Action Plan 20 Monitoring Management Action, Status, and Trends

Problem

Monitoring is used to track the effectiveness of management action or inaction. For Clean Water Act initiatives like the National Estuary Program, a key question has always been, "Are we making waters more fishable and swimmable?" This question is understood as whether government is preserving and protecting ecosystem health and the integrity of the natural environment, and whether waters meet specified "designated uses." An especially difficult challenge in all environmental monitoring programs is recognizing that static environmental conditions in the face of new development or pollution inputs is in itself a measurable success.

Increasingly, funding agencies want to know not only whether a project was completed successfully, but also whether it was successful in protecting or restoring the environment. In fact, the 1987 amendments to the Clean Water Act section 320(b)(6) specified that each NEP Management Conference shall "...monitor the effectiveness of actions taken pursuant to the plan," to meet these two goals: "measure the effectiveness of the management actions and programs implemented under the [CCMP]; and provide essential information that can be used to redirect and refocus the CCMP during implementation." Implicit in these requirements are programmatic monitoring, environmental monitoring, and some level of research to ensure that selected environmental monitoring is adequately characterizing environmental conditions and risks.

Each action plan in the Buzzards Bay CCMP includes monitoring strategies. This action plan reiterates some of the most important elements of other action plans, but also addresses some broader watershed monitoring and reporting needs to meet the broader goals of the Buzzards Bay CCMP.

Goals

Goal 20.1. To document environmental trends of water quality and living resources in order to assess the effectiveness of management actions taken, or identify the need for new actions.

Goal 20.2. Identify research and monitoring needs to understand more clearly the causes of impairments, reduce uncertainties about health risks, and better define conditions in Buzzards Bay.

Objectives

Objective 20.1. Collect and monitor programmatic actions to document implementation of Buzzards Bay CCMP recommended actions.

Objective 20.2. Ensure that regulatory agencies define essential monitoring requirements and collect data necessary to evaluate program and project success.

Objective 20.3. Ensure that funding is available to implement essential monitoring programs.

Objective 20.4. Revise and adapt monitoring programs to meet changing needs and information gaps.

Objective 20.5. Disseminate data and syntheses of information to scientists, managers, and the public.

Objective 20.6. Encourage scientists and agencies to evaluate emerging contaminants and other stressors to the environment.

Approaches

Shellfish bed closures, eutrophication data, and eelgrass bed cover are some of the key water quality measures that must be tracked, but in the long run, the state's list of impaired waters (as river miles and water acres) will be the ultimate measure of success of actions taken to comply with the Clean Water Act. This also means considerable effort will be needed to monitor and characterize the many unassessed freshwater and marine bodies in the bay and watershed.

While programmatic and environmental data are collected by the U.S. EPA, the Buzzards Bay Coalition, Buzzards Bay NEP, and DEP, more effort is needed to make this information available on line, and where needed, synthesizing and aggregating data to show watershed comparisons and trends in time.

Programmatic actions by municipalities to comply with permits and watershed TMDL goals are both short-term and long-term measures to be tracked. Government will need to expand funding to research institutions to enable managers to better discern threats from emerging issues and concerns.

Costs and Financing

Tracking programmatic actions has modest costs. The cost of field monitoring described in the various action plans in the Buzzards Bay CCMP may total hundreds of thousands of dollars annually. Some monitoring needs can be met through new permit requirements, research grants may assist in evaluating contaminants of emerging concern, or federal watershed assessment grants (604b), but most monitoring costs must be borne by agencies managing the environment.

Measuring Success

The measure of success for this action plan will be whether sufficient information exists to evaluate the success of each action plan in this Buzzards Bay CCMP.

Background

Monitoring is often a requirement in environmental permits and environmental grants. It is also an essential need to evaluate the progress or success of environmental initiatives or programs. Broader less-defined ecosystem monitoring efforts can be costly, and must be well thought out and justified. From a scientific perspective, ecological monitoring meets many needs, and can provide basic knowledge of ecological processes, provide baseline data to track changes and long-term trends, serve as an early warning system, and better define the impacts of human perturbations (see discussion Spellerberg, 2005). Lindenmayer and Likens (2010) go so far as to classify all monitoring programs into three categories: passive monitoring, which is generally devoid of specific hypotheses or underlying study design, mandated monitoring where environmental data are gathered as a stipulated requirement of government, and question-driven monitoring, which is typically guided by a conceptual model, rigorous design, and an a priori prediction that can be tested.

