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Preliminary Observations on the Variability of Chlorophyll in the Machipongo Watershed and Hog Island Bay

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Coastal bays or lagoons along the lower Delmarva Peninsula contrast with more northerly coastal bays on the Delmarva Peninsula (Boynton et al. 1996) in that they have numerous open inlets, and water is rapidly exchanged with the coastal ocean. The shoreline is also different, in that the land is primarily agricultural and there is little industry, residential development, or urban areas. Due to the flat topography, surface runoff is reduced. It is thought that, in general, shallow groundwater becomes the source of nutrients from agriculture and other activities, to the aquatic environment (Valiela et al.1990 and Reay et al. 1992). The area is characterized by numerous tidal creeks as well as a complex shoreline and thus the terrestrial environment is intimately linked to the lagoon and coastal ocean.

In order to understand the influence of activities on the shore on the health and productivity of the lagoon and the coastal ocean, we must first understand the buffer zone that the watershed and lagoon represent. In this paper we will discuss the variability of chlorophyll in the water column at several stations in the watershed/lagoon system. Chlorophyll *a* is a measure of the biomass resulting from primary production of phytoplankton and is therefore a fundamental indicator of the first order results of terrestrial influence on the marine ecosystem by water borne nutrients. Furthermore, in line with the focus of this Symposium on " Natural Resource Values and Vulnerabilities", the chlorophyll in the waters of the lagoon represent the food source for the grow-out of hatchery produced clams as well as the other harvestable resources from the bays and coastal waters.

In this paper we will discuss measurements of Chlorophyll *a,* salinity, temperature and phytoplankton at 9 stations on a transect from Willis Wharf to one mile seaward of the Great Machepongo Inlet. Our work was most often done with a 15 ft outboard motorboat so that weather at times kept us from the seaward stations. Chlorophyll was measured fluorometrically with acetone extracts on a Turner Designs model 10-AU Fluorometer. Both a Yellow Springs Instruments (YSI) temperature/salinity sensor and a Seabird Conductivity Temperature Density Probe (CTD) were used. Phytoplankton were identified with a Zeiss inverted microscope.

Looking first at all the data from one station taken over a three year period, one set of measurements taken in March 1994 stands out. The chlorophyll levels in the river/lagoon system were almost ten times the highest measured at any other time over the three year sampling period. Ignoring the March 1994 data for the moment and looking for a general seasonal pattern (see Fig, 1) there are two periods during the year of higher chlorophyll levels, February-March and July-August. The lowest levels are in the Oct-Nov period. (There is no December data.) So on a temporal basis there is a *loose* relationship between the historic pattern of rainfall which is highest in July-August and next highest in February-March and the chlorophyll level in the watershed-lagoon system. This pattern could reflect effects from both shallow groundwater as well as surface water runoff.

Because of the high rate of mixing between ocean water and lagoon waters, a high level of chlorophyll variability is introduced on an almost hourly time scale depending on the stage of the tidal cycle and wind. Chlorophyll at low tide is higher than at high tide with some exceptions in the winter. During most of the year the low nutrient clearer coastal water sweeps into the lagoon/watershed twice a day and leaves with part of the phytoplankton production that has taken place. The typical pattern is shown in Figure 2 for the high and low tide surface and three meter samples from May 1994. Note that there is little difference between surface and three meter samples. Salinity and temperature profiles further substantiate the well mixed nature of the system. During the March 1994, episode the low tide level of chlorophyll at four stations in the first six kilometers from Willis Wharf averaged 98 micrograms of chlorophyll *a* per liter, while for the following high tide the measurement was 40 micrograms per liter. In view of the over 50% dilution of chlorophyll between tides, it must be concluded that at certain times, a substantial contribution of this production from the lagoon goes to the coastal ocean. On an other cruise, sampling over a ten hour period at one station (the mouth of Greens Creek) chlorophyll followed the changing tide going from at low of 3.2 micrograms per liter at high to 8 micrograms at low tide. Exceptions to the low tide-high tide pattern in the data were in October 1994 and November 1995 when low tide chlorophyll levels were higher at the ocean side stations of the transect, indicating a possible oceanic contribution of coastal production to the lagoonal system.

Investigating possible explanations for the March 1994 unusually high chlorophyll, it appears that fertilizer application coincided with a record three-times normal March rainfall which stimulated high phytoplankton production and biomass. In winter months, low chlorophyll levels in the lagoon are enhanced by coastal production which probably resulted from coastal wind driven upwelling.

This then is a very variable system controlled by physical forcing and affected by complex episodic occurrences. The effects of many other factors that we are studying and have not discussed in this paper, will also cause chlorophyll variability such as the rate and seasonality of ground water nutrient input, or tide-sunlight effects on daily production, or the effect on production caused by changing phytoplankton communities. From our three years of studying chlorophyll a we have only a rough framework of how and why chlorophyll varies. This illustrates that we must be cautious in accepting simple explanations for how the watershed-lagoon system operates. Futher understanding of the temporal and spacial variability of the phytoplankton biomass is critical to understanding the productivity of other trophic levels like clam aquaculture and microbial processes on which they depend.

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