Educating and Monitoring for Water Quality and Phytoplankton in New Hampshire Estuaries

Great Bay Coast Watch Final Report
for NHCP Grant #13V057

July 1, 2004 – December 31, 2005

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January 3, 2006

The National Sea Grant College Program of the US Department of Commerce's National Oceanic and Atmospheric Administration supported this report under NOAA Grant #NA16RG1035. UNHMR-AR-SG-06-03

This report was funded in part by a grant from the Office of State Planning, New Hampshire Coastal Program, as authorized by the National Oceanic and Atmospheric Administration (NOAA), Grant No. NA170Z2324.

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Executive Summary

The Great Bay Coast Watch (GBCW) was founded in 1990 as part of the University of New Hampshire (UNH) Cooperative Extension/Sea Grant citizen outreach and education program. The GBCW mission is to protect the long-term health of New Hampshire's coastal environment through volunteer monitoring and education programs.

GBCW is New Hampshire's most wide-ranging program for direct citizen involvement in monitoring estuarine waters. The GBCW strives to involve citizens in conservation efforts aimed at the whole Great Bay Estuarine System, the Hampton/Seabrook Estuary, and the Atlantic Coast of New Hampshire. Citizens are also educated and encouraged to be conscious of how activities in their own backyards affect these ecosystems. GBCW includes adults from many occupations, as well as teachers and students from local schools.

Since 1990, GBCW has expanded water quality monitoring coverage from eight sites to twenty-one sites. Our dataset currently contains results from over 4,000 monitoring sample collections. On each sampling day, GBCW volunteers measure water temperature, pH, salinity, dissolved oxygen (DO), transparency, depth, and fecal coliform bacteria. Samples are taken at low tide and high tide on the same day according to the lunar calendar. All sampling activities are subject to U.S. Environmental Protection Agency (EPA) approved quality control procedures.

Supported by this grant from New Hampshire Coastal Program (NHCP), GBCW continued to engage volunteers in monitoring water quality at 21 sites around Great Bay and its tributaries. These sites are located in the towns of Exeter, Stratham, Greenland, Newmarket, Durham, Dover, Portsmouth, Newington, and New Castle, NH, and Eliot ME.

The phytoplankton monitoring program continued, into its sixth season, at five sites and began a one new site under this grant from the NHCP. Work continued on assembling a library of digital photographs, updated the key, and created a new video to assist volunteers with phytoplankton identification.

GBCW Task List and Actions

1. Recruit new volunteers and provide training for both new and existing volunteers. Recruiting will be done primarily by using newspaper articles and radio announcements. Training will be provided in March and June, through both workshops and quality assurance monitoring.

   Beginning in September 2004, five new volunteers began assisting us in water quality sampling. In the spring of 2005, fifteen new volunteers were recruited for the water quality and phytoplankton monitoring programs. They were recruited through word of mouth, the Seacoast United Way Volunteer Action Center (UW-VAC) website, the New Hampshire Department of Environmental Services (NHDES) website, and articles in the local newspapers. The September volunteers were all trained in the field and were provided additional instruction on an individual basis. The spring volunteers were trained through normal classes and field experience. All monitors are offered the Quality Assurance/Quality Control (QAQC) test in April and August each year. Water quality training for both experienced and new volunteers was held on March 15 and 23, 2005 at Kingman Farm and on March 21 at Oyster River High School for students from Oyster River and Marshwood High Schools.

   Twenty-five hard copies and 50 CD versions of the volunteer technical manual were published. Manuals were distributed at training sessions. Changes to the existing water quality manual included:

   - Formatting an improved tip sheet
   - Adding a significant figures and rounding explanation

- Changing one chapter into two separate chapters separating field sample collection and laboratory fecal coliform procedures
- A modification to correct water transparency recording

GBCW data was more than 99% complete in 2004, meaning that there was very little missing data. The few data points that are missing are due to sites that were not sampled because of safety issues. Site 12, the Newmarket Waste Water Treatment Plant, has become increasingly dangerous due to the nature of the riverbank in that area. As a result, it is being monitored only when volunteers are available who are capable of climbing wet, and often slippery, rocks. The location of the site is being reconsidered at this time.

QAQC testing in April was completed, and the second QAQC session was completed August 30 – September 1, 2005. Details about the August testing will be included in the fiscal year 2006 grant report. A majority of the GBCW volunteers participated in the April QAQC session. GBCW volunteers continue to demonstrate their abilities to provide high quality data.

2. Continue to monitor water quality at 21 sites around Great Bay and its tributaries. These sites encompass the towns of Exeter, Stratham, Greenland, Newmarket, Durham, Dover, Portsmouth, Newington, and New Castle, NH, and Eliot, ME.

Since the beginning of this grant, GBCW volunteers have completed nine water quality monitoring days at 21 previously established sites around the Great Bay Estuary and its tributaries. This completes 15 years of continuous water quality data collection at these sites and begins the 16th year. Monitoring days from July 2005 through December 2005 will be applied to the fiscal year 2006 grant.

The 2004 data has been accepted by the NHDES, entered into their database, and included in the UNH Ocean Processing Analysis Lab's (OPAL) database. Fourteen years of previous GBCW water quality data was accepted by NHDES in the fall of 2004 for inclusion in its statewide water quality database. This GBCW data was the first citizen volunteer water quality monitoring program data accepted for inclusion in this database. Since it has been posted, GBCW data has been requested 24 times.

At the completion of the season in November 2004, volunteers helped collect the kits, clean them, and store them for the winter. Volunteers also helped with data entry, data verification, and archiving records in the office. The 2005 season water quality sampling began on April 26. In preparation for the upcoming season, volunteers assisted with equipment maintenance, including refurbishing Secchi disks, calibrating instruments, filling kits, and inventorying supplies.

3. Continue to monitor phytoplankton at the following six sites: New Castle Coast Guard Station; Parson's Creek, Rye; Hilton Park, Dover; Star Island, Isles of Shoals; Hampton Harbor; and Seabrook Harbor.


Photo by Candace Dolan

This task requires that a team of at least two volunteers travel to each site on a weekly basis from March through October (except Star Island, which is June to September), make their measurements and observations, and report results to the volunteer coordinator. In previous years, GBCW volunteers had been allowed free access to transportation to Star Island on the Isles of Shoals Steamship Line in return for presenting information to interested passengers. However, in response to new regulations instituted by Homeland Security the steamship line was forced to charge for passage this year. This new regulation reduced the number of days volunteers were able to travel. As a result, sampling days at Star Island were limited to eight trips. It was necessary to abandon the Hilton Park sampling site this year as the floating dock was not replaced, limiting safe, effective access to the water. However, this opened up the possibility of partnering with the Seacoast Science Center to establish a new sampling site at the Rt.1A Bridge near the science center. GBCW volunteer phytoplankton monitors began sampling at the new site in August and including any interested visitors in the process.

Phytoplankton monitoring for the 2005 season began the week of April 4. Seven GBCW volunteer phytoplankton monitors were able to train with their Maine counterparts during a two-day workshop held at the Darling Marine Center in Walpole, ME on March 25-26, 2005. While attending, they had the opportunity to view live zooplankton with Bernie McAlice, professor emeritus, University of Maine. They examined wild and cultured samples of toxic cells, and listened to

"How Do Clams Survive Red Tide?," a lecture given by Dr. Laurie Connell, University of Maine scientist. Also assisting during the weekend were staff from Bigelow Laboratory, University of Maine Cooperative Extension (UMCE) and the Maine Department of Marine Resources (DMR). An additional training session was held for new volunteers at Kingman Farm. Since the inception of this grant through July 2005, GBCW phytoplankton volunteers have collected 100 samples from the five coastal sites regularly monitored. GBCW phytoplankton volunteers also participated in the September 18, 2004 "Bio Blitz" data collection activity sponsored by the Seacoast Science Center.

Photo by Candace Dolan

In April, Candace Dolan, the GBCW Phytoplankton Program Coordinator, was contacted by the Hands on Boat Based Education (HOBBES) Program which operates out of Salem Harbor, Salem, MA. The coordinator assisted the HOBBES program coordinator in ordering and adapting equipment, connecting with the appropriate Massachusetts agencies and learning the phytoplankton monitoring protocol. They now include phytoplankton monitoring in their educational program.

On May 5, the paralytic shellfish poisoning (PSP) causative cell *Alexandrium fundyense* was observed in samples collected and examined at the Coastal Lab sampling site. The NHDES/Shellfish Program manager was immediately notified and all GBCW phytoplankton monitoring teams were asked to increase their sampling frequency. Over the next two days, all sampling sites reported seeing varying numbers of *Alexandrium fundyense* cells in their samples.

This proved to be the beginning of the largest documented harmful algal bloom in New Hampshire waters since 1972. The *Alexandrium fundyense* bloom began in the Gulf of Maine in early May and spread into New Hampshire, Massachusetts, and Cape Cod Bay. By early June, the bloom took on massive proportions both geographically and in cell abundance stretching from mid-Maine to Nantucket and Martha's Vineyard and reaching cell concentrations tens to hundreds of times higher than seen normally.

During this event, GBCW phytoplankton data and information was shared with the NHDES, UNH, the Massachusetts Water Resources Authority (MWRA) outfall monitoring program, the Woods Hole Oceanographic Institute (WHOI), the National Oceanographic and Air Administration (NOAA), the U.S. Department of Food and Drugs (USFDA), and the Maine Department of Marine Resources (MDMR).

Throughout the bloom, GBCW volunteer-collected data on the presence of *Alexandrium fundyense* mirrored the accumulated toxin levels detected in mussel meat samples tested by the NH Department of Health laboratory in Concord, NH.

4. Continue to develop a digital photo library of local phytoplankton species by taking color digital photographs of prevalent species through a microscope. A loose leaf binder of waterproof photos and identification tips will be published and distributed to volunteer monitors for use in field identification efforts. As more photos are added to the library, the binders will be updated.

   Work has continued on the phytoplankton photo library. A key sheet, which consists of photographs of commonly seen phytoplankton species, has been updated, laminated, and distributed to volunteers who work at the sampling sites. It has also been shared with the UNH Marine Docent Program and HOBBES. A prototype page for the loose leaf manual has been developed and updated photographs are being double checked to assure correct identification before being included. GBCW was able to take advantage of the diverse array of phytoplankton observed this spring by collecting offshore samples to photograph and add to the library of images.

5. Revise the phytoplankton technical manual and publish it to CD as to include digital photos and video clips of phytoplankton collection and analysis procedures. This will help standardize the collection and analysis procedures used by volunteers.

   Changes were made to the existing volunteer phytoplankton technical manual to address inconsistencies between the established water quality methods. The manual was reformatted and seven hard copies were printed and distributed to volunteers at the beginning of the sampling season. In addition, copies were sent to the National Sea Grant Library. Appendix C is the GBCW "Standard Operating Procedures Phytoplankton Monitoring Program." Film clips of target phytoplankton species have been included in the CD that accompanies this report.

6. Write, publish, and distribute a report on the data collected during the 2004 sampling season.

   A new annual report format was developed in order to make the report more "user friendly" for the volunteers and less cumbersome to produce. Twenty-five printed copies and 25 CD's of the report were printed and many were distributed at the GBCW annual spring meeting that was held at the NH Fish & Game building in Durham, NH on March 10, 2005. Others have been provided at training sessions to new volunteers, to the Technical Advisory Committee, and by request to previous users.

7. Enlist and support local schools involvement in GBCW activities to foster a continuing connection with young area residents.

   The following schools have participated with GBCW water quality monitoring during the grant period and most will continue to support GBCW monitoring efforts in the next year.

