THE FLOATING LAB RESOURCE MANUAL

(Written for grades 7 - 12)

Michael J. Brody
B. Sharon Meeker

Edited by Frank O. Smith

Report No.: UNH-MP-AR-SG-83-3

The publication of this material is supported by the NOAA Office of Sea Grant, Department of Commerce, under Grant No. NA-81-AA-D-00035. The U.S. Government is authorized to produce and distribute reprints for governmental purposes, any copyright notation that may appear hereon notwithstanding.

Sea Grant Marine Advisory Program
University of New Hampshire
Durham, N.H. 03824, U.S.A.

April, 1983

Preface

New Hampshire's coast--its marshes, estuaries, beaches, rocky shoreline and open ocean--has been a vital resource since colonial times, and continues to provide food, transportation, jobs, recreation and an attractive place to live. Population growth, increasing utilization of this area's resources, and probable impacts of offshore oil development place the future of the coast in jeopardy. Vital decisions will be made in the next few decades by the students who are in our schools today. By increasing their knowledge and appreciation of our coastal resources, we can ensure that those decisions will be enlightened ones and that the future of New Hampshire's coast will be a bright one.

Since 1977, the Sea Grant Marine Advisory Program at UNH has sponsored the Floating Lab: an opportunity for students to have "hands-on" experiences aboard a 70-foot vessel outfitted with various kinds of oceanographic sampling equipment. More specifically, the Floating Lab program enables students to observe physical ocean processes such as waves, currents, and tides, as well as living organisms. They learn to take samples, collect data, and analyze their data in meaningful ways. They examine the various ecosystems found in the Hampton area and become aware of human impact on them. Through the Floating Lab experience, students are exposed to marine career possibilities, learn something of oceanographic research and methods, and develop an awareness of the richness of the coastal environment.

Acknowledgements

We would like to acknowledge our debt to the research and advances in marine education made by the following:

Blue-Water Marine Laboratory, University of Hawaii
Gulf of Maine Marine Education Association (GOMEA)
Jackson Estuarine Laboratory, UNH
Los Angeles County Marine Science Floating Laboratory
Massachusetts Marine Educators
Normandeau Associates, Inc.
Odiorne Point (NH) Interpretive Center
Project Oceanology, Groton, Connecticut
Public Service Company of New Hampshire
UNH Floating Lab, 1977-79
Sea Grant Marine Advisory Program at UNH

For their review and critical comments on this manual, we are grateful to Robert Croker, UNH Professor of Zoology, and to Robert E. Goode, Professor of Oceanography, Southern Maine Vocational-Technical Institute. In addition, we thank Professor Arthur C. Borror, Department of Zoology, University of New Hampshire, for the bird illustrations which he drew especially for this book, and Ms. Sharon Ossenbruggen and Ms. Claire Curtis, who were responsible for the remainder of the illustrations.

We are indebted to Diana Couture, Valerie Lloyd, and Cathy Vuksanovic for their stamina in typing and retyping the manuscript, and to Frank Smith, who edited it. For their guidance and suggestions, we thank the members of the Floating Lab Committee and faculty advisor Herbert Tischler, Professor and Chairman of the UNH Department of Earth Sciences. Finally, we appreciate the Floating Lab instructors, participating teachers and students for their evaluations, criticisms and contributions.

How to Use this Manual

The information and activities in this manual have been selected to accommodate a wide range of abilities and interests on the part of the users (grades 7-12). The looseleaf format encourages duplication of selected pages for student use, and for background for teachers and chaperones. This format also encourages the inclusion of related materials and the reorgnization of existing materials so that teachers may develop their own curricula using the manual as the primary resource.

The Floating Lab Resource Manual is organized in five sections, ranging from program information through appendices. A general table of contents directs the user to the appropriate section, and each section opens with its own detailed table of contents arranged either by station or by subject content. Finally, an index is provided.

Cruise Preparation

We suggest the following as minimum preparation for a Floating Lab cruise.

The teacher should become familiar with the General Program Information (Section I), preview the material with the class, and duplicate pages as indicated (Directions for drivers, Teacher Information for chaperones, Release Form for all participants, etc.)

The class should be introduced to the On-Board Activities (Section III) before the cruise, supplemented with background material from Site Environment (Section II) to flesh out key concepts. Certain Appendices (Section VI), e.g. Mini Math Review, may also be useful at this point.

The Pre- and Post-Cruise Activities (Section IV) include a few which are recommended for before the cruise. There are also several to choose from in support of the on-board activities at each station on the cruise.

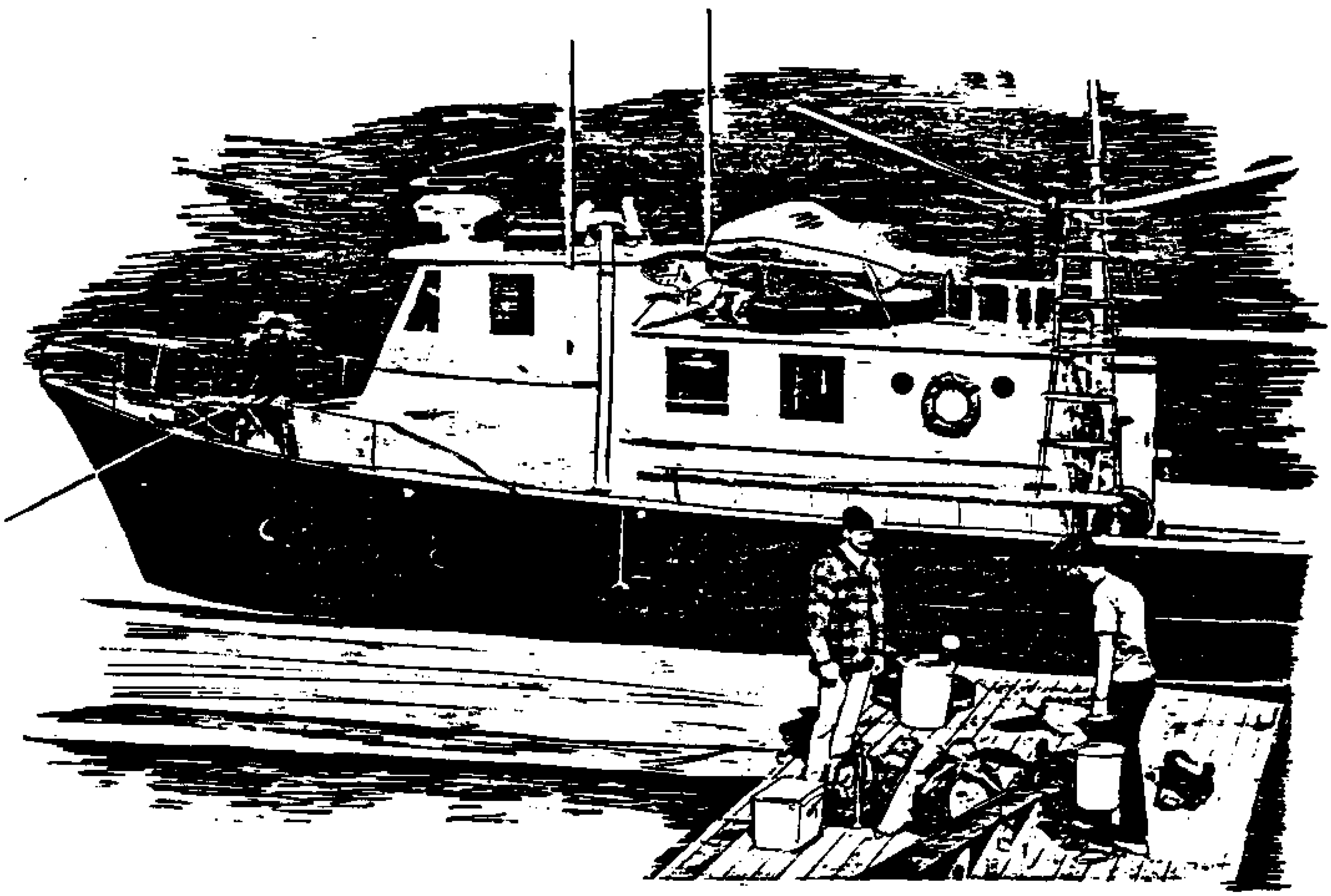
The Concept Activity Check-List (Appendices to p) correlates concepts, site environment information, and pre- and post- cruise activities. Use it to plan a program of preparatory and follow-up study for students.

Follow-up

Follow-up to the cruise is important. The interpretation and discussion of the data the class has collected on board will be enhanced by reference to Site Environment (Section II) and by selected Pre- and Post-Cruise Activities (Section IV). The Appendices (Section V) include keys and checklists for the identification and study of specimens and samples brought back from the cruise. The class's analysis of its collective data should be mailed to the Floating Lab Director as soon as possible.

Table of Contents

SECTION I: PROGRAM INFORMATION



Program Information

Table of Contents

Introduction

The Floating Lab is a unique educational opportunity for teachers and students to study the marine environment. The program offers "hands-on" experiences aboard a 70-foot boat, a resource manual with curriculum materials suitable for grades 7 through 12, and two teachers' workshops.

The two workshops are required in the Floating Lab program to help teachers and other adult chaperones fully participate in the lab experience. Certificates of attendance are available for staff development credit. All participants are asked to look critically at their Floating Lab experience so the program, including the manual and field work, can be revised and improved as a result of their constructive suggestions and evaluations. The first workshop will introduce the curriculum and equipment, cover the logistics of the trip, and acquaint teachers and chaperones with selected pre- and post-cruise activities. The second will be aboard the lab, itself, for familiarization with the sequence and content of onboard activities and the oceanographic methods to be used.

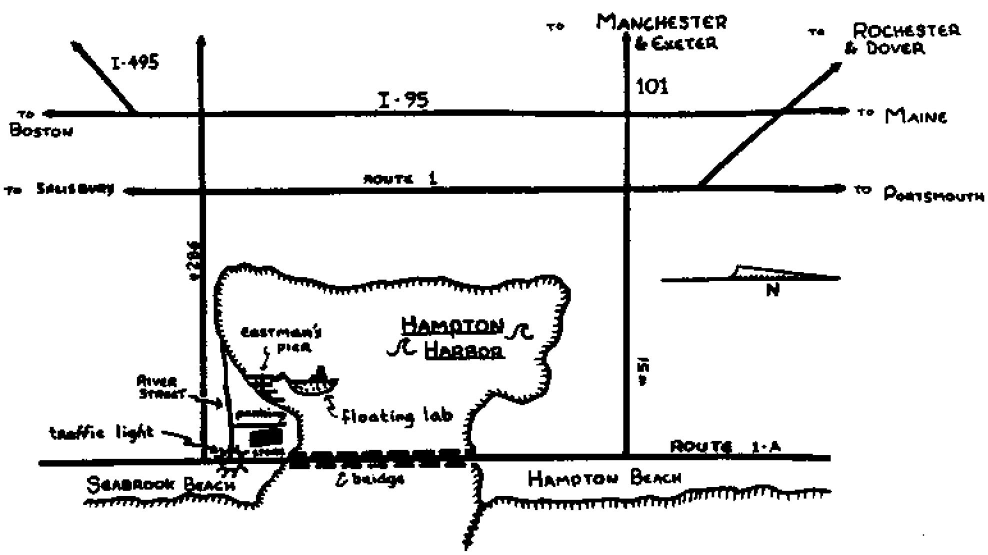
The Floating Lab, a large fishing boat outfitted with oceanographic sampling equipment, is berthed at the Eastman's Pier in Hampton Harbor. The three hour trip will take the boat to three sampling locations, beginning at the dock, moving to a point in the harbor, and then proceeding out into the ocean. Students and teachers will participate fully, operating equipment, taking samples, and keeping records at five learning stations aboard the boat. Four Floating Lab instructors trained in marine science will be aboard the lab assisting students and teachers at each station. Back in their classrooms, students will analyze data and report their results to us. We will, in turn, help compile returning data from all classes into a "profile" of the study. That profile will be sent back to the students and their teachers.

Directions

Departure and Arrival Time

The Floating Lab leaves Eastman's Pier at 8:30 a.m. sharp for the morning session and returns at 11:30 a.m. Afternoon sessions begin at 12:30 p.m. and end at 3:30 p.m. Please be prompt. Eastman's Pier is located adjacent to River Street, off Route 1-A, south of the Hampton Harbor Bridge in Seabrook, New Hampshire.

Location and Map



Trip Cancellation

Trips will be cancelled only for severe weather conditions or exceptionally high seas. (Light rain and cool weather are not considered severe.) If a trip is cancelled, teachers will be notified by 6:00 a.m. It is up to the teachers to notify the other participants. If the weather seems bad and you are wondering whether the trip will occur, call Mrs. Lillian Eastman at 603-474-3461. Should it be necessary to cancel a trip because of weather, it may be possible although difficult to re-schedule.

Teacher Information

Participation and Responsibility

There should be no more than 30 participants. Each class must be accompanied by one teacher and two chaperones who are familiar with first aid procedures. They will participate as assistants to the Floating Lab staff.

Teachers and chaperones are also responsible for the conduct of their students during the cruise. Please remind students that a ship demands respect and is a hazardous place for those who ignore rules of safe conduct. There must be no running, jumping or horseplay. Students should know the old sailor's maxim, "one hand for the ship, and one for myself," and practice it at all times. All participants must know the location of life jackets, rafts, and buoys. These will be pointed out on the day of the cruise. Procedures for their use will also be discussed.

Everyone, including adults, should sign a release form (see sample, next page). These forms should be handed to the Floating Lab coordinator on the day of the cruise.

Checklist of Recommended Equipment (No glass)

- ___ Cooler for specimens (a necessity if you plan to collect specimens).
- ___ Various-sized plastic, covered containers (two or three plastic buckets; ziplock baggies for sediments; thermos bottles for plankton).
- ___ Fixatives for specimens. (Magnesium chloride (Epsom Salts) is an effective relaxant for invertebrates; a plastic jar with 100cc of formalin is useful for preserving plankton).
- ___ Hand lenses.
- ___ List of students, teachers and chaperones with emergency contact phone numbers for each.
- ___ Release forms for everyone going on the Floating Lab (see sample, next page) to be given to coordinator on the day of the trip.

Release Form

____
(Date)

______________________________ has my permission
(Student's Name)

to accompany his class aboard the Floating Lab on _______________
(Day)

_______________.
(Date)

In case of emergency, please call _______________
(Name)

at _______________. If my child should require a doctor's
(Phone)

care, the instructors and captain aboard the Floating Lab, as well as the teacher, have my permission to secure that care.

____
(Parent or Guardian)

____
*(Daytime Phone)

____
(School)

____
(School Phone)

*For immediate notification in event of an accident.

Student Information

Student Checklist

- ___ Personal items should be kept to a minimum and contained in a small, soft bag to be stowed aboard the boat.
- ___ Shoes with rubber soles will be worn at all times. No bare feet.
- ___ Clothing should provide adequate coverage and warmth by layering, and should be resistant to mud and salt. A slicker or raincoat is required.
- ___ Skin protection is important. Sunscreen lotion, and protective clothing such as long sleeves and securely fastened visors or hats are advised.
- ___ Food: Eat a light breakfast, but be sure to eat. Bring a snack (including saltines) and a drink to have on the boat. No glass containers.
- ___ Mal de mer: Those concerned about motion sickness should take precautions by taking anti-motion pills 30 minutes to one hour before the cruise. Marezine, Bonine, and Triptone are suggestions. All may cause drowsiness.
- ___ Cameras and binoculars may be brought at the owner's risk. Double plastic bags are recommended for minimum protection.
- ___ A clipboard and two pencils are needed.

Conduct Aboard Ship

A ship at sea is a hazardous place. Follow the rules:

1. Know all safety regulations and proper conduct. No running, jumping or horseplay of any kind.
2. Follow the captain's orders without question. He is responsible for the boat and everyone on it.
3. Be responsible for your own trash; what comes on with you goes off with you. Help keep boat clean.
4. Follow first aid procedures:
   a. If an accident occurs, immediately notify a teacher, instructor, captain or any adult.
   b. If the accident is a fall on deck, do not move the injured person. Immediately obtain help from an adult.

UNH Floating Lab Data Sheet

Your Name ______________________ Grade ______________________

School ______________________ Ship ______________________

Teacher ______________________ Captain ______________________

Instructors ______________________ ______________________

______________________ ______________________

STATION 1 WATER SAMPLING Van Dorn bottle, hydrometer, therm., kits							
Location		Depth(m)	Temp. (°C)	Density (gr/cc)	Salinity 0/00	DO(ppm)	pH
Dock	S						
	B						
Channel	S						
	B						
Ocean	S						
	B						

STATION 2 TURBIDITY, COLOR, CURRENTS			Secchi disc., Forel/Ule kit, current meter, drift bottles
Location	Turbidity (m)	Color (#)	Current Speed (f/sec.)
Dock			
Channel			
Ocean			

STATION 3	PLANKTON Plankton nets, scopes	
Location	Species: Surface	Bottom (depth ________ m.)
Channel		
Ocean		

BETWEEN LOCATIONS: OTTER TRAWL		(Minutes ________)
Location	Animals	Plants

STATION 4: SEDIMENTS AND INVERTEBRATES				Grab, Corer, Assorted traps			
SEDIMENTS							
Location	Depth	Grab	Corer	Organisms	Sed. Type	Smell	Color
Dock							
Channel							
Ocean							

INVERTEBRATES (caught or already in tank)		
Species	Number	Comments

STATION 5: NAVIGATION | Check equipment seen; fill out observations

Radio__ Loran__ Sonar__ Auto Pilot__ Radar__ Depth finder__

Sky conditions:____________ Wind direction:____________

Wind Speed:____________ Sea Color:____________

Size of swell: (estimate)______ Tide: High___ Mid___ Low___

Surface Conditions:____________ Weather: ____________

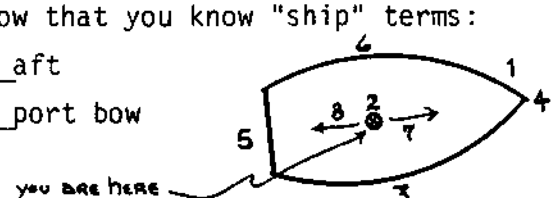
Marine Birds (check or write in your count)		Fishing Boats
__Herring gull	__Black-bellied plover	__Lobster boat
__Great Blackbacked gull	__Lesser yellowlegs	__Gillnetter
__Immature gulls	__Black duck	__Trawler
__Canadian geese	__Mallard duck	__Others
__Tern	__Cormorant	

Label parts of the diagram to show that you know "ship" terms:

___port ___bow ___aft

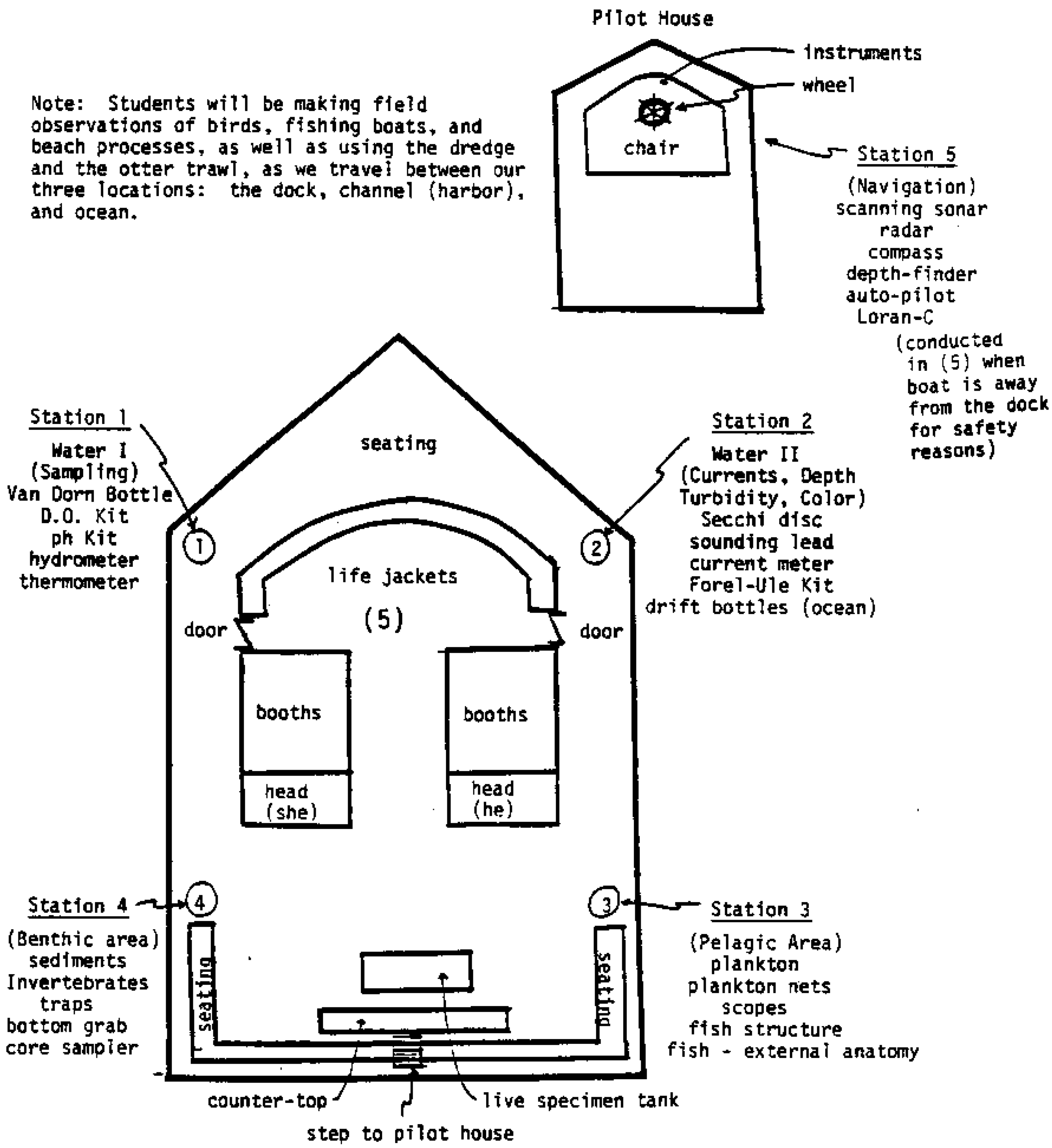
___stern ___starboard ___port bow

___amidships ___fore



On-Board Sampling Stations

Note: Students will be making field observations of birds, fishing boats, and beach processes, as well as using the dredge and the otter trawl, as we travel between our three locations: the dock, channel (harbor), and ocean.