In recent years, there has also been an increasing trend to evaluate the success of public expenditures, thus in 1993, Congress passed the Government Performance and Results Act (GPRA) "to provide for the establishment of strategic planning and performance measurement in the Federal Government." Fifteen years later, the implementation of this law is still evolving and changing how federal agencies, and federally funded state agencies, gather information to evaluate the performance of programs and how they monitor the environment. The act required federal programs to identify measurable goals for tracking progress towards the agency's mission. To answer such a fundamental question, each program needed to adopt performance indicators that were objective and valid (see 2005 to 2009 EPA Performance and Accountability Reports to see examples of the recorded metrics, and for a critique of the approach, see Gueorguieva et al., 2009).

To meet elements of the U.S. EPA's compliance with the GPRA, all the NEPs now track CCMP actions completed, and acres of wetland and habitat protected and restored. Beyond these minimum requirements, each NEP is responsible for developing and implementing a monitoring program to track both programmatic actions recommended within a CCMP, and measures to document water quality, habitat, populations, and measures of ecosystem health and integrity.

There are many fundamental challenges faced by any program attempting to meet such goals. The most important challenge is cost. In the original Buzzards Bay CCMP, a "tiered monitoring program" was developed to answer and address a wide variety of water quality and habitat issues. Full implementation of the recommendations for new monitoring might have cost millions annually, consequently only a few new monitoring initiatives were implemented.

For example, in the mid 1990s, DEP implemented an eelgrass monitoring program (a CCMP recommendation) building upon methodology for eelgrass mapping in Buzzards Bay (Costa 1988). This program continues to the present day and is informing management and guiding policy (see recent eelgrass trends in Costello and Kenworthy, 2012). In 2001, DEP, recognizing the value of aerial surveys from its eelgrass and wetland mapping efforts of the 1990s, implemented a wetland change program based on the analysis of aerial photographs that has caught and prosecuted numerous wetland alterations (Langley, 2009).

Similarly, in 1992, the Buzzards Bay NEP created and funded a water quality monitoring program to evaluate eutrophication, in partnership with the Buzzards Bay Coalition (based on approaches identified in Costa et al., 1992; see also Taylor and Howes, 1994). This program has gone on to be one of the most successful programs in the country. The Buzzards Bay Coalition assumed all management and most of the funding of the program by 1997. In the late 1990s, and in some subsequent years, the Massachusetts legislature became the principal sponsor of the volunteer monitoring program, first by providing $100,000 annually, then $150,000 annually by the mid-2000s. By 2008, when a budget crisis eliminated state funding for the program, the Coalition had begun to put in place an endowment fund to help the citizen group maintain funding for this popular program.

However many other recommendations in the original Buzzards Bay CCMP monitoring plan were not implemented because state and federal funding for monitoring programs diminished greatly through the 1990s and 2000s. For example, bay wide monitoring of PCBs and other toxic constituents in seafood in Buzzards Bay to document the effectiveness of state and federal efforts to clean up the New Bedford Harbor superfund site ceased[226], despite the many uncertainties and needs identified (e.g., Farrington and Capuzzo, 1990). Other federal programs like the Mussel Watch program continued with reduced frequency of monitoring and analyte testing. These programs were once deemed essential to monitor effectiveness of efforts to reduce toxic discharges from point and nonpoint sources. Other recommendations in the Buzzards Bay monitoring plan were never funded.

[226] The original monitoring plan recommended that PCB measurements be "repeated every 5 years in the outer harbor following remediation." Contractors cleaned up the Superfund site PCB hotspots by 2001, but the lower level contaminated areas are now gradually being excavated and transferred to landfills outside of Massachusetts. This last part of the PCB cleanup may not be complete for another twenty years.

While the Massachusetts Division of Marine fisheries continued its shellfish resource area. FDA mandated water quality testing program for the past three decades, similar recommended efforts to monitor and identify upstream sources of bacteria, or to evaluate stormwater discharges to establish priorities for remediation were never implemented in a systematic way because of high costs and the lack of funding at any level of government. The Buzzards Bay NEP, municipalities, and the Buzzards Bay Coalition have attempted to address the latter issue within specific projects, but these actions have been piecemeal. In some respects, the Phase II MS4 stormwater permit program and bacteria TMDLs should address and drive some unmet monitoring needs because municipalities are required to evaluate discharges as part of their municipal stormwater systems and networks, but municipalities are also facing serious budget shortfalls, and water quality testing may remain a low priority for some time.

