Tampa Bay Environmental Monitoring Program

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Significant damage to, and loss of natural habitats in Tampa Bay can be traced to the uncontrolled development and pollution that started in the 1950s. Although great strides have been made over the last decade to reverse this trend, many agreed that a bay management and restoration plan, including monitoring programs that would evaluate bay conditions and progress, were needed.

The nomination and designation of the Tampa Bay National Estuary Program (TBNEP) in 1990, provided the platform to assist the community in developing a comprehensive plan to protect and restore the bay.

The process for developing the master plan includes the following components: identify and rank priority problems; assess bay conditions and needs; establish specific goals for the bay; develop management options; prepare the Comprehensive Conservation and Management Plan (CCMP); develop an implementing agreement among bay partners; implement the plan; and monitor progress (TBNEP 1996).

Methodologies for bay assessment, goal setting and development of comprehensive monitoring strategies are described. These methodologies could be useful to others interested in evaluating environmental protection and restoration schemes for natural resources.

Program Organization and Goal Setting

Since there already existed strong local and regional involvement in bay management, the TBNEP built on this commitment through the creation of its governing structure which consisted of the following committees: Policy, Management, Technical Advisory (TAC) and Community Advisory (CAC). From the Program's inception, the overall management goal was to protect and enhance the bay's natural resources. In support of this goal, the committees were required to characterize the natural systems of the bay and the impacts to these systems and define and implement actions to address those impacts. A Management Conference, with participation from all committees and stakeholders, was convened to identify priority bay issues. The following priority problems were identified by the Policy Committee in March 1991(TBNEP 1996):

- Water quality deterioration/eutrophication
- Reduction/alteration of living resources
- Lack of community awareness
- Increased user conflicts and impacts from various recreational activities, industrial and navigation needs, and urban development
- Lack of agency coordination and response
- Lack of circulation and flushing
- Hazardous/toxic contamination

Traditionally, monitoring and evaluating water quality conditions within a watershed are used to measure watershed health and productivity. Vigorous bay monitoring and management activities were being conducted by the time the TBNEP began in 1991; however, many of these activities focused on individual components and/or processes of the bay (Greening 1998). It was necessary to organize the information, coordinate bay managers' and stakeholders' participation and evaluate how these individual activities could be integrated to establish bay ecosystem management.

Quantifiable Restoration and Protection Goals

In keeping with the overall goal of protecting and restoring the bay's natural resources, the TAC worked to define species or biological communities which could be used as "indicators" of functioning bay ecosystems. The significant loss of submerged aquatic vegetative ("seagrass") habitat stood out as the premier concern of bay managers, scientists and concerned public. This habitat is crucial for many invertebrates and fish and provides for sediment stabilization (Busby and Virstein 1993). If quantifiable seagrass restoration goals and management strategies could be developed and implemented, it would be feasible to develop similar procedures for restoring other targeted habitats and natural resources.

Quantitative targets for the restoration and protection of seagrass habitat, as well as emergent habitats, were approved at a Management Conference in 1993. The approach to habitat restoration and protection was as follows (Janicki et al., 1994):

1. Map the historic living resource distribution during a benchmark time period.

2. Map the existing distribution of these living resources.

3. Overlay the historical and existing distributions to define potential restoration and protection targets.

4. Subtract physically altered (non-restorable) areas to identify restoration targets.

Seagrass Restoration and Protection Goals

Utilizing the approach described above, it was determined that the benchmark for establishing seagrass protection and restoration goals would be the period circa 1950. This era was chosen because the area was beginning to experience explosive growth and the major development alterations were not yet complete. Additionally, comparable habitat data were not available before 1950 (NUS Corp. 1986).