- Marshwood High School
- Oyster River High School
- New Franklin Elementary School
- Little Harbour Elementary
- Newmarket High School
- Cochecho Arts and Technology Academy (CATA)

Training was provided to the science teacher from the Cocheco Arts and Technology Academy, a new charter school established in Dover, NH. Students from the academy will now be sampling at established Site #17, which is located at the covered walkway bridge in Dover, NH.

Several schools have been monitoring sites for GBCW for the past 10 years. They include Marshwood High School in South Berwick, Oyster River High School in Durham, Newmarket High School, and Little Harbour and the New Franklin Elementary Schools in Portsmouth. Students from the Portsmouth Middle School will not be returning this year due to staff changes in Team Piscataqua (8th grade).

During this report period, GBCW phytoplankton program volunteers completed six additional presentations to Portsmouth Middle School students as part of their study of South Mill Pond ecology. The presentations consisted of PowerPoint slides and hands on work with microscopes and live samples of phytoplankton collected near the inlet of the pond. Additionally, four Hampton area students continued to monitor at the Seabrook site, and two students at the newly established Seacoast Science Center site.

In addition to monitoring, GBCW offers important educational opportunities for volunteers. These opportunities are provided for them through a variety of programs and community events such as Dover's Apple Harvest Day, Portsmouth's Martin Luther King Day Celebration, and the United Way Day of Caring. Preparations began in May for the summer joint barbecue with the Great Bay Stewards, to which over 500 volunteers, partners, and Great Bay Stewards were invited. A table of events that GBCW participated in is provided in Appendix B. The Annual BBQ event will be reported on in the fiscal year 2006 grant.

In the spring of 2005, Ann Smith (a GBCW volunteer and retired school teacher) led a workshop training session at New Franklin School for first-third graders. In this session, students learned how to take salinity and temperature measurements, and how to perform a DO titration. Supplies and borrowed equipment were provided by GBCW.

Results

In total GBCW volunteers' provided $32,613.49 value to this grant in time and mileage. Their contributions to the body of knowledge and understanding of the

Great Bay Estuarine System are invaluable to researchers and scientists. Currently, GBCW Data is used on a regional and state wide basis, with a potential to be used on a nation wide level by its inclusion in the NHDES online database. This important resource needs to continue to be cultivated and valued.

Appendix B Table of GBCW Events provides a glimmer of the opportunities that GBCW offers to environmentally active citizens in the coastal area. Scientific data collection is only a part of the activities in which volunteers can participate. A variety of education and teaching events allow a variety of people to find their niche in the program.

Appendixes

Time and Mileage Summary Report Final Report

From 9/8/2004 **To** 12/31/2004

UNIVERSITY of NEW HAMPSHIRE COOPERATIVE EXTENSION

Sea Grant New Hampshire

Project *NHCP WQ and Phytoplankton 04*

Grant Number	Project Starts	Project Ends
13V057	9/8/2004	12/31/2005

Report Time and Milage

Activity **Area Leader Support**

	Time (min.)	Miles
Summary for 'Activity' =	(8 detail records)	
Sum	**1020**	**56**

Activity **Clerical Work**

	Time (min.)	Miles
Summary for 'Activity' =	(14 detail records)	
Sum	**1879**	**184**

Activity **Kit Care**

	Time (min.)	Miles
Summary for 'Activity' =	(1 detail record)	
Sum	**60**	**10**

Activity **Lab QA/QC Certification**

	Time (min.)	Miles
Summary for 'Activity' =	(3 detail records)	
Sum	**630**	**37**

Activity **Laboratory Cleanup**

	Time (min.)	Miles
Summary for 'Activity' =	(2 detail records)	
Sum	**360**	**60**

Activity **Laboratory Counts**

	Time (min.)	Miles
Summary for 'Activity' =	(6 detail records)	
Sum	**655**	**82**

Activity **Laboratory Processing**

	Time (min.)	Miles

Summary for 'Activity' =	(6 detail records)	
Sum	1620	71

Activity **Monthly Meeting**

	Time (min.)	Miles
Summary for 'Activity' =	(5 detail records)	
Sum	585	50

Activity **Monthly Sampling**

	Time (min.)	Miles
Summary for 'Activity' =	(144 detail records)	
Sum	21413	4218

Activity **Phytoplankton ID**

	Time (min.)	Miles
Summary for 'Activity' =	(2 detail records)	
Sum	1482	78

Activity **Phytoplankton Sampling**

	Time (min.)	Miles
Summary for 'Activity' =	(71 detail records)	
Sum	6915	1112

Activity **Special Function**

	Time (min.)	Miles
Summary for 'Activity' =	(2 detail records)	
Sum	360	35

Activity **Special Function - Chili & Chowdah Fest**

	Time (min.)	Miles
Summary for 'Activity' =	(20 detail records)	
Sum	3960	369

Activity **Special Function - Speaker @ Ch & Ch fest**

	Time (min.)	Miles
Summary for 'Activity' =	(1 detail record)	
Sum	0	0

Activity **Special Function - Varney, WWMD**

	Time (min.)	Miles
Summary for 'Activity' =	(1 detail record)	
Sum	120	0

Activity **Special Function- Varney, WWMD**

Time (min.) Miles

Summary for 'Activity' = (2 detail records)

Sum **360** **40**

Activity **Teaching**

Time (min.) Miles

Summary for 'Activity' = (4 detail records)

Sum **480** **36**

Activity **Training**

Time (min.) Miles

Summary for 'Activity' = (2 detail records)

Sum **960** **118**

Activity **Writing**

Time (min.) Miles

Summary for 'Activity' = (4 detail records)

Sum **750** **52**

Summary for 'Project' = (298 detail records)

	Time (Minutes)	Miles
Sum	**43609**	**6608**
Value	**$12,021.55**	**$2,478.00**

	Time (Minutes)	Miles		
Grand Total	**43609.00**	**6608.00**	**Time Value : $**	**16.54**
			Mileage Value: $	**0.375**

Total Value **$14,499.55**

Matching Funds

Source	Amount	Inkind Match	Comments
	$0.00	None	

Total: **$0.00**

Donations

Amount	Date Given	Comments	Contact ID
$750.00	12/30/2004	Town of Greenland Support	0
$100.00	12/16/2004	General Supplies	184
$83.41	9/10/2004	pH Meter for Site 18	611
$50.00	11/23/2004	for Sodium Thiosulfate Bottles	167

Total: **$983.41**

Grand Total Match: $15,482.96

Time and Mileage Summary Report Final Report

From 1/1/2005 To 6/30/2005

Grant Number	Project Starts	Project Ends
13V057	9/8/2004	12/31/2005

Project *NHCP WQ and Phytoplankton 04*

Report Time and Milage

Activity **Annual Meeting**

	Time (min.)	Miles
Summary for 'Activity' =	(10 detail records)	
Sum	**2000**	**312**

Activity **Area Leader Support**

	Time (min.)	Miles
Summary for 'Activity' =	(3 detail records)	
Sum	**380**	**42**

Activity **Calibration**

	Time (min.)	Miles
Summary for 'Activity' =	(8 detail records)	
Sum	**1650**	**134**

Activity **Clerical Work**

	Time (min.)	Miles
Summary for 'Activity' =	(4 detail records)	
Sum	**690**	**72**

Activity **Data Review**

	Time (min.)	Miles
Summary for 'Activity' =	(5 detail records)	
Sum	**990**	**36**

Activity **Kit Care**

	Time (min.)	Miles
Summary for 'Activity' =	(18 detail records)	
Sum	**3510**	**548**

Activity **Laboratory Counts**

	Time (min.)	Miles

Summary for 'Activity' =	(2 detail records)	
Sum	**330**	**75**

Activity **Laboratory Processing**

	Time (min.)	Miles
Summary for 'Activity' =	(4 detail records)	
Sum	**739**	**29**

Activity **Monthly Sampling**

	Time (min.)	Miles
Summary for 'Activity' =	(51 detail records)	
Sum	**9125**	**1610**

Activity **Photo Selection**

	Time (min.)	Miles
Summary for 'Activity' =	(3 detail records)	
Sum	**510**	**18**

Activity **Phytoplankton Field Trianing**

	Time (min.)	Miles
Summary for 'Activity' =	(3 detail records)	
Sum	**360**	**60**

Activity **Phytoplankton Sampling**

	Time (min.)	Miles
Summary for 'Activity' =	(42 detail records)	
Sum	**3360**	**518**

Activity **QA/QC Certification**

	Time (min.)	Miles
Summary for 'Activity' =	(52 detail records)	
Sum	**4933**	**950**

Activity **QA/QC Team**

	Time (min.)	Miles
Summary for 'Activity' =	(28 detail records)	
Sum	**5885**	**761**

Activity **Special Function**

	Time (min.)	Miles
Summary for 'Activity' =	(5 detail records)	
Sum	**720**	**153**

Activity **Training**

	Time (min.)	Miles

Summary for 'Activity' = (25 detail records)		
Sum	4710	713

Activity **Training - Phytoplankton**

	Time (min.)	Miles
Summary for 'Activity' = (13 detail records)		
Sum	8010	742

Activity **Transporting**

	Time (min.)	Miles
Summary for 'Activity' = (1 detail record)		
Sum	5	2.5

Activity **Writing**

	Time (min.)	Miles
Summary for 'Activity' = (12 detail records)		
Sum	2070	168

Summary for 'Project' = (289 detail records)

	Time (Minutes)	Miles
Sum	**49977**	**6943.5**
Value	**$14,318.41**	**$2,812.12**

	Time (Minutes)	Miles		
Grand Total	**49977.00**	**6943.50**	**Time Value : $**	**17.19**
			Mileage Value: $	**0.405**

Total Value **$17,130.53**

Matching Funds

Source	Amount	Inkind Match	Comments
Match 9/8/04 - 12/31/04	$15,482.96		
Total:	**$15,482.96**		

Donations

Amount	Date Given	Comments	Contact ID
$25.00	5/24/2005	Kids Meals for Oyster River High Schools S	0
Total:	**$25.00**		

Grand Total Match: $32,638.49

Appendix B Table of GBCW Education Events
September 8, 2004 – June 30, 2005

Event	Date	Topic	# of Attendees
2004			
Apple Harvest Festival	September 2		>100 10 New Interest Sign-ups
NH Shellfish Resource Seminar	September 16		41
Monthly Meeting	October 6	pH Meter Clinic & Meet Mark Wiley	9
Chili & Chowdah Fest	November 9	"Birds of Great Bay" by Pam Hunt	40
2005			
Portsmouth Middle School's Martin Luther King Day	January 17	Display for High School Volunteers	>100 8 New Interest Sign-ups
GBCW Annual Meeting	March 10	Ground Water Research in NH by Lindsay Anderson	20
Water Quality and Phytoplankton Training and Refresher Course Part I	March 15	Introduction to the Kits, Manuals and Monitoring	10
Student Training at Oyster River High School (for all schools)	March 21	The Kits, Manuals and Monitoring	11
Water Quality Training and Refresher Course Part II	March 23	Review the kits, and Manuals, complete Water Quality Monitoring Techniques	10
Phytoplankton Training and Refresher Course Part II	March 24	Review the kits, and Manuals, complete Phytoplankton Monitoring Techniques	8
Soundings Institute Presentation (Nova Scotia)	April 10-13	Advanced Community Based Practices in Marine Conservation and Management	>100

Event	Date	Topic	# of Attendees
Monthly Meeting	May 11	“Meeting of the Minds,” how Cooperative Extension works with the public, by Paul Bonaparte-Krogh	11
Exeter Alewife Festival	June 4	Street Fair	>100 14 New Interest Sign-ups
NH Shellfish Resource Seminar	June 14	“Shellfish Harvesting Opportunities” by Chris Nash	29

Appendix D

Standard Operating Procedures

Phytoplankton Monitoring Program

March 2005

Prepared By

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Report No. UNHMP-SG-05-09

Great Bay Coast Watch

Mission Statement:

The Great Bay Coast Watch is citizen volunteers working within the UNH Cooperative Extension/NH Sea Grant Program, protecting the long-term health and natural resources of New Hampshire's coastal waters and estuarine systems through monitoring and education projects.