Besides the lack of funds to implement additional monitoring programs is the fact that there are many challenges to interpreting monitoring data and communicating the results to both the public and managers. The cost of synthesizing information and translating data into understandable findings conveyed through various communications media can sometimes exceed the cost of data collection and laboratory analysis.

In addition to the cost of data synthesis, the results of monitoring programs may fail to show clear trends. This is often the case because changes in pollutant discharges are small relative to background levels, other sources, or natural variability. In particular, seasonal rainfall amounts greatly affect those pollutants conveyed through stormwater runoff and ground water flow. For example, when evaluating eutrophication impacts, seasonal rainfall amounts strongly affect eutrophication indicators. Even if changes in land use or sewering result in theoretical increases or declines in nitrogen loading over a period of time, invariably during wet summers, eutrophication indicators will show poor water quality in most embayments, whereas during a drought summer water quality may become exceptional.

Major issues

Financial and Personnel Constraints

The information needed by government to characterize pollution problems, define health risks, document habitat impairments, and better define strategies to protect the environment often exceed the financial and staffing capacity of agencies and universities.

Conveying Information

Even for data that is available, synthesizing and communicating effectively to the public can be time consuming and sometimes expensive. Adding to the problem, multiple entities collect data on different pollution measures, with sometimes contradictory trends, making it difficult to communicate a clear message with a simple "story."

In the case of nitrogen loading, this problem led the Buzzards Bay NEP to create the Eutrophication Index for the Buzzards Bay Coalition volunteer monitoring program in 1992, combining five different parameters (chlorophyll, secchi depth, inorganic nitrogen, organic nitrogen, and oxygen concentrations) into a single water quality index. The Buzzards Bay Coalition adopted a similar approach by creating scores for a series of other numeric indicators for its State of the Bay reports beginning in 2001, renaming it a Health Index. This technique allowed the establishment of a single Bay Health Index cutting across numerous water quality and living resource issues. Environmental programs have increasingly adopted these approaches across the U.S. and elsewhere.

A non-trivial subset of problems with communicating environmental trends is the fact that there has been a substantial increase in population and development and a dramatic loss of natural habit in the coastal zone in the last 20 years. If certain water quality indicators remain steady in the face of these trends, this is in fact a management success. However, getting funding agencies and the public to appreciate such realities has been difficult at best.

A more disturbing impediment to the development and funding of new monitoring programs is that government often does not want to document the extent of existing or new problems. In this context, monitoring the environment is seen neither as an investment, nor as a mechanism to build a healthy economy. More rigorous monitoring can close swimming beaches; discourage tourism and recreation, and cost government and industry money by exposing problems that cost money to solve. An extension of this logic is that it is more appropriate to use limited government funds and budgets to solve problems already documented by earlier monitoring efforts than to implement new monitoring programs.

Programmatic versus Field Monitoring

In recognition of the financial constraints of monitoring, challenges in interpreting and communicating the results of the monitoring programs, and the practical aspects in detecting modest trends in the face of a noisy environment impacted by increasing development, certain compromises must be made to create a meaningful program to track the progress and effectiveness of the Buzzards Bay CCMP.

For example, monitoring the effectiveness of management actions on the shifting shoreline action plan is best tracked by regulatory and non-regulatory management actions taken. Perhaps the true effectiveness of

actions taken in preparation of catastrophic storm flooding can only be judged after another category 3 hurricane (like the hurricane of 1938) strikes Buzzards Bay, but even then each storm presents unique circumstances that define its effects. Similarly, the success of management recommendations in Action Plan 10 Managing Water Withdrawals to Protect Wetlands, Habitat, and Water Supplies will best be judged by tracking municipal per capita water use. In fact, throughout the action plans, programmatic and management action monitoring is the principal tracking mechanism.

Other measures of the environment, like eelgrass habitat area, wetland area, endangered species population counts, bacteria concentrations (and the documentation of resulting beach and shellfish bed closures), and eutrophication indicators will remain the direct indicators of overall ecosystem integrity, program success, and the effectiveness of government actions.

