buzzards BAY COALITION

Citizens' Water Quality Monitoring Program Manual

BAYWATCHERS

revision, March 2019

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Acknowledgments

We would like to thank the more than 800 volunteers who have participated in the Buzzards Bay Citizens monitoring program since 1992. Their dedication, time and efforts have created a database of information and a model program that is the primary source of long-term data assessing the health of each of the bay's 30 major harbors and coves in 10 municipalities from the Westport Rivers to Quissett Harbor in Falmouth including the Elizabeth Islands. This "citizen scientist" data is providing the information needed to make informed, science-based decisions about the restoration and protection of Buzzards Bay. We wish to also thank all the Marinas, Harbormasters, Shellfish Wardens, Coastal Landowners, and neighbors that allowed us use of their services, docks, and have access to the water. Thanks to Dr. Brian Howes and the staff of the Coastal Systems Program at the UMass Dartmouth School for Marine Science and Technology Laboratory who provided technical support and laboratory analysis, for the program from 1992-2008. Dr. Joseph Costa, Director of the Buzzards Bay National Estuary Program and Tracy Warncke, Administrative Assistant at the Buzzards Bay Project, for all their program start-up assistance and the Bay Setting information provided in this manual. We extend our appreciation to the Falmouth Pondwatchers, whose program of coastal salt pond monitoring has provided us with a useful working knowledge in the logistical development of this effort. We would like to acknowledge the use of publications from The Alliance for the Chesapeake Bay's Citizen Monitoring Program, which provided an excellent resource in the initiation of this effort. Lastly, thanks to our partner organizations, The Westport River Watershed Alliance and the Lloyd Center for the Environment.

Beginning in 2009, technical oversight and laboratory analysis to the Baywatchers Program is being provided through a partnership with The Ecosystems Center at The Marine Biological Laboratory (MBL) in Woods Hole, MA.

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Program Coordinated By- Tony Williams, Director of Monitoring Programs, Buzzards Bay Coalition
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Manual Written By: J.E. Costa, B.L. Howes, E. Gunn, D. Goehrenger, T. Williams

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Baywatchers logo (cover) by Dan Vasconcellos.

Introduction

Citizen-based water quality monitoring is a cost-effective approach for gathering the long term environmental data required for the protection and remediation of coastal waters. Involvement of citizens at all levels of environmental management practices is one of the best mechanisms to ensure support for environmental protection from an active and educated citizenry.

The Buzzards Bay Citizen's Water Quality Monitoring Program is coordinated by the Buzzards Bay Coalition, a nonprofit citizen education and advocacy organization. The citizens monitoring program for Buzzards Bay was initiated in 1992 to document and evaluate nitrogen-related water quality and long term ecological trends in embayment health. Until the inception of this program, no comprehensive database existed on nutrient concentrations in the harbors and coves of Buzzards Bay and the extent of eutrophication in these sensitive areas of the Bay ecosystem. The Buzzards Bay Coalition's Water Quality Monitoring Program is the largest coastal monitoring effort in Massachusetts, covering more than a quarter of the Commonwealth's coastline.

In order to start collecting this information the Buzzards Bay National Estuary Program helped to establish a monitoring program to be coordinated by the Buzzards Bay Coalition. The Buzzards Bay National Estuary Program , established to protect and restore the water quality and living resources of the Bay, is one of 28 participants in the EPA's National Estuary Program. The Project administers funding for research, public education, pollution characterization, remediation projects, and technical assistance and grants for Buzzards Bay municipalities. The Buzzards Bay National Estuary Program also developed the Buzzards Bay Comprehensive Conservation and Management Plan (CCMP), which was approved by MA Governor William Weld in September 1991 and EPA Administrator William Reilly in April 1992.

The Water Quality Monitoring Program's primary focus is on long-term trends in nutrient related estuarine quality, specifically the cultural eutrophication of the Bay's subembayments. The observed effects of nitrogen enrichment include increased algal blooms, lower dissolved oxygen levels and shifts in species abundance. The program is the primary source of long-term data assessing the health of each of the bay's 30 major harbors and coves in 10 municipalities from the Westport Rivers to Quissett Harbor in Falmouth including the Elizabeth Islands providing the information needed to make informed, science-based decisions about the restoration and protection of Buzzards Bay. The Program also provides data to the Buzzards Bay National Estuary Program for their work to implement the Buzzards Bay Comprehensive Conservation and Management Plan.

Beginning in 2009 the Water Quality Monitoring program is continuing in partnership with The Ecosystems Center, MBL in Woods Hole, MA. The Ecosystems Center assists with technical oversight, recommendations on water quality sampling equipment, assists with training on the use of the sampling equipment, and preforms laboratory analyses of water samples for selected parameters.

The Citizen's Water Quality Monitoring Program assists The Buzzards Bay Coalition with its advocacy, education and conservation efforts to preserve the health of the bay ecosystem. These goals include providing assistance to local municipalities and communities in embayment restoration efforts and to provide accurate and reliable water quality data for most of the major embayments around Buzzards Bay. In addition the Coalition's monitoring efforts aim to assist environmental managers in their decision making by:

- Establish baseline water quality,
- Evaluate nitrogen loading inputs,
- Characterize and identifying sources of pollution,
- Document long-term environmental trends in water quality,
- Evaluate the relative success of clean-up efforts,
- Facilitate implementation of management recommendations contained in the CCMP

In addition to collecting valuable water quality data, we hope this monitoring program will help educate the participants on water quality issues, increase public understanding of environmental management issues, and encourage local citizens to take an active role as stewards of their environment.

Participation by citizen volunteers is vital to accomplishing water quality monitoring in a large scale system like Buzzards Bay. It is extremely difficult and expensive for state and local government to gather all data needed to protect coastal ecosystems. Through the use of trained volunteers, we can effectively collect the substantial amount of data needed to evaluate water quality conditions in these valuable nearshore resources.

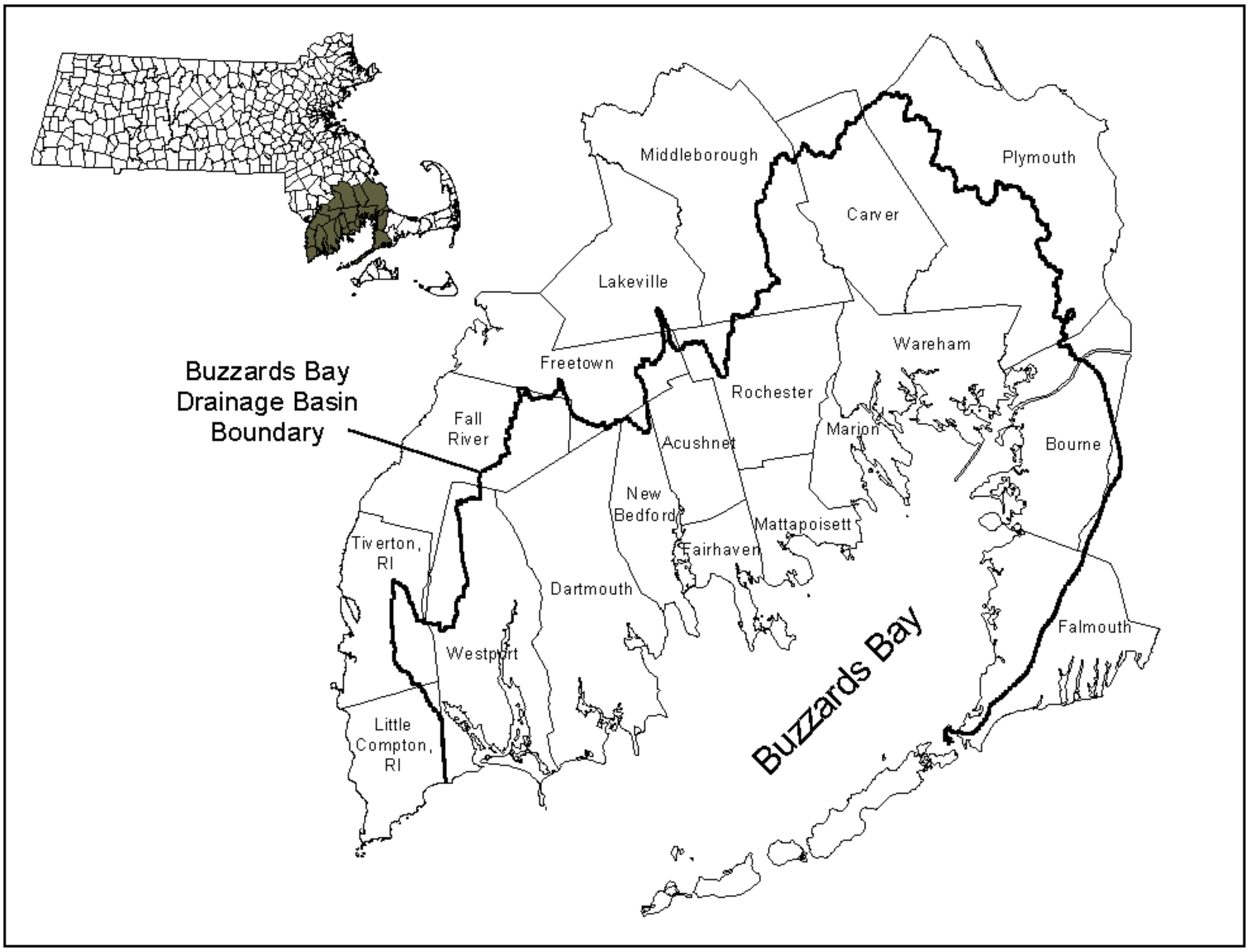
This manual outlines the purpose and goals of the program, describes the pollution problems facing the Bay, documents the need for water quality sampling, and provides technical guidance on sampling protocol and methods. Additional information and questions should be sent to The Buzzards Bay Coalition-Director of Monitoring Programs.

