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AN EUTROPHICATION MANAGEMENT STRATEGY

BY

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Introduction

Spaulding, French and Rines (1989) in their review of the Tampa Bay water quality model system, outline a simplified, but effective plan for management of Tampa Bay eutrophication. Only the components which are required to answer management questions need to be considered in this plan. There is no need to understand or study the details of all components of the system.

Following their approach, effective management of Tampa Bay eutrophication can be limited to the understanding of how changes in total nitrogen loadings to the bay over time have affected algal biomass. Algal biomass can be reasonably estimated from chlorophyll-a concentrations. Further, when nitrogen is available in sufficient quantities (not severely limiting), the nitrogen to chlorophyll-a ratio of the phytoplankton is constant. Therefore, chlorophyll-a concentrations will be directly related to changes in nitrogen loading (see discussion by Spaulding, French and Rines 1989).

Tampa Bay researchers and managers generally agree that a successful strategy of eutrophication abatement must ultimately result in the natural restoration of persistent seagrass meadows to most areas which historically (pre-1940) supported seagrasses. Accordingly, effective management of Tampa Bay eutrophication involves these four tasks:

1. Determine how changes in total nitrogen loadings from major sources over time have affected ambient chlorophyll-a concentrations in Tampa Bay.

2. Determine a desirable ambient concentration of chlorophyll-a, which will support persistent seagrass growth in Tampa Bay. Utilize historic information and/or comparisons with other areas with persistent seagrass meadows for this important management decision.

3. Implement management of nitrogen loadings to sustain the desirable Tampa Bay chlorophyll-a concentration.

4. Conduct long-term monitoring of Tampa Bay water quality and nitrogen sources for determination of current nitrogen loading and evaluation of implemented nitrogen loading reductions.

The second task of this management strategy has already been addressed in the Tampa Bay chlorophyll-a target position paper (TBRPC 1989). The report suggests that a chlorophyll-a concentration between 4 and 5 ug/l will allow persistent seagrass growth in Tampa Bay.

The present report examines the past and current relationship between nitrogen loadings and ambient chlorophyll-a concentrations in Hillsborough Bay, which generally is the most eutrophic subdivision of Tampa Bay (Task 1). A management strategy for eutrophication abatement, involving the reduction of present nitrogen loadings to levels which will sustain the desirable chlorophyll-a concentration and support persistent seagrass growth in the near future, is also presented for Hillsborough Bay (Task 3). The urgent need for a comprehensive long-term water quality and loading source monitoring program, specifically for Hillsborough Bay, is also discussed (Task 4).

Nitrogen Loading and Chlorophyll-a Concentrations

Only nitrogen loadings entering Hillsborough Bay are addressed at this time. Approximately 60 percent of all Tampa Bay surface freshwater flows to Hillsborough Bay (Goodwin 1987). Further, Tampa Bay's largest domestic wastewater treatment plant (the Hookers Point facility) discharges into Hillsborough Bay. In addition, approximately 90 percent of all nitrogen containing fertilizer (ammonium phosphate) exported from Tampa Bay, is loaded and shipped from Hillsborough Bay. Nitrogen loadings to Tampa Bay from other sub-sections of the bay may, therefore, be of secondary importance.

Two time periods, based on the Hillsborough Bay chlorophyll-a record (Boler 1988 and HCEPC unpublished data report), were chosen to determine changes in nitrogen loading and ambient chlorophyll-a concentrations with time (Figure 1). The annual average chlorophyll-a level for the period 1980 through 1983 (Period I) was compared with the average for the period 1984 through 1989 (Period II). The annual average nitrogen loadings for Period I and Period II were generally calculated for the same time intervals as the chlorophyll-a averages. However, nitrogen loading from the Hookers Point Treatment Plant for Period I is an exception. Period I loadings from this facility are calculated as the annual average nitrogen loading caused by discharges of primary treated effluent from 1975 through 1978, a period just prior to the conversion to advanced wastewater treatment (see the Appendix for a detailed descriptions of loading calculations). Although the treatment conversion at Hookers Point, which resulted in a large reduction of nitrogen loading to Hillsborough Bay (Figure 2), took place between 1979 and 1980, ambient chlorophyll-a concentrations did not decrease substantially until four years later in 1984 (Figure 1). Assuming that nitrogen discharges from the Hookers Point Treatment Plant were the predominant nitrogen loading reduction to Hillsborough Bay between Periods I and II, then, a time lag of several years appears to exist between reduced nitrogen loading and the response of ambient chlorophyll a concentrations in Hillsborough Bay.