Equipment Inventory

The following equipment will be provided and used aboard the lab.*

1. *Secchi disc: white or black and white disc used to measure turbidity (lack of clarity) of the water. Turbidity is measured by lowering the disc on a line and determining the length of line from the water's surface to the depth at which the disc goes out of sight.
2. Forel-Ule scale: a color-comparison scale used with the Secchi disc to determine water color.
3. Van Dorn bottle: a plastic cylinder with a stopper at each end connected by a rubber tube. A water sample recovered from a chosen depth with the Van Dorn bottle may be tested to determine temperature, salinity, pH and dissolved oxygen conditions at that depth.
4. pH test kit: used in determining the pH of a water sample by adding indicator solution and matching colors.
5. *Hydrometer: used to measure density of liquids.
6. Drift dyes, bottles or ballons: detect currents.
7. Current meter: a device for measuring current speed. A current meter with electric read-out will be used aboard the Floating Lab.
8. Oxygen test kit: used to determine dissolved oxygen content of a water sample.
9. Peterson grab: a clamshell-like device which grabs bottom sediment.
10. Gravity corer: a tube which collects vertical samples of bottom sediments.
11. *Plankton net: a nylon mesh net for collecting Plankton.
12. Otter trawl: a long, sturdy net for collecting fish samples.
13. Recording thermometer: records temperatures at various depths.
14. Dredge: a device dragged along the bottom to sample bottom communities.

*Teachers and students may wish to build their own hydrometers, plankton nets, and Secchi discs according to suggestions in the Pre- and Post-Cruise Activities section of this manual. There will be opportunities to try them out aboard the lab.

Shipboard Activity Schedule

Pre-Cruise (5 minutes):

Greetings, introduction of personnel, grouping of students.

Cruise (approximately 3 hours):

1. Boarding (5 minutes): Stow gear; go to bench in stern.
2. General information: Vessel safety rules; location of emergency equipment; emergency procedures.
3. Trip planning: Site description; station description; instructions for moving from station to station; groups move to assigned stations.
4. Dock sampling location (15-20 minutes):

   Station 1: Water sampling using the Van Dorn bottle, thermometer, pH and oxygen kits, and hydrometer.

   Station 2: Water's physical parameters using the Secchi disc, Forel-Ule scales, current meter, and sounding lead.

   Station 3: Plankton and fish using the plankton net and microscope, and studying fish structure.

   Station 4: Benthic communities and sediments using the core sampler, bottom grab, invertebrate traps, and screen.

   Station 5: Navigation using modern equipment such as the sonar, depth finder, Loran, radar, and radio; learning history of navigation; observations of sea, tide, wind & weather conditions.
5. Underway to harbor sampling location (10 minutes): Observation of birds, shoreline, clam-digging, and fishing boats; horizontal plankton tow.
6. Harbor sampling location (30 minutes): Teams repeat the previous measurements; rotate once.
7. Underway to ocean sampling location (15 minutes): More observation; optional horizontal plankton tow;
8. Ocean sampling location (includes otter trawling for 20 minutes and allows time for one rotation of stations; about 50 minutes): Station investigations repeated; fish samples taken; identification of fish; deployment of current bottles.
9. Return trip (20 minutes): Examine fish species; complete data sheets.

Wrap-up (5-10 minutes): Summary; clean-up; good-byes.

Description of Study Site

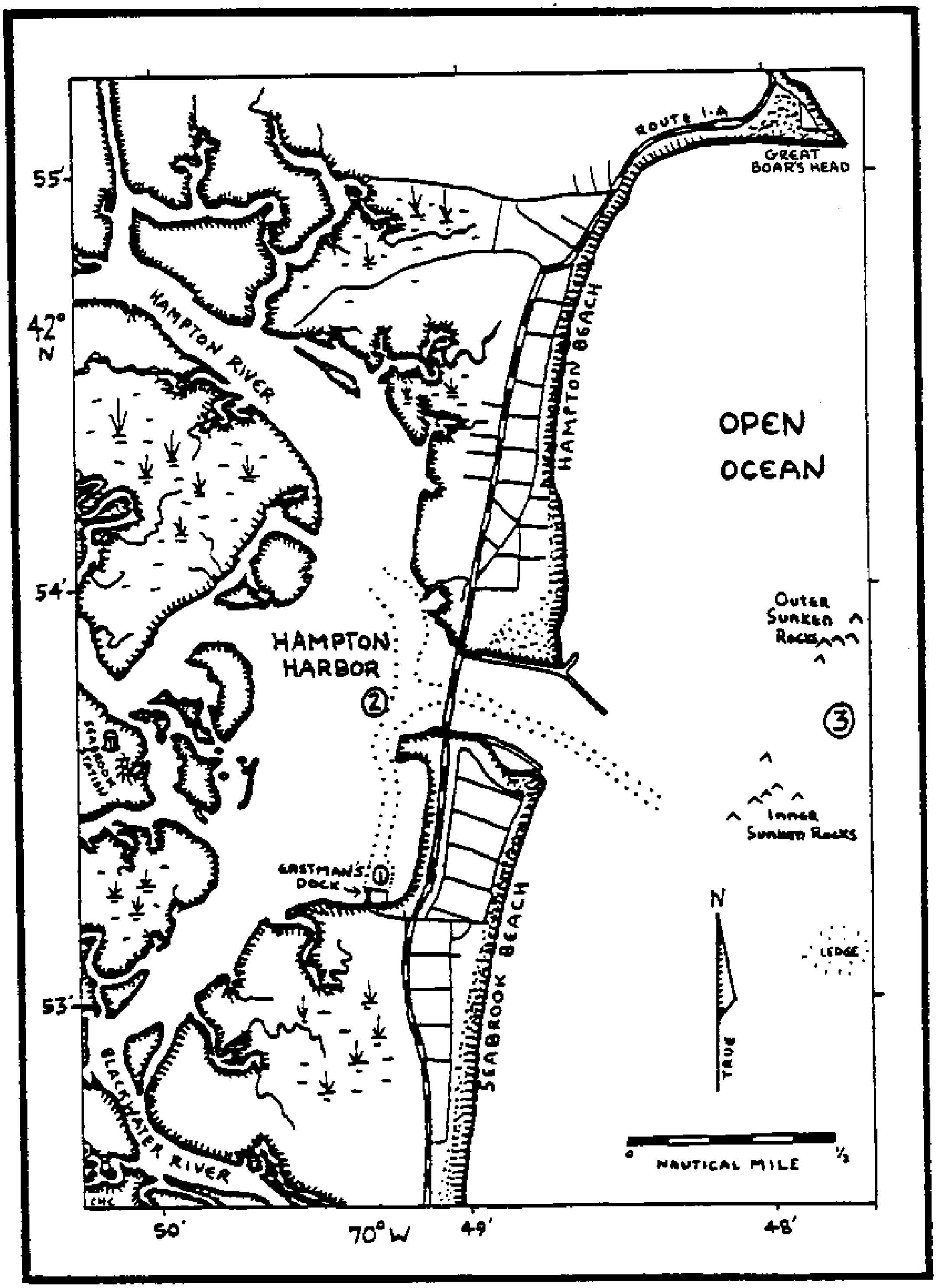
The Floating Lab studies areas of Hampton-Seabrook Harbor and adjacent waters which are within that part of the western North Atlantic known as the Gulf of Maine. The harbor and surrounding marsh area cross the boundaries of Hampton, Hampton Falls and Sea-Brook. The area is five miles long and about one and one-half miles wide. On shore, the site is divided into two sections by Interstate 1A which runs north and south along the entire New Hampshire coast. Extensive development in the Hampton-Seabrook area includes housing developments along Interstate 1A. There are marinas which include docks, moorings and support facilities. Public Service Company's Seabrook Nuclear Power Station is located at the eastern edge of the harbor, in an upland area.

The Hampton-Seabrook Harbor is bounded by beaches, and by the breakwaters built by the Army Corps of Engineers in the 1930's. Longshore currents bring sand south from Hampton Beach and form a shallow sand bar extending from the northern breakwater to rocks outside the harbor. Previously, sand moved freely up and down the coast, causing the harbor's entrance to shift. Even today that shifting continues, and the harbor must be dredged periodically to maintain a 20 to 30-foot depth at mean low water.

Off shore, the sampling area has sediments which vary from coarse-grained sand near the beaches to much finer sand with more silt content farther out. There are several rocky outcroppings like Great Boars Head, Inner and Outer Sunken Rocks, and a deeper subtidal bedrock area labeled "Ledge" in the accompanying map. Most of the sediment has recently been deposited here by currents; however, some of the material was deposited by glaciers in this part of the northeast about 20,000 years ago. The bottom slopes gently to a depth of about 50 feet and is broken by rocky outcroppings, large boulders, and sand bars formed by currents along the shore.

Farther offshore, the western Gulf of Maine, adjacent to the coast, becomes a sandy sloping area called the Bigelow Bight. Twenty miles to the east is a shallow rise known as Jeffrey's Ledge.

Hampton-Seabrook Area



SAMPLING LOCATIONS

① Eastman's Dock

② Harbor

③ Open ocean

SECTION II: SITE ENVIRONMENT

Site Environment

Table of Contents

Sea Water

Water temperature is considered the most important factor in the distribution of marine life. Temperatures at the study site seasonally range from 0.8°C to 19.7°C. Distribution of species, reproduction periods, length of time for development, and other physiological functions are all controlled by temperature.

Temperature layers separated by thermoclines occur when surface water, warmed by the sun, rests on top of colder, denser water. Temporary thermoclines which form in summer months are often broken down by vertical mixing caused by northeast winds.

The intertidal areas near Sunken Rocks at the mouth of the harbor and the shallow waters within the harbor have high temperatures due to the heat of the sun. Harbor waters may be much warmer than adjacent open ocean water.

Salinity is the total amount of dissolved solids in the water and is made up of all known elements. The salinity of open ocean water is approximately 34 parts per thousand (o/oo) or about 3.5%. This can change drastically, however, in bays and estuaries. Salinity varies with amount of precipitation, evaporation, and runoff from rivers.

In the Hampton-Seabrook area, salinity normally ranges from 31 o/oo to 34 o/oo, except during the spring when rain and runoff may lower it to 25-27 o/oo. On any particular day, salinity may vary from 1-3 o/oo between the harbor and open ocean. The Hampton-Seabrook estuary has relatively high salinity most of the year because little fresh water runoff enters from upland.

Dissolved oxygen in the water is important because marine animals need oxygen for respiration. Oxygen comes from photosynthesis by phytoplankton and algae, and from the atmosphere. Other significant dissolved gases are nitrogen and carbon dioxide.

pH is the measure of alkalinity and acidity. Open ocean water is slightly alkaline with a pH of 8.0. Biological activity in estuarine waters lowers pH as the production of carbon dioxide produces carbonic acid. Tidal currents mix these waters, so animals must adapt to rapid changes in pH.

Light. The photic zone (the layer into which sunlight can penetrate) is usually the top 100 meters or so of ocean water, but it may be 50 meters or less in coastal waters. Light is absorbed, reflected and scattered by particles in the water. Wavelengths of light differ in their penetrating power; green-blue light penetrates the deepest.

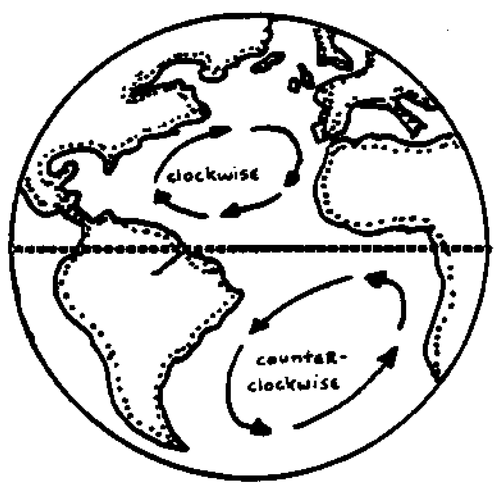
The color of water is the result of the reflection or scattering of light by suspended particles. A greenish color occurs when many particles are suspended, reflecting back most of the light.

Nutrients. Plant growth substances, such as nitrogen and phosphorus, are dissolved in seawater as NO_3 (nitrate), NO_2 (nitrite), NH_4+ (ammonia), and PO_4 (phosphate). These compounds are liberated from fecal waste and decaying plant and animal matter, and are distributed by currents, becoming available to plants for growth.

Currents

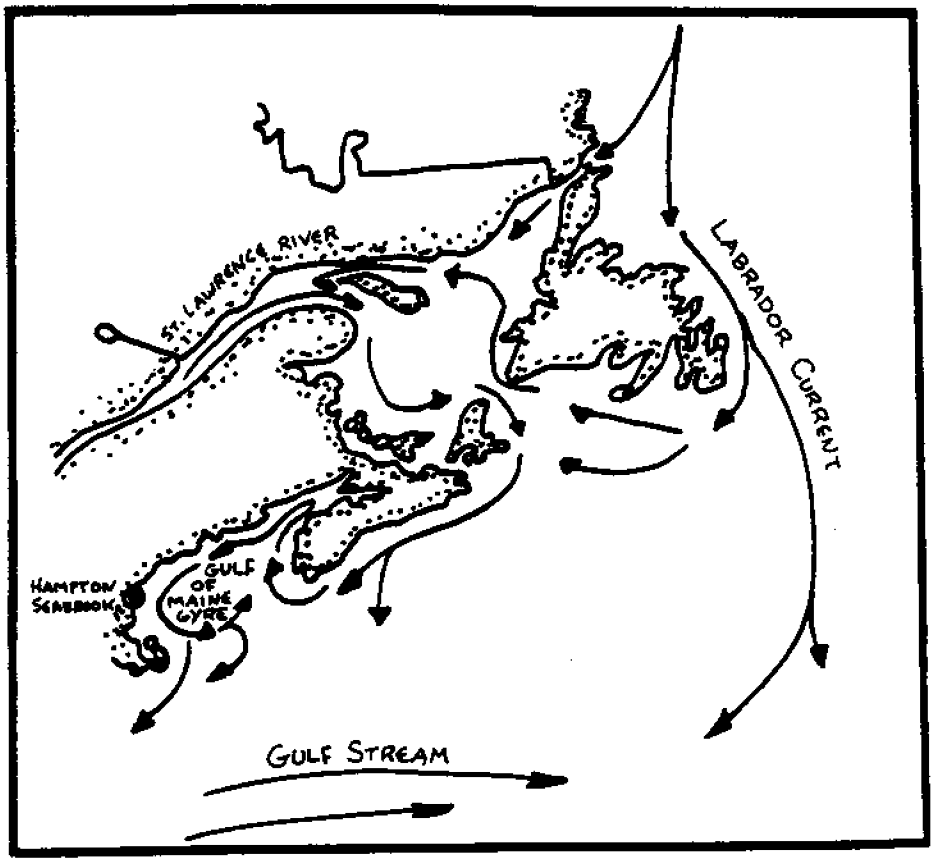
Ocean waters are constantly in motion, and that motion is called "current." There are two major types of currents: density currents and wind-driven currents. The Gulf Stream is an example of a wind-driven current. Urged on by the trade winds, it flows west from northern Africa until it hits the waters of the Gulf of Mexico. From there it jets out into the Atlantic in a stream 50 miles wide and 1,500 feet deep at speeds of up to five miles an hour, pushing along four billion tons of water a minute. Off Newfoundland, it meets the icy Labrador Current which drifts southward, and together, they flow east toward Europe.

A combination of three forces--the sun's heat, winds, and the Coriolis effect--cause sea currents to circulate in a clockwise direction in the northern hemisphere and a counterclockwise direction below the equator in the southern hemisphere. (The Coriolis effect is the tendency, due to the earth's rotation, for all moving objects to turn slightly to the right in the northern hemisphere and to the left in the southern hemisphere.



In the Gulf of Maine, waters move in a gyre (or eddy) in a general counterclockwise direction, which is opposite to the general direction of currents in the northern hemisphere. The

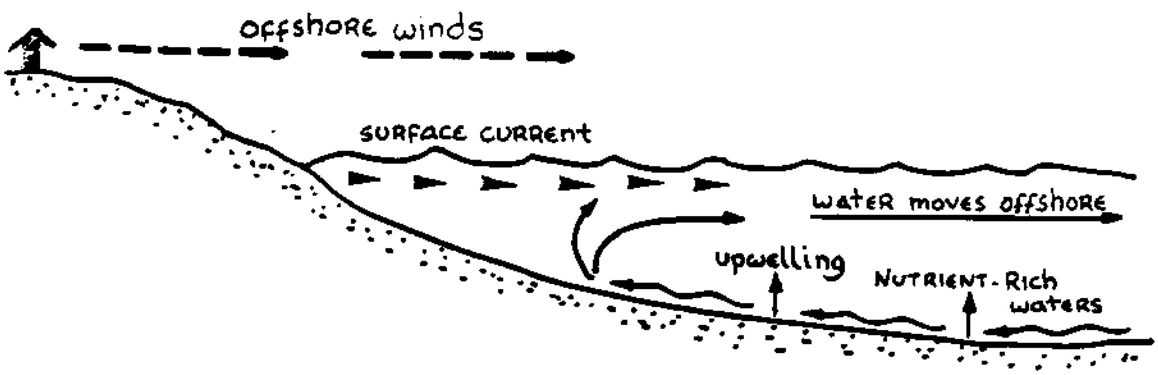
Gulf of Maine Gyre movement is due to fresh water runoff from Nova Scotia, wind from the north called the Westerlies, and basin and shoreline shapes.



Density currents are the result of differences in density among water masses. Cold water is more dense than warm water; sea water, with its dissolved salts, is more dense than fresh water.

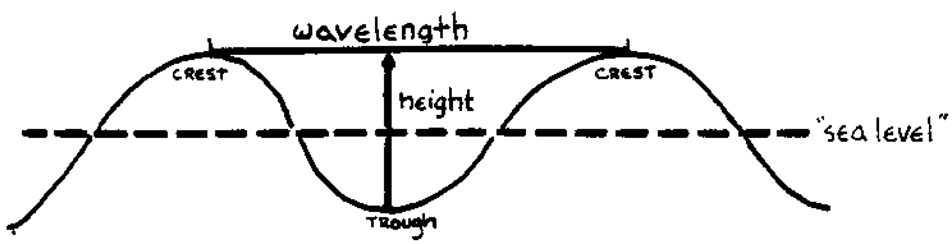
The heat from the sun acts on the oceans as it does on the atmosphere. As air is warmed, it becomes less dense and rises. Cooler, heavier air moves in to take its place, creating a wind. When the same process occurs in the ocean, the motion of the water masses is called a current. In some places, the winds act to increase the water currents, and major ocean currents, such as the Gulf Stream, are the result.

Upwelling vertical currents near the shore bring colder nutrient-rich water from great depths into the photic (light-penetrating) zone where the nutrients can be utilized by marine organisms.