Buzzards Bay Setting

Buzzards Bay is a moderately large estuary located between the western most part of Cape Cod, Southeastern Massachusetts, and the Elizabeth Islands. The bay is 28 miles long (45 kilometers), averages about 8 miles (12 kilometers) in width, and has a mean depth of 36 feet (11 meters). It is approximately 228 square miles (590 square kilometers) in size. Buzzards Bay was formed by glaciers that receded approximately 15,000 years ago, leaving a complex network of shallow embayments and estuaries. The southeastern side of the Bay (Bourne, Falmouth, and the Elizabeth Islands) consists of glacial debris deposited by the glacier's leading edge. Consequently, it has a relatively smooth shoreline composed mostly of sand and gravel particles. The northwestern side (Wareham to Westport), with its numerous elongated bays and inlets, was formed by the glacier's retreat to the north. Along its western shore (west of the Cape Cod Canal) the drainage basin is formed by seven major river basins and a number of smaller ones. The largest river basins include the Agawam, Wankinco, Weweantic, Mattapoisett, Acushnet, Paskamanset, and Westport. The eastern shore of Buzzards Bay (Cape Cod Canal to Woods Hole) is drained mostly by groundwater. Several river systems smaller than those on the western shore also drain this portion of the basin. The prominent freshwater streams along the eastern shore are the Back , Pocasset, and Wild Harbor Rivers and Herring Brook. In general, rivers within the drainage basin are slow-moving, meandering streams near their headwaters and for most of their freshwater length. The coastline stretches over 350 miles (563 kilometers--this includes inner harbors, bayward facing portions of the Elizabeth Islands, and portions of the Cape Cod Canal within the watershed.) and includes 11 miles (18 kilometers) of public beaches that lure thousands of tourists from Massachusetts and neighboring states. More than 12,000 boats can be found moored or on Buzzards Bay during peak summertime holidays.

Buzzards Bay is part of the Atlantic Intracoastal Waterway system, and is connected to Cape Cod Bay by the Cape Cod Canal. The 480-foot wide Cape Cod Canal (operated by the US Army Corps of Engineers) is the world's widest sea-level canal, and has a navigational depth of 32 feet at mean low water. As noted on the Army Corps Cape Cod Canal website, more than 20,000 vessels pass through the Canal annually. Many of these vessels are smaller recreational vessels, but in a busy 24 hour period, perhaps 30 to 60 larger transport vessels including tankers, barges, tugs, ferries, fishing vessels, container vessels, cruise ships, and other transport vessels pass through the canal. In 2002, the Army Corps noted that 1.9 to 2.0 billion gallons of petroleum products were shipped through the Cape Cod Canal annually.

Eleven coastal communities share the bay (City of New Bedford and Towns of Westport, Dartmouth, Acushnet, Fairhaven, Mattapoisett, Marion, Wareham, Bourne, Falmouth, and Gosnold (Elizabeth Island Chain, town hall on Cuttyhunk Island), and 5 more are in the watershed, including nearly all of Rochester, and large portions of Plymouth, Carver, Middleborough, and Fall River. The Buzzards Bay drainage basin covers 432 square miles (1120 square kilometers) and includes all or sections of 17 municipalities.



The Buzzards Bay area's population is over 400,000 people that live within the watershed boundaries (including the watershed portions of Falmouth and Bourne). Wastewater is discharged into Buzzards Bay by five municipal sewage treatment plants and the remainder of homes are serviced by on-site wastewater disposal systems (septic systems). A small amount of the basin's land area are used for some form of agriculture including raising of livestock. The Bay also receives numerous industrial discharges, CSOs (combined sewer overflows), and inputs from animal waste via stormwater and overland runoff. Buzzards Bay has also been subjected to chronic and periodic catastrophic oil and chemical spills. All these uses and pressures have resulted in

- closure of shellfish beds and swimming beaches due to the possible presence of disease causing organisms;
- contamination of shellfish, fish, and lobsters by toxic substance such as trace metals, hydrocarbons, and polychlorinated biphenyls (PCBs); and
- excessive nutrient inputs to the Bay, causing water quality degradation and habitat loss.

Despite these pressures, the central portion of Buzzards Bay is relatively healthy when compared with other major estuary systems. It does not yet comparably suffer from many of the system-wide problems found in other estuaries like Chesapeake Bay or Long Island Sound. Nevertheless, the health of many of its harbors are in jeopardy from pollution associated with continuing growth and development within their respective drainage basins. This water quality degradation along the margins of the Bay is most pronounced in many of the poorly flushed embayments.

In 2003, The Buzzards Bay Coalition released its first-ever State of the Bay report documenting the state of pollution, watershed health and living resources in the Bay. The result of that analysis revealed a Bay functioning at roughly half of its ecological capacity – a score of 48 out of 100. At that time, more than 1/2 of the bay's harbors and coves were found to be degraded by excessive nitrogen pollution, and accelerating sprawl development was consuming the watershed's forests and wetlands – the bay's natural filters – at an unprecedented rate.

Four years later in 2007, The Buzzards Bay Coalition found the situation worsening with significant declines in some of the most important indicators – particularly in those linked to nitrogen pollution. Simply put, the nitrogen pollution problem was expanding and driving bay decline more than any other factor.

For many additional areas with shellfish bed closures, the water quality degradation are the result of land use practices in the drainage area surrounding that embayment, particularly from so-called "non-point" sources. These pollutants are typically conveyed by streams, groundwater, or overland runoff and stormwater discharges.

In 2016 The Buzzards Bay Coalition released its updated State of the Bay report documenting the state of pollution, watershed health and living resources in the Bay. The result of that analysis revealed a Bay functioning at roughly half of its ecological capacity – a score of 45 out of 100.

Additionally tracking water temperature is particularly valuable given a recent analysis of the Coalition's long-term data, which shows that water temperatures rose significantly in the waters of Buzzards Bay between 1992 and 2013. Furthermore, the analysis suggested that increased temperatures have led to a worsening in water quality associated with nitrogen levels.

These are the reason the Buzzards Bay Coalition Water Quality Monitoring Program-Baywatchers is primarily focused on long-term trends in nutrient related estuarine water quality.

Types of Monitoring to Be Conducted

Nutrient Impacts

Excessive inputs of nutrients, particularly nitrogen, pose a major threat to the long-term health of our coastal waters. Once known for their clear waters, underwater eelgrass meadows and abundant bay scallop harvests, today you may find Buzzards Bay's nearshore waters clouded and murky. Under the surface, their bottoms may be covered in algae which deprives the water of life giving oxygen for fish and shellfish. In some areas, these impacts can lead to bad odors, algae-covered shorelines and even fish kills. Of the various forms of pollution (nutrients, pathogens, and toxins), nutrient inputs are the most insidious and difficult to control. This is especially true for nutrients originating from nonpoint sources, such as nitrogen transported in groundwater from on-site septic systems. It is not actually the nutrients that cause problems for the health of our coastal embayments but rather the impact these nutrients have on algae production and oxygen conditions in these waters. For this reason, monitoring of nutrients alone is not sufficient to evaluate the health of our coastal water bodies.

The major source of nitrogen from unsewered areas surrounding many Buzzards Bay embayments is on-site septic systems (including a properly functioning Title 5 septic system), with lawn fertilizers as secondary sources. In certain drainage basins, agricultural activities may be the major source. Other sources of nitrogen are from acid rain (burning of fossil fuels), runoff, and in some water bodies waterfowl may be contributors to nitrogen pollution. Septic systems can account for up to 70-80% of nitrogen inputs to some coastal embayments. These introduce nitrogen to groundwater, which can travel great distances without being attenuated. This nitrogen-rich groundwater eventually enters coastal waters through groundwater-fed streams and rivers or through springs near shore.

The natural response of coastal aquatic systems to excessive nutrient loading is termed eutrophication. Because the constituent chemical elements in phytoplankton exist in very nearly fixed proportions, the element in shortest supply, the "limiting nutrient," determines the rate at which these plants grow. Although nitrogen is an essential component of a healthy ecosystem, too much can cause the deleterious effects of eutrophication.

Once nitrogen compounds reach the water column, they can stimulate the growth and accumulation of microscopic plants (phytoplankton and periphyton) and macroalgae ("seaweeds"). This enhanced production ultimately results in reduced night-time water column oxygen concentrations. At night photosynthesis does not occur, but plants still respire (consume) oxygen. Oxygen is also consumed during the decay of organic matter in the water and sediments, and in eutrophic environments this process is more pronounced. When water column oxygen becomes depleted (anoxic [no oxygen present] or hypoxic [little oxygen present]), bottom-dwelling organisms can be stressed or even killed (so-called "fish kills"). Even short period low oxygen events can cause serious damage to the health of these communities or can change the kinds of animals that may be found on the bottom.

Low oxygen concentrations are the most acute manifestation of eutrophic conditions. Before these events occur, other more gradual and insidious effects may occur. For example, eelgrass beds can disappear due to the shading effect of phytoplankton in the water column and periphyton on their leaves. Because eelgrass beds are an important habitat and nursery for many species, their loss can have dramatic ecosystem effects. In some shallow bays, unattached algae ("drift seaweed") may accumulate to such a thickness that it smothers shellfish and other species that normally live on the mud and sand bottom. Since it is the complex interactions among nutrients, oxygen, and physical parameters that ultimately determine the health of a coastal water body, and because of the difficulty of gathering these data, the monitoring of nutrient impacts is the major focus of the Buzzards Bay Citizen's Water Quality Monitoring Program.

Coliform sources

Many embayments around Buzzards Bay are experiencing additional threats of pathogen contamination. Consequently, areas are being closed to shellfishing and swimming. Sources of coliforms and pathogens contributing to these closures include stormwater discharges, animal wastes, failing or old septic systems, and wastes from boats.

Public officials need to assess the risk of disease associated with pollution sources. Because it is too costly and time consuming to test for all known pathogenic (disease-causing) organisms, regulators use a fecal coliform indicator test as an overall assessment of human health risks. Fecal coliforms in themselves do not cause disease but are indicators that human pathogens may be present. This test was chosen because most pathogens are associated with human wastes, and human wastes have high concentrations of fecal coliforms. As with any simplified method, this test has its limitations, nonetheless it is expected to remain the universally accepted testing standard for some time.