As was the case with the original Buzzards Bay CCMP monitoring plan, most water quality and living resource problems around Buzzards Bay are highly localized, and are related to local land use around each embayment. Conditions in the central bay remain generally good. Consequently, this monitoring action plan remains focused on evaluating water quality and living resources within the context of coastal embayments and their contributing watersheds. The action plan also supports efforts to monitor the effectiveness of individual projects and BMPs. In all these endeavors, funding is a severe constraint. Consequently, in the case of evaluating BMPS, public funds should only be expended to evaluate new or novel applications of technologies. Some monitoring needs can also be met through conditions of permits.

The goals and objectives of the Action Plan 20 Monitoring Management Action, Status, and Trends remain focused on gathering information necessary to evaluate the effectiveness of management action recommendations specified by the Buzzards Bay CCMP, both individually, and cumulatively. The mechanisms to evaluate the outcome of each action plan recommendation are already specified throughout this document under the "measuring success" heading under each action plan recommendation. The recommendations in Action Plan 20 Monitoring Management Action, Status, and Trends focus on mechanisms to support those more specific recommendations, as well as more broader actions to implement successful efforts to monitor the environment and communicate those findings.

Data Availability and Reporting Results

To be meaningful to scientists, managers and the public, monitoring data must be made readily available both in its raw form, and in more synthesized forms that can be understood by the lay public. This increased availability makes the action of government more accessible and transparent to the public.

On the other hand, efforts involving online relational databases merging disparate data have not proven widely useful, and can be expensive to maintain. Data should be made available in its native or original format (spreadsheets, GIS shapefiles, etc), for use by scientists and analysts to import into their own software or statistical programs. Data analysis and synthesis, which can be costly, should be reserved for specific programs.

To communicate other aspects of tracking Buzzards Bay CCMP progress and outcomes, the Buzzards Bay NEP established a Status and Trends web page (buzzardsbay.org/trends.htm) that includes a variety of water quality, living resource, and management tracking parameters. The Buzzards Bay Coalition created a complimentary State of the Bay page on their website[227]. Both programs collaborate when evaluating datasets to ensure the data and information presented on these web pages are consistent. The Buzzards Bay NEP also continues to track and post information on Buzzards Bay CCMP implementation projects with links and information on their outcomes.

Other state and federal agencies are making individual datasets available online. Some websites, like the Massachusetts Department of Public Health beach monitoring results website[228] are very popular with the public and the increased transparency and availability of the data in some cases has focused municipal efforts to address pollution problems or issue precautionary rainfall advisories.

Research Needs

While the monitoring efforts described in this section will be used to track progress in meeting the goals and objectives of this Buzzards Bay CCMP, there is an ongoing need for research to study the many uncertainties and unanswered questions that remain about the threats facing Buzzards Bay. Some important research questions include:

What are the impacts of pharmaceuticals and other emerging contaminants?

What are the synergistic or additive effects of pollutants and other stressors?

How will shifts in precipitation, water temperatures, and ocean acidification caused by green house gas emissions alter coastal ecosystem structure and function, including populations of non-natives?

What are the human health threats of low-level contaminants in seafood?

[227] www.savebuzzardsbay.org/Document.Doc?id=11. Last accessed October 11, 2013.

[228] mass.digitalhealthdepartment.com/public_21/index.cfm. Last accessed October 11, 2013.

How are invasive species altering coastal and inland ecosystem?

Management Approaches

Lindenmayer and Likens (2010) argue that the major characteristics of effective monitoring programs typically include: (1) good questions, (2) a conceptual model of an ecosystem or population, (3) strong partnerships between scientists, policy-makers and managers, (4) frequent use of data collected. These should be the principals that drive monitoring programs in Buzzards Bay.

In the face of shrinking environmental program budgets, more than ever, tracking environmental progress will be met through cost effective strategies of monitoring indicator species like herring abundance using field counters, or through remote sensing for eelgrass and wetland coverage. Tracking of water quality stressors like nitrogen in receiving waters by the Coalition's volunteer water quality testing program must continue, and this program must be expanded to incorporate nitrogen TMDL sentinel stations. Other cost effective programs must be implemented to serve other environmental assessments in this document. Some needs, like the systematic monitoring of stormwater discharge to rank them for prioritization, or monitoring the fate and pathways of toxic compounds in the environment will be costly endeavors, even with innovation.

Tracking of programmatic action (permits issued, acres protected, etc.) will remain an essential tool, and the programmatic monitoring approach will be used to evaluate land protection, water withdrawals and water conservation measures, and shellfish bed closures to name a few examples. Because of the self-reporting required under various state and federal permit programs, it is essential that regulators continue to require and expand well-reasoned monitoring requirements, and make this data readily available for analysis.