Using aerial photography coupled with the Arc/Info GIS system, it was determined that the extent of seagrass coverage in 1950 (not including areas that were irrevocably altered by 1990) was estimated to be 40,400 acres (NUS Corp. 1986). In 1990, Ries (1993) estimated the seagrass habitat coverage to be approximately 25,200 acres. Having already factored the physical losses due to dredge and fill activities, the remaining losses were most likely caused by degraded water quality conditions (Janicki et al., 1994). Recent investigations suggest that the loss of seagrass meadows can be attributed to lack of sufficient sunlight because of attenuation by excess phytoplankton, suspended solids and epiphytic algal growth (Morris and Tomasko 1993; Tomasko 1993; and Stevenson et al., 1993). Excessive algal concentrations or eutrophic conditions are predominantly caused by excessive nutrient (e.g., nitrogen and phosphorous) loading.

Acreage goals for seagrass restoration and protection were developed by overlaying the 1950, 1990 and non-restorable acreage data sets. Seagrass areas observed in 1990 were designated as seagrass protection areas. All areas in which seagrasses were mapped in 1950, but which did not support seagrass in 1990 and were not classified as non-restorable, were identified as seagrass restoration areas (Greening 1998). Based on a review of the data sources, method evaluation and uncertainty in estimating the 1950 coverage, the Management Committee agreed to adopt a minimum seagrass restoration goal of 38,000 acres bay-wide. This goal includes protection of an existing 25,650 acres and restoration of 12,350 additional acres.

Development of Intermediate Targets

Assessing bay management success via living resource goals is considerably more difficult than using traditional water quality criteria because it takes much longer to realize results. It is not too difficult to evaluate annual water quality trend response to management actions. It has been demonstrated, however, that seagrass quality and quantity improvements may not be observed for decades after a management action is implemented (Johansson and Ries 1997). To ensure that correct management actions were being implemented and bay water quality improvements would lead to the achievement of the seagrass restoration and protection goal, it was necessary to establish intermediate targets so that more timely evaluations and management adjustments could be made if necessary.

In the Tampa Bay area it has been demonstrated that seagrass health and distribution are adversely affected by incident sunlight being attenuated within the water column by elevated suspended solids or phytoplankton concentrations (Lewis et al., 1985; Lewis et al., 1991). If seagrass does not receive adequate light, plant maintenance and reproduction are inhibited (Janicki et al., 1994).

For the purpose of determining the relationship between nutrient loadings to the bay and adequate water quality to support the seagrass restoration target, a two-pronged modeling approach was developed. The first was a series of empirical regression-based models to estimate external nutrient loadings consistent with the proposed seagrass enhancements (Janicki and Wade 1996), and the second was a WASP-based box model which provided a process-oriented examination of relationships between nutrient loadings, chlorophyll *a* concentration and light attenuation (Martin et al., 1996; Morrison et al., 1997).

Both the empirical and mechanistic models produced similar results, suggesting that acceptable nutrient management targets could be developed. The critical relationships that were established were external nitrogen (limiting nutrient) loads and resulting chlorophyll *a* concentrations; chlorophyll *a* concentrations and density of phytoplankton in the water column; and chlorophyll *a* concentrations and light levels at the deep edges of historic seagrass beds.

Since the estuary is about 1,031 km^2 (398 mi^2) with varying land uses, fresh water inflow, nutrient loadings and circulation patterns, it was decided that the best way to manage this system was to partition or segment according to similar conditions. The segmentation scheme defined by Lewis and Whitman (1985) was adopted to establish the official management subdivisions of the bay (Figure 1).

Following numerous scientific workshops, the TAC and Management Committee adopted chlorophyll *a* targets necessary to maintain water clarity needed for seagrass growth for each bay segment. The adopted segment-specific annual average chlorophyll *a* targets (8.5 *u*g/l for Old Tampa Bay; 12.3 *u*g/l for Hillsborough Bay; 7.4 *u*g/l for Middle Tampa Bay; and 4.6 *u*g/l for Lower Tampa Bay) will be used as indicators for evaluating water quality conditions necessary to meet long-term seagrass restoration and protection goals.