State agencies and municipal boards that monitor water quality typically devote most of their resources to determine if our shellfish are safe to eat and if our beaches are safe to swim by measuring fecal coliforms. If water quality is found to be degraded, a resource area may be closed, but seldom do these authorities have the manpower or resources to investigate the cause of the problem and identify upstream sources. From time to time The Buzzards Bay Coalition assists towns in collecting water samples and identifying potential pollution sources. This effort will support the ongoing efforts by the Division of Marine Fisheries, the regulatory agency that controls the closure of shellfish beds and is mandated to test waters in shellfish areas to protect the public.

Samples collected by the Citizen's Water Quality Monitoring Program will be analyzed with a laboratory contracted by the Buzzards Bay Coalition. We will work closely with municipal and state officials to target areas for sample collection. This upstream local coliform data will be very important for setting priorities for remediation of various pollution sources.

Other monitoring

The Coalition recently initiated additional monitoring projects aimed at providing a better understanding of ecological changes in the Bay and its watershed. These long-term initiatives, which focus on monitoring stream flow, river herring, and salt marshes, will gather important new data while expanding the Coalition's commitment to engaging volunteers who are interested in learning about and protecting the Bay.

Contact the Director of Monitoring Programs at 508-999-6363 ext. 203, if you are interested in volunteering in any of these other monitoring programs.

Toxic Pollution monitoring

Among all threats to Buzzards Bay, toxic chemicals are the most difficult to measure and often require special safety concerns, equipment and training. The Citizen's Water Quality Monitoring Program is currently not engaged in any Toxic Pollution monitoring efforts.

Sources include oil spills, discharges from industry and wastewater treatment plants, household hazardous wastes, agricultural pesticides and stormwater. With nearly 2 billion gallons passing through the Cape Cod Canal each year, Buzzards Bay is under constant threat of an oil spill.

Additionally New Bedford Harbor, is one of the few marine areas listed as a National Superfund Site because of widespread PCB contamination. This is the only truly urban and industrial sub-watershed around Buzzards Bay. The Buzzards Bay area's population is over 400,000 people and, of these, approximately 40% live in Greater New Bedford. Fishing and lobstering in most of this area has also been banned since 1979 after the discovery of the PCB contamination. In addition to PCBs, poorly treated sewage from Combined Sewer Overflows (CSO) and industrial waste have made the New Bedford area subject to considerable regulatory, enforcement, and legal action. Dredging of PCBs and heavy metals in the New Bedford Harbor continues.

The Role and Responsibilities of Citizen Monitors

We need citizens who are conscientious, committed, and care about the health and future of Buzzards Bay. **Citizens participating in the monitoring program must collect accurate and reliable data for this effort to succeed.** Volunteers will attend an initial training course and participate in follow-up quality control/quality assurance sessions. It is important that volunteers **adhere to the sampling guidelines and protocols described in this manual.**

The Buzzards Bay Coalition Citizens' Water Quality Monitoring Program, "Baywatchers" operates using a 5 Year Quality Assurance Project Plan (QAPP). This plan is approved by a U. S. EPA Quality Assurance Officer and a MassDEP Quality Assurance Officer. This program's QAPP is written to focus sampling efforts on maintaining a high quality program, and data that is capable of supporting comparisons between years. The Baywatchers Program is committed to providing continued scientifically validated data on the nutrient-related health of the waters of Buzzards Bay

To report the results of your efforts, The Buzzards Bay Coalition will produce *Baywatchers* Reports, Posters, and fact sheets exhibiting the data and highlighting the progress of the program. In addition, data summaries for all embayments are included on our web site at http://www.buzzbaywatcher.org/baywatcher/ . After long-term analysis of the data, we will be able to better pinpoint pollution sources and work with you and your towns to implement remediation projects and other cleanup efforts.

If you have problems or questions, it is important that you ask for help. The Director of Monitoring Programs at The Buzzards Bay Coalition will be the primary contact for questions, assistance and equipment.

Some volunteers will work as teams, others separately, and each should make contact with the Coordinator or a back-up person in their area to assist them during absences.

Each volunteer is given a sampling schedule at the training sessions. It is very important whenever possible to adhere to this schedule. If you cannot make this date, alternate dates are given. If you cannot make these dates either, or if you are going away or need a backup to perform your sampling for whatever reason, make sure you notify the Coordinator or back-up person as soon as you can.

We will welcome any suggestions you have for improving the program.

Organization and Training

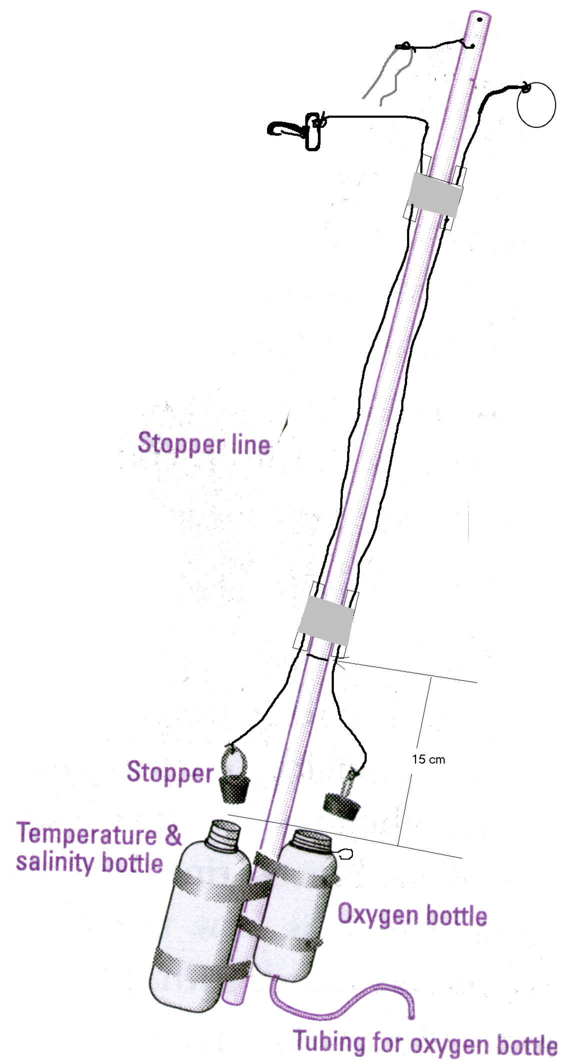
Organization and training sessions will be held prior to initiation of the monitoring program with periodic retraining sessions or special sessions for other types of monitoring (nutrients) to provide logistical information and hands-on demonstrations of the use of the equipment. The sampling protocol will be outlined with tips and advice on specific techniques and problems that may be encountered. This protocol provides step-by-step instruction on how to make measurements and collect samples for use on station. Because the ultimate goal of the monitoring program is to make identical measurements from each station, the methodology is crucial and directly effects the reliability, accuracy, and comparability of the data. The training sessions are a good time to ask any questions regarding both the monitoring protocol, care and maintenance of sampling equipment, and the recording of data.

Measurements

On the following pages, we give an overview of the parameters that will be monitored using the basic water quality test kits and the nutrient sample kits in the program. Depending upon which equipment you are supplied with, your time availability, and your location, you may be involved with taking many of these measurements or only a few.

General Observations

Much can be learned from what may appear to be casual observations during sample collection. Comments on sea state, weather, any unusual occurrences such as odors, algal blooms, etc. can often provide needed information when interpreting the results of the monitoring program. Don't hesitate to write down any observation. Recording and/or communication of information during non-sampling periods can be extremely important to the effort, particularly in the case of large algal blooms, fish kills, or odors. Additional or specific sampling efforts may be undertaken under these circumstances and can be extremely valuable to understanding the causes of these unusual events, as well as providing needed information on water quality conditions.



Water sampling collection pole

Equipment Checklist for Basic Water Quality Test Kits

The basic water quality sampling kit supplied to citizen monitors is described below. Additional equipment for more specialized measurements or supplemental kits may also be provided.

_____Binder containing water quality monitoring manual, data sheets and other materials

_____Sampling pole, with two bottles (0.5 and 1 liter) hose clamped to the end, one for salinity and one for oxygen. Strings with stoppers run the length of the pole to prevent water from flowing into the bottles before the desired sampling depth is reached.

_____Sampling kit (tool box) for transport of sampling gear. It should contain all the equipment below.

_____Hydrometer, for determination of salinity;

_____Thermometer, for measurement of water temperature;

_____Secchi disk, a flat white disk with 2 black quads, attached to a measuring tape for measurements of turbidity (water clarity) in the water column as well as total depth;

_____Graduated cylinder;

_____Oxygen kit, for on-site measurement of oxygen concentrations;

_____Safety Glasses and Scissors to open reagent packets for oxygen test:

_____Waste water container, for waste reagent water from oxygen test;

_____1 liter bottle cap;

_____**Miscellaneous pens, pencils volunteers provide.

_____Wash bottle, filled with tap water to rinse off hydrometer and oxygen test kit bottles

Nutrient Kits will include:
_____Plastic filter holder unit, box of filters, filter forceps, (for filtration of nutrient sample into 60cc bottle to be analyzed for dissolved nutrients) ice cooler with ice packs, 1 liter brown sample bottle, 60 cc bottle, marker pen,

Secchi Disk (Turbidity-Water Clarity)

Water clarity (turbidity) is measured by lowering a Secchi Disk into the water column until it no longer can be seen. The depth of disappearance, in combination with other information on particulate concentration in the water column, can provide information on both water clarity, production in the water column, and light availability. High turbidity in the water column can impede light penetration, affecting photosynthesis and production in both the water column and on the bottom. Whether changes in turbidity are due to over production or resuspension of bottom sediments from circulation or physical activities such as boat traffic is important to understanding the overall impacts direct versus indirect activities (i.e. boating versus housing development) on has water quality conditions in these systems.