Acknowledgements:

The volunteer phytoplankton monitors in the Great Bay Coast Watch must be recognized and gratefully acknowledged for it is through their efforts that we all better understand and appreciate the Great Bay Estuarine System and the New Hampshire Atlantic Coast. The volunteer monitors for 2004 were:

Hanna Hock	Lyn Beattie	Jack Chambers	Don Chamberland
Mary Jane Williams	Linda Coe	Andy Stewart	Nate Hazen
Ann Antaya	Wally Fries	Dorothy Kilcoyne	Emory Hutchins
Tim Antaya	Sheila Johannson	Steve Cooper	Sam Wensman
Claire Antaya	Clif Horrigan	Michele Wensman	
Andrew Antaya	Barbara Baird	Sophie Wensman	

This publication was supported by the National Sea Grant College Program of the US Department of Commerce's National Oceanic and Atmospheric Administration under NOAA Grant No. 16RG1035 to the NH Sea Grant College Program The views expressed herein do not necessarily reflect the views of any of these organizations.

The University of New Hampshire's Cooperative Extension has also provided funding in support of the Great Bay Coast Watch's work and the publishing of this manual. The University of New Hampshire Cooperative Extension is an equal opportunity educator and employer, US Department of Agriculture and NH counties cooperating.

This report was also supported by a grant from the Office of Energy and Planning, New Hampshire Coastal Program, as authorized by the National Oceanic and Atmospheric Administration (NOAA), Grant No. 03N054190091.

Table of Contents

1.0 INTRODUCTION

1.1 Purpose

Thank you for taking part in this volunteer-based phytoplankton monitoring project. With your help, Great Bay Coast Watch (GBCW) and the University of New Hampshire Cooperative Extension hope to obtain baseline and continuing information on the toxic phytoplankton present in Gulf of Maine waters. This information will be used to provide data on algae blooms and, in turn, further aid the New Hampshire Department of Environmental Services (NHDES) in their management of shellfish resources.

You will be collecting and monitoring water samples to determine whether any of the four toxic or potentially toxic phytoplankton species (*i.e., Alexandrium tamarense, Dinophysis spp*., *Prorocentrum lima, and Pseudonitzschia spp.*) are present and in what quantity. *Alexandrium tamarense* causes Paralytic Shellfish Poisoning (PSP), *Dinophysis spp.* and *Prorocentrum lima* are associated with Diarrhetic Shellfish Poisoning (DSP), and *Pseudonitzschia spp.* is associated with Amnesic Shellfish Poisoning (ASP). These toxic or potentially toxic cells will be referred to as target cells throughout the procedures contained in this manual.

1.2 Getting to the Sampling Sites

Phytoplankton monitoring is conducted at five sites in coastal New Hampshire:

- Seabrook Harbor
- Hampton Harbor
- Parson's Creek, Rye
- Coastal Lab, New Castle
- Rte. 1A, Seacoast Science Center
- Star Island, Isles of Shoals

These sites are primarily near shellfish growing areas or sampling stations currently used weekly by the NHDES Shellfish Monitoring program, and have historically been good locations for indicating early the presence of initial, low-level toxins when they exist. We will provide you with maps and/or instructions on how to locate these stations. Monitoring should be conducted at the same sites weekly March through October at high slack tide. You may be asked by

GBCW to change your designated site if a more representative site is discovered.

1.3 Safety

Although collection of samples at scheduled times is important, your safety and health are more important. If weather conditions are such that collecting the samples might cause injury or illness, reschedule your sampling run for later in the week. Remember to dress appropriately for the current weather and be prepared for unexpected bad weather. On wet, cold days avoid wearing cotton clothing as cotton offers little thermal protection when wet. On hot, sunny days be sure to have plenty of fluids to avoid dehydration and sunscreen to prevent burning. Always have a first aid kit either with you or in the car.

If sampling from a dock be sure to wear appropriate footwear to reduce risk of falling and always be sure to steady yourself when working near the edge of the dock. If sampling from a boat, be sure to follow all federal and state safety procedures. Additionally, be careful when reaching over the side of the boat to collect the sample. Although we want you to collect the samples and have fun, the most important thing is your safety.

2.0 GETTING READY TO SAMPLE

2.1 Data Sheets

Data sheets have been provided for recording your observations and sampling results. A sample data sheet is included in Appendix A for you to refer to as you review the procedures in this manual. Note that various environmental factors are listed on the data sheets (e.g., recent weather events, current, wind speed and direction, water temperature, transparency, salinity, dissolved oxygen). These observations will help indicate what conditions existed at sampling time that may have enhanced or deterred the development of a bloom.

Note: It is very important that you completely fill in the data sheet

2.2 Preparation

Before beginning the observation and sampling procedures described below, first enter the Site Name, assigned Site Number, and Date on the first line of the Data Sheet, followed by the names of the Samplers participating in the testing. Then enter the following parameters on your data sheet:

- Recent Weather Events – Note any recent weather events (i.e., storms, wind, heavy runoff) or unusual environmental factors.
- Water Current – Observe the water current at the location where you will be towing the phytoplankton net. (If this is difficult to observe, it may be easier to estimate the current when using the Secchi disk.) Enter 0 for no current, L for a current of one to two knots, M for a current of three to four knots, or H for a current of five knots or greater.
- Wind Speed – Enter wind speed in knots (i.e., use Beaufort scale to estimate speed as explained in Appendix B) and wind direction.
- Time – Enter current time in military format (i.e., 24 hour format).

3.0 MEASURING THE WATER AND AIR TEMPERATURE

3.1 Required Equipment:

- Air Temperature Thermometer
- Armored Thermometer
- Water Sampling Bucket

3.2 Step-by-Step Procedure:

1. Check both thermometers for continuous fluid - no breaks.
2. Hang the air thermometer in a location above ground and out of the sun for at least three (3) minutes.
3. Rinse sampling bucket twice by filling it halfway and disposing of contents in an area **downstream** and **away from the sampling spot**. Let water flow through the tube in order to rinse it out and then clamp tube shut.
4. Take water sample with bucket at a depth of one to two feet, hang armored thermometer in bucket, and note the temperature reading after waiting at least three but no more than five minutes. Record the temperature value **to the nearest half degree using one decimal place** (e.g., 12.0 and 13.5 are OK – 12 is not). When reading the armored thermometer make sure the bottom of the thermometer remains in the water.
5. Record air temperature reading on the data sheet **to the nearest degree using no decimal points** (e.g., 16 or 18 is OK – 16.5 is not). Make sure to use the Celsius scale. If you have a thermometer that reads in Fahrenheit, you must convert Fahrenheit to Centigrade. To do this, first subtract 32 degrees from the Fahrenheit reading; then divide this result by 9 and multiply by 5.

4.0 MEASURING THE WATER TRANSPARENCY

4.1 Required Equipment:

- Secchi disk with line marked every five centimeters

4.2 Step-by-Step Procedure:

1. Take transparency readings at the same spot each time. If possible, stand with your back to the sun to shade the sampling spot. Do not wear a hat or sunglasses when taking these readings.
2. Lower the Secchi disk into the water until it just goes out of sight. Note depth to the closest five centimeters. Then raise the Secchi disk until it just reappears. Again, note the depth to the closest five centimeters. Record the average of the two depths to the nearest centimeter under Water Transparency on the data sheet. If the disk hits bottom and is still visible, record the water depth to the nearest five centimeters under Water Transparency. (In this case Water Depth and Water Transparency will be the same value.)
3. Lower the Secchi disk into the water until it hits bottom (i.e., the rope will go slack at this point) and note the water depth to the nearest five centimeters. Record this value under Water Depth on the data sheet.

5.0 MEASURING THE SALINITY

5.1 Required Equipment:

- Armored thermometer
- Hydrometer
- Hydrometer jar (500 ml cylinder)
- Hydrometer case with cork stopper

5.2 Step-by-Step Procedure:

1. Using water from the sampling bucket, fill the 500 ml cylinder to approximately one inch below the rim.
2. Hang the armored thermometer in the jar.
3. **Gently** insert the hydrometer with a twisting motion. This removes any air bubbles. Be sure not to drop the hygrometer into the jar because it could hit the bottom of the jar too hard and break.

> Note: The water temperature you measured in the sampling bucket in the "Measuring Water and Air Temperature Procedure" cannot be used for this test as it may have changed. You must measure the water temperature in the cylinder just before you read the hydrometer.

4. Level the cylinder so that the hydrometer is vertical and not touching the sides. Try to keep it out of the wind.
5. After three minutes, read the thermometer to the nearest 0.5º C and record on the data sheet using one decimal place (e.g., 12.5 and 14.0 are OK – 12 or 14 are not). Make sure the bottom of the thermometer remains in the water.
6. Remove the thermometer.
7. Read the density using the scale on the hydrometer, taking care to read at the bottom of the curve formed where the water rises slightly as it touches the sides of the hydrometer. (A magnifying glass may be helpful.) This curve is called the meniscus.
8. On your data sheet, show where the meniscus is by marking the "Reading the Hydrometer" diagram. Record the density reading on your field data sheet.

9. To determine the salinity use the five-page salinity table (see Appendix C). Locate your density reading in the left hand column and your recorded temperature across the top of the appropriate page. Then read down to the appropriate salinity value and record the result on your field data sheet using one decimal place.

Note: If you find the density or temperature reading to be a value ending in five, you will need to interpolate the result on the table. This is done by taking the average of the values immediately above and below the reading. For example, if the hydrometer read 1.0135, you would then take the salinity values for 1.0130 and 1.0140 and average them. Record the average using one decimal place. Round the average value as necessary.

6.0 MEASURING THE DISSOLVED OXYGEN

6.1 Required Equipment:

- 2 graduated burettes
- 2 glass rods
- 2 glass marbles
- 2 glass Wheaton DO/BOD bottles with stoppers
- 1 100 mL graduated cylinder
- 1 box manganese sulfate pillows (pillow #1)
- 1 box iodide-azide pillows (pillow #2)
- 1 bag sulfamic acid pillows (pillow #3)
- 1 pair scissors or clippers
- 1 bottle starch solution
- 1 dropper bottle sodium thiosulfate
- 1 plastic beaker
- 1 transfer pipette (optional)

6.2 Step-by-Step Procedure:

1. Insert flow tube from sample bucket into the BOD bottle, all the way to the bottom of bottle. Then let the water flow into the bottle by opening the clamp on the sampling bucket.
2. Keep track of the amount of time it takes to fill the bottle to the point of overflow (counting as it fills will be fine), and allow enough time for the bottle to have filled three times. Remove the flow tube from the bottle slowly before stopping the flow of water from the bucket. This ensures the bottle is full to the brim.
3. Examine sample to make sure no bubbles are trapped inside. Don't splash water out. Repeat step 2 until there are no bubbles. Temporarily replace glass stopper if carrying sample away from water's edge to do the procedure. Once a satisfactory sample has been collected, proceed to steps 4, 5, and 6.

> Note: Should powder stick to the neck of the bottle as a result of step 4 or 5 below, use the stopper to wet the neck and gently mix the powder in. Once you insert the stopper (some liquid will overflow), do not remove it until step 7.

4. Cut open the manganese sulfate powder (pillow # 1) and add to sample.

5. Cut open the alkaline iodide-azide powder **(**pillow #2**)** and add to sample.
6. Carefully add a small marble to the bottle. Replace the stopper while twisting it 1/4 turn to get a good seal. Place finger on top to hold the stopper on the bottle. Swirl bottle gently several times, using a circular wrist motion, to mix the reagents with water. A precipitate will form. Place sample aside and allow precipitate to settle to bottom half of bottle. Once precipitate has settled, repeat the mixing and settling process once to ensure the chemical reaction is complete.