Financial Approaches

Monitoring programmatic actions has modest costs. The cost of field monitoring described in the various action plans in the Buzzards Bay CCMP may total hundreds of thousands of dollars annually. Some monitoring needs can be met through new permit requirements, research grants may assist in evaluating contaminants of emerging concern, or federal watershed assessment grants (604b), but most monitoring costs must be borne by agencies managing the environment.

Monitoring Progress

This action plan is primarily concerned with ensuring sufficient data and information is collected to evaluate progress on all the other action plans. The success of this action plan will be defined by whether the information is readily available and communicated to ensure that agencies and the public can evaluate the success of the Buzzards Bay CCMP. In this respect, the status and trends webpages on the Buzzards Bay NEP and Buzzards Bay Coalition websites, and related outreach documents clearly and concisely communicate this information.

References

Costa. J. E. 1988. Eelgrass in Buzzards Bay: distribution, production and historical changes in abundance. Environmental Protection Agency Publication BBP-88-05. 204 pp.

Costa, J. E., B. L. Howes, I. Valiela, and A. E. Giblin. 1992. Monitoring nitrogen and indicators of nitrogen loading to support management action in Buzzards Bay. *In:* McKenzie et al. (eds.) Ecological Indicators, Chapt. 6, pp. 497-529.

Costello C. T. and W. J. Kenworthy. 2010. Twelve-Year Mapping and Change Analysis of Eelgrass (*Zostera marina*) Areal Abundance in Massachusetts (USA) Identifies Statewide Declines. Estuaries and Coasts 34(2). 232-242.

Farrington, J. W. and J. M. Capuzzo. 1990. Toxic chemicals in Buzzards Bay: sources, fates and effects. Final Report to U.S. Environmental Protection Agency - Buzzards Bay Project. Lloyd Center for Environmental Studies, South Dartmouth, Mass.

Gueorguieva, V., J. Accius, C. Apaza, L. Bennett, C. Brownley, S. Cronin, S., and P. Preechyanud. 2009. The Program Assessment Rating Tool and the Government Performance and Results Act Evaluating Conflicts and Disconnections. The American Review of Public Administration, 39(3), 225-245.

Langley, L. 2009. EPA Wetland Demonstration Pilot Grant Year 3 Results. February 2, 2009. MassDEP Wetland Program, 1 Winter Street, Boston MA 02108.

Lindenmayer, D. B., and G. E. Likens. 2010. The science and application of ecological monitoring. Biological Conservation, 143(6), 1317-1328.

Spellerberg, I. F. 2005. Monitoring ecological change. Cambridge University Press.

Taylor, C. D. and B. L. Howes. 1994. Effect of sampling frequency on measurements of seasonal primary production and oxygen status in near-shore coastal ecosystems. Marine Ecology Progress Series 108: 193-203.

The Buzzards Bay Volunteer Monitoring Program: A Buzzards Bay Success Story

One of the hallmarks of monitoring in Buzzards Bay has been the Buzzards Bay volunteer-based water quality monitoring program, which was initially jointly implemented by the Buzzards Bay Coalition (then called the Coalition for Buzzards Bay) and Buzzards Bay National Estuary Program in the spring of 1992. The program was designed by Dr. Joe Costa and Dr. Brian Howes to address the need to monitor and evaluate nitrogen impacts to coastal waters as outlined in the Buzzards Bay Comprehensive Conservation and Management Plan. The Coalition organizes and trains the volunteers and coordinates data collection and entry.

The volunteers measure dissolved oxygen concentrations with Hach Kits™, secchi depth, salinity, and temperature approximately 15 times between June 1 and September 30. The volunteers also collect 2-4 water samples during summer, which are analyzed for dissolved, and particulate organic nitrogen, nitrate + nitrite, ammonia, orthophosphate, and chlorophyll. Generally, the program monitors 2 to 4 sites within each embayment. In some smaller embayments, only one site is monitored; in larger embayments, 5 or more sites were sampled. The volunteers take samples for nutrient analyses during outgoing tides, while oxygen and secchi data included both incoming and outgoing tides because the oxygen measurements are needed in the early morning hours, generally taken between 6-9 AM, as indicated by Taylor and Howes, (1994).