Dissolved Oxygen

Dissolved Oxygen (DO) concentrations is one of the most important parameters for determining coastal water quality, particularly in evaluating nutrient loading conditions. Besides ecological processes, temperature, wind speed, wave action, and water column stratification all determine what oxygen concentrations are observed. At high temperatures, the solubility (and therefore concentration) of oxygen in water is low; when water is cooled, oxygen content increases independent of biological activity (cold water holds more dissolved oxygen gas than does warm water). When water temperatures in coastal embayments increase, biological activities also increase, which consumes more oxygen. Oxygen depletion occurs when the rate of consumption exceeds the rate of delivery to the water either from mixing with the atmosphere or from photosynthesis.

In vertically well mixed waters, oxygen exchange with the atmosphere can maintain high oxygenated concentrations even at high rates of oxygen consumption. At night, when photosynthesis does not occur, oxygen concentrations may become reduced. During calm periods, prolonged overcast, or during precipitation, dissolved oxygen may drop appreciably. These reduced oxygen concentrations are typically lowest between 6 and 9 AM (before photosynthesis makes up for the night time oxygen demand). Because of the complex interaction between physical and biological processes, DO concentrations may need to be monitored more often during critical summer periods.

Measuring DO

Carefully follow the analysis instruction provided on the sampling protocol sheet. It is critical that the oxygen water sample be processed immediately for the data to be accurate and reliable. Avoid getting air bubbles in bottle. **If you get an oxygen value below 3 mg/L or a really unusual number of drops counted, please re-sample and record it on your data sheet. Please notify us and try to re-sample the next morning to see if the level persists.

Overview

Parameter: Oxygen

Units: milligrams per liter (mg/l) which is also equivalent to parts per million (ppm)

Precision recorded: 0.5ppm

Technique: Employ Hach Kit Ox-2P

Sampling frequency: on all dissolved oxygen sampling dates (May-Sept.)

Precautions: wear safety glasses and wash hands after using chemical reagent packets, save waste in a screw cap plastic bottle (e.g. softdrink bottle) that you keep in your kit.

Helpful hints:

Follow protocol (directions) carefully avoid air bubbles in bottle until sample is “fixed” (after reagent packet 3 is added)

Practice dropping glass stopper into glass bottle to avoid air bubbles

Fix sample immediately

Store chemicals in cool dry place always.

Note: Water samples may exceed these values (that is, they may be "supersaturated" with oxygen) during some conditions such as on sunny days during peak photosynthetic activity or under windy conditions when surface water are agitated.

Oxygen Saturation Table (in mg/l or ppm)

(assume elevation at sea level and 100% water saturation of air above sample)

Temp (°C)	Salinity (ppt) 0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
0	14.6	14.4	14.2	14.0	13.8	13.6	13.4	13.3	13.1	12.9	12.7	12.6	12.4	12.2	12.0	11.9	11.7	11.6
1	14.2	14.0	13.8	13.6	13.4	13.3	13.1	12.9	12.7	12.6	12.4	12.2	12.1	11.9	11.7	11.6	11.4	11.3
2	13.8	13.6	13.4	13.3	13.1	12.9	12.7	12.6	12.4	12.2	12.1	11.9	11.7	11.6	11.4	11.3	11.1	11.0
3	13.4	13.3	13.1	12.9	12.7	12.6	12.4	12.2	12.1	11.9	11.8	11.6	11.4	11.3	11.1	11.0	10.8	10.7
4	13.1	12.9	12.7	12.6	12.4	12.2	12.1	11.9	11.8	11.6	11.5	11.3	11.2	11.0	10.9	10.7	10.6	10.4
5	12.7	12.6	12.4	12.3	12.1	11.9	11.8	11.6	11.5	11.3	11.2	11.0	10.9	10.7	10.6	10.5	10.3	10.2
6	12.4	12.3	12.1	11.9	11.8	11.6	11.5	11.3	11.2	11.0	10.9	10.8	10.6	10.5	10.3	10.2	10.1	9.9
7	12.1	12.0	11.8	11.7	11.5	11.4	11.2	11.1	10.9	10.8	10.6	10.5	10.4	10.2	10.1	10.0	9.8	9.7
8	11.8	11.7	11.5	11.4	11.2	11.1	10.9	10.8	10.7	10.5	10.4	10.3	10.1	10.0	9.9	9.7	9.6	9.5
9	11.5	11.4	11.2	11.1	11.0	10.8	10.7	10.5	10.4	10.3	10.2	10.0	9.9	9.8	9.6	9.5	9.4	9.3
10	11.3	11.1	11.0	10.8	10.7	10.6	10.4	10.3	10.2	10.0	9.9	9.8	9.7	9.6	9.4	9.3	9.2	9.1
11	11.0	10.9	10.7	10.6	10.5	10.3	10.2	10.1	9.9	9.8	9.7	9.6	9.5	9.3	9.2	9.1	9.0	8.9
12	10.8	10.6	10.5	10.4	10.2	10.1	10.0	9.9	9.7	9.6	9.5	9.4	9.3	9.1	9.0	8.9	8.8	8.7
13	10.5	10.4	10.3	10.1	10.0	9.9	9.8	9.6	9.5	9.4	9.3	9.2	9.1	8.9	8.8	8.7	8.6	8.5
14	10.3	10.2	10.0	9.9	9.8	9.7	9.6	9.4	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.5	8.4	8.3
15	10.1	9.9	9.8	9.7	9.6	9.5	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2
16	9.8	9.7	9.6	9.5	9.4	9.3	9.2	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0
17	9.6	9.5	9.4	9.3	9.2	9.1	9.0	8.9	8.8	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.9
18	9.4	9.3	9.2	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7
19	9.3	9.1	9.0	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.6	7.6
20	9.1	9.0	8.9	8.8	8.6	8.5	8.4	8.3	8.2	8.2	8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.4
21	8.9	8.8	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.5	7.4	7.3
22	8.7	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.2	7.2
23	8.6	8.5	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.4	7.4	7.3	7.2	7.1	7.0
24	8.4	8.3	8.2	8.1	8.0	7.9	7.8	7.7	7.7	7.6	7.5	7.4	7.3	7.2	7.1	7.1	7.0	6.9
25	8.2	8.1	8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.3	7.2	7.1	7.0	6.9	6.9	6.8
26	8.1	8.0	7.9	7.8	7.7	7.6	7.6	7.5	7.4	7.3	7.2	7.1	7.1	7.0	6.9	6.8	6.7	6.7
27	7.9	7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.3	7.2	7.1	7.0	6.9	6.9	6.8	6.7	6.6	6.6
28	7.8	7.7	7.6	7.5	7.5	7.4	7.3	7.2	7.1	7.1	7.0	6.9	6.8	6.7	6.7	6.6	6.5	6.5
29	7.7	7.6	7.5	7.4	7.3	7.3	7.2	7.1	7.0	6.9	6.9	6.8	6.7	6.6	6.6	6.5	6.4	6.3
30	7.5	7.4	7.4	7.3	7.2	7.1	7.1	7.0	6.9	6.8	6.7	6.7	6.6	6.5	6.5	6.4	6.3	6.2

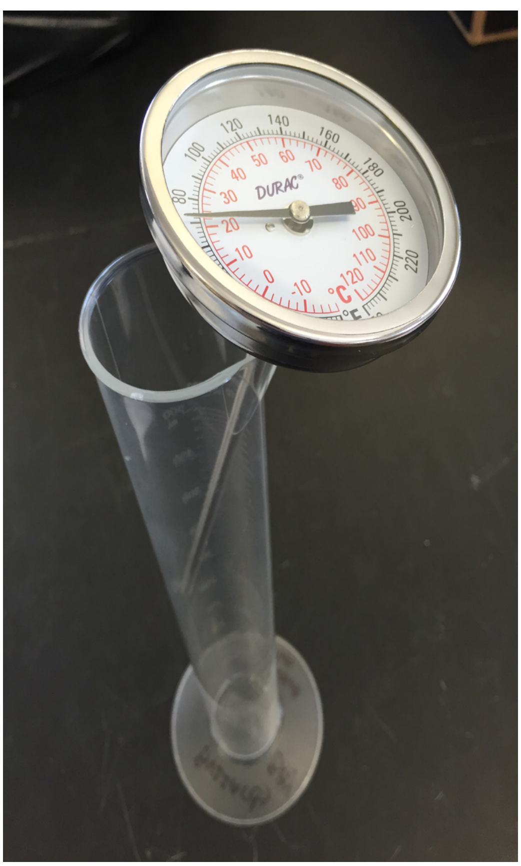
Table prepared by Dr. Joe Costa, Buzzards Bay National Estuary Program. Send comments to: jcosta@buzzardsbay.org

Temperature

Circulation restricted embayments can differ from adjacent coastal waters in an ecological important, but often overlooked way. Summer water temperatures in these shallow embayments can often be many degrees warmer than adjacent coastal waters, and in winter many degrees colder. In the summer, because oxygen is less soluble in warm water, and because elevated water temperatures stimulates respiration, hence oxygen consumption, temperature is a vital component to record. This enables estimation of whether changing oxygen conditions are the result of alterations in nutrient conditions and/or biological production or simply the physical mechanics of gas solubility in water. Temperature at different depths, coupled with salinity measurement is vital to quantify water column stratification which can be of great environmental consequences under certain circumstances.