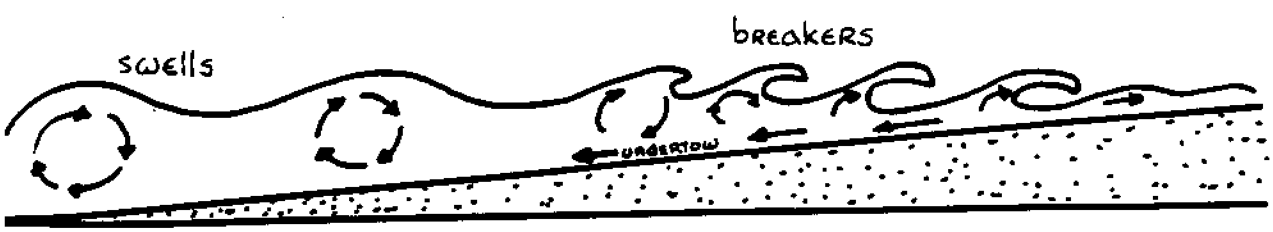


Waves

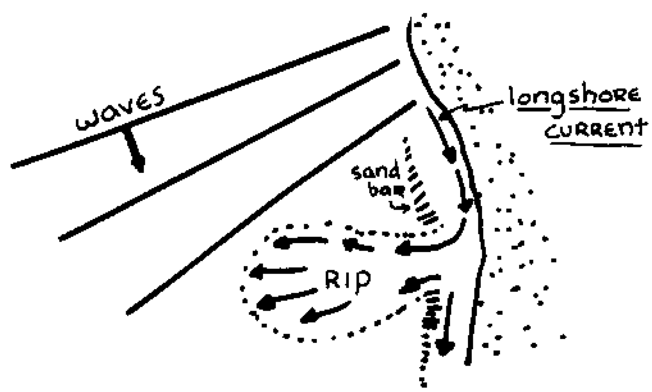
Waves are caused by wind and pressure exerted by the atmosphere. Wave height is determined by wind speed, wind direction, fetch (distance of open water over which the wave was blown), and sea state when the wave was first formed.



As a wave approaches the shore it begins to drag on the bottom due to friction as it moves on the uprising shoreline. As it topples over, it is called a breaker.

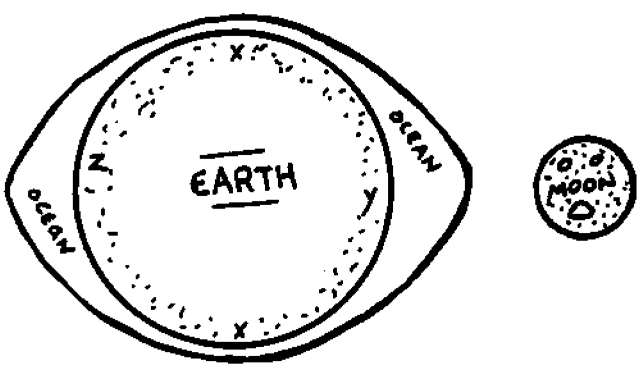


Waves produce longshore currents which move sand along a beach; in New England, the longshore current is generally in a north to south direction. Waves often approach the shore at an angle, and the closer they get the more they tend to bend toward the shore. The part of the wave entering shallow water first is slowed by the bottom, while the part still out in deeper water races ahead. But this action is never complete, and creates flows of water along the beach called longshore currents. If the longshore current flows back out to sea through narrow, storm-cut gaps in offshore sand bars, it may carry a swimmer out to sea. A swimmer caught in such a "rip tide" should try to swim across the current until he is out of it.



Tides

The alternating rise and fall of sea level, commonly called the tidal cycle, is caused by the gravitational pull of the moon and the sun on the earth. The earth, moon, and sun attract one another, and the ocean is pulled toward the moon and sun. Because the moon is closer than the sun to the earth, it exerts a greater tidal influence. Since the earth and moon rotate around each other, there is also a centrifugal force which moves water away from the side of the earth opposite the moon. Thus, high (or low) tides are experienced simultaneously on both sides of the earth.

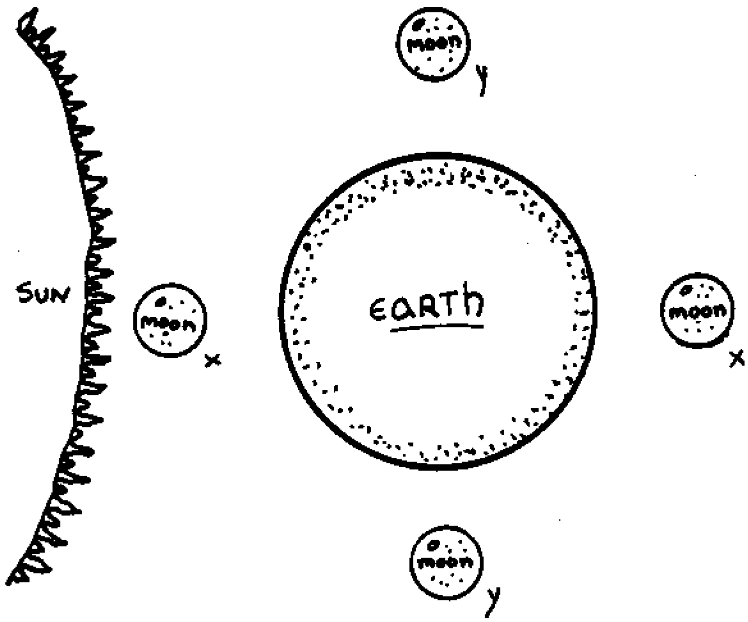


x - low tide (water drawn away)

y - high tide (water drawn toward the moon)

z - water moves away from the earth (centrifugal force)

Because of the earth's rotation and the moon's movement around the earth, tides occur approximately one hour later each day. When the sun, moon, and earth are lined up, tides are extreme due to combined gravitational attraction. These are called "spring tides" (x, next page). When the sun and moon pull on the earth at right angles to each other, the tides don't rise and fall as much as usual and are called "neap tides" (y).



x - "Spring tides," extremely high and low tides (new or full moon, twice each month)

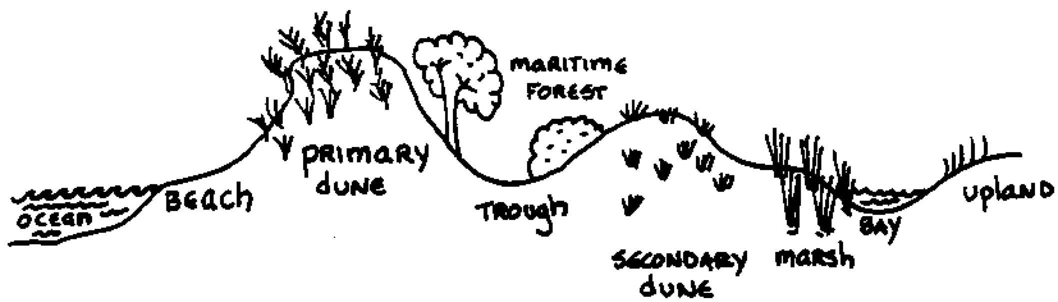
y - "Neap tides," moderate tides (quarter or gibbous moon, twice each month)

At Hampton about 3.5 billion gallons of harbor water are carried into the open ocean during the tidal cycle. The average velocity of water at the Hampton bridge during tidal cycle varies from 0 to 3.05 feet per second.

Local conditions have a tremendous effect on the height, time, and intensity of the tides. The shape of the basin, the volume of water, and friction on the bottom are significant factors. Transitory factors such as barometric pressure, storms, and winds also affect the amplitude of the tides.

Beaches

New Hampshire's coast is dominated by the Hampton and Seabrook barrier beaches which lie just north and south of Hampton Harbor. Both beaches have been subject to intense development, resulting in some disruption of natural processes.



Profile of a Typical Barrier Beach

As waves reach the shoreline, sand and mud, which have been suspended in the water, are deposited along the coast. As the flow of water slows, sediments will settle. Heavy materials drop out first, followed by finer sediments.

The beach, especially the intertidal area, is a relatively harsh environment. Physical factors such as temperature, and wind and water abrasion limit the species that can live on the beach. Temperature may vary a great deal between the surface and a few feet below the surface of the beach.

The very sensitive dune and trough area is held together by the roots of plants. Plants, particularly those which reproduce by rhizomes (creeping stems), such as the sea oat, stabilize the dunes and catch sand carried by the wind. Other plants may include sea pursling, morning glory, goldenrod and daisies. Between the dunes, in the well protected trough area, a maritime forest is often found where shrubs, small trees, pines and poison ivy grow stunted and lopsided from salt spray and prevailing winds.

Beaches are dynamic environments constantly being altered by natural processes. In winter when wave energy is great, fine, light sand materials are moved offshore by wave action. They are deposited as nearshore, underwater sand bars which normally develop parallel to the coast. During summer months the beach is built up again by low rolling waves which carry the sand bars' finer sediments back onto the shore.

Man's activities on the beach may upset these natural processes. Riding vehicles or walking on the dunes, or constructing buildings on them, intensifies beach erosion as the stabilizing grasses are killed. The natural movement of sand along the beach by longshore currents is interrupted by piers, breakwaters and jetties. This construction often builds one beach site while starving another site downstream. During major storms, damage to buildings and loss of human life can often be traced to unwise development.

Estuary

The Hampton-Seabrook estuary fits the classic definition of an estuary: a semi-enclosed coastal body of water with an open connection to the ocean. The estuary's sea water is measureably diluted with fresh water from land drainage, as rivers, creeks, and streams meet the ocean. Plants and animals in the estuary include some species from the adjacent ocean and some from fresh waters.

The Hampton-Seabrook estuarine system includes one of the largest tidal marshes in New England, intertidal flats, submerged lands and vegetation. Several hundred acres of intertidal flats fringe the mouths of the tidal rivers: the Blackwater, Brown's, and Hampton Rivers, and Mill and Hunt's Island Creeks. These contribute little runoff and are quite salty. This system is an important part of the coastal zone and has a significant biological impact on the whole coastal area.

Tidal influences are a dominant feature of an estuary. In the Hampton-Seabrook study area, the normal tidal cycle is twelve and one-half hours long. Daily rise and fall of the tide averages eight feet, submerging the marshlands three to four feet below the high tide.

The estuary and associated salt marsh systems were formed about 10,000 years ago when the sea level rose as a result of glacial melting. Estuaries have also been formed by glacial gouging of coastal areas and by drowning of river valleys as happened in the Piscataqua River basin resulting in the Great Bay estuarine system.

The Floating Lab study site supports a wide variety of plant and animal life. The salt marshes, intertidal flats and submerged areas form a complex habitat that provides food and cover for large populations of shellfish, finfish, sea worms, migratory water fowl, shorebirds, aquatic mammals, and other animals. Even as seaweeds and salt marsh grasses die, they provide important nutrients for plankton, molluscs, crustaceans, and others. These unique habitats are essential to the life cycle of many marine animals as spawning and nursery areas. Tidal creeks of the estuary provide the necessary habitat for flounder, striped bass, American eel, smelt, killifish, stickleback, and other finfish. Clams are dug recreationally in the estuary's tidal flats, and lobsters and sea worms are present in commercial quantities.

Salt Marsh

The extensive Hampton-Seabrook salt marsh is a transitional wetland zone between the uplands and the ocean. Pockets of salt marsh are found along the whole New Hampshire coast, but the most extensive are found in the Great Bay and Hampton-Seabrook estuaries. Of the 7,500 acres of salt marsh in Hampton, 2,800 are found in Hampton Falls and Seabrook near the Floating Lab site.

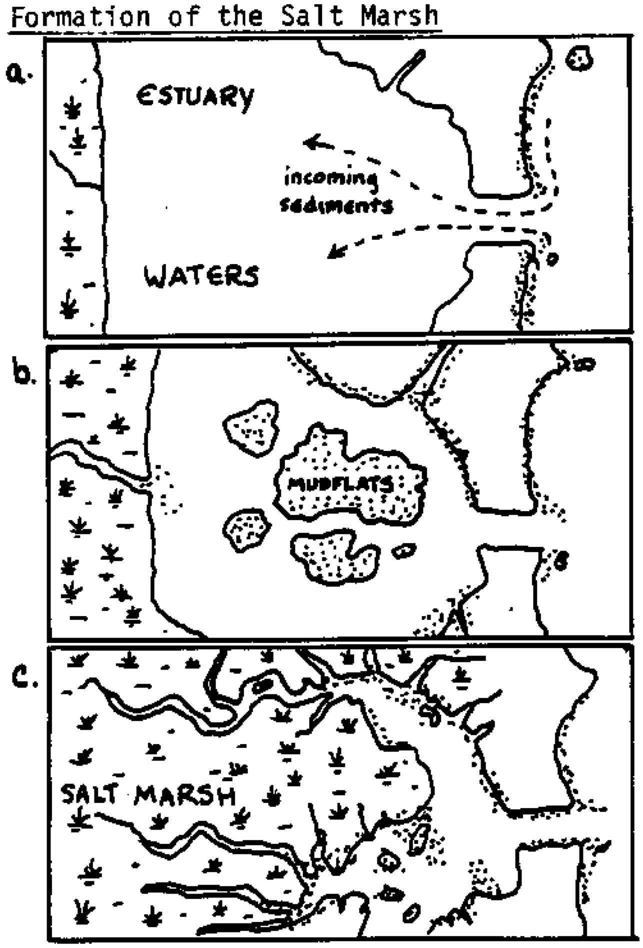
As the glaciers which extended beyond the continental shelf began to melt, the shoreline was exposed, and bays and estuaries were formed along the irregular coast. Gradually the ocean rose, flooded the land, and deposited sediments in shallow areas. Shorebirds carried marsh grass seeds to these sediments, and the marsh began to grow. As the ice continued to retreat, sea level rose, and the process was repeated several times. Evidence of earlier marsh deposits and nearby forest can best be seen at Odiorne Point where marsh and cedar stumps are found among the tide pools.

In the 17th century, New Hampshire colonists valued the salt marsh as a source of food for themselves and nutritious salt hay for their stock. The marsh played a major role in food and forage production until the early part of the 20th century. Then, with increasing population pressure and desirability of water front property, people began to fill and develop salt marshes.

Several natural fluctuations regulate life in the salt marsh: 1) seasonal and daily temperature changes; 2) tidal cycles, and 3) variations in salinity. *Spartina alterniflora* and *Spartina patens* are the dominant vegetation. These grasses produce nearly ten tons of organic matter per acre per year. Some marsh organic matter is eaten on site by "primary consumers" such as insects, snails, and deer. The majority of material, however, is decomposed by bacteria and other micro-organisms, and forms nutritious detritus which is transported by currents into the estuarine system and into adjacent coastal waters. These nutrients contribute to what is called the world's most productive nursery, where shellfish, young finfish, and water fowl thrive. Many kinds of ocean-dwelling fish come to the marshes to spawn and then return to the sea. Clams, oysters, crabs and mussels also live in the marsh. Herons, ducks and egrets are found in the marsh during nesting and breeding times. This abundance of life is directly related to the rich nutrients in the marsh.

Humans are an integral part of the marsh system. Industrialization of the coast has meant increased development. Marshes today cover about one-third of their original area on the Atlantic coast. Salt marshes in New Hampshire have been filled, dredged or cut off from the open ocean by construction of roads, shoreline housing, marinas and industry. Controversy continues to surround the use and development of the salt marsh. It is critical that people be aware of the value of salt marshes and the natural services they provide: nutrient cycling, storm energy absorption, the foundation of our valuable fisheries, and flood and erosion control.

Formation of the Salt Marsh



-- the accumulation of sediments from rivers and the ocean

-- rise in elevation of marsh "foundation" due to sedimentation

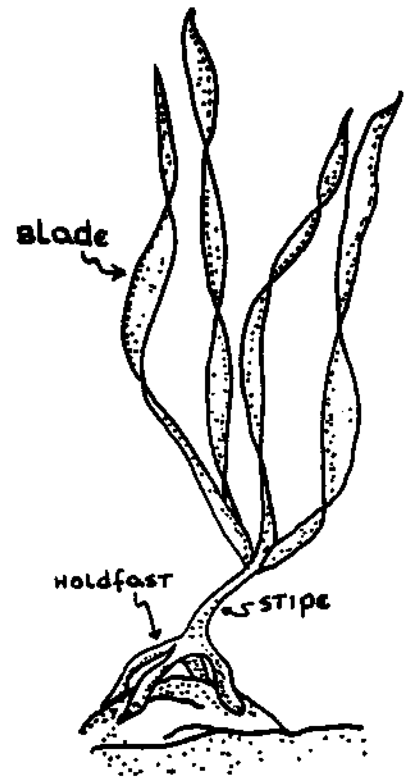
-- a mature salt marsh

(from R. Ladd, The Natural History of the Seacoast Region of New Hampshire, 1974)

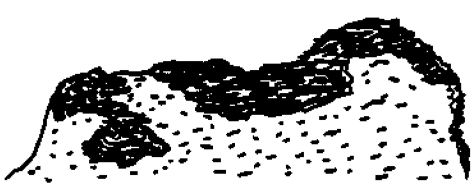
Algae

Algae are primitive plants without roots, stems or leaves. Algae can absorb carbon dioxide, water and the nutrients needed for photosynthesis through their entire surface. Many algae species are single-celled; some are colonial. Others grow in sheets, filaments, or as large, relatively complex plants with a holdfast, stipe, and blade.

Algae has long been valued by man as a source of food which is high in vitamins and minerals. Algin, a stabilizer used in dairy products, is produced by the fingered kelp. Irish moss is a source of carrageenan which is used in ice cream and many other foods. Extracts from algae are also used in the manufacture of cosmetics.

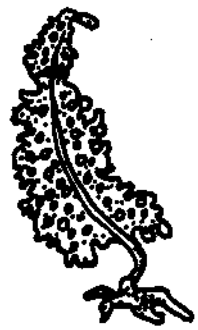


Typical
Algae Parts



Calothrix

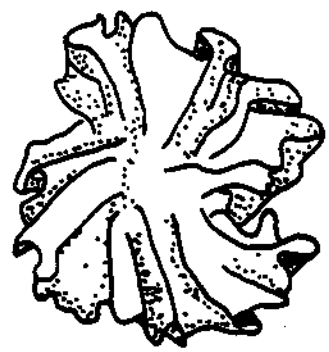
Blue-green algae (phylum Cyanophyta are the simplest in appearance and may be one of the earliest forms of life. The cells lack a nucleus. Chlorophyll is scattered through the cell. These algae form the dark area in the high tidal zone. Pick up a rock that lies near the high tide line. Bring it back to the lab, scrape off the slime and look at it under a microscope. This is probably blue-green algae.



Sea Colander
Agarum cribrosum
1 meter

Brown algae (phylum Phaeophyta) are the largest marine algae. Kelp, prevalent below the low tide line, can grow to 67 meters in depth in the Gulf of Maine. The brown algae also include the rockweeds, which dominate the rocky intertidal zone.

Green algae (Chlorophyta) are more complex plants. Each of their cells contains a nucleus and chloroplasts. They are commonly found in areas that have a freshwater runoff as does the Hampton Harbor area. Many types of marine and freshwater green algae may be used as indicators of pollution. Look for them in the harbor.



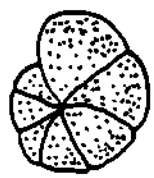
Sea Lettuce
Ulva lactuca
up to 60 cm.

Irish Moss
Chondrus crispus
up to 18 cm.

Red algae (phylum Rodophyta) are found predominantly below the low tide line. They photosynthesize using the limited light in the lower depths of the photic zone. There are also several species that can be abundant in the intertidal zone, including Irish moss.

Animal Classification

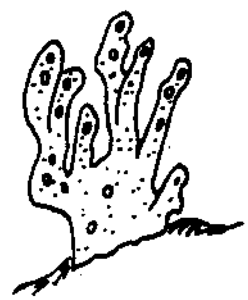
There are fifteen major groups of animals (phyla) found in the marine environment. Most are invertebrates, but the phylum Chordata has a subphylum, "Vertebrata," which includes all marine animals with backbones. Each group of animals has evolved special characteristics which allow it to survive in its own particular habitat.



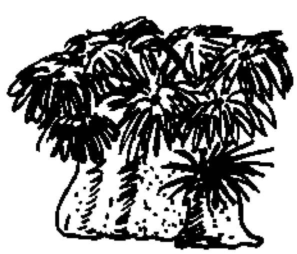
Cibicides lobatulus

Protozoa are one-celled animals such as Cibicides lobatulus, found in the sediment and throughout the water column.

Porifera, or sponges, are collections of semi-independent cells working together. They have skeletons made of silica, spongin or calcium carbonate. Sponges are attached or "fixed" and are found in a great variety of shapes.



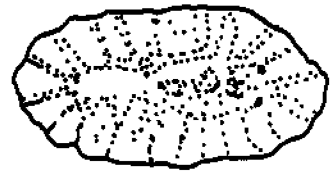
Finger Sponge
Haliclona oculata
up to 46 cm.



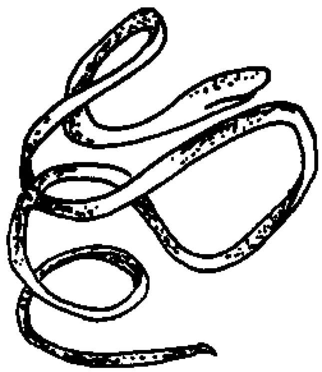
Sea Anemone
Metridium senile
up to 10 cm.