> Note: Addition of the marble in step 6 has two benefits. It tops off the level of the liquid in the bottle, preventing formation of the air bubble can sometimes form between the liquid and the stopper. Also, the marble helps to mix the powered reagents when the bottle is swirled. The marble should be clean and added gently to prevent the possibility of introducing air into the bottle.

After finishing step 6, go on to your other tests while the precipitate is settling. Now that step 6 is complete, contact between the water sample and the atmosphere will not affect the test result. Once the sample has been "fixed" in this manner, it is not necessary to perform the actual test procedure immediately. Thus, several samples can be collected and "fixed" in the field, and then carried back to a testing station or laboratory where the titration procedure (steps 7 through 16 below) is to be performed. Make certain samples are kept cool if titrating later; however, the titration procedure must be completed within eight hours.

7. Cut open the sulfamic acid **(**pillow #3**)** and add to sample. Replace stopper and swirl to mix until all powdered reagents have dissolved. Look at the bottom of the bottle to see if there are crystals that look like grains of sugar. Continue to mix until all crystals are dissolved A clear yellow to brown-orange color will develop, depending on the oxygen content of the sample.
8. Pour 100 ml of the sample carefully into the clean 100 mL graduated cylinder. Tilt the cylinder and pour the sample carefully down the inside wall to avoid mixing bubbles into the sample. (The bubbles will not add dissolved oxygen to the water at this point, but can displace water and give you an incorrect measurement.) Tap the cylinder to remove any bubbles and make sure the meniscus is at 100 mL. If necessary, you may use a transfer pipette to obtain an exact volume of 100 ml. Then pour the

sample from the cylinder into the test beaker by carefully pouring down the inside wall of the beaker.

9. Fill burette to above the zero mark with sodium thiosulfate titrant and clear bubbles out of burette. Tap the burette to get rid of bubbles above the bead valve. Point the tip over your waste container and tap or squeeze the bead valve to remove the bubbles below the bead valve. Make sure liquid fills burette from tip to the zero mark. Refill to zero mark if necessary.
10. Slowly add sodium thiosulfate titrant to the test beaker containing the 100 mL sample, stirring as titrant is added. Stop titrating when the amber-colored solution in beaker begins to lighten to a light hay color. Place white paper under beaker to watch for the test color change in step 12.
11. Add eight drops of starch solution to beaker. Sample will turn a medium blue color.
12. Continue the titration process with the sodium thiosulfate remaining in the burette until test sample becomes colorless. Do not add any more titrant than is necessary to produce the color change. Be sure to stir sample after each drop is added.
13. Using the scale on the side of the burette, count the total number of mL of sodium thiosulfate used in the titration. Enter this number in the space provided on your data sheet.
14. Rinse out the beaker and repeat steps 8 through 13 on a second sample.
15. Record results of the second titration in the space provided on your data sheet.
16. Add the results of the two titrations (ml = mg/L) and enter the value on your data sheet.

> Note: These duplicate titrations are run to guard against analysis errors. If the DO result in the second titration is greater than 0.3 mL different from the first titration, a third titration must be performed. If less than 100 mL of the sample remains for the third titration, use 50 mL of the sample and double the result. Record all three results; however, add only the two results that are within 0.3 mL.

17. Once the DO testing has been completed, rinse the BOD bottle thoroughly. Also make sure glass marbles are cleaned and stored to prevent loss.

7.0 COLLECTING THE PHYTOPLANKTON

7.1 Required Equipment:

- Plankton net with nylon rope marked in meters

> Note: There are two types of nets, one with an open end and one with a collection jar taped to the end

- Canvas bag for storage of net
- Rubber bands
- Sturdy zip-lock plastic bags labeled with Site ID information

7.2 Step-by-Step Procedure:

> Note: The video CD provided with this manual shows you the proper techniques for collecting the phytoplankton sample.

1. If you have a net with the collection jar taped to the end, a rubber band around the outside of the bottle and the elasticized cuff will provide extra security. If you have a net with no collection jar, secure the end of the net by folding it back once and securing with a rubber band.
2. Submerge the net in the water and begin the tow. In order to get the net to "swim" properly, all air must be removed from the net. To do this, place the narrow end of the net in the water and let it sink slowly. As it sinks, it will force air out. If you try to put the open-end of the net under first you will trap air in the net. When the net gets close to being submerged, turn it sideways and let the open end sink towards the bottom.
3. You will know the water depth from the Secchi disk measurement. Using this value, let the head of the net sink to within one-half meter of the bottom and start to gently pull the net up to the surface. Sampling too close to the bottom will add an abundance of diatoms and sediment to your sample. Swim the net slowly to the surface. Just before reaching the surface (i.e., within the top one foot of the water column), relax pressure on the rope and allow the net to once again swim towards the bottom. Again, be careful not to let the net hit the bottom. Also, be careful not to let the net break the surface, as this will cause air to get trapped and prevent the net from sinking properly again.

4. Continue the tow for three minutes by swimming the net up and down as described in the previous step. (Three minutes has been selected as the standardized sampling time, and you will learn that at different times of the year that you will see varying amounts of collected sample in this standardized length of time.)
5. **If you are using a net without a collection bottle:** Once you have towed the net for three minutes, slowly pull the net out of the water. Place the cod-end inside a correctly labeled zip-lock plastic bag while there is still enough water in the net to fill the bag with about one inch of water. (Don't despair! This will become easier to estimate as you gain more experience.) Gently rinse the cod end in the collected water.
6. **If you are using a net with a collection bottle:** Once you have towed the net for three minutes, slowly pull the net out of the water. Turn the net inside out to gain access to the sample container, being careful to retain the contents. Pour the sample from the container into the a correctly labeled zip-lock bag. You may need an extra pair of hands for this part.

> Note: The collected sample should be examined immediately, if at all possible. (Fresh, live samples are the easiest to identify.) If the sample can't be examined immediately, it must be placed in a cooler for transport and examination at a later time.

8.0 ANALYZING THE PHYTOPLANKTON SAMPLE

8.1 Required Equipment:

- Field microscope with penlight
- Flat capillary tubes with container for storage
- Collected sample in zip-lock bag
- Blank data sheets and color identification sheets (see Appendices A and B)
- Identification book
- Bottle of Lugol's preservative
- Glass storage bottle for transporting Lugol's preserved sample
- Small cooler for transporting sample

8.2 Step-by-Step Procedure:

1. Prepare the field microscope for use. You will find instructions for the use and care of your microscope both in the microscope box and in your notebooks. Briefly, when setting up your scope you should:

   - Pull out eyepiece tube flange fully and twist it to the right to lock it into position.
   - If you need illumination, install the illuminator bracket as illustrated and insert the "Mini Mag-Lite". (You will certainly need illumination when working at 400X.)
   - Be sure that all screws are tightened securely, but not too securely.

   The filters have been positioned for you. In many of the scopes, there will be a small piece of paper visible near the filter. Please do not remove it, as this has been used to prevent the filter from falling out.

2. Prepare a capillary tube for examination under the microscope. The collected sample in zip-lock bag should first be gently swirled to re-suspend any material that has settled out. Submerge the end of a capillary tube in the sample until it fills with sample material. Then clip the tube to the microscope stage for examination.

3. Examine the contents of the tube by looking at three random fields of view using a magnification of 100X. Move the tube to the right or left under the microscope clips to obtain the three different fields of view. (The magnifications available with your field microscope are 40X, 100X,

and 400X.) **If there are too many phytoplankton cells to count at 100X, you may count using 400X but please note this on the data sheet.**

4. For each field of view examined, first note and record on the data sheet the total number of phytoplankton cells you observe. Then, note and record the total number of target cells you observe. Finally note and record the total number of each target cell type you observe. To increase the accuracy of the recorded observations, each sampler should make his or her own observations and keep the results confidential until everyone has examined the sample. After everyone has read the capillary tubes, discuss your results and record a consensus of opinion on the field sheet.

> Note: To identify particular species, use the color key sheets in Appendix D and/or the key sheet on the back of the data sheet. It will take some time before you become familiar with the different species and you will certainly see more than those shown in the key sheets. Certain species will be more prevalent than others, depending on the time of year. You will probably switch to 400X to help you in identifying certain species. Don't forget to switch back to 100X to do your counting.

5. Repeat steps 2 through 4 for another capillary tube sample.
6. Once all six fields of view have been examined and the results have been recorded, enter the totals for the six fields of view in the right hand column. Table I on the next page shows a sample completed data sheet for phytoplankton observations.
7. Note on the data sheet the dominant species observed. Also, there is space for you to add additional comments about any unusual observations. If you have seen unidentified species, include a description or drawing.

Table I. Example data sheet entry for phytoplankton observations.

Phytoplankton Sampling Counts	Tube 1			Tube 2			Grand Total
	View 1 100 400	View 2 100 400	View 3 100 400	View 1 100 400	View 2 100 400	View 3 100 400	
Total (all cells)	***9***	***7***	***11***	***7***	***12***	***8***	***54***
Total (target cells only)	***3***	***1***	***5***	***2***	***6***	***2***	***19***
Alexandrium tamarense	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Dinophysis acuminata	***2***	***0***	***3***	***1***	***3***	***2***	***11***
Dinophysis norvegica	***1***	***0***	***0***	***0***	***1***	***0***	***2***
Prorocentrum lima	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Pseudonitzschia spp.	***0***	***1***	***2***	***1***	***2***	***0***	***6***

1. In view 1 of the first tube, note that there were nine cells observed of which three were target cells. All three target cells were Dinophysis species.
2. In view 2 of the first tube, there were seven cells observed of which one was a target cell. This target cell was a Pseudonitzschia species.
3. Continuing over to the Grand Total column, note that there were a total of 54 cells observed of which 19 were target cells. Of the 19 target cells, 13 were Dinophysis spp. and 6 were Pseudonitzschia species.

Important: If you have noted potentially toxic target species or an abrupt increase in the level of previously reported target cells, contact the coordinator (see next page for contact info) as soon as possible so that the need for more intense monitoring can be evaluated.

Reminders:

1. Before drawing some of the collected sample into the capillary tube, make sure you gently mix the sample in the bag.
2. Make sure that your three capillary tube sample views are randomly chosen, i.e., do not purposefully select views that have interesting cells.
3. Once you have selected a random view, do not "expand" the view by moving the tube up or down

Congratulations! This completes the sampling process. Please note the time and mileage for each participating sampler at the bottom of the data sheet. Once the sheet has been completed, either fax it or deliver it to Kingman Farm as soon as is practical.

8.3 Sample Transport and Preservation

You may wish to transport your samples back to the lab or classroom for further identification. Samples should be kept cool and cross-contamination should be avoided. If samples are to be stored for a long period, buffered Lugol's iodine solution has been provided as a preservative. Use the glass storage bottle and add enough Lugol's to turn the sample a pale tea color. Glass containers are used for long term storage to protect the silica casings of the diatoms. Please be careful when handling the iodine solution. Use it in a well-ventilated area avoiding direct skin contact.

Again – thank you for your help! For information, please contact either of the below named persons:

Candace Dolan, Phytoplankton Program Coordinator
Work: 749-1565; Home: 926-7171; Cell: 978-375-9385
e-mail: candace.dolan@unh.edu

Ann Reid, GBCW Program Director
Work: 749-1565; Home: 749-3880
e-mail: ann.reid@unh.edu

9.0 MAINTAINING THE EQUIPMENT

Capillary tubes, nets, buckets, bottles and all sample containers should be thoroughly rinsed between sampling events. Capillary tubes can and should be reused. It is much easier to clean the tubes if you keep them wet until they can be washed. If you note a buildup of algae or dirt in one or more tubes, it will help to soak them in a weak bleach solution for a few minutes.