Measuring Temperature

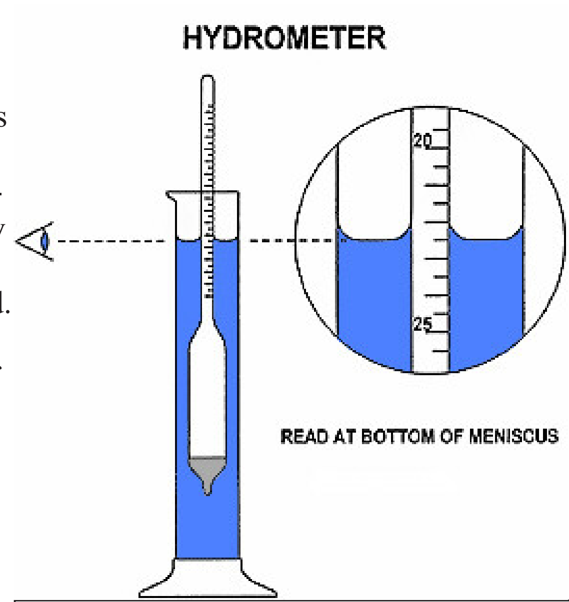
You are provided with a digital or metal thermometer with which to measure temperature. The scale is in centigrade, and this should be recorded on your data sheet to at minimal the nearest half degree (0.5). Immerse at least 2/3 of the probe for at least 1 minute in the water sample. To convert centigrade data to Fahrenheit, multiply centigrade value by 9, divide by 5 and add 32.



Overview
Parameter: Temperature
Units: degrees Centigrade (°C)
Precision recorded: 0.5 °C, (digital 0.01 °C)
Technique: immerse 2/3 of probe in sample for 1-2 minutes.
Sampling frequency: on all dissolved oxygen sampling dates (May-Sept)
Precautions: gauge face is glass, probe has point, handle carefully
Helpful hints: specific gravity measurements always require a concurrent temperature measurement. Remember to turn off digital thermometers.

Salinity-Specific Gravity

The salinity (concentrations of dissolved salts in water) of sea water offshore is relatively constant, and decreased salinity generally indicates dilution with fresh water from either groundwater or stream inputs. Salinity differences can reflect both variations in freshwater inputs as well as the degree of exchange a coastal water body has with offshore waters. In poorly mixed systems, salinity or density stratification of the water column can occur, often resulting in stressful low oxygen conditions in bottom waters. The existence of water column stratification can be determined from profiles of temperature and salinity. Coupling the effects of temperature and salinity we can determine the density of water at a given depth and compare that density with other depths in the water column. If a strong vertical gradient exists, the water column is stratified. Stratification has important ecological effects on nutrient rich coastal environments where production of organic matter by plants and phytoplankton is high. The high rates of organic matter production almost inevitably results in high rates of oxygen uptake at night (when photosynthesis ceases) or when organic matter decays. In a well mixed system oxygen can be replenished from the atmosphere, but in a stratified water column bottom waters become isolated and oxygen concentrations decline.



Measuring Salinity

Cold water is more "dense" (heavier) than warm water and more saline water is more dense than less saline or fresh water. Because a relationship exists between salinity, temperature, and density, we can predict any one from the other two. We will measure density using a hydrometer and temperature with a thermometer to predict salinity according to the table on the following page. To measure density, the hydrometer must be placed in a container of water - in this case we use a graduated cylinder.

Overview
Parameter: Salinity
Units: parts per thousand
Precision recorded: 0.5 ppt
Technique: immerse hydrometer carefully in cylinder, let stabilize, read number at water level, record temperature, cross reference on chart.
Sampling frequency: on all dissolved oxygen sampling dates (May-Sept)
Precautions: Hydrometer is glass, handle carefully
Helpful hints: Lower hydrometer into water in graduated cylinder and allow to float up, don't drop into cylinder. Specific gravity measurements always require a concurrent temperature measurement

Salinity Conversion Table

Salinity Calculation from Hydrometer Readings

revised 7/21/2014

Temperature (in Cylinder)

Hydrometer Reading

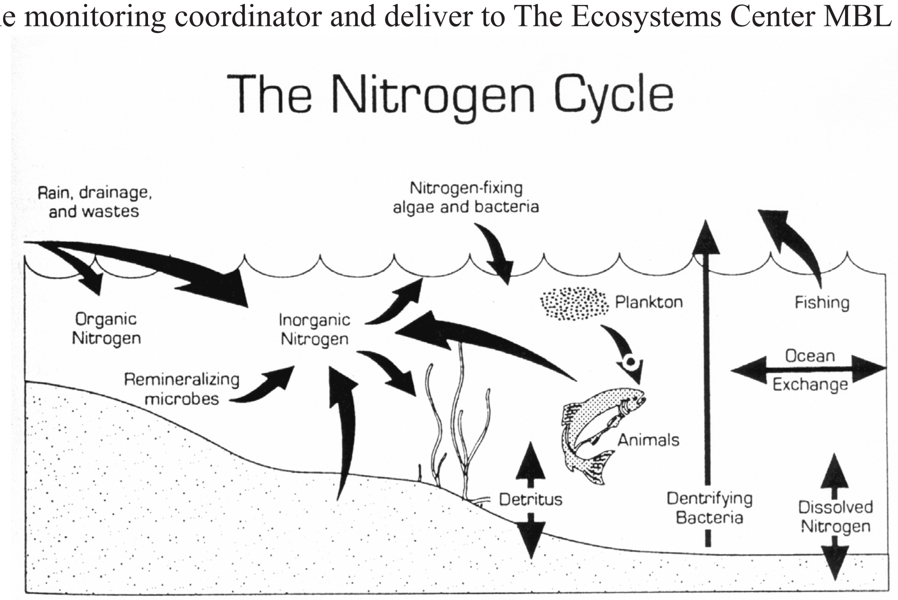
(C)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
(F, Rnd)	32	34	36	37	39	41	43	45	46	48	50	52	54	55	57	59	61	63	64	66	68	70	72	73	75	77	79	81	82	84	86	88	90
0.998																												0	1	1	1	2	2
0.999																							0	0	1	1	1	2	2	2	3	3	3
1.000																	0	0	0	1	1	1	1	2	2	2	3	3	3	4	4	4	5
1.001	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	4	4	5	5	5	6	6
1.002	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5	5	5	6	6	6	7	7	8
1.003	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	5	5	5	5	6	6	6	7	7	7	8	8	8	9
1.004	4	4	4	4	4	4	4	4	4	4	4	5	5	5	5	5	5	5	6	6	6	6	7	7	7	8	8	8	9	9	9	10	10
1.005	6	5	5	5	5	5	5	5	5	6	6	6	6	6	6	6	7	7	7	7	7	8	8	8	9	9	9	10	10	10	11	11	12
1.006	7	7	7	7	7	7	7	7	7	7	7	7	7	7	8	8	8	8	8	9	9	9	9	10	10	10	11	11	11	12	12	12	13
1.007	8	8	8	8	8	8	8	8	8	8	8	8	8	9	9	9	9	9	10	10	10	10	11	11	11	12	12	12	13	13	13	14	14
1.008	9	9	9	9	9	9	9	9	9	9	9	10	10	10	10	10	11	11	11	11	11	12	12	12	13	13	13	14	14	14	15	15	16
1.009	11	10	10	10	10	10	11	11	11	11	11	11	11	11	11	12	12	12	12	12	13	13	13	14	14	14	15	15	15	16	16	17	17
1.010	12	12	12	12	12	12	12	12	12	12	12	12	12	12	13	13	13	13	14	14	14	14	15	15	15	16	16	16	17	17	17	18	18
1.011	13	13	13	13	13	13	13	13	13	13	13	14	14	14	14	14	14	15	15	15	15	16	16	16	17	17	17	18	18	18	19	19	20
1.012	14	14	14	14	14	14	14	14	14	15	15	15	15	15	15	15	16	16	16	16	17	17	17	18	18	18	19	19	19	20	20	21	21
1.013	15	15	15	15	15	15	15	16	16	16	16	16	16	16	17	17	17	17	17	18	18	18	19	19	19	20	20	20	21	21	21	22	22
1.014	17	17	17	17	17	17	17	17	17	17	17	17	18	18	18	18	18	19	19	19	19	20	20	20	21	21	21	22	22	22	23	23	24
1.015	18	18	18	18	18	18	18	18	18	18	18	19	19	19	19	19	20	20	20	20	21	21	21	22	22	22	23	23	23	24	24	25	25
1.016	19	19	19	19	19	19	19	19	20	20	20	20	20	20	20	21	21	21	21	22	22	22	23	23	23	24	24	24	25	25	26	26	26
1.017	20	20	20	20	20	21	21	21	21	21	21	21	21	22	22	22	22	23	23	23	23	24	24	24	25	25	25	26	26	26	27	27	28
1.018	22	22	22	22	22	22	22	22	22	22	22	23	23	23	23	23	24	24	24	24	25	25	25	26	26	26	27	27	27	28	28	29	29
1.019	23	23	23	23	23	23	23	23	23	24	24	24	24	24	24	25	25	25	25	26	26	26	27	27	27	28	28	28	29	29	30	30	30
1.020	24	24	24	24	24	24	24	24	25	25	25	25	25	26	26	26	26	26	27	27	27	27	28	28	29	29	29	30	30	30	31	31	32
1.021	25	25	25	26	26	26	26	26	26	26	26	26	27	27	27	27	27	28	28	28	29	29	29	30	30	30	31	31	31	32	32	33	33
1.022	27	27	27	27	27	27	27	27	27	27	27	28	28	28	28	29	29	29	29	30	30	30	30	31	31	32	32	32	33	33	33	34	34
1.023	28	28	28	28	28	28	28	28	29	29	29	29	29	29	30	30	30	30	31	31	31	32	32	32	33	33	33	34	34	35	35	35	36
1.024	29	29	29	29	29	29	30	30	30	30	30	30	30	31	31	31	31	32	32	32	33	33	33	33	34	34	35	35	35	36	36	37	37
1.025	30	30	30	30	31	31	31	31	31	31	31	32	32	32	32	32	33	33	33	33	34	34	35	35	35	36	36	36	37	37	38	38	38
1.026	32	32	32	32	32	32	32	32	32	32	33	33	33	33	33	34	34	34	35	35	35	35	36	36	36	37	37	38	38	38	39	39	40
1.027	33	33	33	33	33	33	33	33	34	34	34	34	34	35	35	35	35	36	36	36	36	37	37	38	38	38	39	39	39	40	40	41	41
1.028	34	34	34	34	35	35	35	35	35	35	35	35	36	36	36	36	37	37	37	38	38	38	38	39	39	39	40	40	41	41	42		
1.029	35	35	35	36	36	36	36	36	36	36	36	37	37	37	37	38	38	38	38	39	39	39	40	40	41	41	41	42					
1.030	37	37	37	37	37	37	37	37	37	38	38	38	38	38	39	39	39	39	40														
1.031	38	38	38	38	38	38	38	39	39	39	39	39	39	40	40	40	41	41	41														