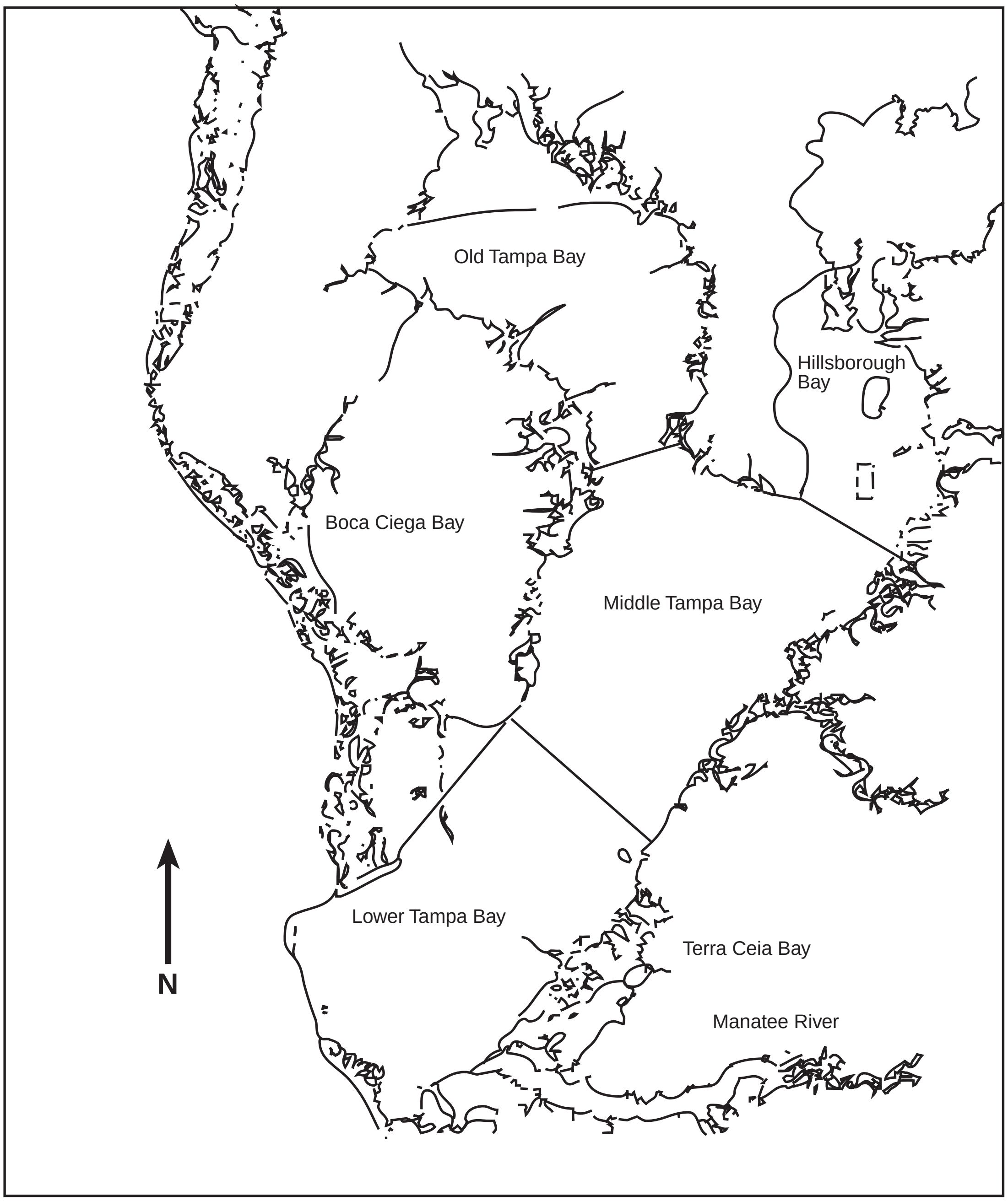

Figure 1. Tampa Bay, Florida segmentation scheme.