After sampling has been completed for the day, please rinse your nets thoroughly with fresh water and allow them to dry. Wipe down the microscope to prevent contaminants and salt spray from drying on the exposed surfaces.

Never store the microscope in your kit near wet equipment!!!

Before closing up the kit for future use, inventory the contents so that any necessary replacement parts, fresh batteries, capillary tubes, chemicals, etc. can be obtained prior to the next sampling event.

Phytoplankton Data Sheet

Appendix A

Great Bay Coast Watch, UNH Kingman Farm, Durham, NH 03824 Phone: 603-749-1565; Fax 603-743-3997

Site Name: _____ Site #: _____ Date: _____

Recent storm, wind event, or runoff? Yes ☐ No ☐ Excessive foam in water? Yes ☐ No ☐

Any noticeable color change in water? Yes ☐ No ☐ If Yes, note color of water _____

Water Current (0, L, M, H)	Wind Speed/Direction (knots) speed	direction	Time (military)	Air Temp (°C)	Water Transparency (cm)	Water Depth (cm)	Water Temp (°C)

Water Temp in Cylinder (°C)	Water Density (g/cc)	Salinity From Chart (ppt)	Tow Depth (m)	Tow Duration (min)	Dissolved Oxygen (ppm) Test 1	Test 2	Test 3	Total

Phytoplankton Sampling Counts:	Tube 1						Tube 2						Grand Total
	View 1		View 2		View 3		View 1		View 2		View 3		
	100	400	100	400	100	400	100	400	100	400	100	400	
Total (all cells)													
Total (target cells only)													
Alexandrium tamarense													
Dinophysis acuminata													
Dinophysis norvegica													
Prorocentrum lima													
Pseudonitzschia spp.													

Dominant Species: _____

Comments: _____

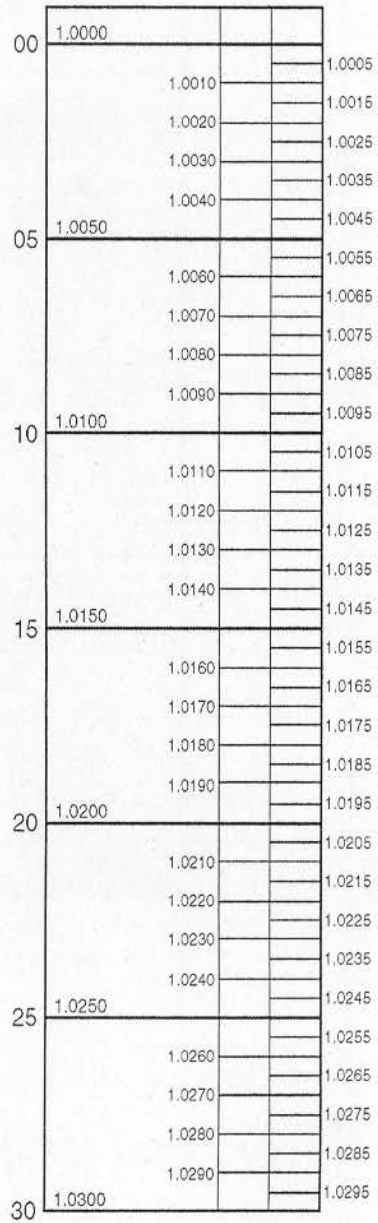
Time & Mileage Statistics:

Sampler 1 – name _____ time _____ mileage _____

Sampler 2 – name _____ time _____ mileage _____

Sampler 3 – name _____ time _____ mileage _____

Reading the Hydrometer

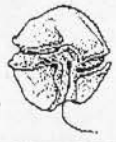
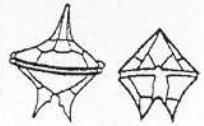
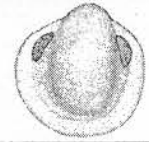


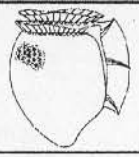
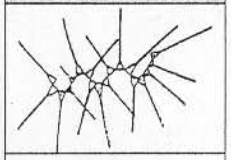
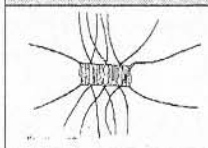
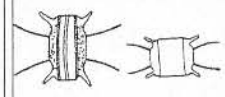
Revised 4/20/04

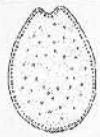
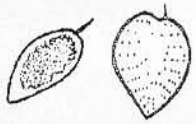
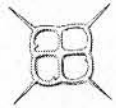
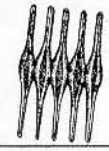
Target Species

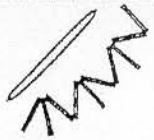
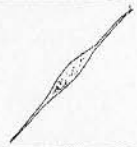
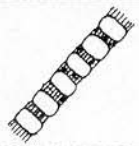
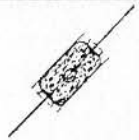
COMMON PHYTOPLANKTON KEY

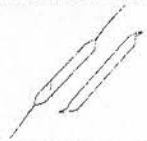
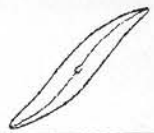
OTHER COMMON PLANKTON (non-phyto)

Alexandrium spp. AL	*Gymnodinium spp.* GY	*Gonyaulax spinifera* GS	*Protoperidinium spp.* PT	*Scripsiella spp.* SC	*Cocinodiscus spp.* CO	*Odontella spp.* OD	*Larval Clam* LC
							
25-46 µm	24-50 µm	25-50 µm	50-95 µm	20-37 µm	40-500 µm	45-70 µm	Generally Large

Dinophysis norvegica DN	*Dinophysis acuminata* DA	*Dinophysis tripos* DT	*Asterionellopsis spp.* AS	*Chaetoceros spp.* CH	*Chaetoceros socialis* CS	*Biddulphia spp.* BD	*Rotifer spp.* RO
							
48-80 µm	40 - 50 µm	40 - 120 µm	30-150 µm	10 - 53 µm	3-15 µm	60 - 160 µm	Generally Large

Prorocentrum lima PL	*Prorocentrum micans* PM	*Ceratium fusus* CF	*Ceratium lineatum* CL	*Ceratium longipes* CP	*Dictyocha spp.* DO	*Fragilaria spp.* FR	*Pollen Grain* PG
							
31-47 µm	35-70 µm	200-540 µm	100-130 µm	150-250 µm	10-45 µm	10 - 70 µm	Generally Large

Pseudonitzschia PS	*Thalassionema spp.* TA	*Thalassiosira spp.* TL	*Nitzschia spp.* NZ	*Skeletonema spp.* SK	*Ditylum spp.* DM	*Leptocylindrus spp.* LP	*Crab Zoea* CZ
							
64-117 µm	16 - 90 µm	12-39 µm	60 - 125 µm	2-21 µm	80 - 130 µm	30 - 75 µm	Generally Large

Species Name CODE	*Rhizosolenia spp.* RH	*Gyrosigma spp.* GY	*Navicula spp.* NV	*Melosira spp.* ML	*Guinardia spp.* GN	*Eucampia spp.* EU	*Tintinnid spp.* TN
(Guide to using key) *illustration of organism*							
Size Range (in µm)	25-57 µm	110 - 175 µm	32-49 µm	10-50 µm	60 - 160 µm	10-33 µm	Generally Large

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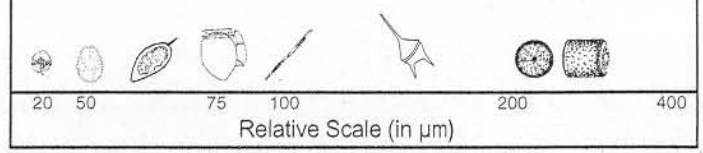

Appendix B

The Beaufort Scale

The Beaufort scale was originally devised in order to estimate wind speeds while at sea without the necessity of instruments. This is done by noting the condition of the sea and using this observation to approximate the wind speed. The following table relates sea state to wind speed.

Beaufort Force No.	Wind Speed (knots)	Description of Sea Conditions
0	<1	Calm, sea like a mirror.
1	1-3	Light air, ripples only.
2	4-6	Light breeze, small wavelets (0.2 m). Crests have a glassy appearance.
3	7-10	Gentle breeze, large wavelets (0.6 m), crests begin to break.
4	11-16	Moderate breeze, small waves (1 m), some white horses.
5	17-21	Fresh breeze, moderate waves (1.8 m), many white horses.
6	22-27	Strong breeze, large waves (3 m), probably some spray.
7	28-33	Near gale, mounting sea (4 m) with foam blown in streaks downwind.
8	34-40	Gale, moderately high waves (5.5 m), crests break into spindrift.
9	41-47	Strong gale, high waves (7 m), dense foam, visibility affected.
10	48-55	Storm, very high waves (9 m), heavy sea roll, visibility impaired. Surface generally white.
11	56-63	Violent storm, exceptionally high waves (11 m), visibility poor.
12	64+	Hurricane, 14 m waves, air filled with foam and spray, visibility bad.

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	-1.0	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
1.0000										
1.0010	0.6	0.6	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2
1.0020	1.9	1.9	1.8	1.6	1.6	1.6	1.5	1.5	1.6	1.6
1.0030	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.8	2.9
1.0040	4.4	4.2	4.2	4.1	4.1	4.1	4.1	4.1	4.1	4.2
1.0050	5.7	5.5	5.4	5.4	5.4	5.3	5.3	5.4	5.4	5.4
1.0060	6.8	6.8	6.7	6.6	6.6	6.6	6.6	6.6	6.7	6.7
1.0070	8.1	8.0	7.9	7.9	7.9	7.9	7.9	7.9	7.9	8.0
1.0080	9.3	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.2	9.3
1.0090	10.5	10.5	10.4	10.4	10.4	10.4	10.4	10.5	10.5	10.6
1.0100	11.8	11.7	11.7	11.7	11.7	11.7	11.7	11.7	11.8	11.8
1.0110	13.0	13.0	12.8	12.8	12.8	12.8	13.0	13.0	13.1	13.1
1.0120	14.3	14.1	14.1	14.1	14.1	14.1	14.1	14.3	14.3	14.4
1.0130	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.6	15.7
1.0140	16.7	16.6	16.6	16.6	16.6	16.6	16.7	16.7	16.9	17.0
1.0150	17.9	17.9	17.9	17.9	17.9	17.9	17.9	18.0	18.0	18.2
1.0160	19.2	19.1	19.1	19.1	19.1	19.2	19.2	19.3	19.3	19.5
1.0170	20.4	20.4	20.4	20.4	20.4	20.4	20.5	20.5	20.6	20.8
1.0180	21.7	21.7	21.6	21.6	21.7	21.7	21.7	21.8	22.0	22.1
1.0190	22.9	22.9	22.9	22.9	22.9	23.0	23.0	23.1	23.3	23.4
1.0200	24.2	24.2	24.0	24.2	24.2	24.2	24.3	24.3	24.4	24.6
1.0210	25.3	25.3	25.3	25.3	25.5	25.5	25.6	25.6	25.7	25.9
1.0220	26.6	26.6	26.6	26.6	26.6	26.8	26.8	26.9	27.0	27.2
1.0230	27.8	27.8	27.8	27.8	27.9	27.9	28.1	28.2	28.3	28.5
1.0240	29.1	29.1	29.1	29.1	29.1	29.2	29.4	29.5	29.5	29.8
1.0250	30.3	30.3	30.3	30.4	30.4	30.6	30.6	30.7	30.8	30.9
1.0260	31.6	31.6	31.6	31.6	31.7	31.7	31.9	32.0	32.1	32.2
1.0270	32.8	32.8	32.9	32.9	32.9	33.0	33.2	33.3	33.4	33.5
1.0280	34.1	34.1	34.1	34.1	34.2	34.3	34.5	34.5	34.7	34.8
1.0290	35.2	35.2	35.4	35.4	35.5	35.5	35.6	35.8	35.9	36.2
1.0300	36.5	36.5	36.5	36.7	36.7	36.8	36.9	37.1	37.2	37.3
1.0310	37.7	37.7	37.8	37.8	38.0	38.1	38.2	38.4	38.5	38.6