Cnidaria are sac-like animals, such as jellyfish, anemones, hydroids and corals. They exhibit radial symmetry and have specialized stinging cells known as nematocysts.

Platyhelminthes are flatworms having soft, unsegmented bodies with no appendages.



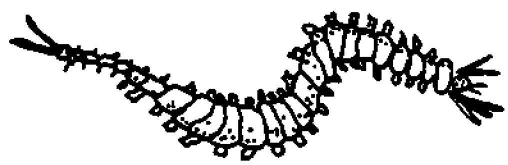
Flatworn
Notoplana atomata
2.5 cm.



Milky Ribbon Worm
Cerebratulus lacteus
up to 1.2 m.

Nemertinea are round worms with soft, contractile, cylindrical bodies. They have a complete digestive system, and are found in mud and soft sediments.

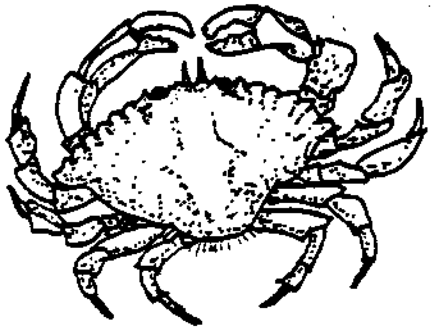
Annelida are segmented worms with a definite head region, bearing organs adapted for hearing, grabbing, tasting and seeing as well as a "brain." The most common marine annelid, the clam worm, is often found in Hampton Harbor.



Clam Worm
Nereis virens
20.5 cm. average

Blue Mussel
Mytilus edulis
up to 10 cm.

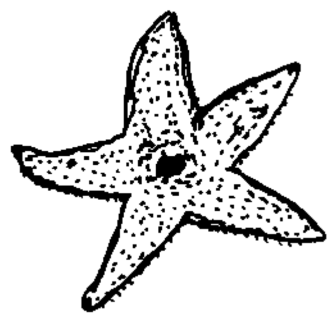
Mollusca include snails, clams, octopuses and sea slugs.



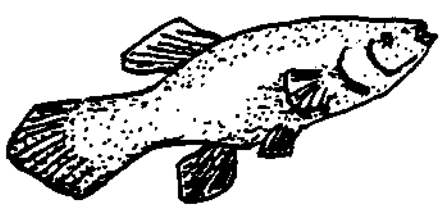
Rock Crab
Cancer irroratus
to 7.5 cm.

Arthropoda are joint-legged animals such as crabs, lobsters, and shrimp. All have a hard exoskeleton.

Echinodermata are spiny-skinned animals usually based on a five-part, radial pattern. Most move around on tube feet eating bivalves (as some sea stars do) or browsing on algae and detritus.



Common Sea Star
Asterias vulgaris
up to 12 cm.



Mummichog
Fundulus heteroclitus
5 cm.

Chordata have nerve cords, often protected by a backbone or notochord. This phylum includes vertebrates such as birds, mammals, reptiles and fish.

Plankton

The term "plankton" originates from the Greek "planktos," meaning "wanderer." Most planktonic organisms are microscopic, but some, such as jellyfish, are larger. The organisms live suspended in water, and are subject to wind, waves and tides. The plant plankton are called "phytoplankton," and the animals, "zooplankton." In your Floating Lab experience you will observe a number from each group.

The two major types of phytoplankton--dinoflagellates and diatoms--are easily distinguishable.

Dinoflagellates are one-celled, mobile, and have two whip-like appendages called "flagella" which propel them through the water. Some give off light (bioluminescence). Some are photosynthetic and are encased in beautiful, ornate shells, while others have thin flexible coverings. All species have two flagella. Reproduction occurs through binary fission. Occasionally, a "bloom," or population explosion, of certain dinoflagellates occurs. "Red tide" is such a bloom and can poison humans who eat filter-feeding molluscs which have ingested the dinoflagellates.

Diatoms have clear silica (glass) cases which surround each cell. They are one-celled but may form colonies. They are the most important plants in the sea and are responsible for 90% of oceanic photosynthesis. All diatoms must spend much of their time in the photic (light-penetrating) zone to ensure their survival.

The zooplankton include members of every major animal phylum known. The life cycles of many aquatic animals include a planktonic stage. These are temporary larval stages of larger animals such as clams, worms, barnacles, or lobsters. Eggs of some fish are also included among the zooplankton. Most of the zooplankters you see will probably be members of the class Crustacea in the phylum Arthropoda. These include copepods and shrimp, which are permanent zooplankters.

The Bottom Dwellers

Benthic Communities of the Hampton-Seabrook Estuary

A community is a group of interacting organisms commonly found living together. Who its members are and the way they make their living are dependent on the environment or "habitat" in which they are found. For example, some people living inland in rural New Hampshire may make their living by farming, while some residents of Seabrook are commercial fishermen. Using the core and the grab samplers, as well as the otter trawl and the dredge, several different benthic marine habitats and their communities can be studied.

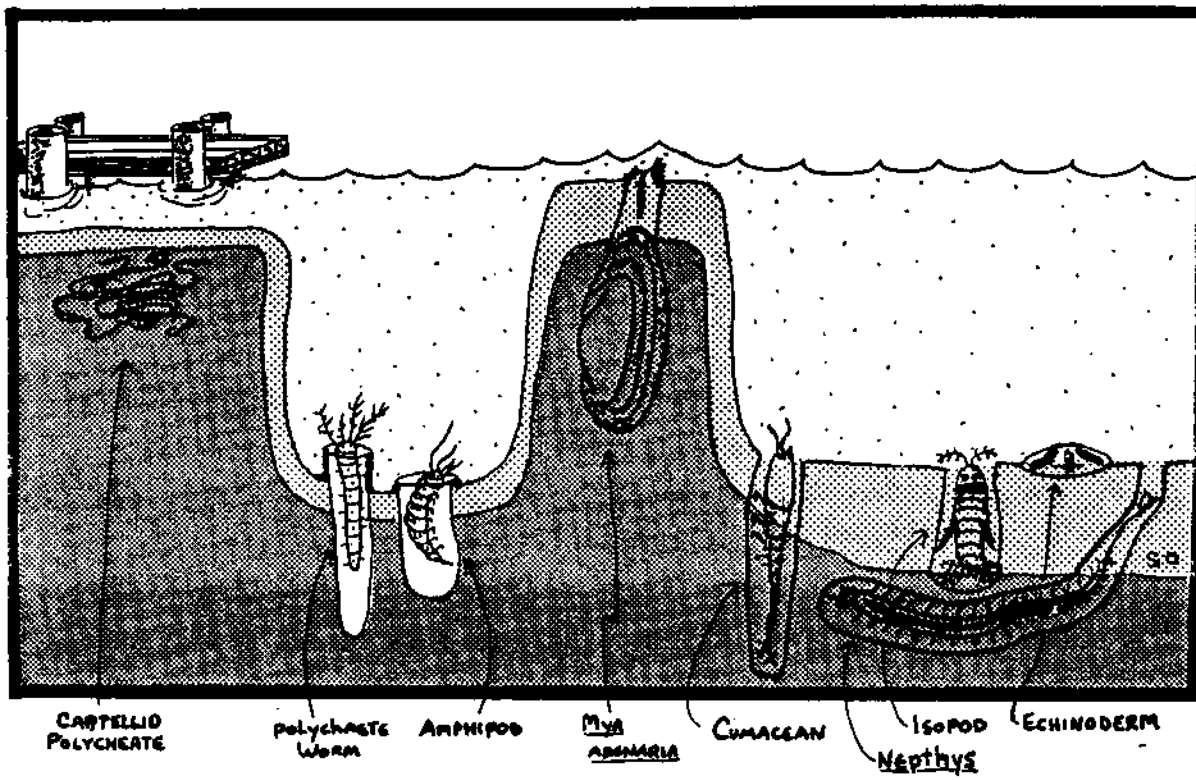
By using three senses--touch, sight and smell--we can investigate our core samples. Sediments relatively high in oxygen are light-colored (tan or light brown), as compared to darker sediments which contain less oxygen. Other factors, such as the source of the sediments and the amount of organic material they contain, can influence color, also.

Sediments that have a large amount of decayed plant and animal life in them will feel sticky or slimy, and the organic material helps hold the sediment particles together. Gritty sediments (the sands) contain less organic material and can be classified as fine, medium or coarse, according to their grain size.

If the sediments smell like rotten eggs, it indicates that hydrogen sulfide (H_2S) is being produced as bacteria break down organic materials. On the other hand, if the sediments have a clean smell, there is more oxygen present and aerobic bacterial activity is breaking down organic materials in a process which produces water.

The anaerobic and aerobic layers of sediments vary in depth, depending upon sedimentation rate and organic content. These layers, and the sediment type present (clay, silt, sand, or gravel) determine the types of animals living in a location. Using the chart and diagram on the next page, notice how the characteristics of each habitat influence what lives where.

Benthic Communities



Location	Habitat	Organisms
Dock	Very thin aerobic layer; almost totally anaerobic.	Captellid polychaetes (small reddish worms--live only one month).
Channel	Thin aerobic layer, atop thicker layer of anaerobic sediments.	Tube-builders (polychaete worms--long, narrow tubes; amphipods--broad, flat tubes). The tubes attach them to the sediments and let them take oxygen from the water. Polychaetes graze the bottom; amphipods resuspend and filter sediments.
Clam Flats	Thick aerobic layer; tidal; clean.	Soft-shelled clam (Mya arenaria): a burrower; filters plankton from water.
Open Ocean	Fairly thick aerobic layer; sandy; hard-packed in places; little organic material.	Mostly burrowers from 3 phyla: 1) Echinodermata--sand dollars; 2) Annelida--polychaetes; 3) Arthropoda, Crustacea--cumaceans, isopods, amphipods.

What Makes a Fish a Fish?

1. Fish live all their lives in water.
2. Fish have scales. Scales are outgrowths of skin, and can be any of several shapes.
3. Fish usually have gills for respiration.
4. Fish have appendages (fins) specially structured for movement through water.

More than 70% of the earth's surface is covered by water, so perhaps it is no wonder that there are so many fish species--some 15-17,000 making up 43% of the known vertebrates. By contrast, there are only about 4,500 species of mammals, the group to which human beings belong.

On earth 400 million years before humans, fish have had time to develop a remarkable diversity. They range in size from a fraction of an inch to monsters 50 feet long. They survive in a range of environments: from three miles above sea level in mountain streams to nearly seven miles beneath the sea; from freezing water to hot springs; from fresh water ponds to salty seas.

Fish come in many different sizes and shapes, each adapted to a particular environment. A flat, triangular fish such as the flounder is well adapted to living on the bottom. The streamlined torpedo shape of a shark is useful for speed and constant locomotion. Some fish, such as the puffer, are round and can "blow themselves up" to a larger size when an enemy approaches. The eel has a snake-like shape and can slip into crevices to hide.

There are three classes of marine fish: the "no-jaw" Agnatha; the cartilagenous skeleton type, Chondricthyes, such as sharks; and the Osteichthyes, or bony skeleton type.

The jawless fish include lamprey eels and hagfish. Both are parasitic, i.e., they attach themselves to the bodies of other living fish to get their food.

The cartilagenous fish include sharks, skates and rays. They are characterized by a skeleton made completely of cartilage rather than bone. Although lacking the swim bladder which prevents a bony fish from sinking to the bottom when not actively swimming, a Chondrichthyes has a large liver which provides some buoyancy. Sharks, the most infamous of the cartilagenous fish, are caught for food in some parts of the world, and though they have been known to return the favor on occasion, stories of their attacks on humans are exaggerated.

Osteichthyes, the bony-skeleton type, include most fish which are caught commercially or recreationally.

Birds of Coastal New Hampshire

Many species of birds inhabit New Hampshire's offshore waters. The most common, the herring gull, and its close relative, the great blackbacked gull, are easily observed. Currently, there are approximately 3800 pairs of herring gulls that nest at the Isles of Shoals, and roughly 2200 pairs of great blackbacked gulls. Competition from the growing population of great blackbacked gulls, and the steady elimination of garbage dumps--a favorite spot for the herring gull--are challenging the latter's current dominance. The great black-backed gulls appear to favor a diet of crustaceans and bivalves rather than the contents of garbage dumps. Both species assume a predator/scavenger role and can be seen descending in great numbers upon the intertidal areas as the tide falls. Sometimes Bonaparte's, ring-billed, and laughing gulls visit the harbor, too.

Canadian geese and many species of ducks may be seen (and heard) while flying in their characteristic "V" formations while migrating north in May. Some ducks, such as mallards and black ducks, live in the estuary and are often found near the Eastman's dock. Both the great and double-crested cormorants are seasonal residents of our coast and may be seen standing on the offshore rocks. Cormorants can often be observed standing in a characteristic "clothes-line" position, that is, with their wings fully extended to catch the wind and dry their feathers. The great cormorant arrives in New Hampshire from more northerly waters in November as the double-crested cormorant is beginning its southward migration to Florida for the winter.

Another familiar bird in Hampton-Seabrook Harbor is the common tern. Terns are often seen flying gracefully over the water searching for small fish or shrimp, which they capture by diving from the air.

Wading birds such as plovers and sandpipers can be seen along the shores of the estuary.

Marine Mammals of Coastal New Hampshire

Marine mammals in the Gulf of Maine include whales (humpback, minke, sei and right whales), whitesided dolphins, harbor propoises and harbor seals. Like land mammals they are warm-blooded and nourish their young on the mother's milk.

Bodies of marine mammals are well-adapted for life in the sea. Most are streamlined, making it easier for them to move through the water. Seals' limbs are modified to form flippers. Rather than vertical tails like fish, whales have horizontal tails--an adaptation that enables them to dive and surface easily. Whales are insulated from cold ocean waters by a think layer of fat (blubber), which also provides buoyancy, padding, and a source of energy when food is scarce.

Young marine mammals are born well-developed and with their eyes open. The high protein and fat content of marine mammals' milk puts fat on the young quickly, giving them needed insulation from the cold and providing quick energy for metabolism. The young grow fast and can care for themselves early in life--adaptations essential to survival in the marine environment. An 80-foot blue whale may give birth to a 25 foot long, two-ton calf. Within one year the calf will double its length.

One of the most fascinating aspects of marine mammals, especially whales, is their ability to dive deep and stay down a long time. Although their lungs are not much larger proportionately than those of land mammals, sperm whales can dive to depths of 3,000 feet and stay down for as long as 90 minutes.

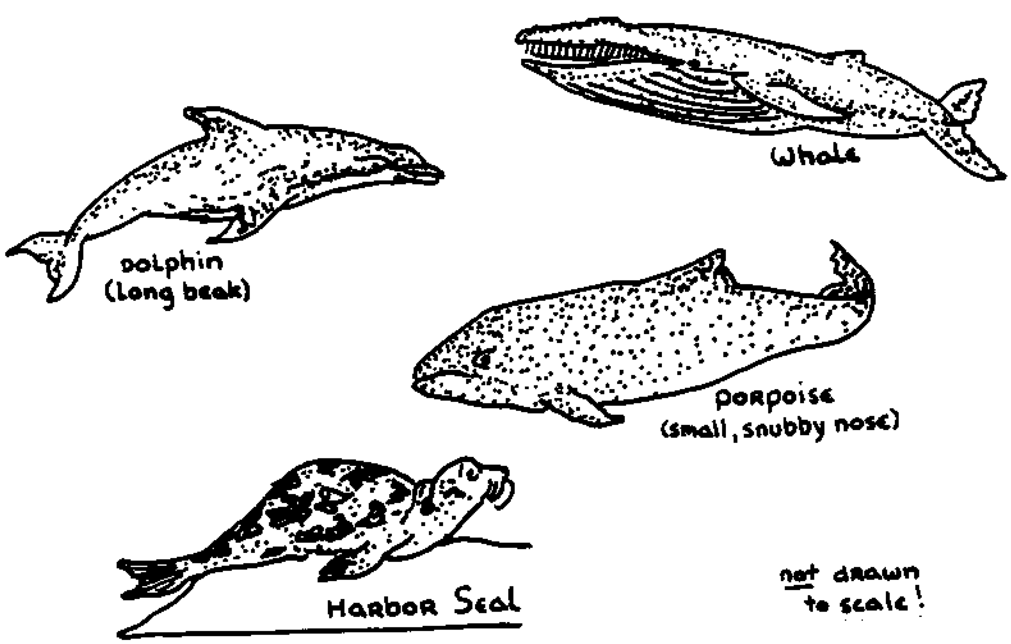
Cetaceans (whales and dolphins) have poor senses of smell and taste, but their eyesight and hearing are excellent. The intelligence of cetaceans has been said to be somewhere between that of dogs and chimpanzees, but some researchers claim that dolphins have an intelligence equal to or greater than humans. Cetaceans make a variety of sounds, both for "talking" with one another and, in some cases, for use as a sort of sonar to locate food and avoid underwater objects. Cetaceans breath through nostrils (blow-holes) on top of the head.

Whales are the largest animals known. In fact, the blue whale, reaching a length of 100 feet and a weight of more than 100 tons, is the largest animal that has ever lived. Whales can grow so large because their body weight is supported by the water.

"Dolphin" and "porpoise" are names that often cause confusion. Generally, the long-beaked forms are called dolphins, and the small, snubby-nosed forms are called porpoises. These words are often used interchangeably, although there is a definite dolphin family (Delphinidae) and a definite porpoise faimily (Phocoenidae). There is also a fish called a dolphin.

Harbor seals may be found basking on offshore rocks at various times of the year. As many as 35 seals have spent the early and mid-winter months near North Beach in Hampton in past years. As spring approaches, seals begin their migration northward back to Maine's coastal islands and coves.

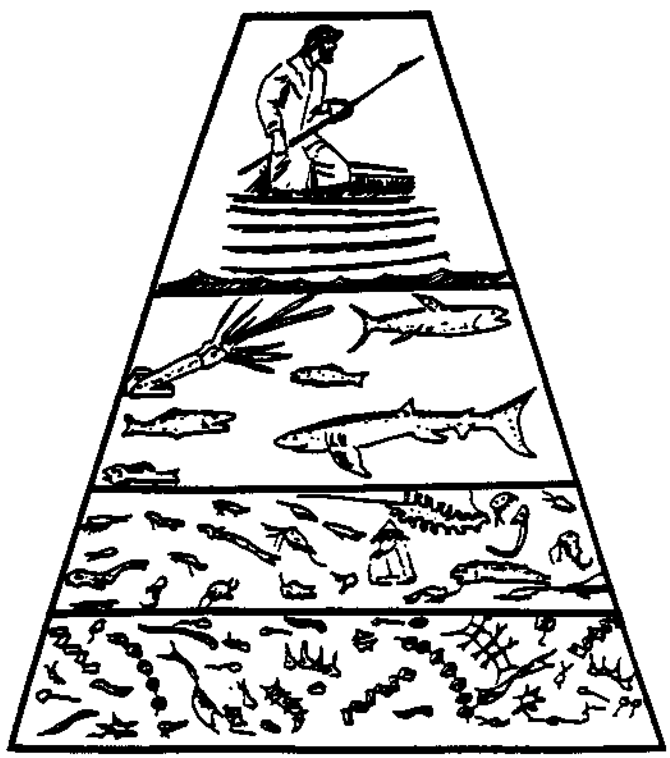
Despite claims by some lobstermen, seals do not generally prey upon lobsters. Stomach content analyses repeatedly find that fish--especially pollock--are their favorite diet.



Ecology

The sun, which provides energy for photosynthesis, is the most important source of energy for marine ecosystems as well as as for those on land. The only known exceptions are the recently discovered communities on the floor of the Pacific Ocean where the driving energy is geothermal.

Most of the living matter of the sea, or "biomass," is plant life: the seaweeds, grasses, and phytoplankton. They are called "primary producers," and only about 10% of their biomass is converted into biomass of the herbivores (plant eaters). The carnivores (meat eaters), in turn, feed on the herbivores, and incorporate only about 10% of their prey into their biomass.



Plants and animals decompose and are chewed into smaller pieces by numerous detritus-feeders such as worms, small crustaceans, snails, etc. The resulting detritus is then fed on by micro-organisms (bacteria, fungi, etc.) releasing phosphorus and nitrogen, nutrients now available for further growth of seaweeds, grasses, and phytoplankton. This cycle is sometimes referred to as the food chain.

The distribution of life forms in the sea is restricted by this fact: that the consumption of one organism by another involves a net loss (about 90%) of energy. Obviously, then, there must be far more primary producers than predators in any ecosystem. Here in the North Atlantic, the combined productivity of primary producers, such as rockweeds, salt marsh grasses, kelp beds and phytoplankton, is probably greater than any comparable area in the world, and forms the basis of our abundant fish populations; and, therefore, our fishing industry.