The change of estimated nitrogen loading and measured chlorophyll-a concentrations in Hillsborough Bay with time is shown in Table 1. The average annual nitrogen loading was apparently reduced by approximately 1400 tons, or 32 percent, from the early to the later period. The greatest reduction occurred when the Hookers Point Wastewater Treatment Plant converted its process from primary to advanced wastewater treatment. Alafia River and Delaney Creek have also had large reductions in nitrogen loading after 1983 (Figure 2), which probably are a result of decreased losses from fertilizer plants located well upstream from Hillsborough Bay (Estevez and Upchurch 1985).

Nitrogen losses from fertilizer industry facilities near or next to the bay are listed separately in Table 1. These losses occur at processing plants, storage facilitates and ship loading terminals. A loss of 0.1 percent to the bay of the nitrogen containing fertilizer handled at these facilities has been used for loading estimates from these sources. Communication with industry personnel, observation of facilities operation, and recent field measurements in East Bay (Figure 3), the northeastern section of Hillsborough Bay where several of these facilities are located, suggest that the estimated loss is likely to be a conservative approximation. However, it should be recognized that the actual loss from these facilities close to Hillsborough Bay is unknown at this time. A scientific evaluation of this nitrogen source must be of the highest priority for Tampa Bay managers. Nevertheless, losses from these fertilizer facilities, based on the limited information available, now appear to be a dominant source of nitrogen to Hillsborough Bay. Furthermore, the amount of nitrogen containing fertilizer handled at these facilities is increasing rapidly (Figure 4). Without proper management of these facilities, future increases in nitrogen loading from these sources can be expected.

Coincident with the estimated annual average reduction of 1400 tons of nitrogen from Period I to Period II, the annual average Hillsborough Bay chlorophyll-a concentration has, for the same time interval, decreased by approximately 10 ug/l (Table 1). This substantial reduction in ambient chlorophyll-a concentrations has apparently allowed for sparse revegetation of seagrasses in Hillsborough Bay (City of Tampa 1988). Based on the available information, for each annual average reduction of 140 tons of nitrogen loaded to Hillsborough Bay, a 1 ug/l decrease in ambient chlorophyll-a concentration can be expected. This calculated relationship between nitrogen loading and ambient chlorophyll-a concentrations is an initial attempt, then, to resolve the first task needed to effectively manage Tampa Bay eutrophication.

Table 1. Total nitrogen loading to Hillsborough Bay from major sources and ambient chlorophyll-a concentrations for Period I (Prior to 1984) and Period II (1984 through 1989). See the Appendix for a detailed description of loading calculations.

SOURCE	TOTAL NITROGEN (tons/year)			
	PERIOD I	PERIOD II	REDUCTION	(%)
Hillsborough River	417	409	8	2
Tampa By-Pass Canal	231	354	(123)	(53)
Alafia River	955	525	430	45
Delaney Creek	395	87	308	78
Bullfrog Creek	53	49	4	8
Hookers Point	1374	213	1161	84
Fertilizer Industry	944	1330	(386)	(41)
Wetfall	80	80	0	0
TOTAL	4449	3047	1402	32
Chlorophyll a (ug/l)	25.9	15.6	10.2	39.8

Future Tampa Bay Chlorophyll-a Concentrations

The second task needed for effective management of Tampa Bay eutrophication addresses the important management question: what is the desirable level of ambient chlorophyll-a in Hillsborough Bay and Tampa Bay as whole? TBRPC (1989) has already addressed this question and suggests that an annual average chlorophyll-a concentration between 4 and 5 ug/l will allow for persistent seagrass growth in Tampa Bay. Therefore, to achieve a desirable ambient chlorophyll-a concentration of 5 ug/l in Hillsborough Bay, current levels must be decreased by approximately 10 ug/l (Figure 1).

According to the calculated relationship between nitrogen loading and ambient chlorophyll-a concentrations (see above), a 10 ug/l decrease in chlorophyll-a concentration apparently corresponds to an annual averaged reduced nitrogen loading of 1400 tons. The conservatively estimated current nitrogen loading from fertilizer industry facilities near or next to the bay is similar to the amount needed to reduce current Hillsborough Bay chlorophyll-a concentrations to the desirable level of 5 ug/l.