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	9.0	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0
1.0000								0.0	0.2	0.3
1.0010	0.5	0.5	0.6	0.6	0.7	0.8	1.0	1.2	1.5	1.6
1.0020	1.6	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.8	2.9
1.0030	2.9	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.1	4.2
1.0040	4.2	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.4	5.5
1.0050	5.5	5.5	5.7	5.8	5.9	6.2	6.3	6.6	6.7	7.0
1.0060	6.8	6.8	7.0	7.1	7.2	7.5	7.6	7.9	8.0	8.3
1.0070	8.1	8.1	8.3	8.4	8.5	8.8	8.9	9.2	9.3	9.6
1.0080	9.3	9.4	9.6	9.7	9.8	10.0	10.2	10.5	10.6	10.9
1.0090	10.6	10.7	10.9	11.0	11.1	11.3	11.5	11.8	11.9	12.2
1.0100	11.9	12.0	12.2	12.3	12.4	12.6	12.8	13.1	13.2	13.5
1.0110	13.2	13.4	13.5	13.6	13.7	13.9	14.1	14.4	14.5	14.8
1.0120	14.5	14.7	14.8	14.9	15.0	15.2	15.4	15.7	15.8	16.1
1.0130	15.8	15.8	16.0	16.2	16.3	16.5	16.7	17.0	17.1	17.4
1.0140	17.0	17.1	17.3	17.5	17.7	17.8	18.0	18.3	18.6	18.7
1.0150	18.3	18.4	18.6	18.8	19.0	19.1	19.3	19.6	19.9	20.0
1.0160	19.6	19.7	19.9	20.1	20.3	20.4	20.6	20.9	21.2	21.3
1.0170	20.9	21.0	21.2	21.3	21.6	21.7	22.0	22.2	22.5	22.7
1.0180	22.2	22.3	22.5	22.6	22.9	23.0	23.3	23.5	23.8	24.0
1.0190	23.5	23.6	23.8	23.9	24.2	24.3	24.6	24.8	25.1	25.3
1.0200	24.7	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.4	26.6
1.0210	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.4	27.7	27.9
1.0220	27.3	27.4	27.7	27.8	28.1	28.2	28.5	28.7	29.0	29.2
1.0230	28.6	28.7	28.9	29.1	29.4	29.5	29.8	30.0	30.3	30.6
1.0240	29.9	30.0	30.2	30.4	30.6	30.8	31.1	31.3	31.6	31.9
1.0250	31.1	31.3	31.5	31.7	31.9	32.1	32.4	32.6	32.9	33.2
1.0260	32.4	32.6	32.8	33.0	33.2	33.4	33.7	33.9	34.2	34.5
1.0270	33.7	33.9	34.1	34.3	34.5	34.7	35.0	35.2	35.5	35.8
1.0280	35.0	35.1	35.4	35.6	35.8	36.0	36.3	36.5	36.8	37.1
1.0290	36.3	36.4	36.7	36.8	37.1	37.3	37.6	37.8	38.1	38.4
1.0300	37.6	37.7	38.0	38.1	38.4	38.6	38.9	39.1	39.4	39.7
1.0310	38.9	39.0	39.3	39.4	39.7	39.9	40.2	40.5	40.7	41.0

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0
0.9990							0.0	0.1	0.2	0.3
1.0000	0.5	0.6	0.7	0.8	1.0	1.1	1.2	1.4	1.5	1.6
1.0010	1.8	1.9	2.0	2.1	2.3	2.4	2.5	2.5	2.7	2.8
1.0020	3.1	3.2	3.3	3.4	3.6	3.7	3.8	4.0	4.1	4.2
1.0030	4.4	4.5	4.6	4.8	4.9	5.0	5.1	5.3	5.4	5.5
1.0040	5.7	5.8	5.9	6.1	6.2	6.3	6.4	6.6	6.7	7.0
1.0050	7.1	7.1	7.2	7.4	7.5	7.6	7.7	7.9	8.1	8.3
1.0060	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.4	9.6
1.0070	9.7	9.8	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9
1.0080	11.0	11.1	11.3	11.4	11.5	11.7	11.8	11.9	12.0	12.2
1.0090	12.3	12.4	12.6	12.7	12.8	13.0	13.1	13.2	13.4	13.6
1.0100	13.6	13.7	13.9	14.0	14.1	14.3	14.4	14.5	14.8	14.9
1.0110	14.9	15.0	15.2	15.3	15.4	15.6	15.7	16.0	16.1	16.2
1.0120	16.2	16.3	16.5	16.6	16.7	17.0	17.1	17.3	17.4	17.5
1.0130	17.5	17.7	17.8	17.9	18.0	18.3	18.4	18.6	18.7	18.8
1.0140	18.8	19.0	19.1	19.3	19.5	19.6	19.7	19.9	20.0	20.1
1.0150	20.1	20.4	20.5	20.6	20.8	20.9	21.0	21.2	21.3	21.6
1.0160	21.4	21.7	21.8	22.0	22.1	22.2	22.3	22.5	22.7	22.9
1.0170	22.9	23.0	23.1	23.3	23.4	23.5	23.6	23.8	24.0	24.2
1.0180	24.2	24.3	24.4	24.6	24.7	24.8	24.9	25.2	25.3	25.5
1.0190	25.5	25.6	25.7	25.9	26.0	26.1	26.4	26.5	26.6	26.8
1.0200	26.8	26.9	27.0	27.2	27.3	27.4	27.7	27.8	27.9	28.2
1.0210	28.1	28.2	28.3	28.5	28.6	28.9	29.0	29.1	29.2	29.5
1.0220	29.4	29.5	29.6	29.8	30.0	30.2	30.3	30.4	30.7	30.8
1.0230	30.7	30.8	30.9	31.2	31.3	31.5	31.6	31.7	32.0	32.1
1.0240	32.0	32.1	32.2	32.5	32.6	32.8	32.9	33.2	33.3	33.4
1.0250	33.3	33.4	33.7	33.8	33.9	34.1	34.2	34.5	34.6	34.7
1.0260	34.6	34.7	35.0	35.1	35.2	35.4	35.6	35.8	35.9	36.0
1.0270	35.9	36.2	36.3	36.4	36.5	36.7	36.9	37.1	37.2	37.5
1.0280	37.2	37.5	37.6	37.7	37.8	38.1	38.2	38.4	38.5	38.8
1.0290	38.6	38.8	38.9	39.0	39.1	39.4	39.5	39.7	39.9	40.1
1.0300	39.9	40.1	40.2	40.3	40.6	40.7	40.8	41.0	41.2	41.4
1.0310	41.2	41.4	41.5	41.8	41.9	42.0	42.1	42.3	42.5	

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0
0.9980							0.1	0.2	0.3	0.6
0.9990	0.5	0.6	0.7	0.8	1.0	1.2	1.4	1.5	1.8	1.9
1.0000	1.8	1.9	2.0	2.1	2.4	2.5	2.7	2.9	3.1	3.2
1.0010	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5
1.0020	4.4	4.6	4.8	4.9	5.0	5.1	5.4	5.5	5.7	5.9
1.0030	5.8	5.9	6.1	6.2	6.3	6.6	6.7	6.8	7.1	7.2
1.0040	7.1	7.2	7.4	7.5	7.7	7.9	8.0	8.3	8.4	8.5
1.0050	8.4	8.5	8.7	8.9	9.1	9.2	9.3	9.6	9.7	10.0
1.0060	9.7	9.8	10.1	10.2	10.4	10.5	10.7	10.9	11.0	11.3
1.0070	11.0	11.3	11.4	11.5	11.7	11.9	12.0	12.2	12.4	12.6
1.0080	12.4	12.6	12.7	12.8	13.0	13.2	13.4	13.6	13.7	13.9
1.0090	13.7	13.9	14.0	14.1	14.4	14.5	14.7	14.9	15.0	15.3
1.0100	15.0	15.2	15.3	15.6	15.7	15.8	16.1	16.2	16.5	16.6
1.0110	16.3	16.5	16.7	16.9	17.0	17.3	17.4	17.5	17.8	17.9
1.0120	17.7	17.9	18.0	18.2	18.3	18.6	18.7	19.0	19.1	19.3
1.0130	19.1	19.2	19.3	19.5	19.7	19.9	20.0	20.3	20.4	20.6
1.0140	20.4	20.5	20.6	20.9	21.0	21.2	21.4	21.6	21.8	22.0
1.0150	21.7	21.8	22.0	22.2	22.3	22.5	22.7	22.9	23.1	23.3
1.0160	23.0	23.3	23.4	23.5	23.6	23.9	24.0	24.3	24.4	24.7
1.0170	24.3	24.6	24.7	24.8	25.1	25.2	25.3	25.6	25.7	26.0
1.0180	25.6	25.9	26.0	26.1	26.4	26.5	26.8	26.9	27.2	27.3
1.0190	27.0	27.2	27.3	27.6	27.7	27.8	28.1	28.2	28.5	28.6
1.0200	28.3	28.5	28.6	28.9	29.0	29.2	29.4	29.6	29.8	30.0
1.0210	29.6	29.8	30.0	30.2	30.3	30.6	30.7	30.9	31.1	31.3
1.0220	30.9	31.2	31.3	31.5	31.7	31.9	32.0	32.2	32.5	32.6
1.0230	32.2	32.5	32.6	32.8	33.0	33.2	33.4	33.5	33.8	33.9
1.0240	33.7	33.8	33.9	34.2	34.3	34.5	34.7	35.0	35.1	35.4
1.0250	35.0	35.1	35.2	35.5	35.6	35.9	36.0	36.3	36.4	36.7
1.0260	36.3	36.4	36.7	36.8	36.9	37.2	37.3	37.6	37.7	38.0
1.0270	37.6	37.8	38.0	38.1	38.4	38.5	38.8	38.9	39.1	39.3
1.0280	38.9	39.1	39.3	39.4	39.7	39.8	40.1	40.2	40.5	40.7
1.0290	40.2	40.5	40.6	40.8	41.0	41.2	41.4	41.6	41.8	
1.0300	41.6	41.8	41.9							
1.0310										

Table 1. Salinity in parts per thousand (ppt)

NOTE: This table is designed for use with 60°/60°F hydrometer.