One key innovation of the program was its attempt to combine a basket of indicators into a single Eutrophication Index. The Buzzards Bay Eutrophication Index was created by Dr. Joe Costa in 1992 as a tool to present a simplified summary of the volunteer monitoring program data (read the first Baywatchers Report, issued December 1992). The Index was modeled after a water quality index adopted by Hillsborough County in Florida to evaluate changes in Tampa Bay water quality. This approach to create a water quality index was based on defining, for each water quality parameter used, a "poor" water quality value (0 points), and an "excellent" water quality value (100 points). The adoption of the 0 and 100-point values was made after consultation with Dr. Brian Howes, who had set up the monitoring program with Dr. Costa. The values are log transformed in the formula for calculating the index because of the lognormal ecosystem response to nitrogen loading. More details on the methodology are provided on our Eutrophication Index page.

In the first 4 years of the program, the Buzzards Bay NEP funded the startup of the program and provided nearly all the funds necessary to operate the program, which included funds to the Buzzards Bay Coalition for a monitoring program coordinator and funds to a research laboratory to provide for water quality analyses. Since 1996, the program has been managed exclusively by the Buzzards Bay Coalition, with technical support first from UMass Dartmouth and later by the Marine Biological Laboratory Ecosystems Center. In the mid-1990s, the Buzzards Bay NEP suspended funding to the water quality monitoring program due to federal cutbacks. During that time, the Coalition continued the program with grants and donations. They also received roughly $10,000 annually from Buzzards Bay municipalities. In later years, the Coalition was able to secure state funding through an earmark of the state legislature of $50,000 to $150,000, which covered a large portion of monitoring costs, and enabled the Coalition to expand nutrient testing further upstream in some estuaries. Today, the Buzzards Bay National Estuary Program continues to provide between $20,000 and $30,000 annually to support the program. Through the years, the Coalition has continued to fund unmet needs through private donations and fund raising.

In 2002, Massachusetts DEP began using the data from this program to develop watershed nitrogen TMDLs in the Massachusetts Estuaries Project and this effort is continuing today. The Buzzards Bay NEP remains a strong advocate for this effort, and is using these data to evaluate the success of efforts to protect and restore Buzzards Bay.

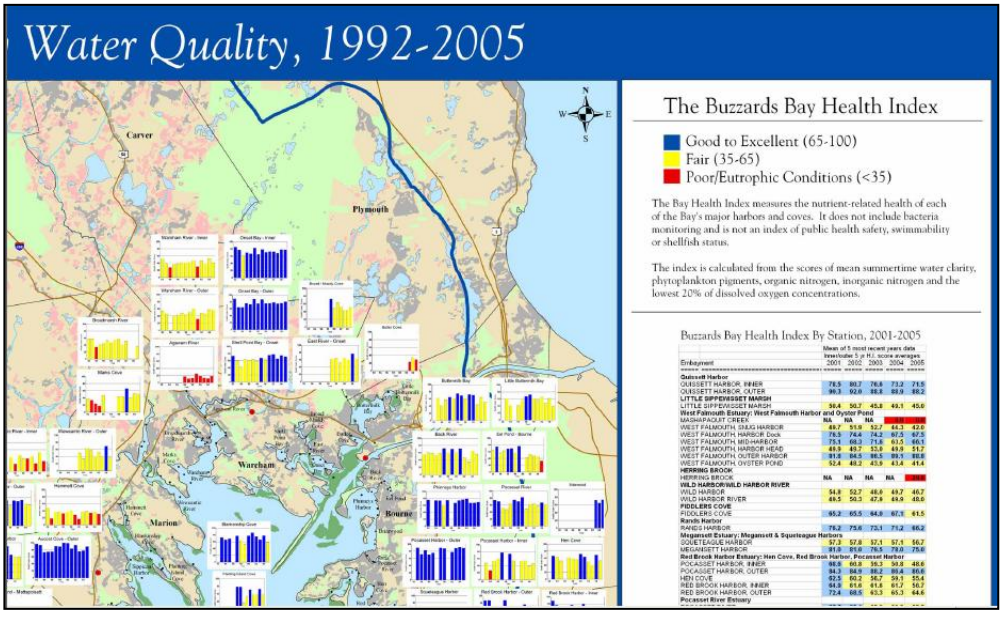

Figure 112. Portion of a poster prepared by the Buzzards Bay NEP for the Buzzards Bay Coalition, showing 13 years of water quality results collected through the volunteer water quality monitoring program.