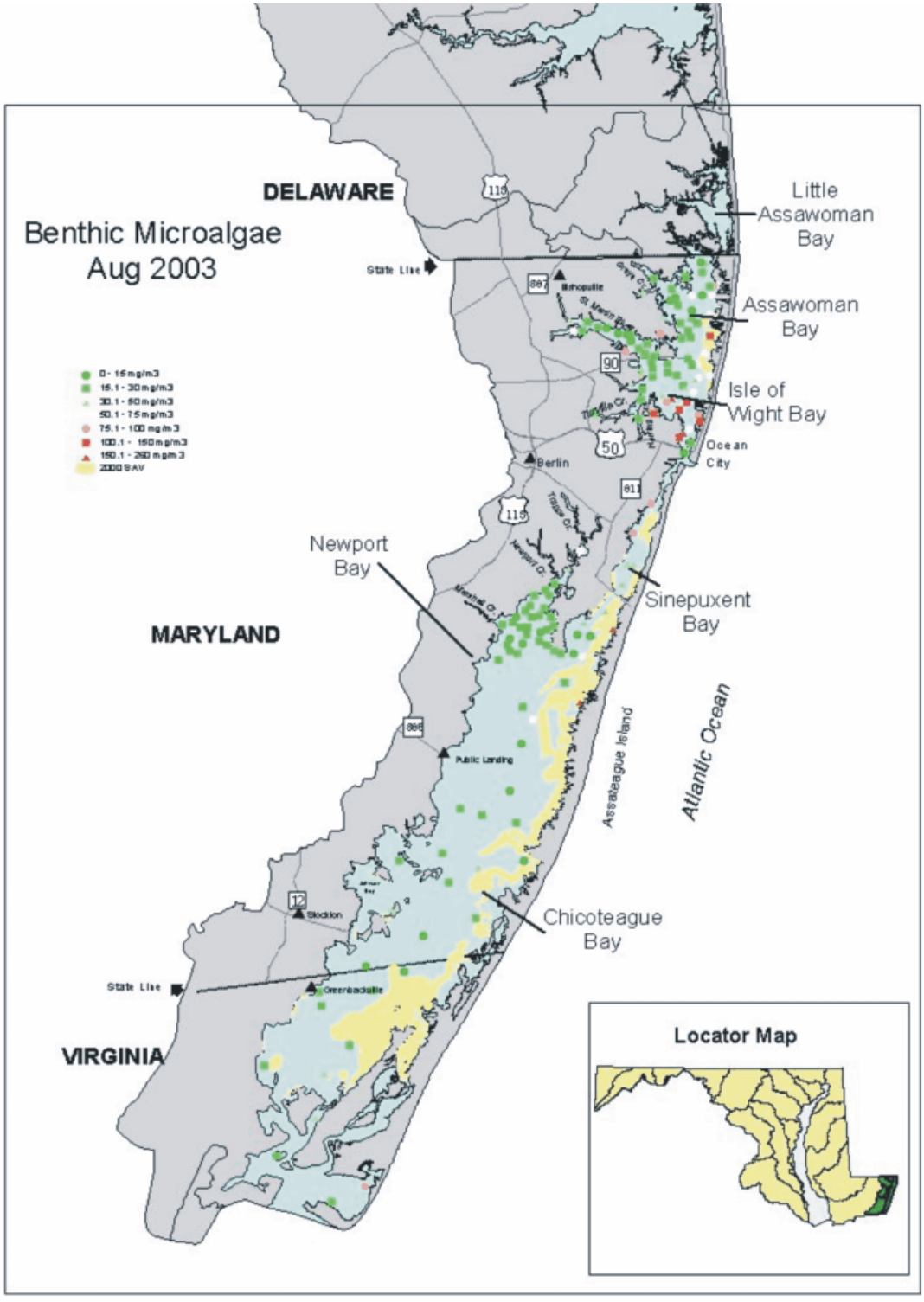

Figure 4.5.2: Benthic chlorophyll distribution during the summer of 2003.