Observed	Temperature of Water in Graduated Cylinder (°C)									
Reading	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0	32.5	33.0
0.9980	0.7	0.8	1.1	1.2	1.5	1.6	1.9	2.0	2.3	2.4
0.9990	2.0	2.3	2.4	2.5	2.8	2.9	3.2	3.4	3.6	3.8
1.0000	3.4	3.6	3.7	4.0	4.1	4.4	4.5	4.8	4.9	5.1
1.0010	4.8	4.9	5.1	5.1	5.4	5.5	5.8	5.9	6.2	6.4
1.0020	6.1	6.3	6.4	6.6	6.8	7.0	7.2	7.5	7.6	7.9
1.0030	7.4	7.6	7.7	8.0	8.1	8.4	8.5	8.8	9.1	9.2
1.0040	8.8	8.9	9.2	9.3	9.6	9.7	10.0	10.1	10.4	10.5
1.0050	10.1	10.2	10.5	10.6	10.9	11.0	11.3	11.5	11.7	11.9
1.0060	11.4	11.7	11.8	12.0	12.2	12.4	12.6	12.8	13.1	13.2
1.0070	12.8	13.0	13.1	13.4	13.6	13.7	14.0	14.1	14.4	14.7
1.0080	14.1	14.3	14.5	14.7	14.9	15.2	15.3	15.6	15.7	16.0
1.0090	15.4	15.7	15.8	16.1	16.2	16.5	16.6	16.9	17.1	17.3
1.0100	16.7	17.0	17.1	17.4	17.5	17.8	18.0	18.2	18.4	18.7
1.0110	18.2	18.3	18.6	18.7	19.0	19.1	19.3	19.6	19.7	20.0
1.0120	19.5	19.6	19.9	20.1	20.3	20.5	20.6	20.9	21.2	21.3
1.0130	20.8	21.0	21.2	21.4	21.6	21.8	22.1	22.2	22.5	22.7
1.0140	22.2	22.3	22.6	22.7	23.0	23.1	23.4	23.6	23.8	24.0
1.0150	23.5	23.6	23.9	24.0	24.3	24.6	24.7	24.9	25.2	25.3
1.0160	24.8	25.1	25.2	25.5	25.6	25.9	26.1	26.3	26.5	26.8
1.0170	26.1	26.4	26.5	26.8	27.0	27.2	27.4	27.7	27.8	28.1
1.0180	27.6	27.7	27.9	28.1	28.3	28.5	28.7	29.0	29.2	29.4
1.0190	28.9	29.0	29.2	29.5	29.6	29.9	30.0	30.3	30.6	30.8
1.0200	30.2	30.4	30.6	30.8	30.9	31.2	31.5	31.6	31.9	32.1
1.0210	31.5	31.7	32.0	32.1	32.4	32.5	32.8	33.0	33.3	33.4
1.0220	32.9	33.0	33.3	33.4	33.7	33.9	34.1	34.3	34.6	34.8
1.0230	34.2	34.5	34.6	34.8	35.0	35.2	35.5	35.6	35.9	36.2
1.0240	35.5	35.8	35.9	36.2	36.4	36.5	36.8	37.1	37.2	37.5
1.0250	36.8	37.1	37.2	37.5	37.7	37.8	38.1	38.4	38.6	38.8
1.0260	38.2	38.4	38.6	38.8	39.0	39.3	39.4	39.7	39.9	40.2
1.0270	39.5	39.8	39.9	40.2	40.3	40.6	40.8	41.0	41.2	41.5
1.0280	40.8	41.1	41.2	41.5						

Appendix D

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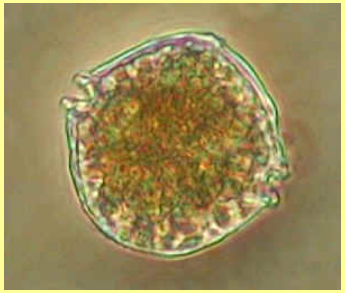
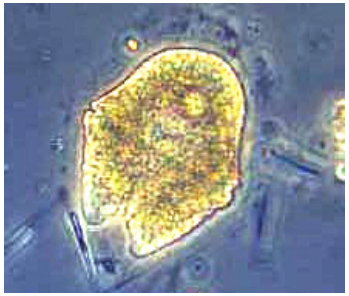
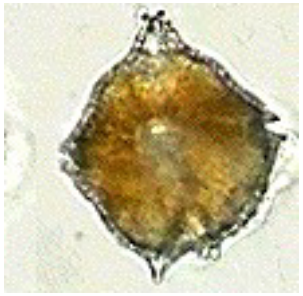
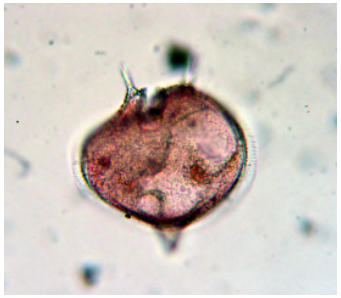
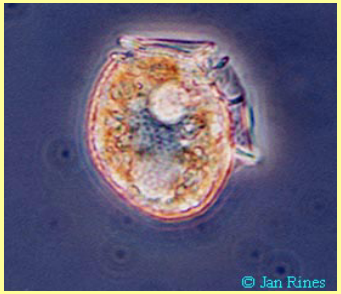
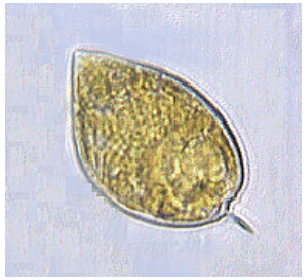
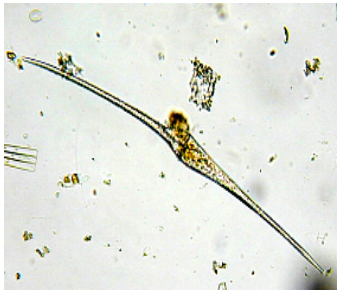
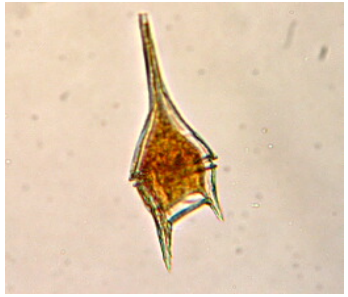
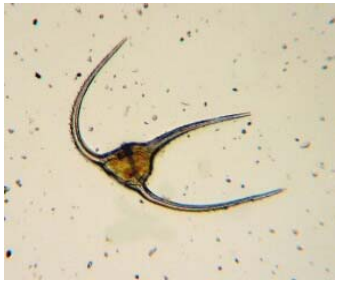
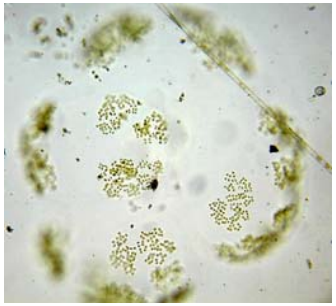
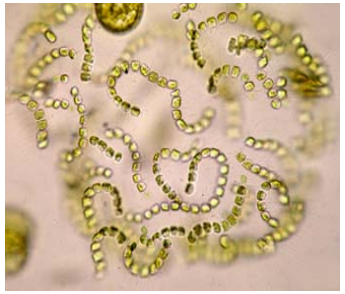
 **Alexandrium tamarense (AT) (400x)**	 **Gymnodinium sanguineum (GS) (400x)**	 **Gonyaulax spinifera (GP) (400x)**	 **Protoperidinium spp (PP) (400x)**	 **Scrippsiella spp (SS) (400x)**
 **Dinophysis norvegica (DN) (400x)**	 **Dinophysis acuminata (DA) (400x)**	 **Dinophysis tripos (DT)(400x)**	 **Prorocentrum lima (PL) (400x)**	 **Prorocentrum micans (PM) (400x)**
 **Ceratium fusus (CF) (100x)**	 **Ceratium lineatum (CL) (100x)**	 **Ceratium longipes (CP) (100x)**	 **Phaeocystis spp (PC) (100x)**	 **Chaetoceros socialis (CS) (100x)**

Note: Species with light yellow shading around potentially produce harmful toxins.

