An Examination of Benthic Macroalgae Communities as Indicators of Nutrients in Middle Atlantic Coastal Estuaries - Maryland Component
Final Report 1998 - 1999

Maryland Department of Natural Resources
Resource Assessment Service
Tidewater Ecosystem Assessment Division
Annapolis, MD 21401
May 2001

An Examination of Benthic Macroalgae Communities as Indicators of Nutrients in Middle Atlantic Coastal Estuaries - Maryland Component
Final Report 1998 - 1999

Dave Goshorn
Margaret McGinty
Carrie Kennedy
Calvin Jordan
Cathy Wazniak
Kara Schwenke
Kevin Coyne
Maryland Department of Natural Resources
Annapolis, MD 21401

ACKNOWLEDGEMENTS

This project, entitled *An Examination of Benthic Macroalgae Communities as Indicators of Nutrients in Middle Atlantic Coastal Estuaries - Maryland Component Final Report 1998 - 1999,* was funded by the U.S. Environmental Protection Agency via University of Delaware under Contract NO. CR826092-01-1 to Maryland Department of Natural Resources.

The authors gratefully acknowledge the U.S. EPA and the University of Delaware for financial support of this project. We would also like to thank Chris Millard, Dan Ostrowski, William Rodney and Jeff Ramsey for assistance in data collection. Thanks also to Patricia Matthews for assisting in all of the administrative details associated with this project, and to Cathy Wazniak for reviewing and editing this report.

INTRODUCTION

More than one-half the nation's population now lives and works within 50 miles of the coastline, but coastal areas account for only 11 percent of the nation's land area. In recent years, 40 percent of new commercial development and 46 percent of new residential development happened near the coast (NOAA). As the population grows and there are more people living near our coasts, potential threats to the health and productivity of coastal waters increases. Nitrogen and phosphorus loads from wastewater, fertilizer and atmospheric deposition increases. Lawn care, transportation, water treatment and energy generation practices all have the potential to deliver toxic compounds to local waterways, either directly through surface run off or indirectly through groundwater contamination and atmospheric deposition. These threats and their attendant effects on the natural resources need to be evaluated.

The ocean coastal area of Maryland is a microcosm of these nationwide trends. This area represents a small watershed in Worcester County, Maryland. The coastal bays watershed covers approximately 200 square miles with a narrow, yet well develop beach front. Recreational and tourism opportunities have attracted many year round and transient residents resulting in large population increases over the last few decades. Maryland Department of Planning census data show nearly a twofold increase in population in Worcester county since 1970, with population at in 1970 at 24,442 increasing to 43,950 in 2000. (These numbers represent the permanent residents, however on any given weekend over the summer, population can reach well over 100,000 individuals). Much of this growth has occurred and will continue in the Maryland Coastal Bays watershed. “Census statistics for 1990 show approximately 62 percent of the population living in the coastal bays watershed and by 2020 that percentage is expected to rise to 73 percent. To accommodate this population growth, many acres of uplands, wetlands and forest, and productive farmland in the county have been converted both to residential and commercial use.” Maryland Coastal Bays Program, 1997. This scenario of growth and land development have generated concern for the coastal resources that are both economically and ecologically important for the livelihood of the residents and economy of Worcester County.

In 1997, the Maryland Coastal Bays Program identified eutrophication as the “single greatest environmental problem in the coastal bays” (MCPB, 1997). They also cited a need to better understand the “extent of eutrophication in the bays *to* aid in targeting and tracking restoration efforts” (MCBP, 1997). In 1998, the Maryland Department of Natural Resources entered into a joint assessment project with the University of Delaware. The purpose of the study was to evaluate the relationships among nutrient concentrations, phytoplankton and macroalgae in the coastal embayments along the Delmarva Peninsula. The primary objective of this study is to test the null hypothesis: Nutrient enrichment does not influence the distribution of aquatic plants or promote shifts in the primary producer community along a nutrient gradient. The alternate hypothesis states nutrient enrichment does influence these communities along the gradient. For this study, the specific measurement parameters were macroalgae volume, chlorophyll *a* concentration, and nutrients.

A secondary objective of the study was to determine if macroalgae biomass is an adequate indicator of nutrient levels. Macroalgae have become the focus of indicator development efforts, due to their life histories (Shubert 1984). Because macroalgae aren’t vascular plants, and do not use a root system to remove nutrients from the sediments, they must get their nutrients from the surrounding environment. As a result, macroalgal tissues often closely reflect water column contents, including nutrients (Shubert 1984, Lapointe et al. 1992; Peckol et al. 1994; Horrocks et al. 1995). While there are many factors affecting the growth of macroalgae, including temperature (Broderick and Dawes 1998), light availability (Mazzella and Alberte 1986; Dawes 1995), grazing (Hauxwell et al. 1998; Valiela et al. 1997a), and desiccation (Broderick and Dawes 1998), a large increase in macroalgal biomass has most often been associated with eutrophication (Shubert 1984,;Lapoointe et al. 1992; Valiela et al. 1992; Fong et al. 1993; Peckol et al. 1994; Taylor et al. 1995; Timmons and Price 1996; Valiela et al. 1997a; Hauxwell et al. 1998; Kinney and Roman 1998). Valiela et al. (1992) found that a rise in nutrients increased algal biomass 3-4 levels of magnitude, shading out eelgrass, creating more anoxic events, and changing the benthic faunal communities. Hauxwell et al. (1998) also found that as nitrogen loading increased, macroalgal biomass increased by three times. In 1993, Fong et al. ran a series of microcosm experiments and found that nitrogen levels directly controlled the macroalgal biomass, and which in turn controlled levels of phytoplankton. In this study we sampled the coastal bays of Maryland and Virginia from June through December 1999 in an attempt to correlate levels of nitrogen and phosphorous with macroalgae biomass.