Fish and Fishing in the North Atlantic

The continental shelf broadens out from the New England coast to form Georges Bank, one of the most productive fishing grounds in the world. Most New Hampshire fishermen, however, fish on Jeffrey's Ledge, West Jeffrey's, or near the Isles of Shoals, all within 30 miles of Hampton-Seabrook Harbor.

On the north side of the harbor, the State of New Hampshire operates a 350-foot fish pier with moorings, a 65-foot recreational boating dock, and a launching ramp. In 1980, there were 4.5 million pounds of fish landed at the Hampton State Fish Pier, accounting for about one-quarter of the catch at all three state piers (the others being at Rye and Portsmouth).

Otter trawls are used by most of the fishing vessels in the northeast; however, about 70% of New Hampshire fishermen set gillnets. Gillnetting is popular here because smaller, less-expensive boats and equipment can be used. A three or four-man crew plays out the transparent polypropelene nets from the boat so that they hang like a fence in the water. The "fence," with floats on the top and weights on the bottom, is anchored in the water for a day or so. Then it is hauled in over the side of the boat, and the crew removes the fish which have been caught by their gills in the net, cleans them, and packs them in ice.

In 1980 there were three trawlers, or "draggers," operating from the Seabrook side of the harbor. Larger than a gillnet boat, a trawler is equipped with a big rotating drum on which the net is rolled and stored. Trawling is done with a cone-shaped net, 100 to 150 feet long, called the otter trawl. It's mouth spread open by heavy steel or wooden doors, the otter trawl is towed for several hours. The bottom of the net, or "ground line," is weighted and sometimes has rollers to help it move more smoothly over the bottom. At the mouth of the net, "tickler chains" help nudge the fish into the net. The net is pulled in until the "cod-end" (the tapered end) can be lifted into the boat. The fish are dumped into the bottom of the boat, and cleaned and iced as the boat returns home.

Most fish caught by local fishermen are sold to the Tri-coastal Cooperative, or to local restaurants and fish markets. Although Booth Fisheries operates a seafood processing plant nearby on Interstate 95, it buys no local fish.

Commercially important species caught off the New Hampshire coast include hake, haddock, pollock, cusk, halibut and herring. In the summer, the swordfish and the bluefin tuna migrate to the Gulf of Maine where they are taken commercially or for sport with rod and reel, or with harpoon. The bluefin, an oceanic wanderer, may grow as long as fourteen feet and weigh more than 1,000 pounds.

Two of the most important commercial species to New England fishermen are the cod and the flounder.

The Cod

The Cod (*Gadus morhua*) was a major factor in the diet and trade of the early European settlers of the New England coast, and has been a mainstay for commercial fishing here ever since. Records kept by early colonists tell of an abundance of large cod, some over 200 pounds and six feet long. Today, the cod is still important commercially, constituting 95% of the early spring catch off New England, with most fish weighing between 12 and 35 pounds and averaging about three feet in length.

Cod are "groundfish," usually swimming within six feet of the bottom. They live in the Gulf of Maine year-round, tolerating a range of water temperatures. Cod spawn in winter, each female producing about one million transparent, buoyant eggs. The newly hatched larvae feed on diatoms and later on zooplankton. As the fish develop, they turn to worms and small crustaceans, and soon are swallowing whole clams and mussels, and eating squid and octopus as well. Fishermen report occasionally seeing a cod supplementing its diet with an offshore bird.

The Flounder

Thousands of pounds of flounder are caught and marketed in New Hampshire each year. The winter flounder (*Pseudopleuronectes americanus*) and the yellowtail (*Limanda ferrugina*) are leading contributors to the New England flounder fishery, which exceeds two million dollars per year. Sportfishing for flounder, with rod and reel or with dropline, is also very popular throughout New England.

The life cycle of the flounder is similar to that of the cod. The larval flounder eats diatoms and zooplankton. As the larvae become adult fish, tiny crustaceans, worms and molluscs become the preferred prey. When the young flounder completes its metamorphosis--when one eye migrates over the nose to locate beside the other, and the fish settles to the bottom to live there permanently--it adds amphipods and isopods to its diet. From that point on, most of the flounder's movement is horizontal, migrating to the open ocean for the summer and early fall, and returning to spend the winter and spring in the estuary.

Like cod, flounder are groundfish, and as such are among the first finfish to feel the effects of environmental change. Their prey live in and on the bottom sediments, where pollutants accumulate. Estuaries that have high concentrations of pollutants, or are victims of dredge and fill operations, may have their "nursery" characteristics harmed; but in any case, they pose a potential threat to human health. Whenever people eat fish, they enter the marine food chain and are exposed to the environmental conditions under which the fish lived. This is an important consideration in the siting of power plants, dumps, sewage treatment plants and the like. It is also a concern when runoff from agricultural and industrial areas includes harmful chemicals.

Lobsters and Lobstering

A large and valuable New England industry, lobstering in New Hampshire grosses more than one million dollars annually and employs about 150 people, about one-third of which are full-time lobstermen. During the '70's, more than 360 commercial and 150 recreational lobster licenses were sold annually. There are about 35 lobster boats operating out of Hampton-Seabrook Harbor. Most local lobstermen set their traps near shore, some going out to sea all seasons of the year.

Lobstering in New England is hard work. Bad weather, poaching by skin divers, an ever-changing market, and costly gear loss are some of the problems faced by lobstermen. Bad weather alone can cause a loss of fishing time, damage to the boat and loss of traps and buoys. Often these lost "ghost traps" contain lobsters, resulting in a double loss to the lobstermen.

It can cost as much as $75,000 to outfit oneself with a boat, traps, a truck, dock, and tools for full-time lobstering. However, many lobstermen build their own wooden traps, use existing docks, and buy smaller, used boats to start with. Still, initial expenses for starting a lobstering business are considerable, and upkeep and replacement of equipment is a continuing expense.

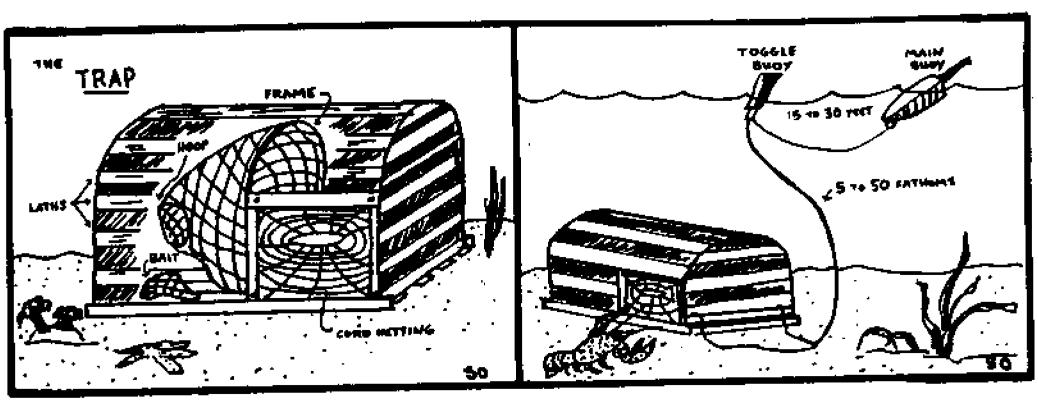
Locally, lobstermen sell their catch to restaurants, fish markets, and individuals, but most are sold to the New Hampshire Lobster Company located near the State Pier in Hampton Beach. They may keep their fall and early winter catch in "holding cars," submerged boxes where lobsters are kept alive until prices go up.

New Hampshire state laws require the licensing of all lobstermen, and limit minimum size to 3-3/16 inches measured from the back of the eye to the beginning of the tail (the same size that Maine allows). Egg-bearing females cannot be kept, and their tails are often notched before release as an aid to future identification.

Legally, a would-be lobsterman can fish for lobster anywhere within the jurisdiction of his state license. In practice, he must be accepted by those already working out of a particular harbor. All lobster traps are marked by buoys, and each lobsterman has his own uniquely colored buoys. Although lobstermen are very independent, often working alone in their small boats, they do cooperate to regulate their own territories, and even impose some conservation measures upon themselves.

The American lobster (<u>Homarus americanus</u>), a hard-shelled, bottom-dwelling crustacean that lives at depths of from 6 to 1200 feet, is the famous New England lobster. In winter they migrate to warmer water and may bury themselves in mud or hide out in the kelp-rich areas. Lobsters are scavengers, eating small crustaceans, clams, mussels, oysters, and even fish. They are also cannibalistic, which is one of the reasons lobstermen use rubber bands or pegs to hold their claws closed when they are caught. Lobsters molt several times during their growth, usually in the summer, and go into hiding each time until their new shells harden.

Lobsters are usually caught in wooden traps which are lowered to the bottom and retrieved after a couple of days, either by hand or with the aid of a motor-driven winch. The trap is then rebaited with "chum" (redfish is a favorite lobster bait) and dumped over the side once again.



Clams and Clamming

On almost any weekend during the winter and spring months when the tide is low, you can see people harvesting clams on the flats to the west of the Eastman's dock. Clamming, an important marine industry in Maine, is strictly recreational in New Hampshire, where licenses are sold to state residents by agents of the Fish and Game Department. One peck a day is the limit, and the delicious steamers (Mya arenaria) taken recreationally cannot legally be sold. Harvesting can be done on Friday and Saturday only. Although Maine has a minimum size limit on clams, New Hampshire has none, trusting people to throw back the smaller ones. It is estimated that about 9,400 bushels of clams were available for harvesting in the Hampton Harbor area in 1982.

Clams are harvested with a short handled fork which is driven into the flat at an angle, and hefted to flip over a forkful of sediment and expose the clams. No area should be dug more than twice every four to six months, to allow the small clams time to re-orient themselves in their habitat.

Clams are filter feeders, drawing in water and straining food out as the water passes through their filters. They grow wherever there are tidal flats such as those in Hampton. Because they are filter feeders, they concentrate pollutants suspended in the water. New Hampshire clam flats are regularly closed each summer when the increase in human population nearby directly affects the pollution level of the estuary.

Clams are depositories for the toxin of the Gonyaulax tamerensis organism, the local source of the dreaded "red tide," which causes paralytic shellfish poisoning (PSP) in humans who eat tainted bivalves. New Hampshire flats are closely monitored for red tide, and warnings are posted when the organism becomes too prevalent. All flats are closed from the end of May through September.

Navigation Aids

Through the use of equipment aboard ship and aids to navigation in the water, a navigator can take bearings from fixed landmarks, locate the position of his ship precisely on a chart of the area, determine the direction, course, and speed of the ship, and predict arrival time once speed and distance are known.

Along the coast are a series of aids to navigation:

1. Buoys are floating markers anchored to the bottom. They are visually coded for ease of identification and appear on all navigational charts.
   a. Red buoys mark the right side of harbor entrances as one returns to port. An easy way to remember this is by reciting "red on the right, returning." Red buoys are evenly numbered starting at the farthest marked point out to sea. At night they are lit with red lights which flash at specific time intervals. A red buoy is called a nun buoy.
   b. Black buoys mark the left side of harbor entrance as one returns to port, and are assigned the odd numbers. Green flashing lights mark them at night. Many are plain black cylinders, or can buoys, although other shapes may also be used.
   c. Mid-channel markers are vertically striped black and white buoys with flashing white lights at night.
2. Range markers are mounted in harbors so that they are visible to vessels from far out at sea. A ship coming into port can line up the two standard range markers, or ranges, so that one appears on top of the other, and know that it is sailing down the center of the channel. Ranges are large fluorescent orange or yellow rectangles with a white strip down the center, and are mounted high off the ground. At night they are marked by especially bright lights, the colors (such as amber, green, red) varying from port to port to facilitate identification.

Navigation Aboard the Floating Lab

Most navigation aboard the Floating Lab is done with sophisticated electronic gear. A depth finder measures depth and bottom topography directly beneath the ship, while the depth recorder makes a record of that information on paper. It is supplemented by a scanning sonar which detects solid objects within a wide arc. Bottom material--rocks, sand, obstructions--as well as large concentrations of fish can be "read" in this manner.

Loran (Long Range Navigation) is another widely used electronic device. The unit inside the pilot house receives low frequency electromagnetic signals from two transmitters at known on-shore locations. The Loran receiver in the boat translates these signals into numbers that show the boat's relationship to each transmitter. These numbers can be plotted on a map with Loran coordinates on it to determine the boat's location.

Other equipment includes: radar, which sends out radio-waves and picks them up after they have been reflected by a land mass, rock jetty, channel marker, ship or other object; ship-to-shore radio to communicate with the shore and other boats; an automatic pilot, especially useful on longer trips.

Even with all this automatic equipment, the captain and his crew still must know how to navigate using a compass, charts, dividers, and parallel rules, in case of equipment failure.

Pollution

Man is responsible for introducing many pollutants into the southern Maine-New Hampshire marine ecosystem. Some rivers in Maine and New Hampshire are classified as polluted, and some clam flats in southern Maine have remained closed due to pollution for many years.

Eventually all pollutants reach the ocean. Although DDT has been banned from use, its residues will continue to seep into the oceans for several more years. Oil tankers that pump their bilges off the coast contribute to a condition that can create both immediate and long-term problems for the environment. Both nuclear and fossil fuel power plants produce thermal pollution. When heat places a stress on organisms that may result in death for certain individuals or species, it is considered a pollutant. Nuclear power plants also release low-level radiation into the environment. The effects of low-level radiation on marine food chains is not yet known.

Pollutants are accumulated within a food chain by a process called bio-concentration. The process begins as phytoplankters (producers) each accumulate small amounts of a pollutant. The zooplankton (primary consumers) then feed on the plant material and concentrate higher amounts of the pollutants in their bodies. Small fish feed on the zooplankton, and the process snowballs.

For example, suppose that one million plankton each accumulate one part of DDT. Then 100 small fish eat 10,000 plankton each. One mackeral eats the 100 small fish assimilating all of the DDT into its tissues. A fisherman catches the mackeral and brings it home for dinner. In this way, the highest members of the food chain, human beings among them, receive a much higher concentration of pollution than is present in the surrounding environment.

SECTION III: ON-BOARD ACTIVITIES

On-Board Activities

Table of Contents

The Van Dorn Bottle and Water Sampling

(Station 1)

Introduction

Water sampling provides a great deal of information about the ocean and our relationship to it. The Van Dorn bottle collects water from a chosen depth and prevents it from being mixed or contaminated on its way to the surface. Close examination will show that water varies considerably at different places, depths, times and seasons.

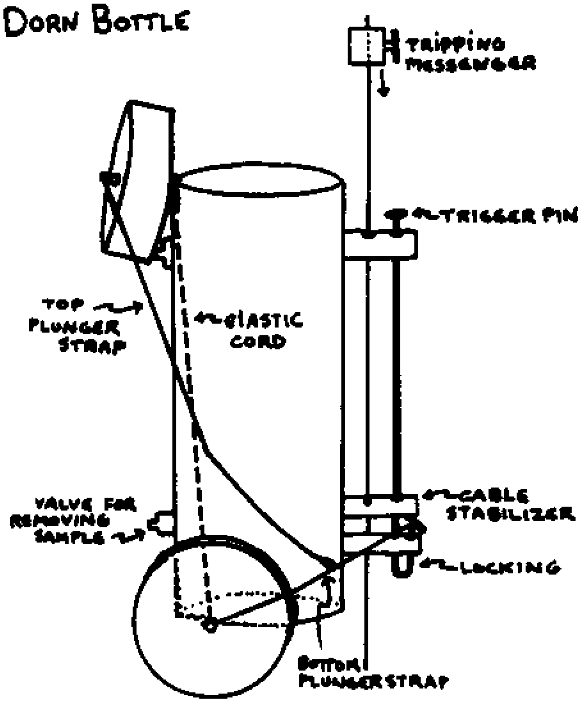
Purpose

To obtain water samples for various analyses.

Procedure

1. The Van Dorn bottle is to be used only when the vessel is on location.
2. Open the plungers, placing the bottom plunger strap through the top plunger strap. Insert the loop into the slot in the locking device, letting the pin go through the loop, locking the bottle in the open position.
3. Lower the bottle over the side to the bottom.

VAN DORN BOTTLE



4. Attach a messenger to the line and release the messenger. Hold onto the line to feel the jerk when the bottle trips.
5. Raise the line and retrieve the bottle <u>very slowly</u>.
6. <u>Do not</u> expose the sample to air until you are ready to test for oxygen. Avoid contamination from any source.
7. Remove water for the following analyses:
   - temperature
   - pH
   - salinity
   - dissolved oxygen
8. Record all data on the data sheet.
9. Transfer water to a container for use in the lab.
10. Repeat operation at middle and surface depths.

The Hydrometer, Thermometer and Salinity

(Station 1)

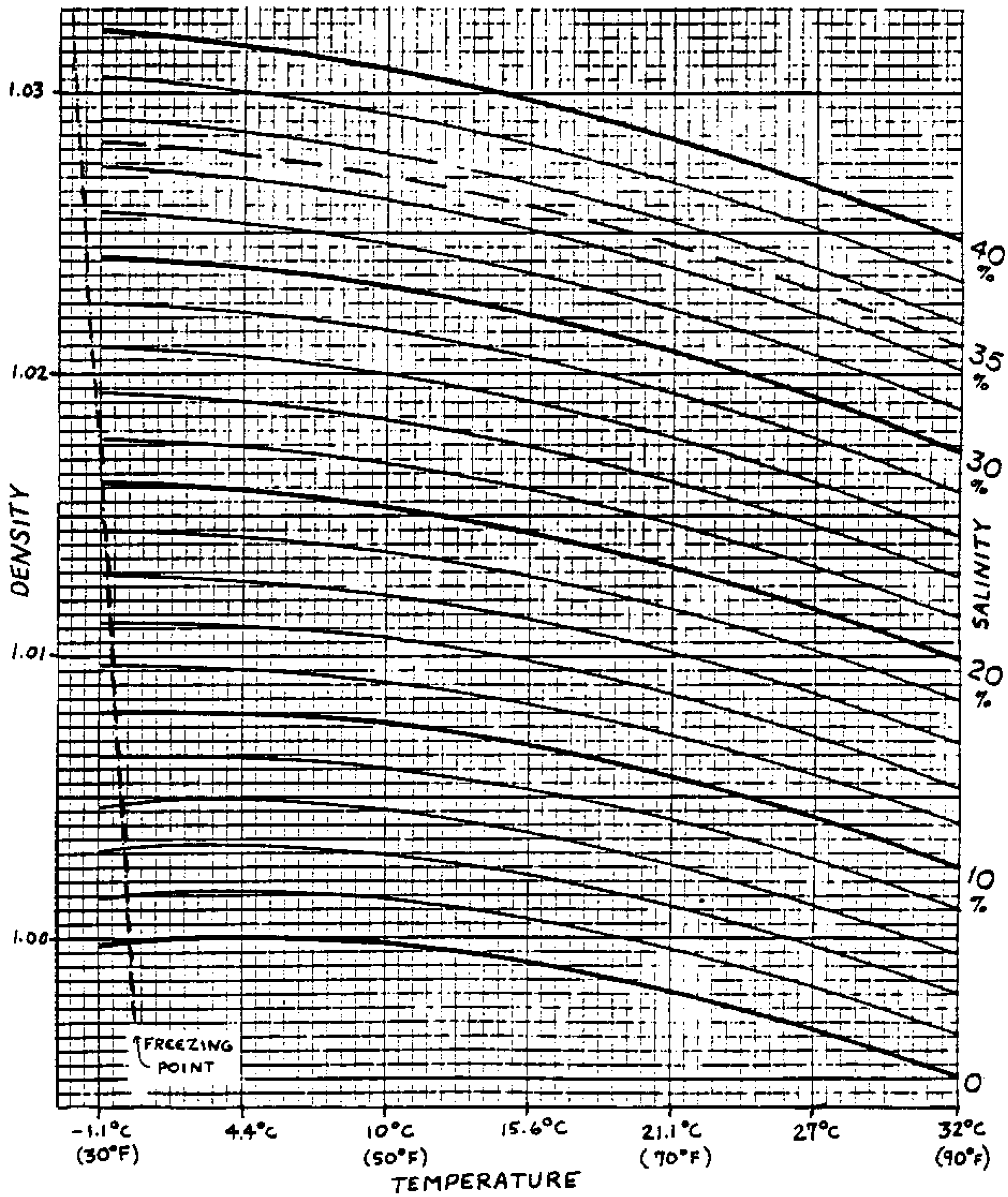
Introduction

Salinity refers to the concentration of salts dissolved in water. It is usually expressed as the number of grams of salt in 1,000 grams of water, or parts per thousand (o/oo). The salinity of the open ocean is about 35 parts per thousand, but estuaries usually have a lower salinity level because of their fresh water input. Using temperature and density of water, a conversion table may be used to calculate the sample's approximate salinity. We use a hydrometer to measure density and a thermometer to measure temperature. Using the graph on the next page entitled "Salinity Determination by Density," we can determine the approximate salinity of the water at the site.