Nutrients

Nitrogen and phosphorous, essential plant nutrients, when inputs in excessively high levels contribute to environmental degradation in coastal ecosystems. Nitrogen is generally considered the more problematic nutrient in coastal waters. Nitrogen inputs, conveyed by river flow or groundwater, affect each embayment differently depending upon the variety of physical parameters to which each is subject. The primary factors modifying the ecological impact of nutrient loading are flushing rates, bathymetry (depth profile) of the embayment, stratification, temperature (oxygen consumption), and the form of nitrogen involved (organic/inorganic).
Water quality surveys of nitrogen and phosphorus will be conducted in a number of Buzzards Bay embayments during July and August. Nitrogen can be found in several forms; inorganic forms (ammonium and nitrate) which directly stimulate plant growth and lead to eutrophic conditions; organic (dissolved and particulate) which is more limiting in effects but due to biological processes can be rapidly transformed into inorganic forms. Knowing both the amount and form of nitrogen at any location helps to identify its source as well as its potential impact. Samples collected for nitrogen analysis will be filtered (for inorganic) and unfiltered (for particulate) to enable partitioning of the various nitrogen species found at the monitoring stations.

Measuring Nutrients

Nutrient samples will be collected and analyzed through arrangements with The Ecosystems Center at the Marine Biological Laboratory (Ecosystems Center MBL) in Woods Hole, MA. Citizens monitors will be responsible for collecting one liter samples according to protocol. One sample will be kept in a darkened bottle for Chlorophyll analysis. Monitors will filter some of the sample into a 60 cc bottle, and keep all samples in the dark and on ice or refrigerated until the samples are delivered or picked up by the monitoring coordinator and deliver to The Ecosystems Center MBL lab.



Adapted from EPA 1987

Where to Send Your Results and How The Data Will Be Used

Data recording sheets are provided in your notebook. Be sure that before sending in your data sheet all required information is entered accurately and legibly. If two tests were performed for a sample (i.e., dissolved oxygen), record both results even if only partial results were obtained (temperature but no salinity). Make a copy for your file just in case the original is lost in the mail. Send the original to The Buzzards Bay Coalition, 114 Front Street, New Bedford, MA 02740; Attn. Tony Williams. The data will be entered in a data base by the program staff at the Buzzards Bay Coalition. Once the data are compiled, they will be presented in reports and on the website, and mailed to volunteers, town officials, and environmental managers. After a period of monitoring, we will continue to plot trends in water quality and discuss the results. Volunteers can also plot trends on their own to understand the dynamics and seasonal variations in their embayment. Through time, The Buzzards Bay Coalition uses the data to help identify pollution sources and will advocate for efforts to implement protection and cleanup strategies.

General Precautions

Safety

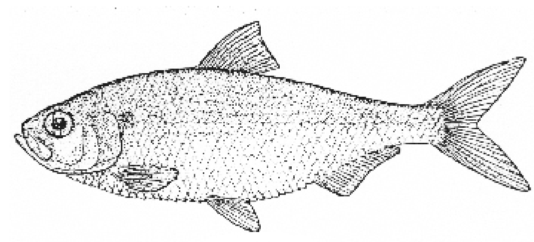
Safety is not only important for the health of the participant, but also for contributing to the success of the overall program. Protect yourself from overexposure to potentially harsh conditions of weather and currents; be aware of potential hazards when collecting samples such as loss of balance in sample collection or potential injury from the sampling pole. At no time should you put yourself in jeopardy to collect a sample; alternate arrangements can be made through the embayment leader or program coordinator.

- Read all instructions to familiarize yourself with the test procedures before you begin. Note any precautions and first aid information for the reagents contained in the dissolved oxygen kits.
- Keep all equipment and reagent chemicals out of reach of children.
- Avoid contact between reagent chemicals and skin, eyes, nose, and mouth. Eye protection and gloves are recommended when handling any of the chemicals.
- Tightly close all reagent containers and reagent waste water immediately after use.

Chemical waste

The waste generated during the sampling for dissolved oxygen (the completed sample with reagents) is to be collected in a plastic dissolved oxygen waste container provided in the toolbox. A container with a tight cap is preferred. The waste should be stored in a safe place away from children. Periodically, and at the end of the sampling season the waste will be collected and disposed of properly by the Coalition at The Ecosystems Center laboratory. **Do not mix test kit waste water with any other liquid or chemicals (old gas, household items, etc)**!

Glossary



Aerobic. Living, active, or occurring only in the presence of oxygen.

Algal Bloom. A condition resulting from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

Anadromous Fish. A species, such as salmon, alewives, or river herring, that is born in fresh water, spends a large part of its life in the sea, and returns to freshwater rivers and streams to procreate.

Anaerobic. A process occurring in the absence of free oxygen.

Anoxic. A condition in which oxygen is absent.

Attenuation. The process by which a compound is reduced in concentration over time or distance through absorption, degradation, or transformation.

Bioaccumulation. The process by which a contaminant accumulates in the tissues of an individual organism. For example, certain chemicals in food eaten by a fish tend to accumulate in its liver and other tissues.

Biochemical Oxygen Demand (BOD). A measure of the organic material that can be readily oxidized through microbial decomposition, consuming oxygen dissolved in water. BOD is often used to assess the effects of a discharge, especially sewage.

Board of Health. A municipal, elected or appointed authority responsible for administering bylaws addressing health, safety, and welfare issues covered in the State Environmental Code, including Title 5.

Bordering Vegetated Wetlands (BVW). As defined in 310 CMR 10.55, the Wetlands Protection Act Regulation, freshwater wetlands that border on creeks, rivers, streams, ponds, and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps, and bogs. They are areas where the topography is low and flat, and where the soils are saturated at least part of the year.

Carcinogen. A substance that causes cancer.

Carrying Capacity. The limit of a natural or man-made system to absorb perturbations, inputs, or population growth.

Catadromous Fish. A freshwater species that spawns in salt water.

Cesspool. A covered pit with a perforated lining in the bottom into which raw sewage is discharged: the liquid portion of the sewage is disposed of by seeping or leaching into the surrounding porous soil; the solids, or sludge, are retained in the pit to undergo partial decomposition before occasional or intermittent removal. Cesspools are no longer permitted for waste disposal.

Chlorinated Hydrocarbons (CHCs). All aromatic and nonaromatic hydrocarbons containing chlorine atoms. Includes certain pesticides, polychlorinated biphenyls, and other solvents.

Coastal Zone Management (CZM) Program. A federally funded and approved state program under the Federal Coastal Zone

Management Act of 1972. The program reviews federal permitting, licensing, funding, and development activities in the coastal zone for consistency with state policies.

Combined Sewer Overflow (CSO). A pipe that, during storms, discharges untreated wastewater from a sewer system that carries both sanitary wastewater and stormwater. The overflow occurs because a system does not have the capacity to transport and treat the increased flow caused by stormwater runoff.

Combined Sewers. A system that carries both sewage and stormwater runoff. In dry weather, all flow from sewer lines and street drains goes to the wastewater treatment plant. During heavy rains, treatment plants usually can handle only part of this flow, and the sewer system is overloaded. The overflow mixture of sewage and stormwater is discharged untreated into the receiving water.

Conservation Commission. An appointed municipal agency responsible for administering the Wetlands Protection Act at the local level.

Cumulative Effects. The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible impact, the combined effect can be serious.

Department of Environmental Management (DEM). The state agency responsible for managing natural resources, including, but not limited to, water resources. DEM administers the Massachusetts Ocean Sanctuaries Act.

Department of Environmental Protection (DEP). The state agency, formerly known as the Department of Environmental Quality Engineering, responsible for administering laws and regulations protecting air quality, water supply, and water resources, such as Chapter 91 and Title 5, and for administering programs such as the Wetlands Protection Program and Wetlands Restriction Program. It is also responsible for overseeing the cleanup of hazardous waste sites and responding to hazardous waste emergencies and accidents.

Division of Marine Fisheries (DMF). The agency within the Massachusetts Executive Office of Environmental Affairs responsible for managing the Shellfish Sanitation Program, overseeing shellfish relays, depuration plants, commercial fishing licenses, and management and stock assessment of Massachusetts fisheries.

Drainage Basin. The land that surrounds a body of water and contributes fresh water, either from streams, groundwater, or surface runoff, to that body of water.

Dredging. The removal of materials including, but not limited to, rocks, bottom sediments, debris, sand, refuse, and plant or animal matter in any excavating, cleaning, deepening, widening or lengthening, either permanently or temporarily, of any tidelands, rivers, streams, ponds or other waters of the Commonwealth, as defined in 310 CMR 9:04.

Ecosystem. A community of living organisms interacting with one another and with their physical environment, such as a salt marsh, an embayment, or an estuary. A system such as

Buzzards Bay is considered a sum of these interconnected ecosystems.

Eelgrass (Zostera marina). A marine flowering plant that grows subtidally in sand and mud. In Buzzards Bay, eelgrass is widespread and grows to depths of 20 feet. Eelgrass beds are an important habitat and nursery for fish, shellfish, and waterfowl.

Effluent. The outflow of water, with or without pollutants, usually from a pipe.

Embayments. A small bay or any small semi-enclosed coastal water body whose opening to a larger body of water is restricted.

Environmental Protection Agency (EPA). The federal agency principally responsible for administering the Clean Water Act, National Estuary Program, CERCLA, Superfund, and other major federal environmental programs.