Nitrogen Management Strategy

Based on light conditions observed during a present day period (1992-1994), it was determined that water quality conditions were adequate to support the long-term seagrass restoration goals; therefore, a nitrogen loading "hold-the-line" strategy was adopted (Janicki and Wade 1996). This means that if the nitrogen loads observed during the period 1992-1994 remained constant into the future, it would be possible to achieve the seagrass restoration goal. However, it is estimated that by the year 2010, the watershed will experience a 20% increase in population and approximately a 7% increase in annual nitrogen loading (Zarbock et al., 1996).

In lieu of developing stringent future nitrogen load reduction allocations, local governments and agency partners in the TBNEP developed an unprecedented interlocal agreement (Memorandum of Understanding for the Federal agencies) pledging the development and implementation of action plans that will defer or reduce future nitrogen loadings, thereby maintaining the "hold-the-line" commitment.

Monitoring and Reporting

The process for developing monitoring strategies for this program was as unique as that used in developing the living resource goals. There were many monitoring activities ongoing when the TBNEP program was established, but these activities were localized and designed for specific needs.

The first task was to evaluate all of the different monitoring programs being conducted for Tampa Bay to determine whether they would meet the monitoring criteria for National Estuary Programs (USEPA 1991). Their criteria include: "measuring the effectiveness of management actions and programs implemented under the CCMP and providing essential information that can be used to redirect and refocus the management plan." Additionally, a 1992 monitoring workshop recommended four additional monitoring objectives (Versar 1992):

- To estimate the areal extent, and temporal trends in areal extent, of habitat conditions in Tampa Bay not meeting living resource requirements
- To assess the relative abundance and condition of fish populations of Tampa Bay over time
- To estimate the areal extent and quality of seagrass, mangroves, and coastal marshes in Tampa Bay over time and
- To estimate the areal extent and trends in areal extent of oligohaline habitat in Tampa Bay and its tributaries

To accomplish most of these monitoring objectives, it was decided that a probability-based sampling design be developed that would allow statistically valid, unbiased estimates of abundance and areal extent of key indicator species on a bay-segment and bay-wide basis. The chosen design was based on the U.S. Environmental Protection Agency's (USEPA) Environmental Monitoring and Assessment Program (EMAP) (Versar 1992). Since most of the existing monitoring activities were biased, fixed station designs, modifications to these programs were necessary.

In order to prepare and implement the new monitoring strategies, the local and regional agencies responsible for sample analyses and data reporting created a coalition known as the Florida West Coast Regional Ambient Monitoring Program ("RAMP"). RAMP participants meet regularly for the purpose of standardizing methodologies, evaluating quality assurance between laboratories, and coordinating field sampling strategies. These coordinated activities have 1) allowed the local agencies to develop expertise in areas other than general water quality monitoring (e.g., benthic and seagrass monitoring); 2) economized resources by linking bay areas and programs instead of creating overlap; and 3) allowed utilization of the existing EMAP probabilistic design to build monitoring programs required by other regulations (i.e., NPDES stormwater).

Another very important component of the monitoring strategy is reporting. The monitoring design described has both short- and long-term targets and goals. In order to provide bay resource managers timely information, the TBNEP, with assistance from state, regional and local scientists conducting monitoring and research, will prepare a biennial Tampa Bay Environmental Monitoring Report. The information provided in these reports is intended to provide decision makers timely access to information critical for successful restoration and protection of Tampa Bay's living resources.

Conclusions

The restoration and protection strategies designed for Tampa Bay by local, regional, state and federal participants epitomize coordinated ecosystem management. The development of resource-based targets, as defined by the environmental requirements of critical living resources, is difficult but essential for maintaining the health and productivity of critical habitats.

The real key to successes experienced in Tampa Bay is the concerted effort put forth by agency personnel, elected officials and concerned members of the public in dealing with difficult, complex issues and making critical management decisions. These accomplishments were possible because participants possessed dedication and commitment to restoring and protecting the living resources of Tampa Bay.

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