Procedure

1. Fill a graduated cylinder with water from the Van Dorn bottle.
2. Take the temperature of the water immediately and record it.
3. Insert the hydrometer in the cylinder, twirling it slightly to move it into the water.
4. Let it rise until it stops; read the density of the water.
5. On the "Salinity Determination by Density" graph, find the point where your temperature and density readings intersect. Where does that point fall on the salinity gradient? Record the salinity of your sample.

SALINITY DETERMINATION BY DENSITY



Dissolved Oxygen Kit and Water Oxygen Content

(Station 1)

Introduction

Perhaps the most important and abundant of the gasses in sea water, oxygen reaches solution as a byproduct of photosynthesis and by direct absorbtion from the atmosphere. Both plants and animals require oxygen for respiration.

In a healthy estuary, the level of oxygen dissolved in the water cannot fall below a minimum of 3 or 4 parts per million (ppm) without placing a lot of stress on the plants and animals in the immediate area.

The amount of oxygen in the water fluctuates with:

- -circulation and mixing of the water;
- -pollutant level;
- -nutrient load;
- -temperature;
- -salinity.

Cool water holds more oxygen than warm water, and layers of water contain different levels of dissolved oxygen.

Purpose

To measure dissolved oxygen of water sample.

Procedure

Because different dissolved oxygen kits are used, follow the directions on the kit provided to you.

pH Test Kit and Water Acidity

(Station 1)

Introduction

The pH scale runs from zero to fourteen. A pH of 7 is neutral. The pH of ocean water is slightly basic, usually 8.0 to 8.4. In estuaries, the pH in marine muds or tidepools may vary from below 7.0 to 8.6. Marine life cannot survive if the pH is very far outside these limits. The ocean has a buffer system that tends to neutralize acids and bases; therefore, the pH is fairly constant.

Purpose

To determine pH at several depths at three locations.

Procedure

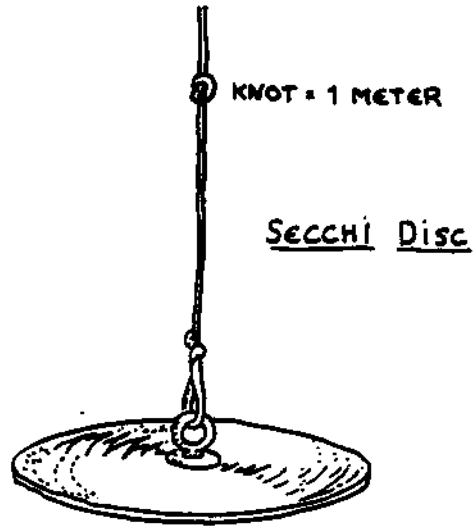
1. Rinse the test tube with the water to be tested, then refill the test tube to the 5 ml. line.
2. Add the indicator solution to the sample in the tube. Read the instruction label on the front of the comparator to determine the proper number of drops of indicator solution to be used.
3. Hold the dropper bottle or pipette vertically (not tilted) to dispense drops of uniform size.
4. Cap the tube and invert several times to mix the contents.
5. Insert tube in comparator and match the color of the test sample against the color standards to obtain the pH test result.
6. Carefully wash and rinse test tubes after each use.
7. Put comparator and test tubes in kit for the next group's use.

The Secchi Disc and Turbidity

(Station 2)

Introduction

The instrument used to measure the turbidity, or lack of clarity, of the water is the Secchi Disc. Resistance to the passage of light is an important parameter because it limits the depth to which photosynthesis is possible. Divers and underwater photographers use the Secchi disc to determine how much light is available. In clean coastal waters the disc should be visible through up to 25 meters of water. Although this was one of the first methods used to quantitatively estimate light penetration in ocean waters, it is still useful today.



Turbidity is affected by the number, size, shape and refractive index of suspended particles in the water. It can be influenced by large amounts of fresh water entering the ocean. Some human activities affecting turbidity are municipal sewage effluents, storm drain effluents, industrial discharges, poor grading practices of land surfaces, harbor dredging, and bilge pumping from boats.

Turbidity can both influence, and be influenced by, plant productivity in the ocean. An increase of nutrients in water with sufficient light can result in phytoplankton blooms which temporarily increase overall productivity but may have detrimental long-range effects. Such blooms can occur in poorly circulated harbor waters where stream effluents, other land-based runoffs, and dumping of wastes abnormally raise the nutrient level. The resultant bloom can make the water more turbid, limiting light penetration, and hence, limiting other forms of life, particularly on the bottom.

Purpose

To assess turbidity at three depths.

Procedure

1. To determine the turbidity of the water, secure a line end to the boat and lower the Secchi disc on the shady side.
2. Find the point at which the disc just disappears. Lower a meter more and return it until it reappears.
3. To check, lower disc twice on each side of the bow. Average results.
4. Record your results on the data sheet.

The Forel/Ule Scales and Water Color

(Station 2)

Introduction

The names of many of the world's seas refer to color: the Black Sea looks dark because its bottom is covered with black sediment; the Yellow Sea off northern Siberia contains lots of river-borne yellow mud; the Red Sea (near Egypt) and the Vermilion Sea (in the Gulf of California) appear red because of algae that has a reddish color. The White Sea is so named because it is frozen solid more than 200 days of the year.

The Forel/Ule scales each consist of eleven colored solutions and are used to assign a standard color to seawater. The color can then be related to biological activity, sediment content, bottom condition, etc. Yellowish-green suggests dense phytoplankton population. Brown indicates the presence of algae or mud in the water. Estuaries often range through these two colors. The open ocean tends to be greenish where the depth is not great. People often assume that the ocean is greenish-blue because that is its usual color near the coast; the deep ocean actually looks dark blue.

The Forel scale ranges from green to deep blue and is used for open ocean water. The Ule scale includes colors varying from green to brown and is used for inland and estuarine waters.

Purpose

To determine water color.

Procedure

1. Secure the loose end of the Secchi disc line to the boat's rail and lower the disc below the water's surface two meters.
2. Holding the Forel/Ule scale at arm's length, view the disc through hole in the scale.
3. Record the Roman numeral of the sample that is most nearly the color of the water seen with the disc as a background.

Drift Bottles and Currents

(Station 2)

Introduction

Many methods are in use to study currents. The oldest and still most widely used method is the use of drift bottles. Drifter release data obtained by Normandeau Associates show most recoveries of drift bottles released from the Hampton-Seabrook area have been between Cape Ann and southern Maine with the remainder in Maine, Massachusetts Bay, and Cape Cod. The most distant recoveries include Nova Scotia; Azores Islands; Fire Island, New York; and Block Island, Connecticut. Drift bottles were typically carried southward and offshore out past Cape Ann by the Gulf of Maine Gyre. Surface flows of the drift bottles were generally one to three miles a day.

Purpose

To study local current systems.

Procedure

1. Use floats outside the breaker zone. Floats should be made by students (see Pre- and Post-Cruise Activities section). The effect of wind should be minimized by having as little of the float above water as possible.

2. Floats should be released at stations 1 and 5 (five bottles each). We will have each class release ten drift bottles (total: 200).

3. Time your bottle as it moves from bow to stern of the boat. You can see how fast the water is moving by dividing the distance (length of the boat is 70 feet) by the time it took to move from bow to stern,

$$\frac{\text{Distance (feet)}}{\text{Time (seconds or minutes)}} = \text{Rate}$$

   or by estimating how long it takes for one bottle to drift 100 yards (length of a football field).

4. If you provide the Floating Lab coordinator with information on your returns, your data will be combined with that of other classes and returned to you as a composite picture of current movement.

5. Ordinary rubber balloons filled with fresh water are sometimes used to study currents. They are put into the water beyond the surf zone where they float because fresh water has a lower density than does salt water.

Current Meter and Water Currents

(Station 2)

Introduction

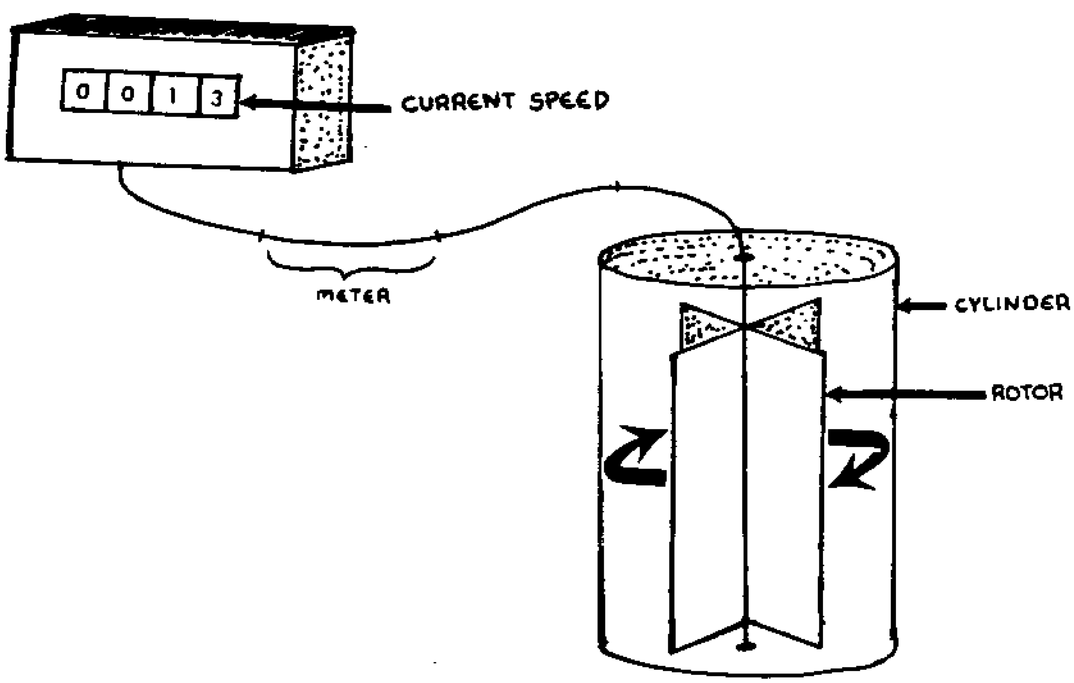
The meter electronically counts the number of revolutions the rotor makes in a given period of time. The number of revolutions is directly proportional to the speed of the moving water. A digital read-out will be available on an attached device.

Purpose

To determine the current speed.

Procedure

1. Lower the rotor into the water just under the surface.
2. Turn on the switch.
3. Read the current speed on the digital meter.
4. Record both the depth and the current speed on your data sheet.
5. Repeat steps 2-4 with the rotor at the bottom, and then at mid-depth. Is there any difference among the current speeds at the three depths?



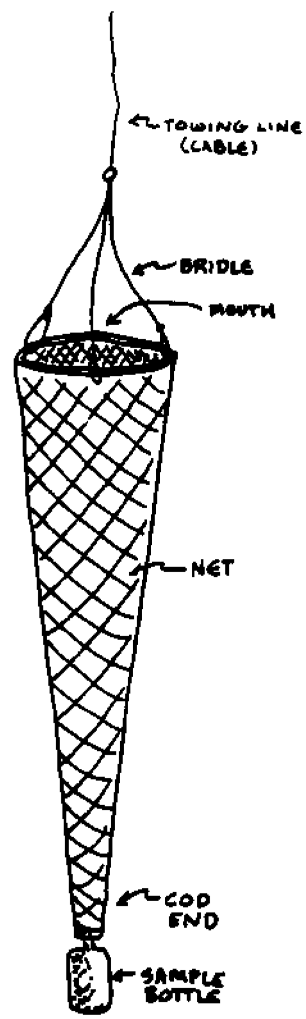
Sampling with a Plankton Net

(Station 3)

Introduction

Since many plankton are microscopic, they are sampled by filtering the water through a fine mesh net. These nets are towed behind a boat or along the beach, or are weighted, lowered vertically, and held in the current at different levels. Once collected, the plankton are identified and counted.

Plankton numbers and species vary with depth. A vertical haul will sample from all depths. The net is lowered to the bottom and then pulled rapidly to the surface.



Purpose

To sample plankton at various points in the water column.

Procedure

1. Prepare the net: attach the plankton bucket to the end of the net; attach the line to the net.
2. At signal, lower net slowly until it reaches the desired depth.
3. Pull the net up slowly and allow it to hang out straight.
4. Keeping the hose on the outside of the net, wash all the plankton down from the sides of the net and into the plankton bucket.
5. Pour the sample into the specimen container. Wash the net once or twice to remove all plankton.
6. Take a surface, mid-depth, and bottom sample.
7. Take the plankton back for further study with a microscope. Add about 10 milliliters of formalin to the sample to preserve it. Keep the sample cold until you want to examine it.

8. The plankton can be identified under the microscope, using references in the Appendices of this manual.
9. Between stations we will take a horizontal tow, dragging the net just under the surface.

(Station 4)

Introduction

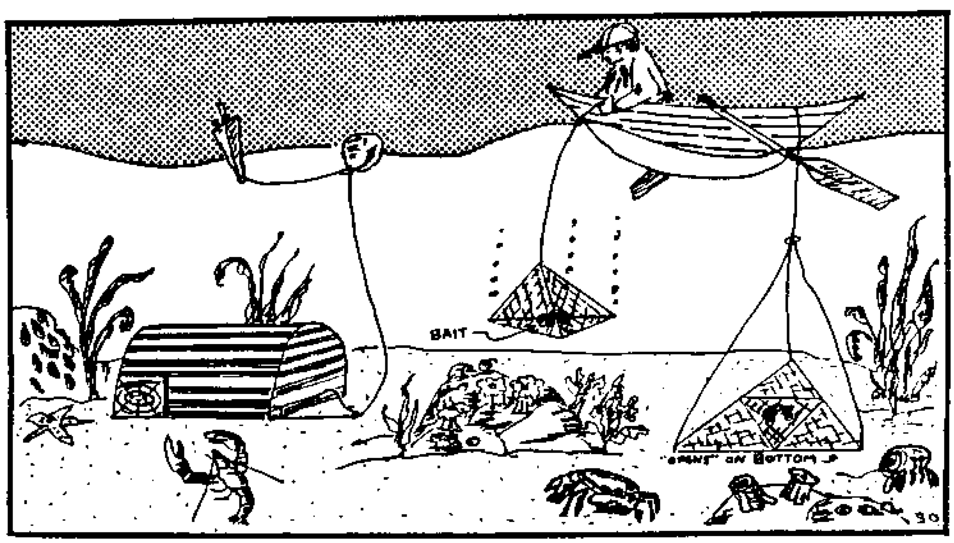
The invertebrate traps are baited with bits of fish ("chum") and lowered to the bottom where invertebrates such as crabs and lobsters are crawling along looking for bits of food to eat.

Purpose

To find what types of marine invertebrates live on the bottom of the sampling areas.

Procedure

1. Bait trap with "chum."
2. Hook it together; lower over the side.
3. Pull trap up in 5-10 minutes.
4. Place organisms in small pans or large tank.
5. Identify, describe, count, and determine the sex of the organisms according to requirements of your lab sheet.



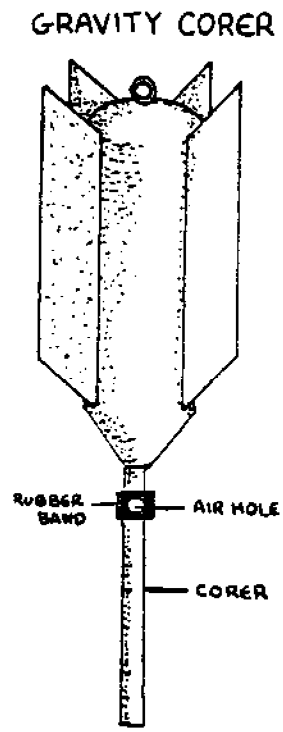
The Gravity Corer and Bottom Sediments

(Station 4)

Introduction

Sediments are layers of mud, sand and other substances that make up the seashore and ocean floor. Wave action, current speed, biological activity and chemical processes help to determine the character of the sediment. Examination of sediment and its layers can reveal recent and historical climatic changes and biological activity.

The gravity corer is a pipe that is driven by a heavy weight into the ocean floor. It samples the sediment as a solid cylinder of material called a core sample.



Purpose

To sample bottom sediments.

Procedure

1. Secure the end of the rope attached to corer to the deck. Notify instructor of intent to sample. (Boat must be stopped.)
2. Move rubber down to expose air hole.
3. Gently place corer over the side, nose down.
4. At signal, release corer.
5. Reel in corer.
6. Unscrew core tube. Push out core with plunger. Examine it. Record field observations, particularly color and odor.
7. Wrap core sample in aluminum foil for lab analysis.
8. Use Core Analysis Sheet in Pre- and Post-Cruise Activities section to record your findings.

The Bottom Grab, Sediments, and Benthic Communities

(Station 4)

Introduction

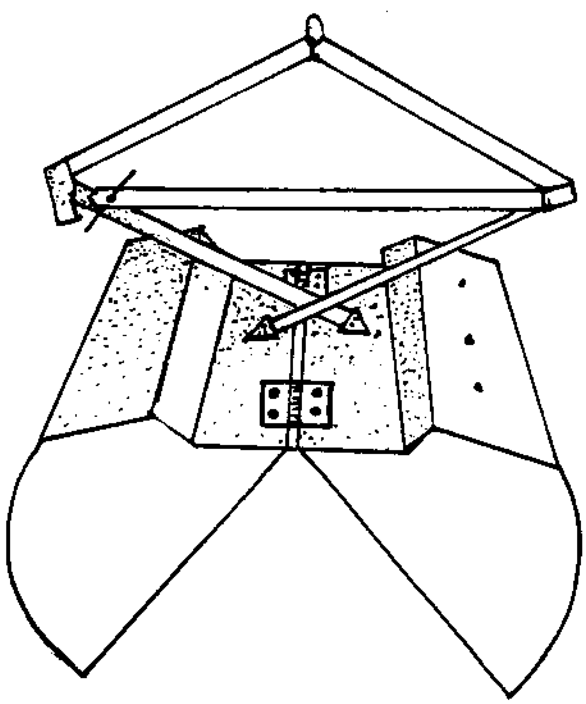
A bottom grab is used to sample sediments and organisms living in the sediments. Sediments may include clay, silt, sand, or gravel. Organisms include polychaete worms, amphipods, isopods, cumaceans, clams, and smaller marine organisms called infauna. Unexciting as they may seem at first, these organisms are vital to the ecology of the marine environment, and are among the first creatures to be sensitive to environmental change.

Purpose

To sample sediments and organisms living in them.

Procedure

1. Notify the instructor that you are ready to make a grab sample.
2. Cock the grab sampler, then carefully lower it over the side until it hits the bottom.
3. Find out the depth from the ship's depth recorder. Write this down on the data sheet.



4. Pull the sample back up and bring it on board ship.

5. Note the following characteristics and record on data sheet:
   - Odor--none, rotten eggs, etc.
   - Color--olive green, brown, etc.

6. Using buckets of water, wash the sediments through the sieve.

7. Organisms:
   - Wash off any organisms found in the sediment.
   - Place each kind of organism in a dish of sea water.
   - Record names of organisms on the data sheet.

(Station 5)

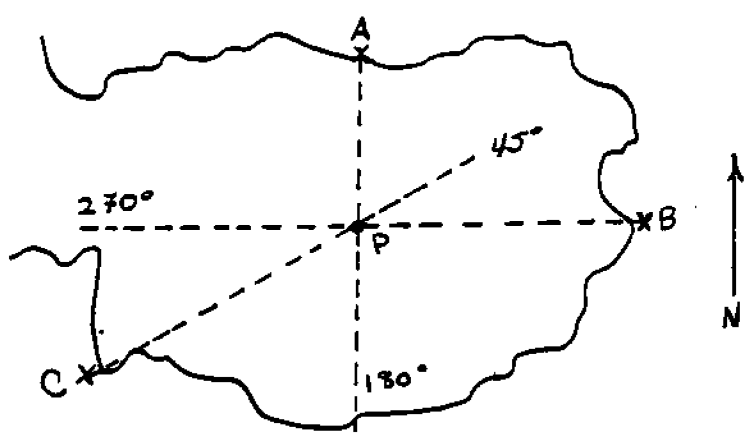
Introduction

Knowing the location of the ship at all times is important information for anyone venturing away from land. In oceanographic sampling, the location of individual sampling stations is critical. Historically, the merchant marine and trading companies recorded temperature, currents and weather conditions, and collected this data to inform other mariners. Sailors were constantly aware of sea conditions and used that knowledge to chart courses which would be most beneficial. Today, through the use of equipment aboard ship and aids to navigations in the water, navigators can determine the location, course, and speed of the ship. Within sight of land, the ship's location can be determined by using compass bearings taken on various known landmarks.

If we take bearings to three different objects, then plot the reverse bearing (the measured bearing minus 180°), the lines will intersect at a point which defines the location of the ship. For example, we have the following data:

Object	Bearing	Reverse Bearing
A	360°	180°
B	90°	-90° or 270°
C	225°	45°

If we plot these on our map, we find the ship is at point P:



In this case the intersection is a point (P). In reality, the lines will intersect and form a triangle due to errors in measurement. Then the best we can do is to say that the ship is within that triangle.