Estuary. A semi-enclosed coastal body of water having a free connection with the open sea and within which seawater is measurably diluted with fresh water.

Eutrophication. The process of nutrient enrichment in aquatic ecosystems. In marine systems, eutrophication results principally from nitrogen inputs from human activities such as sewage disposal and fertilizer use. The addition of nitrogen to coastal waters stimulates algal blooms and growth of bacteria, and can cause broad shifts in ecological communities present and contribute to anoxic events and fish kills. In freshwater systems and in parts of estuaries below 5 ppt salinity, phosphorus is likely to be the limiting nutrient and the cause of eutrophic effects.

Fecal Coliform. Bacteria that are present in the intestines of feces of warm-blooded animals and that are often used as indicators of the sanitary quality of water. Their degree of presence in water is expressed as the number of bacteria per 100 milliliters of the sample. The greater the number of fecal coliforms, the higher the risk of exposure to human pathogens.

Flushing Time. The mean length of time for a pollutant entering a water body to be removed by natural forces such as tides and currents; also referred to as residence time or turnover time.

Food and Drug Administration (FDA). The federal agency that is responsible for, among other things, administering the National Shellfish Sanitation Program.

General Bylaws. Local laws that can be adopted with a simple majority vote at the town meetings. Cities adopt ordinances by a simple majority vote of the city council.

Grandfathering. A provision from Massachusetts General Law Chapter 40 that allows existing land uses or structures to remain without coming into compliance with upgraded zoning or building requirements.

Habitat. The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all the basic requirements for survival.

Heavy Metals. A group of elements that is present in the environment from natural and anthropogenic sources and can produce toxic effects. This group includes mercury, copper, cadmium, zinc, and arsenic.

Hypoxia. A condition in which oxygen is deficient.

Impervious Surface. A surface that cannot be easily penetrated. For instance, rain does not readily penetrate asphalt or concrete pavement.

Impervious Material. With respect to Title 5 Regulations, a material or soil having a percolation rate greater than 30 minutes per inch; including, but not limited to, bedrock, peat, loam, and organic matter.

Industrial Pretreatment. The removal or reduction of certain contaminants from industrial wastewater before it is discharged into a municipal sewer system. Reduced loading of contaminants from industries can reduce the expense of managing and designing municipal treatment facilities.

Infiltration. The penetration of water through the ground surface into subsurface soil. Some contaminants are removed by this process.

Kettle Holes. A small, glacially formed freshwater body.

Leaching Facility. An approved structure used for the dispersion of septic-tank effluent into the soil. These include leaching pits, galleries, chambers, trenches, and fields as described in 310 CMR 15.11 through 15.15.

Massachusetts Environmental Policy Act (MEPA). Massachusetts General Laws Chapter 30, the state law, administered by the MEPA unit within the Executive Office of Energy and Environmental Affairs, establishing a uniform system of environmental impact review.

Massachusetts Ocean Sanctuaries Act. Administered by the Department of Environmental Management, the state law governing activities and structures in the ocean, seabed, or subsoil that would have an adverse affect on the "ecology or appearance" of the ocean sanctuary. Buzzards Bay is included in the Cape and Island Ocean Sanctuary.

Mean High Water. The average height of the high tides over a 19-year period.

Mean Low Water. The average height of the low tides over a 19-year period.

Mounded Septic System. Similar to a typical septic system except the leaching facility, in order to maintain an adequate separation to groundwater, is installed in mounded or filled material above the naturally occurring ground elevation. The mounds are typically planted with grass vegetation. In the velocity zone, some mounded systems are armored with rip rap, but this approach conflicts with CZM policies.

National Estuary Program (NEP). A state grant program within the U.S. Environmental Protection Agency established to designate estuaries of national significance and to incorporate scientific research into planning activities.

National Pollutant Discharge Elimination System (NPDES). A requirement in the federal Clean Water Act for dischargers to obtain permits. EPA is responsible for administering this program in Massachusetts.

Nonpoint-Source Pollution. Pollution that is generated over a relatively wide area and dispersed rather than discharged from a pipe. Common sources of nonpoint pollution include stormwater runoff, failed septic systems, and marinas.

Notice of Intent. A form submitted to the municipal conservation commission and MA DEP which serves as the application for an Order of Conditions under the Wetlands Protection Act. It includes information on the site's wetland resources and the proposed work.

Nutrients. Essential chemicals needed by plants and animals for growth. Excessive amounts of nutrients, nitrogen, and phosphorus, for example, can lead to degradation of water quality and growth of excessive amounts of algae. Some nutrients can be toxic at high concentrations.

Order of Conditions. The document, issued by a conservation commission, containing conditions that regulate or prohibit an activity proposed in the resource area defined in MGL Chapter 131 §40.

Pathogen. Any organism, but particularly bacteria and viruses, that causes disease. For example, human pathogens in shellfish can cause hepatitis and intestinal disorders.

Petroleum Hydrocarbons. The mixture of hydrocarbons normally found in petroleum; includes hundreds of chemical compounds.

Point-Source Pollution. Pollution originating at a particular place, such as a sewage treatment plant, outfall, or other discharge pipe.

Polychlorinated Biphenyls (PCBs). A class of chlorinated aromatic compounds composed of two fused benzene rings and two or more chlorine atoms; used in heat exchange, insulating fluids and other applications. There are 209 different PCBs.

Porous Pavement. A hard surface that can support some vehicular activities, such as parking and light traffic, and which can also allow significant amounts of water to pass through.

Primary Treatment. Physical processes used to substantially remove floating and settleable solids in wastewater. This process can include screening, grit removal, and sedimentation.

Publicly Owned Treatment Works (POTW). Any sewage treatment system operated by a public agency.

Pumpout. The process through which septage is removed from a septic tank or boat holding tank, usually by a mobile tank attached to a truck, and taken to a wastewater treatment plant for disposal.

Request for Determination of Applicability. A written request made by any person to a conservation commission or to the Department of Environmental Protection for a determination as to whether a site or work on that site is subject to the Wetlands Protection Act.

Runoff. The part of precipitation that travels overland and appears in surface streams or other receiving water bodies.

Salt Marsh. A coastal wetland that extends landward up to the highest high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted

to living in saline soils.
Salt Pond. A shallow, enclosed or semiclosed saline water body that may be partially or totally restricted by barrier beach formation. Salt ponds may receive fresh water from small streams emptying into their upper reaches or groundwater springs in the salt pond itself.
Secondary Treatment. The process used to reduce the amount of dissolved organic matter and further reduce the amount of suspended solids and coliform in wastewater.
Septage. That material removed from any part of an individual sewage disposal system.
Septic System. A facility used for the partial treatment and disposal of sanitary wastewater, generated by individual homes or small business, into the ground. Includes botha septic tank and a leaching facility.
Septic Tank. A watertight receptacle that receives the discharge of sewage from a building sewer and is designed and constructed so as to permit the retention of scum and sludge, digestion of the organic matter, and discharge of the liquid portion to a leaching facility.
Sewerage/Sewage. Liquid or solid waste that is transported through drains or sewers to a wastewater treatment plant for processing.
Shellfish Bed. An area identified and designated by the Division of Marine Fisheries or conservation commissions as containing productive shellfish resource. Shellfish bed maps are based upon written documentation and field observations by the shellfish constable or other authoritative sources. In identifying such an area, the following factors shall be taken into account and documented: the density of all species of shellfish, the size of the area and the historical and current importance of the area to recreational or commercial shellfishing. Protecting designated shellfish beds may be an important consideration when local boards and state agencies review projects.
Shellfish Resource Area. An area, designated by the Division of Marine Fisheries, that contains productive shellfish beds, and used for establishing shellfish resource area closure boundaries.
Shellfish Resource Area Closures. Closure, due to potential health risks, of shellfish resource areas to shellfish harvesting. Closure decisions are made by the Division of Marine Fisheries, using a current standard that specifies that if the geometric mean of 15 samples equals or exceeds 14 fecal coliform per 100 milliliters of sample water or if 10% of the samples exceed 49 fecal coliform per 100 milliliters of sample water, the station can be closed. The five shellfish-bed classifications are approved, conditionally approved, restricted, conditionally restricted, and prohibited.
Sludge. Solid or semisolid material resulting from potable or industrial water supply treatment or sanitary or industrial wastewater treatment.
Soil Conservation Service (SCS). A branch of the U.S. Department of Agriculture that, among other things, provides technical assistance in resource management and planning and implementation of agricultural BMPs. SCS works closely with

Agricultural Stabilization and Conservation Services (ASCS) and County Extension Services to achieve their goals.

Spring Tides. Higher than normal high tides observed every 2 weeks when the earth and moon align.

Storm Drain. A system of gutters, pipes, or ditches used to carry stormwater from surrounding lands to streams, ponds, or Buzzards Bay. In practice, storm drains carry a variety of substances such as oil and antifreeze which enter the system through runoff, deliberate dumping, or spills. This term also refers to the end of the pipe where the stormwater is discharged.

Stormwater. Precipitation that is often routed into drain systems in order to prevent flooding.

Suspended Solids. Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as organic solids in wastewater.

Swales. Vegetated areas used in place of curbs or paved gutters to transport stormwater runoff. They also can temporarily hold small quantities of runoff and allow it to infiltrate into the soil.

Tertiary Treatment. The wastewater treatment process that exceeds secondary treatment; could include nutrient or toxic removal.

Tidal Flat. Any nearly level part of the coastal beach, usually extending from the low water mark landward to the more steeply sloping seaward face of the coastal beach or separated from the beach by land under the ocean, as defined in 310 CMR 9:04.

Tidelands. All lands and waters between the high water mark and the seaward limit of the Commonwealth's jurisdiction, as defined in 310 CMR 9:04. Tidewaters are synonymous with tidelands.

Title 5. The state regulations (CMR 15) that provide for minimum standards for the protection of public health and the environment when circumstances require the use of individual systems for the disposal of sanitary sewage. The local board of health is responsible for enforcement of these regulations and may upgrade them.