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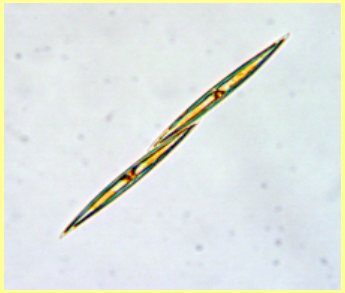
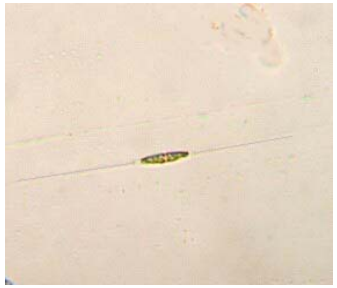
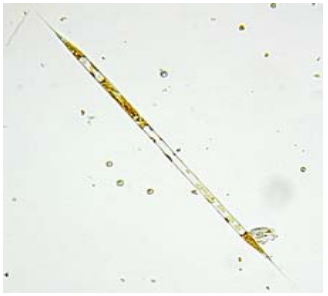
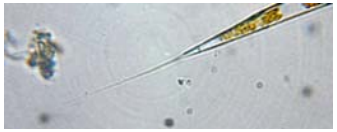
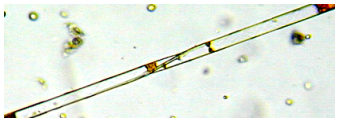
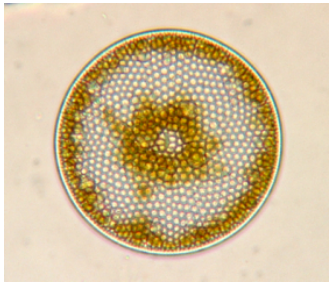
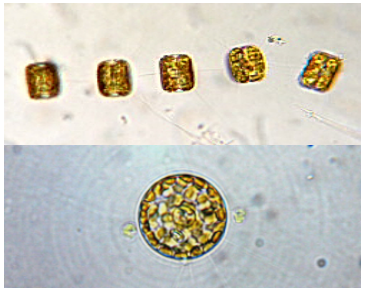
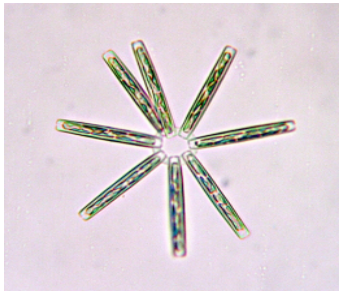
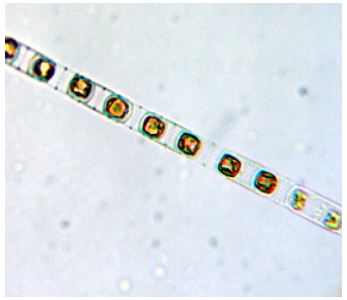
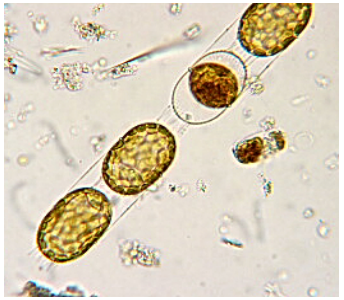
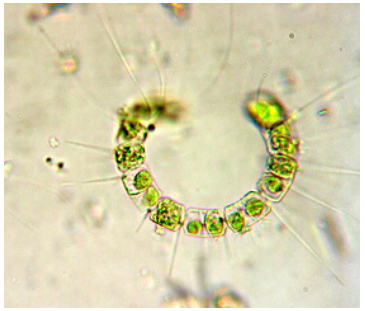
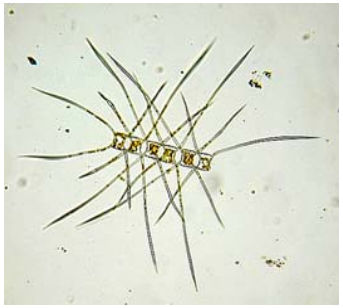
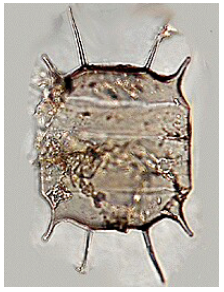
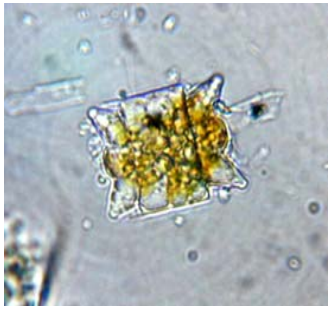
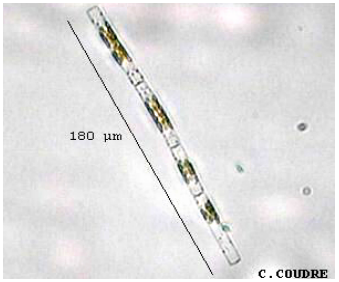
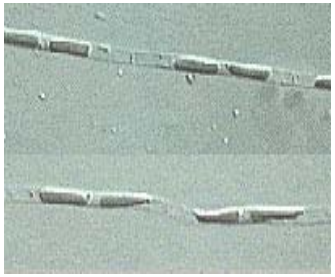
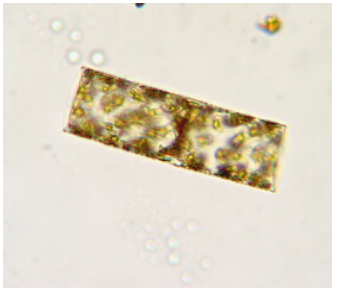
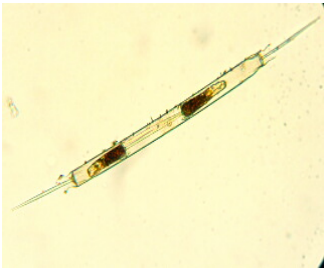
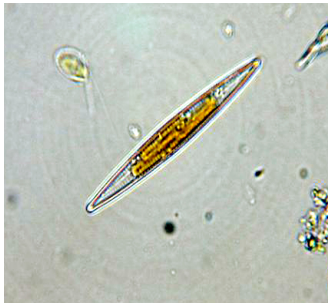
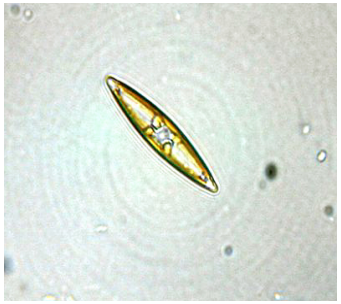
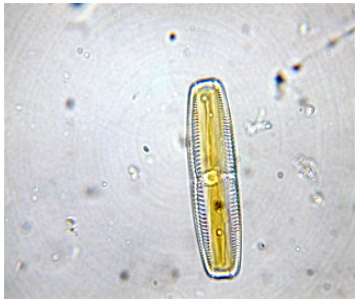
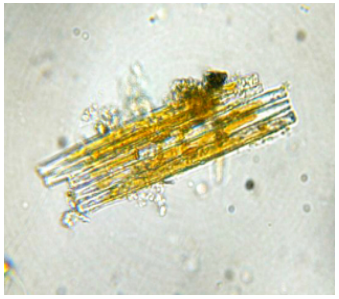
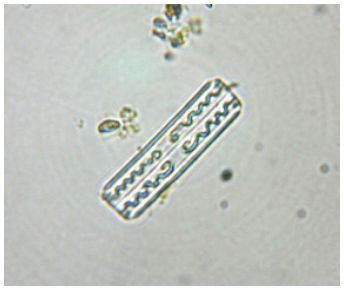
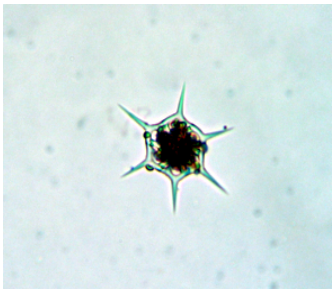
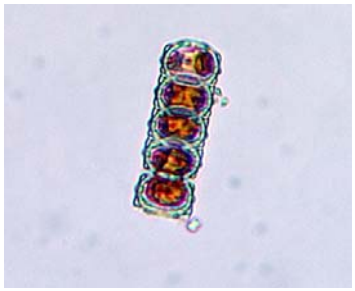
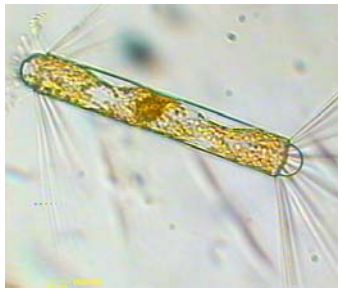
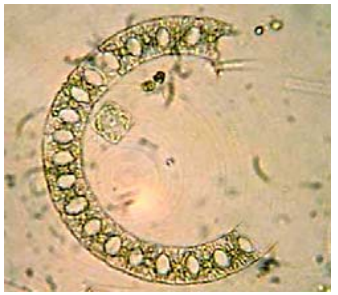
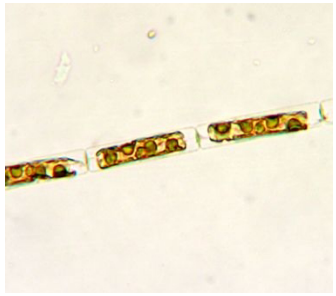
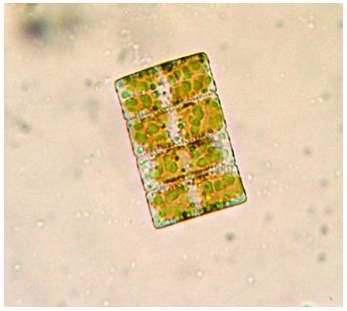
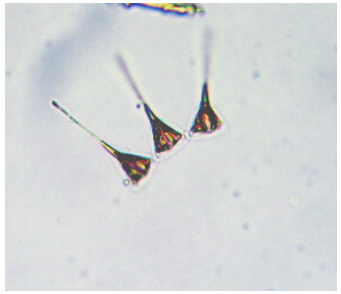
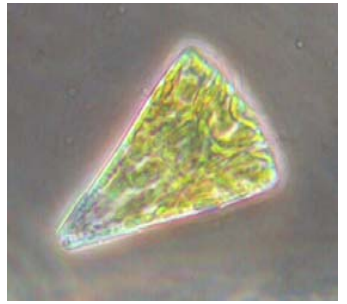
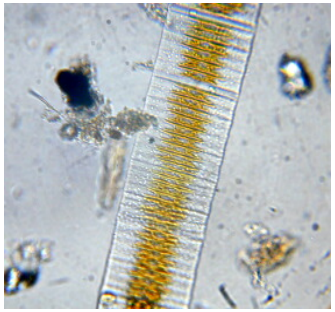
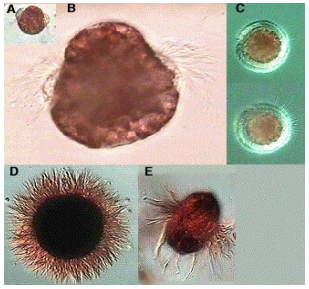
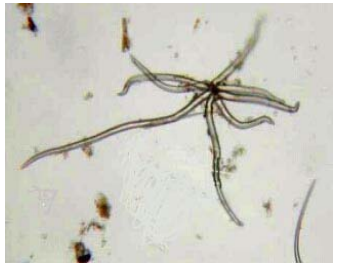
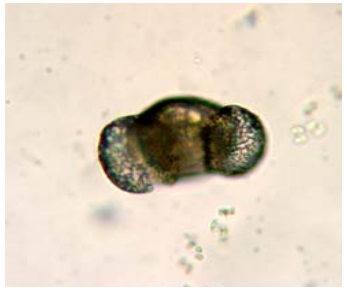
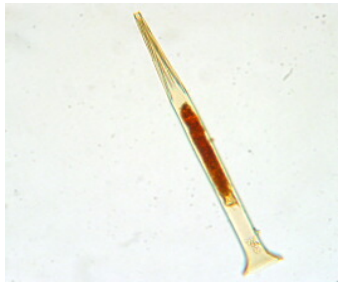
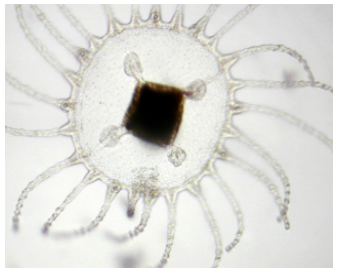
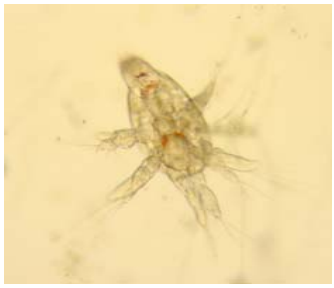
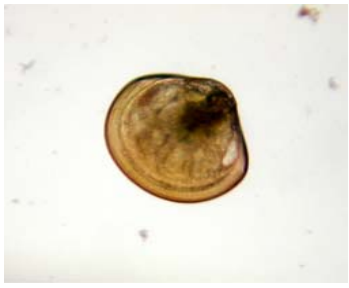
 **Pseudonitzschia spp (PN) (100x)**	 **Pseudonitzschia delicatissima (PD) (400x)**	 **Cylindrotheca closterium (CY) (400x)**	 **Rhizosolenia spp (RH) (100x)**	 **Rhizosolenia end (400x)**  **Rhizosolenia junction (400x)**
 **Coscinodiscus spp (CD) (400x) valve view**	 **Thalassiosira spp (TS) (400x) girdle view(tp)/valve view(btm)**	 **Thalassionema nitzschiodes (TN) (400x)**	 **Skeletonema costatum (SC) (400x)**	 **Stephanopyxis spp (SP) (400x)**
 **Chaetoceros spp (CC) (100x)**	 **Chaetoceros spp (CC) (100x)**	 **Chaetoceros spp (CC) (100x)**	 **Biddulphia spp (BD) (400x)**	 **Odontella spp (OD) (400x)**

Note: Species with light yellow shading around potentially produce harmful toxins.

Common Gulf of Maine Phytoplankton (page 3 of 4)

 **Leptocylindrus danicus (LD) (400x)**	 **Leptocylindrus minimus (LM) (400x)**	 **Melosira spp (MS) (400x)**	 **Guinardia flaccida (GF) (400x)**	 **Ditylum brightwelli (DB) (100x)**
 **Navicula spp (NC) (400x)**	 **Navicula spp (NC) (400x)**	 **Navicula spp (NC) (400x)**	 **Bacillaria paradoxa (BP) (400x)**	 **Pleurosigma spp (PG) (400x)**
 **Grammatophore spp (GM) (400x)**	 **Dictyocha spp (DY) (400x)**	 **Paralia sulcata (PS) (400x)**	 **Corethron spp (CR) (400x)**	 **Eucampia spp (EC) (400x)**

Common Gulf of Maine Phytoplankton (page 4 of 4)

 **Dactyliosolen spp (DS) (400x)**	 **Detonula spp (DL) (400x)**	 **Fragilariopsis spp (FG) (400x)**	 **Asterionellopsis spp (AS) (400x)**	 **Licmophora spp (LC) (400x)**
 **Fragilariopsis spp (FG)(400x)**	 **Mesodinium rubrum (MR) (400x)**	 **Trichome (not plankton) (TC) (100x)**	 **Pollen (not plankton) (ZP) (100x)**	 **Tintinid (zooplankton) (ZT) (100x)**
 **Obelia (zooplankton) (OB) (100x)**	 **C. nauplii (zooplankton) (ZN) (100x)**	 **Bivalve larva (zooplankton) (ZC) (100x)**	 **Copepod – side view (zooplankton) (CO) (100x)**	 **Copepod – top view (zooplankton) (CO) (100x)**

Photos by S. Cooper except: C. Coudre (LD), C.Dolan (ZC,OB,TC), K. Embleton (GS,SS), A. Godhe (GP), S. Hedrick (GS), Rebecca Jones (CO), B. Karlson, (DT,LM,MR), G. Larsen (AT), L. Maranda (PL), J. Parmentier (CS), J. Rines (DA), M. Webber (LC), Unknown (BD,CO,CR,EC,PM)

1/17/2006