Purpose

To acquaint the student with some basic navigation techniques.

Procedure

1. When on station, the navigation group will go into the pilot house to talk to the captain about how he runs the ship.
2. Write down a verbal description of the station location in the space provided on the data sheet, e.g., near shore, off of the pier, etc.
3. Record the sky conditions, air temperature, wind speed, and wind direction in the spaces provided on the data sheet.
4. Record a description of the sea surface conditions in the spaces provided on the data sheet.
5. Record any other observations you feel are important in the spaces provided on the data sheet.
6. Using the hand bearing compass, take the bearings to three different objects on shore, e.g., a tower, a smokestack, a steeple, etc.
7. Write down a description of each object sighted, along with its bearing, in the spaces provided on the data sheet.
8. Using this data and a chart of the area, the position of the ship at each station can be pinpointed.

(Between locations)

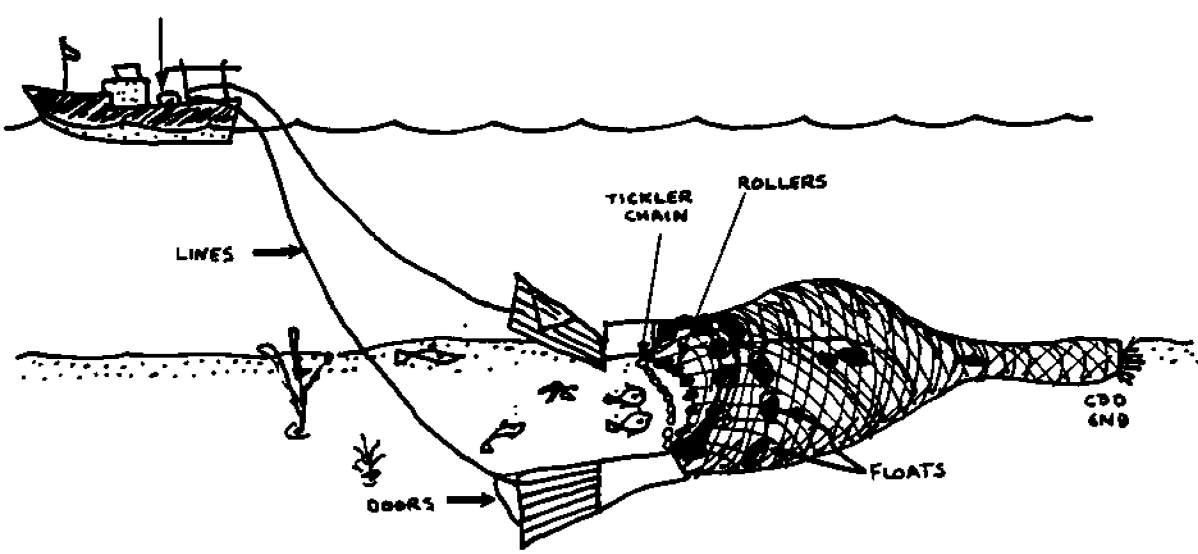
This sampling technique is unpredictable. We never know exactly what we will collect. It is very exciting when we find a new and unusual animal.

The otter trawl is a funnel-shaped net about seven meters long and five meters wide. It is towed by the boat. A row of floats holds the mouth of the net open vertically. A chain keeps the net close to the ocean floor. On both sides of the trawl are boards called doors. As the boat moves forward, water pressure keeps the mouth of the net fully open. The net is dragged slowly along the bottom. It scoops up everything in its path that can't escape fast enough. However, it may get caught on rocks and come up empty.

<u>Activity A</u>: Setting the Otter Trawl

<u>Introduction</u>

Setting the trawl is a critical operation. There must be careful timing, coordination and communication among students,



crew and captain. When setting the trawl, be sure to follow instructions carefully.

Purpose

To sample benthic communities.

Procedure

1. To set otter trawl, line up on both sides of stern; hold lines.
2. The instructors will check the line to be sure it is coiled properly. (Be sure lines are not crossed. Doors pull to either side.)
3. Tie cod end of the net.
4. When the captain gives the signal, release cod end. Let the net follow the doors last. Stay clear of net.
5. Let lines out at same rate (they are four times as long as the water's depth).
6. Tow net at one or two knots for 10-20 minutes.
7. Pull net in at end of tow. Everyone will help do this, following instructor's directions.
8. Lift net over the stern.
9. Bring catch bag onboard when the captain gives the signal.
10. Release catch into water table. Wait until instructor identifies dangerous species (sharks, skates, sculpins).
11. Identify animals and plants. Count organisms and record data.
12. Surviving animals should be returned to the ocean.

Activity B: Fish Specimen Study

Introduction

All organisms brought onboard live will be returned to the ocean as soon as possible except for a representative sample of the specimens. A sample of specimens may be saved for preservation and classroom use if the teacher in charge so requests. Some organisms will die when brought up. You should recognize this as a negative effect of marine studies. Put the representative sample of organisms into the saltwater holding tank and observe their behavior.

Purpose

To learn to examine specimens and record data in a scientific way.

Procedure

1. Obtain specimen pans and fill them with seawater. Separate fish into pans according to species.
2. Using the fish identification key (in Appendices), identify; record name. Measure length in centimeters and determine sex of fish if possible. Record data.
3. Obtain scale sample from fish. Put scales in envelope labelled with type, length, and sex of fish. Save for classroom activity (see "How to Age Fish," in Pre- and Post-Cruise Activities section).
4. Sort, count and identify invertebrates. Record data.
5. Sort and identify algae species.

The Dredge and Benthic Communities (Optional)

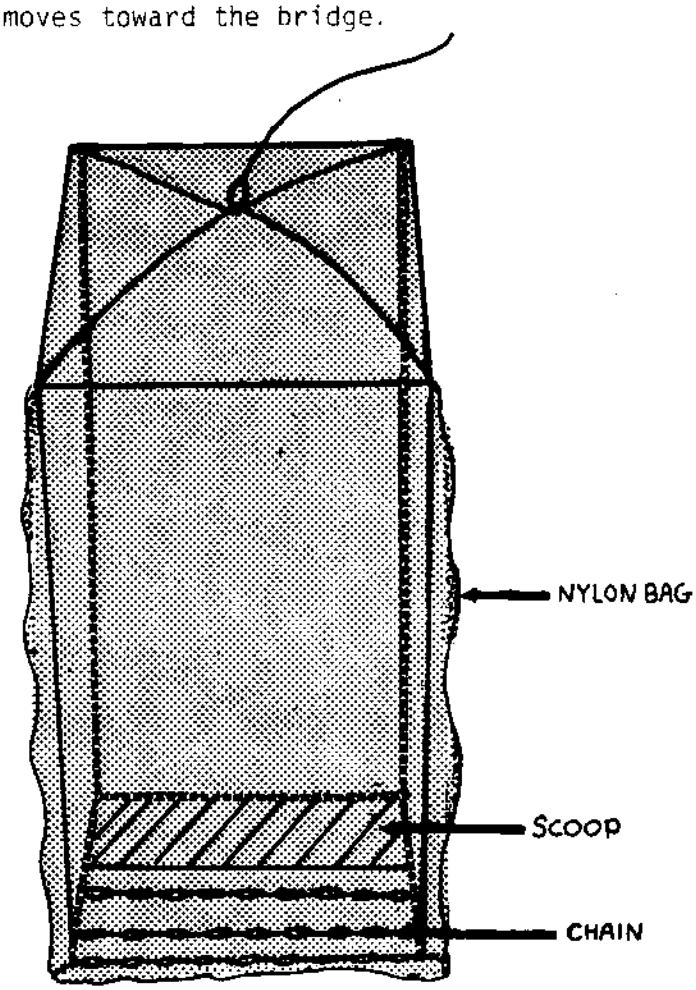
(Between Locations)

Introduction

The dredge is lowered off the stern and dragged ("dredged") along the bottom as the boat proceeds from the harbor location out the channel to the ocean. The chains dislodge bottom dwellers such as clams, sand dollars and flounder, and they are collected by the steel scoop as the dredge moves through the water. The dredge is used in this area because it is too rocky to use the otter trawl. The dredge will be used for only a few hundred yards.

Procedure

1. The instructors will carefully lower the dredge over the stern as the boat moves toward the bridge.



2. The dredge will be hauled in after a few minutes.
3. Students can help separate contents into tubs.
4. Record number, species and size of animals, and number and species of plants, on your record sheet.

NOTE: Hauling a lobster trap may be substituted for this activity.

SECTION IV: PRE- AND POST-CRUISE ACTIVITIES

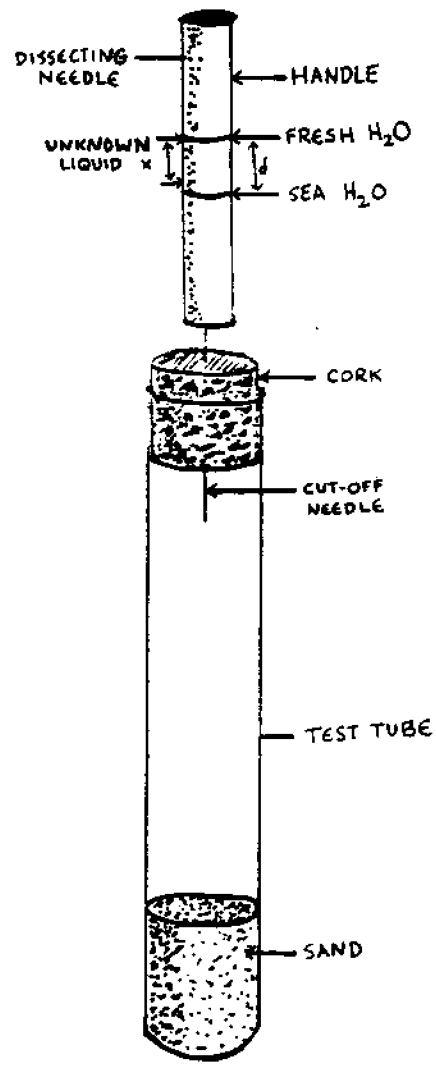
Pre- and Post-Cruise Activities

Table of Contents

Activities are arranged according to which station each supports. Please note that those preceded by an asterisk (*) should be done before the cruise. Those with two asterisks (**) can be done with samples collected during the cruise.

Homemade Hydrometer

(Calculate Relative Density and Determine Salinity)



Introduction

A hydrometer compares the density of a liquid to that of pure distilled water at 1°C. Pure water is used as a standard (=1), and the densities of other liquids are referred to as relative densities.

Purpose

To find relative densities of liquids and use to determine salinity.

Procedure

To construct hydrometer:

1. Insert dissecting probe into wooden cork.
2. Add sand to test tube and seal tube with cork and probe.
3. Place tube in cold fresh water. Note how far water rises up probe.
4. Continue to add sand until test tube floats with one-half of probe above water. Mark point on probe handle reached by surface of water.
5. Place in cold sea water. (Use samples collected on Floating Lab if you have them.) Mark water surface again.
6. Measure distance "d" between marks.
7. Now use your hydrometer to test various liquids: alcohol, glycerine, etc.

Solution	Is the mark higher or lower than cold, fresh water?	Is the liquid more or less dense than cold, fresh water?	Density vs. Seawater	Actual relative density
1				
2				
3				
4				
5				

To calculate relative density of an unknown liquid:

1. Place hydrometer in liquid and observe where the surface meets the wooden handle. If the liquid is less dense than fresh water (relative density less than 1), the fresh water mark will be below the surface. If it is more dense than fresh water (relative density greater than 1), the fresh water mark will be above the surface.
2. Measure the distance from the fresh water mark to the mark corresponding to the unknown liquid; call it "x."
3. Form the ratio x/d and multiply it by 0.025; let z be the product.
4. If the freshwater mark is under the surface, the unknown liquid has relative density = 1 - z; if the fresh water mark is above the surface, the unknown liquid has relative density = 1 + z.

Examples

a. Suppose d = 2 cm. and x = 1 cm. below the fresh water line, then x/d = 1/2 = 0.5 and z = 0.5 x 0.025 = 0.0125, and the relative density is 1.0125.

b. Suppose x = 0.4 cm. above the fresh water line, then x/d = 0.4/2.0 = 0.2, z = 0.2 x 0.025 = 0.005 and the relative density is 0.995.

Now, using water of unknown salinity, find the relative density. Next, find its temperature (F). Use the graph in the Appendices of this manual to find intersection of relative density and temperature coordinates, interpolate between curves, and read salinity at right. Example: temperature = 70°F; relative density = 1.015; salinity = 22.5%.

Davy Jones Locker Demonstration

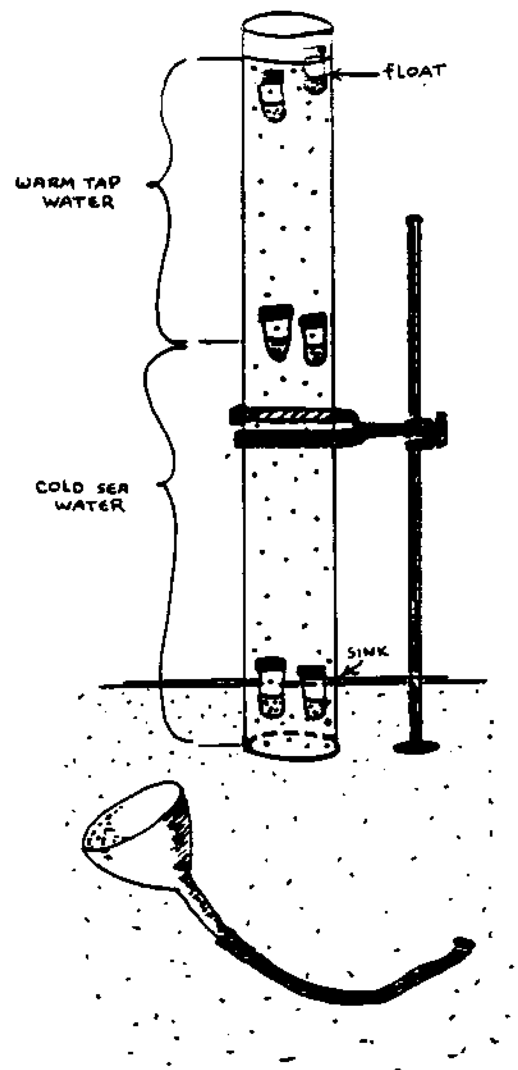
(Experiments on Density Layering and Vertical Mixing)

Introduction

It has been believed that when bodies are lost at sea they neither float nor sink but enter into a special area known as Davy Jones' Locker. Is this fact or fiction? This experiment investigates properties of water and floating objects that might help explain Davy Jones' Locker. The demonstration also shows density, temperature, and salinity relationships.

Purpose

To study properties of water and floating objects, and relationships among density, temperature and salinity.



Apparatus and Set Up

1. Set up two buckets. Fill one with warm tap water, and the other with cold sea water.
2. Obtain six screw-cap vials or test tubes and fine, dry sand. Add enough sand to the different vials until:
   a. two vials sink in cold sea water;
   b. two vials sink in warm tap water but float in cold sea water;
   c. two vials float in warm tap water.
3. Obtain a tall, narrow plastic tube closed at one end, a clamp and ring stand.
4. Put the vials in the tube with the water as shown in the diagram. Put sea water first, and then warm tap water. Use funnel and rubber hose.

Procedure

1. Note location of the vials in the water column.

2. Suggest several hypotheses to explain their position. Be sure to note the characteristics of the vials and the water.

3. Suggest an experiment to test each hypothesis:
   a. vials vary in density;
   b. water layers vary in density;
   c. both water layers and vials vary in density;
   d. neither vary in density.

4. Observe the teacher setting up the column using dyed water. Do the vials float exactly at the boundaries? Why?

5. How long will it take the water to mix? What will happen to the vials?

Analysis

1. Could there really be a Davy Jones' Locker? How?

2. Look up the words "thermocline" and "halocline." Do these occur naturally in the ocean? Where? How?

Further Investigation

1. Record the temperature in the column top to bottom.

2. Graph the temperature versus the depth.

3. Add dyes to the water and observe mixing at interface between dyed and clear water.

4. How long does it take to mix?

5. Put ice cubes in and watch the movement of dyed water. Describe its path.

(Adapted from Weiss, Investigations in the Marine Environment.)

Making Current Bottles

Introduction

Currents are mass movements of water generated by tides, wind, river discharge, and differences in density among water masses. Even today, ships follow favorable currents to save time and fuel. Currents distribute pollutants such as plastic particles, DDT, and tarballs throughout the ocean.

Little is known about smaller longshore currents, but they are very important. They can carry an oil spill ashore on Hampton Beach, bring sewage onto a shellfish bed, or carry a swimmer far from shore.

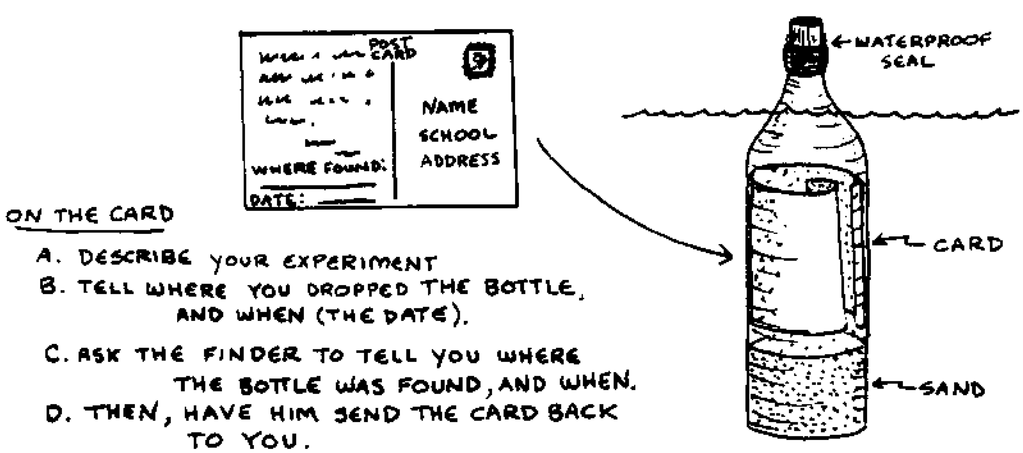
On the Floating Lab trip, bring ten homemade current bottles You will be using these when we study currents. The bottles will be released offshore in the hope that the cards inside will be returned to you when the bottles are found. It will be very interesting to learn where the bottles wash ashore, as this will give some indication of strength and direction of currents off our shores.

Purpose

To observe and chart currents near shore over a period of time.

Procedure

1. Assemble materials: soda bottles, stamped post card, wax and sand.
2. Prepare the cards first, using a pencil. (It will not fade.)



3. Put cards in bottles and add sand until the bottles stand upright in water, but are not completely submerged.
4. Put caps on as tightly as possible. Dip tops in hot wax and allow to cool.
5. Add second, third and fourth layers of wax to ensure water-tight seal.
6. Check for leaks in a bucket of water.
7. BRING THESE BOTTLES WITH YOU TO THE FLOATING LAB. AT SIGNAL, RELEASE BOTTLES OFFSHORE.

Tide Chart and Graphing Exercise
(Hampton-Seabrook, May 1983)

Introduction

On the next page are the tide tables for Boston Harbor. The information is about the same for Hampton Harbor. Graph this information, showing the lunar cycle, too. Try to predict where the spring and neap tides will be.

1. Study the tide charts.
2. What will be the tide on the day of your Floating Lab cruise?
3. Which day has the greatest tidal range? Which has the least?
4. When are the spring tides? When are the neap tides?
5. In what phase is the moon during the spring and neap tides?
6. List the days that would be best for clam-digging.
7. Which days would be best for fishing off the Eastman Pier?