Total Nitrogen. A measure of all forms of nitrogen (for example, nitrate, nitrite, ammonia-N, and organic forms) that are found in a water sample.

Toxic. Poisonous, carcinogenic, or otherwise directly harmful to life.

Wastewater. Water that has come into contact with pollutants as a result of human activities and is not used in a product, but discharged as a waste stream.

Water Column. The water located vertically over a specific point or station.

Watercourse. Any natural or man-made stream, pond, lake, wetland, coastal wetland, swamp, or other body of water. This includes wet meadows, marshes, swamps, bogs, and areas where groundwater, flowing or standing surface water, or ice provide a significant part of the supporting substrate for a plant community for at least five months of the year, as defined in 310 CMR 15:01. Boards of Health can adopt the definition of wetlands in 310 CMR 10.0 or broader language in Title 5 as a "watercourse" in

determining setbacks.
Wetlands. Habitats where the influence of surface water or groundwater has resulted in the development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.
Wrack. Algae, plant and animal matter, and drift material (including solid wastes and other pollutants) that accumulate on beaches, usually at the high tide mark.
Zoning Bylaws. Local laws that designate areas of land for different uses at established densities. These bylaws require a two-thirds majority vote of town meeting or city council.

Appendix A:

Sampling Protocols and Data Sheets

On the following pages are sampling protocols and data sheets used in The Buzzards Bay Coalition Citizen's Water Quality Monitoring Program- Baywatchers.

Notes:

Buzzards Bay Citizens' Water Quality Monitoring Program 2019

BASIC PARAMETER SAMPLING AND ANALYTICAL PROTOCOLS

MONITORING OVERVIEW

1) Record weather and general observations
2) Measure Secchi depth and total depth
3) Collect surface sample -analyze temperature, dissolved oxygen, salinity
4) Collect bottom sample -analyze temperature, dissolved oxygen, salinity

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GENERAL/ WEATHER CONDITIONS Record parameters listed on data sheet:
*Time of nearest low tide from tide table and if the tide is Ebbing (approaching low) or Flooding (approaching high)
*Wave conditions- see Beaufort scale 0-12
*Wind direction- the direction the wind is coming from
*Weather conditions
*Rainfall in last 24 hours.

SECCHI DEPTH/TOTAL DEPTH

Step 1. Lower Secchi disk into water slowly from shady side of a boat, dock or pier until it just disappears from view. Raise and lower slightly to insure the proper average depth of disappear¬ance.
Step 2. Read depth on tape where it intersects the water surface, record on data sheet. Note: Sometimes the Secchi disk will hit the bottom before it disappears- in this case write a line "----" on secchi disk depth on data sheet.
Step 3. Lower Secchi disk slowly until it touches bottom, record total water depth at station on data sheet.

COLLECTING A WATER SAMPLE

Note: For simplicity we use the sampling pole for both surface and deep water sample collection.
Step 1. Put stopper in salinity bottle (1 liter) and in the oxygen bottle (0.5 liter). Make sure the tube on the oxygen bottle is secured in the wire loop at the mouth of the bottle.
Step 2. Move a couple of feet upstream from where you measured total depth with Secchi (to avoid disturbed sediments from the Secchi test). Lower the sampling pole gently to the appropriate depth (6 inches (15 cm) below the water surface for the SURFACE sample or 1 foot (30 cm) up from the bottom for BOTTOM sample) [Use total depth minus 30cm to calculate depth for bottom sample without disturbing bottom sediment] Collect surface and bottom samples when there is at least 1.20 meters (4 ft) of water at your station. If there is less than 1.20 meters (4ft) collect a bottom sample 30 cm (1ft) up. If there is less than 1 foot (.30) of water, you may not be able to collect a sample at 15cm below surface at that location.
Step 3. While holding sampling pole in place, pull the colored string oxygen bottle stopper first, let sample bottle fill.
Step 4. When all bubbles have ceased coming to the surface then pull white string salinity bottle stopper (1 liter), allow to fill. NOTE: It is imperative that the oxygen bottle (colored string) is filled first to avoid oxygenating the sample from air within the salinity bottle.
Step 5. Keeping the pole vertical, bring the pole water samples on deck for the following analysis.
Step 6 Record sampling collection time and collection depth on datasheet.

WATER SAMPLE ANALYSIS

First: Fill glass O2 reagent bottle from blue oxygen kit:
Step 1. Remove glass stopper.
Step 2. Lower rubber tube from oxygen bottle on pole to the bottom of the glass bottle from the blue oxygen kit.
Step 3. Drain ¾ of the poles plastic oxygen (0.5 liter) bottle through the glass bottle, overflowing the glass bottle.
Step 4. Gently tap glass bottle to insure that no bubbles stick to sides.
Step 5. As volume reaches ¾ empty of the 0.5 liter plastic bottle, slowly remove the rubber tube out of the glass bottle and then carefully insert glass stopper so as not to trap any bubbles. Dropping glass stopper in works best.
Step 6. Set sample aside for now.

Next: Put thermometer in the salinity bottle on pole, let stabilize, record this as "water temperature". Remove thermometer and cap the salinity bottle and set it aside till after the dissolved oxygen is tested.
Now: Continue the dissolved oxygen analysis instruction below....Please wear safety glasses.

DISSOLVED OXYGEN

1. open Reagent packet #1 (use the scissors in your kit);
2. open Reagent packet #2
3. remove glass stopper from glass oxygen reagent bottle;
4. pour Reagent #1 into bottle and then add reagent packet #2 to bottle.
5. replace glass stopper, careful not to trap bubbles.
6. shake bottle vigorously holding bottle and stopper (some reagent may stick to bottom of bottle...this is O.K.).
7. let stand 2 minutes, for the reaction to take place and floc to settle, then shake again and let stand again.

NOTE: AT THIS POINT YOU CAN MEASURE SPECIFIC GRAVITY (Salinity) WHILE YOU WAIT

8. After a total of 5 minutes (when the chemical floc has settled the second time and there is a clear division), open Reagent packet #3, remove glass stopper, add powder to bottle, replace stopper (no bubbles), shake vigorously until water in bottle becomes clear (no #3 particles). THE SAMPLE IS FIXED NOW AND CAN BE TRANSPORTED if needed.
9. Remove glass stopper and fill small plastic tube from kit to top TWICE (two volumes) pouring each time into the square glass bottle in the kit. It helps to tip the bottle to overcome the surface tension.
10. To determine the oxygen content, shake the sodium thiosulfate solution in the plastic eyedropper bottle in kit. Take the eyedropper and fill with sodium thiosulfate solution. Now the critical part: (be sure to hold dropper upright) add 1 drop to the square bottle and swirl. Continue to add and count drop by drop (about 10 seconds between drops) and swirl until the yellow color goes away. Record the number of drops (1 drop = 0.5 mg O_2/liter-ppm).

NOTE: Be careful not to contaminate sodium thiosulfate solution by touching the dropper in O_2 sample.

11. Pour waste reagent in to waste bottle and save in clear plastic container for disposal at our office.
12. Rinse all the oxygen kit bottles and plastic tube with tap water and shake dry before processing next sample.

SALINITY = SPECIFIC GRAVITY/TEMPERATURE

Step 1. Rinse 500 ml graduated cylinder with 100-200 ml sample from 1 L salinity bottle on pole.
Step 2. Rinse hydrometer directly from bottle with a little water (no more than 100 ml).
Step 3. Fill graduated cylinder with 500 ml of sample.
Step 4. Gently place hydrometer in cylinder (do not drop).
Step 5. Read number on stem of hydrometer where it intersects the water line in the cylinder, record on data sheet.
Step 6. Take hydrometer out and put thermometer into cylinder and measure temperature (AGAIN); record as cylinder temperature on data sheet.
Step 7. Obtain salinity in ppt. from your yellow salinity table in manual, record on data sheet.
Step 8. Rinse equipment with tap water from squirt bottle.

*Repeat all analysis steps for both sampling depths.
**Rinse off sampling pole and allow kit to air dry in cool dry place.
***Look over your data sheets to make sure everything is complete.

****Contact Buzzards Bay Coalition staff if the Drops divided by 2 (Dissolved Oxygen) is 3ppm or less so we can visit site to verify low oxygen levels.

Mail data every two weeks to: Baywatchers, 114 Front Street, New Bedford, MA 02740

Baywatchers
Citizen Water Quality Monitoring Program – Water Sampling Data Sheet 2019

General Conditions

______	Station ID Embayment ______
______	Sample Date Volunteers Name ______
______	Beaufort Scale (Force # 0-12)
______	E/F Ebb (outgoing) or Flood (incoming) Tide Time of nearest LOW tide ______ am/pm (Refer to your table)
# ______	Weather Conditions: (choose 1) 1 Cloudless 2 Pt. Cloudy 3 Overcast 4 Fog/Haze 5 Drizzle 6 Intermit. Rain 7 Rain 8 Snow
# ______	24 hour Precipitation (choose one) 1 None 2 Light 3 Heavy
______	Wind direction (ie. SE, NW)
______	(meter) Secchi disk depth (draw a line --- if you can see the disk on the bottom)
______	(meter) Total water depth at station ______ Total depth - .30 (30 cm) = ______ Bottom collection depth

Other observations
Please continue comments on back

Depth Specific Parameters

	SURFACE 15cm below surface		Replicate Duplicate	BOTTOM 30cm up from bottom		Replicate Duplicate
Collection Time (6-9am)						
Sample collection depth		meters			meters	
Bay Water Temperature		°C			°C	
Count # of Reagent drops		#			#	
Drops divided by 2 (Dissolved Oxygen)		ppm			ppm	
Hydrometer Reading	1.0			1.0		
Graduated Cylinder Temperature		°C			°C	
Salinity		ppt			ppt	

Please check over the data sheet and then mail to: Baywatchers, 114 Front Street, New Bedford, MA 02740