Additionally, this study yielded much needed information on the composition of macroalgae in the Maryland coastal bays as well as providing cursory distribution maps. This report summarizes the results of the Maryland portion of this joint study.

Study Area

This part of the study focused on the Maryland coastal bays, located within Worcester County, MD. These bays are formed by two barrier islands (Fenwick and Assateague) and consist of the Assawoman, Sinepuxent, and Chincoteague bays, the Isle of Wight, Newport and St Martin's River, and various smaller tidal creeks. The surrounding land is generally composed of sandy, poorly drained soils with very low gradients. *Spartina* dominated wetland types border the majority of the coastal bays. The water depth in the bays is predominantly shallow, rarely deeper than two meters. The coastal bays watershed is relatively small, covering approximately 200 square miles. The Maryland portion of Fenwick Island is dominated by the well developed resort town of Ocean City, which in summer months can influence the areas population size dramatically, with some estimates putting the areas population well over 100,000 during summer weekends. In contrast, Assateague Island is an environmentally protected area (through both state and federal parks) with little development. The west coast of the coastal bays is sparsely developed, but supports a moderate amount of agricultural and farming operations.

Previous investigations

In 1993, the Environmental Monitoring Assessment Program (EMAP) conducted an assessment of the ecological condition of the Delaware and Maryland coastal (EPA, 1996). This project utilized a probability-based sampling design that incorporated strata representing bottom sediment types and chlorophyll *a* concentrations. This allowed assessment of the coastal bays as a whole. Each of the four major subsystems within the coastal bays (Rehoboth Bay and Indian River Bay, Delaware, and Assawoman Bay Chincoteague Bay, Maryland) and four areas of special interest (Upper Indian River, Delaware, St. Martin River and Trappe Creek, Maryland, and dead end canals in both states) were sampled for biological and chemical measures. Timmons and Price (1996) conducted a conventional study of the abundance and species composition of macroalgae for Rehoboth and Indian River Bays during 1992 and 1993, and Orris and Taylor surveyed benthic macroalgae of Rehoboth Bay in 1973. Linder et al.(1996) reported the ecological integrity of the Maryland coastal bays. Orth et al.(1996) reported submerged aquatic vegetation distribution in Chincoteague Bay. Wells et al. (1994) mapped sediment types within the coastal embayments and reported an east to west gradient of dominant mud in the west that transitions to sand toward the eastern side of the bays.

Nutrient conditions

Excess nutrient loads can cause eutrophic conditions in aquatic ecosystems. Eutrophication process can lead to depletion or extinction of dissolved oxygen, leading to decline or depletion of valuable biological resources. Previous studies by Bohlen and Boynton (1998) and EMAP (1996) found a north to south nutrient gradient in the coastal embayments, with higher nutrient concentrations in the north region of Maryland's coastal bays. Price (1993) reported that in the Indian River Bay, phytoplankton levels were most prolific (as measured by chlorophyll *a* concentrations) in the portions of the estuary closest to nutrient sources (e.g., upper and middle Indian River Bay). The most turbid water in the coastal embayments is witnessed in the summer season and probably results from a combination of biological effects (plankton blooms) and physical effects (boat traffic) (Ullman et al.1993). Secchi depths in upper Indian River average approximately 0.5 meters year-round, but may be as low as 0.10 meters in the summer season during extremely high chlorophyll concentrations (Ullman et al.1993). These nutrient fluctuations likely play a significant role in defining limitations on the coastal embayments biological structure and integrity.

Submerged Aquatic Vegetation (SAV) and Macroalgae

Submerged aquatic vegetation (SAV) is an important resource in the Delmarva coastal bays. SAV is both commercially and ecologically important, providing critical habitat for various fish, crabs, and shellfish. The presence or absence of SAV can also be a useful indicator of water quality conditions and nutrient levels (Dennison et al.1993).

Sea grass beds in the Delmarva coastal bays suffered a serious decline in the 1920's and 1930's, in part due to disease (Orth et al.1998). During the 1970's SAV beds were also effected by an extremely large input of sediment and nutrient levels due to Tropical Storm Agnes (Orth et al.1998). Orth et al. (1997) reported that circular clam dredging within the Chincoteague Bay, Virginia was negatively effecting and degrading existing SAV beds. Orth and Moore (1998) also found hydraulic clam dredging in Maryland negatively effecting beds in the Chincoteague and Sinepuxent Bays. In recent years the coastal bay SAV beds have increased in size. In 1986, there was a reported 2,128.83 hectares of SAV. In 1996 there was an increase in bed size to 4,558.56 (Orth et al. 1996). This overall increase in SAV has been documented in most areas of the Chesapeake Bay region.

Timmons and Price (1996) and Orris and Taylor (1973) documented multiple species of benthic macroaglae in the Delaware coastal bays. Timmons and Price (1996) found *Agardhiella tenera* dominant in Rehoboth Bay, and *Ulva lactuca* dominant in Indian River. These species dominance are similar to results reported by Orris and Taylor (1974). Timmons and Price reported instances of SAV being smothered by benthic macroalgae communities, and suggest that nutrient level fluctuations influence macroalgae abundance. Macroalgae habitats were found to be utilized by some juvenile fish species and crabs (Timmons and Price, 1996).

METHODS

Sampling was conducted over a two-year period, 1998 and 1999. A combination of fixed and