TIDE TABLES

BOSTON

MAY

Times and Heights of High and Low Waters

MAY

Day	Time (h m)	Height (ft)	Height (m)	Day	Time (h m)	Height (ft)	Height (m)
1	0139	0.3	0.1	16	0248	0.8	0.2
W	0748	9.9	3.0	Th	0858	8.7	2.7
	1407	-0.4	-0.1		1501	0.9	0.3
	2020	10.1	3.1		2116	9.3	2.8
2	0234	-0.5	-0.2	17	0330	0.5	0.2
Th	0845	10.3	3.1	F	0941	8.8	2.7
	1458	-0.8	-0.2		1540	0.9	0.2
	2111	10.8	3.3		2154	9.5	2.9
3	0330	-1.2	-0.4	18	0410	0.2	0.1
F	0940	10.6	3.2	Sa	1021	8.8	2.7
	1548	-1.1	-0.3		1620	0.8	0.2
	2202	11.5	3.5		2232	9.7	3.0
4	0420	-1.8	-0.5	19	0449	0.0	0.0
Sa	1033	10.7	3.3	Su	1102	8.8	2.7
	1639	-1.2	-0.4		1658	0.9	0.3
	2251	11.8	3.6		2308	9.8	3.0
5	0512	-2.1	-0.6	20	0528	-0.1	0.0
Su	1125	10.7	3.3	M	1139	8.8	2.7
	1727	-1.1	-0.3		1736	0.9	0.3
	2341	11.9	3.6		2346	9.8	3.0
6	0603	-2.2	-0.7	21	0608	-0.2	-0.1
M	1218	10.5	3.2	Tu	1219	8.7	2.7
	1817	-0.8	-0.2		1815	1.0	0.3
7	0031	11.8	3.6	22	0025	9.8	3.0
Tu	0654	-1.9	-0.6	W	0648	-0.1	0.0
	1311	10.1	3.1		1300	8.6	2.6
	1908	-0.4	-0.1		1855	1.2	0.4
8	0124	11.4	3.5	23	0106	9.8	3.0
W	0748	-1.4	-0.4	Th	0731	-0.1	0.0
	1404	9.6	2.9		1343	8.5	2.6
	2001	0.2	0.1		1939	1.3	0.4
9	0219	10.8	3.3	24	0150	9.7	3.0
Th	0843	-0.8	-0.2	F	0815	0.0	0.0
	1500	9.1	2.8		1428	8.4	2.6
	2057	0.7	0.2		2025	1.4	0.4
10	0315	10.2	3.1	25	0237	9.6	2.9
F	0939	-0.2	-0.1	Sa	0904	0.1	0.0
	1600	8.7	2.7		1518	8.4	2.6
	2157	1.2	0.4		2118	1.4	0.4
11	0416	9.6	2.9	26	0329	9.5	2.9
Sa	1039	0.3	0.1	Su	0955	0.2	0.1
	1701	8.4	2.6		1613	8.6	2.6
	2258	1.5	0.5		2214	1.3	0.4
12	0516	9.1	2.8	27	0424	9.5	2.9
Su	1142	0.7	0.2	M	1050	0.2	0.1
	1803	8.4	2.6		1706	8.9	2.7
					2314	1.0	0.3
13	0004	1.5	0.5	28	0523	9.5	2.9
M	0619	8.3	2.7	Tu	1146	0.1	0.0
	1240	0.8	0.2		1802	9.4	2.9
	1901	8.5	2.6				
14	0104	1.4	0.4	29	0014	0.6	0.2
Tu	0717	8.7	2.7	W	0624	9.6	2.9
	1332	0.9	0.3		1241	-0.1	0.0
	1952	8.8	2.7		1857	10.0	3.0
15	0158	1.1	0.3	30	0115	0.0	0.0
W	0811	8.7	2.7	Th	0723	9.7	3.0
	1417	0.9	0.3		1337	-0.3	-0.1
	2037	9.1	2.8		1952	10.6	3.2
				31	0213	-0.7	-0.2
				F	0821	9.9	3.0
					1431	-0.5	-0.2
					2045	11.1	3.4

Eastern Standard Times.

Add 1 hour for Daylight Savings Time.

Simple Wave Machine

Introduction

This activity investigates slow-motion waves. It is popular with students of all ages and abilities.

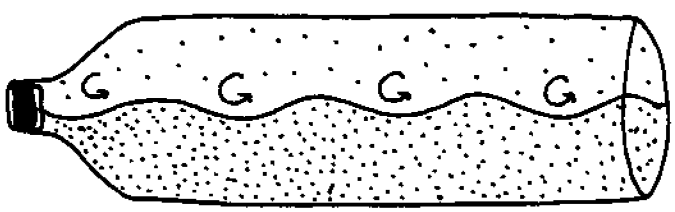
Two immiscible (not capable of mixing) liquids--denatured alcohol and Thinnex, a commercial paint thinner--are used. Prepare these for the class by warming them in a sink of hot water. DO NOT USE FLAME. THEY ARE FLAMMABLE. Alcohol is heavier and does not mix with Thinnex. They are close in density so only very slow motions or displacements occur. As the fluids move, resistance occurs at the interface. Waves are formed and then slowly fall to their original position (waves dissipate).

Purpose

To study slow motion waves.

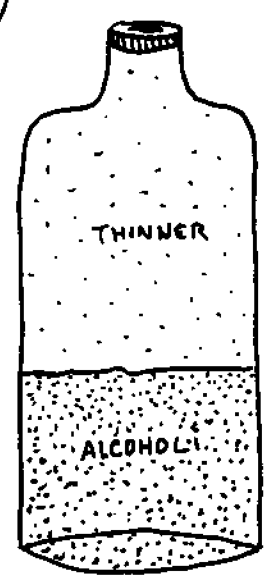
Equipment

Long narrow bottles with tightly fitting tops. (Long test tubes with rubber stoppers may be used.)



Procedure

1. Fill bottle one-third full with warm alcohol.
2. Add a few drops of blue coloring. (Methyl blue works well.)
3. Fill bottle to the top with warm Thinnex.
4. Screw top on tightly. Let cool. The liquids will contract and hold the top on tightly.
5. Observe wave motion as you move the jar up and down.



Water Currents

Introduction

Currents help ships save many days on long voyages. These same currents determine, to a great extent, where marine organisms live. Most of the major surface currents of the world begin in areas where warm water of low density meet cooler, denser water. As these warmer waters move they are deflected by the rotation of the earth. The greater the density gradient (change of density over a given distance), the faster the current. The direction of the wind determines the course of many of the surface currents, but density differences rate second as the cause for movements of large masses of water. When the density gradient is a reflection of differences in salt content between masses of water, the resulting currents are referred to as salinity currents.

Purpose

To demonstrate movements of water caused by differences in salinity.

Materials

Several aquariums or pyrex baking dishes, salt, water, dropper, food coloring, spoon, beakers or small mixing bowls, small pieces of glass, metal, plastic or cardboard as a divider, scale (gram).

Procedure

1. Place a divider across an aquarium or baking dish. Make sure it fits tightly against the bottom and the two sides.
2. Seal the bottom of the divider with clay. Make sure there are no holes.
3. Add table salt to water until it is about 3% (30 g per 1000 ml) salt.
4. In marine science salt content is expressed in parts per thousand, so your 3% water will be 30 o/oo. Ocean salinity is around 35 o/oo.
5. Work with a partner.
6. Each person will add one beaker of water to the dish or aquarium. One adds clear water on one side of the divider, while the partner adds salt water to the opposite side.
7. When the water has been added on both sides of the divider, <u>slowly</u> and <u>carefully</u> lift out the divider.

8. Disturb the water as little as possible.

Questions

1. Which water mass has the greatest density?
2. What do you think will happen to the water masses?
3. What did happen?
4. Why do you think the water masses moved as they did?
5. Can you design an experiment to show that temperatures can cause currents?
6. All water from polar regions moves toward the equator. Would it move on the surface of the ocean? Why or why not?

Wave Frequency Versus Water Depth

Introduction

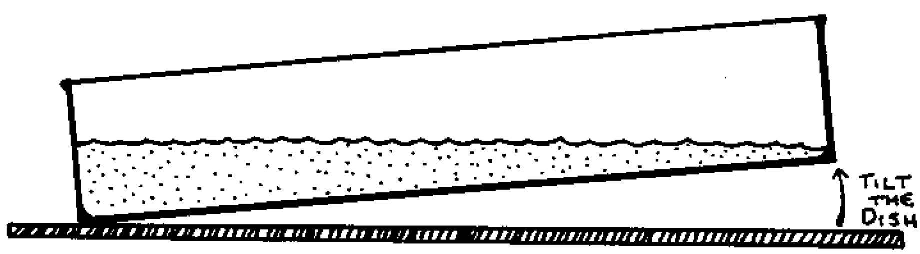
As a wave approaches the shore, it becomes more unstable and finally breaks and hits the shore as white water. The depth of the water has a direct effect on wave energy.

Purpose

To observe and graph the relationship between depth and wave frequency.

Procedure

1. Fill a long, narrow, shallow dish (18" x 10" x 2") about two inches full of water.
2. Gently tip the dish at one end to set up wave energy.
3. Count how many times the wave energy travels from one end to the other in 15 seconds; 30 seconds; 60 seconds.
4. Repeat the procedure with water depths of ½, 1 and 1½ inches.



5. Fill in the table:

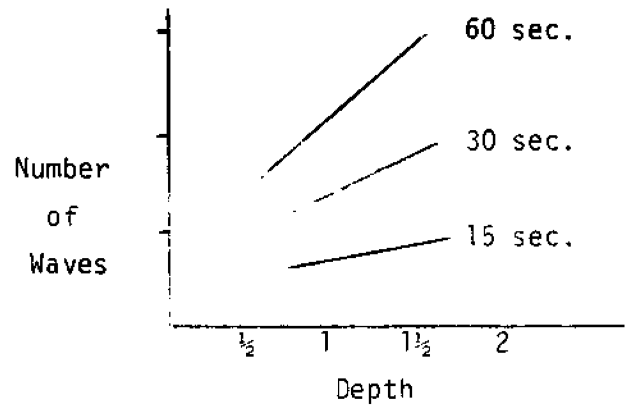
Depth	# Waves in		
	15 sec.	30 sec.	60 sec.
2 inches			
1½ inches			
1 inch			
½ inch			

6. Graph number of waves versus depth. Have three curves on the same graph (15, 30, 60).

Questions

1. What does the table show about speed of waves in relation to depth of water?

2. Are the results in accord with the information on waves in this manual?



Contour Maps

Introduction

Navigational charts have contour lines which show the ridges, valleys, and mountains on the ocean floor, as well as their depths. These charts, produced by NOAA (National Oceanic and Atmospheric Administration), in Washington, D.C., are available at hardware stores, marinas, and the United States Coast Guard and Geodetic Survey offices.

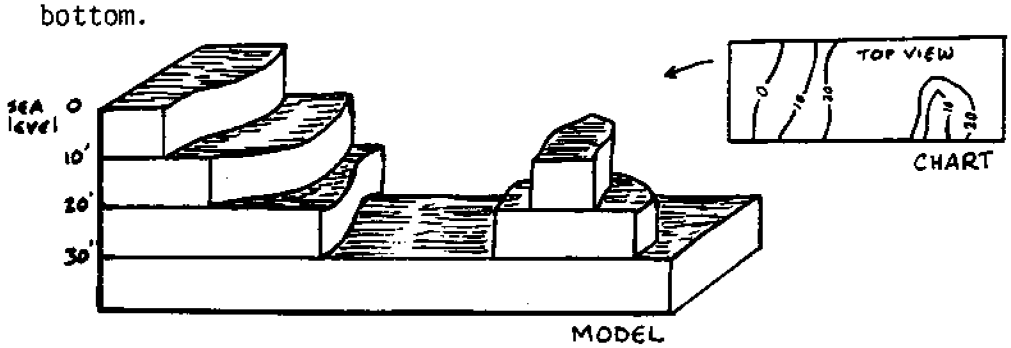
Obtain Chart #13278, Portsmouth to Cape Ann, which shows Hampton Harbor and offshore waters. (Note to teachers: One chart can serve the whole class. Trace the contour lines and transfer to a duplicating master. Duplicate copies for each student.)

Purpose

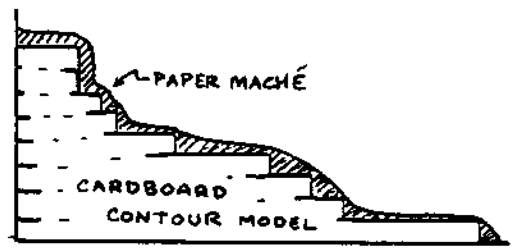
To construct a model of the estuarine and offshore bottom features of the study site area to use with beach and wave experiments.

Procedure

1. Color various depths on the maps.
2. Select a proper contour interval that will best show the bottom features. Details require a small interval; a large interval will show gross features.
3. Cut along the shoreline and trace this into 1/4-inch or 1/2-inch cardboard. Using an appropriate depth interval (10 feet on local charts or 100 feet on offshore charts), cut along contour lines.
4. Glue these to cardboard stock or styrofoam and cut out on contour lines.
5. Place these sections on top of each other to produce "wedding cake" effect with land on the top and deepest area on the bottom.



6. For a more realistic model, use very fine paper mache (tear paper in very small pieces, add to thick wheat paste and blend in a blender) and fill in areas to produce gradual dropping contours. Paint land and ocean areas. Cover with waterproof sealer and use model in beach processes and wave laboratory exercises.



Sand Investigations*

Introduction

Sand is made up of particles of many different sizes and shapes. Sand is moved about our beaches by wind, tides, currents, plants and animals.

Purpose

To observe variations in sand: grain size, shape, and biological content.

Materials

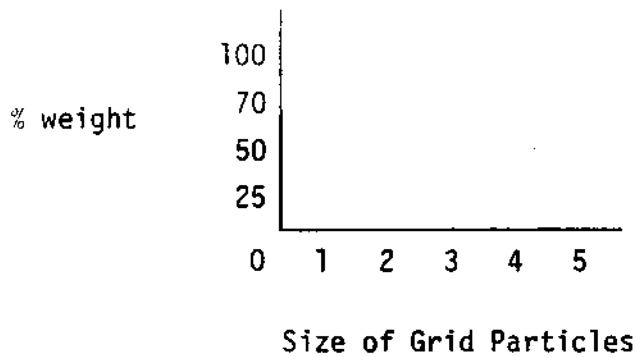
Sand (dried) from the three locations on the Floating Lab, or sand from the shore.

Procedure

1. Using a dissecting scope, observe each sand sample. What is the average grain size? Are there any living organisms? Are there remains of dead plants and animals? Compare the sediment sand samples from the three Floating Lab locations. Are there differences in size or composition? Make a chart to record your observations.
2. Obtain screen from a hardware store (ask for scraps). The mesh should range from 1/2 inch down to 1/32 inch. Five sizes of screen are desirable.
3. Make a set of screens using cottage cheese cartons, embroidery hoops, or other cylindrical objects. Shake the samples through the sieves (screens). Start with the largest mesh and work through to the smallest.
4. Remove material from each sieve and place on a piece of paper which has been numbered to indicate screen size. (Number 1 would be the largest, with 5 being the smallest.)
5. Weigh each sample separately and carefully.
6. Add the weights to provide totals.
7. Calculate the percentage composition of different sized particles at each location by dividing the weight of each sample by the total weight and multiplying by 100. Record on graph.
8. Graph the percent-weight of total sample versus the particle size.
9. Use three lines to represent the three sampling stations if you are using samples from the Floating Lab.

*This is an excellent follow-up activity to the Floating Lab trip.

Mesh size	Weight % Sta. 1	Weight % Sta. 2	Weight % Sta. 3
1:			
2:			
3:			
4:			
5:			



Gyotaku
(Japanese Fish Printing)

Introduction

This is an ancient art that is now used to record catches of sportfish and to document information about fish biology. Fish prints often show details of the fish's external structure that are not apparent when looking at the fish, itself. Before making the print, identify the fish, list its characteristics, research its natural history, and learn when, where and how it was caught.

Purpose

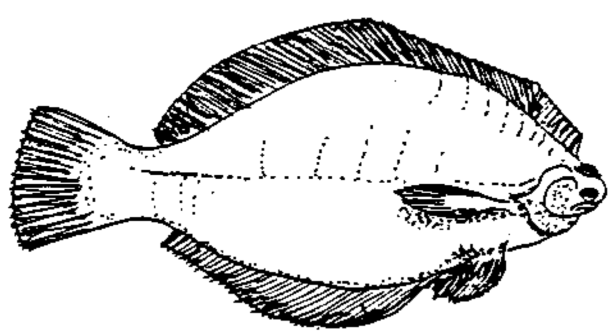
To learn the process of fish printing and what it can reveal about external fish structure.

Materials

Fresh fish (flounder are excellent), newspaper, watercolor paper, newsprint or rice paper, tempera or water-base ink (linoleum block ink is best), stiff 1/2-inch brush.

Procedure

1. Obtain a whole (ungutted) fresh fish. (Ask local fish market or buy in a supermarket. Fish brought back from Floating Lab trip could be used, also.)
2. Wash the fish with soap and water. Dry thoroughly.
3. Place the fish on newspaper on a wooden board. Arrange fins properly.



4. Brush on a light, even coat of diluted tempera paint or water-base printer's ink.
5. Place paper over the fish and press lightly with your hand all over the body and fins, noticing scales, body structures, body shapes, etc.
6. Lift paper with print (a small brush may be used to paint in the eye).
7. Notice shape and location of the eyes, gills, scales, fins and lateral line. Do a print of another kind of fish and compare the two.
8. Label your print with both popular and scientific name of species, your name and date of print.
9. You can also try the process with starfish, crab bodies, scallop shells, etc. Experiment!

Guppy Observations

Introduction

Fish are cold-blooded animals of the phylum Chordata with gills and fins. Guppies have been selected for this experiment because they are easily obtainable from pet stores, easy to keep alive in a classroom aquarium, and very interesting. Be careful not to overstress fish.

Purpose

To observe and study guppies in various ways.

Materials

Guppies, aquarium.

Procedure

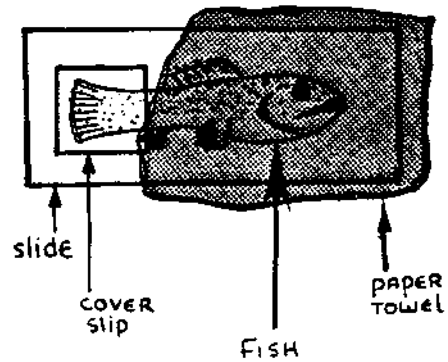
1. Observe feeding behavior of a particular fish. Does it gulp its food or skim it? Is it a surface, bottom or mid-water column feeder? How long does it take to satisfy its appetite?

2. Put the fish in a smaller container of water and change various aspects of the environment: temperature, salinity, food amounts, light, addition of oil, etc. Observe reaction of guppies to these changes and record on the chart below. The gill structures are indicators of stress. Fast pumping indicates distress and high metabolic rate. BE CAREFUL NOT TO OVERSTRESS FISH.

STIMULUS	RESPONSE
Temperature	
Salinity	
Food	
Oil	
Light	

3. Using a glass slide, lay a live guppy on the slide. Cover with a damp towel to keep it moist. Put a glass cover slip over its tail. Transfer slide to a microscope and observe movement of blood in tail capillaries. Does it flow steadily or in spurts? (Return fish to the aquarium as soon as possible.)

4. Using a reference book, make a list of similarities and differences between fish and humans. Pay particular attention to anatomical features such as the heart.



Sampling Plankton with a Homemade Plankton Net

Introduction

You can make a plankton net from a piece of wire (coat hanger) and a nylon stocking. You can collect plankton from lakes, streams, bays and estuaries, as well as the ocean. Collect samples at different areas, or from the same area at different times of the year.

Purpose

To make an inexpensive plankton net and to collect, observe, and record data on various types of plankton.

Procedure

1. Bend wire into circle about the size of the top of a nylon stocking and attach to a three-foot stick.
2. Secure ends with staples or tape, or sew together.
3. Cut off foot of the stocking and attach a small bottle in end to catch the sample.
4. Secure jar or bottle with string or tape.
5. Mark off a known distance (100 meters is good) on the shore or along the dock.
6. Pull the net at a uniform rate between the marks. Reverse your direction and cover the same distance again. Continue for 10-15 minutes.
7. Record distance that you've pulled the net on the sample label which will be placed on the collection bottle.
8. Rinse stocking to wash plankton down to the bottle, remove bottle, cap it and label it.
9. Use a microscope (binocular is best) and a shallow dish or well slide to view plankton.
10. Use references and appendices in this manual to identify organisms.
11. Count numbers of each type of plankton and record.

Plankton Sample Label

Date_____ Tow#_____	Depth______
Time	
Start______	Distance (m)_____
End_______	Water temp.______
Total______	

Check List For Plankton

(This activity can be done in the classroom with plankton samples taken aboard the Floating Lab. Samples can also be gathered standing on the shore or dock.)

Date of Cruise ______________________ Grade ____________________

School ______________________________ Teacher ___________________

Vertical Plankton Haul

Net diameter ___________

Location ____________________ Depth __________________ Time ___

Horizontal Plankton Tow

Net diameter ___________

Location ____________________ Distance towed _________ Time ___

<u>Phytoplankton</u> (indicate numbers)

Dinoflagellates	vert. haul	horiz. tow
Ceratium		
Peridinium		
Goniaulux		
Prorocentrum		

Diatoms	vert. haul	horiz. tow
Coscinodiscus		
Chaetoceros		
Coscinosera		

<u>Zooplankton</u> (indicate numbers)

Permanent	vert. haul	horiz. tow
copepod (calanoid)		
copepod (cyclopoid)		
copepod (naupliar stage)		
protozoan (radiolarian)		
protozoan (foraminiferan)		
Amphipoda		
Euphausia		
Pleurobranchia		
Temporary		
nauplius larva		
zoea larva		
megalops larva		
veliger larva		
brachiolaria larva		
ophiopluteus larva		
auricularia larva		
trochophore larva		
late polycheate larva		
Leptomedusa		
Obelia medusa		

Fun with a Fundulus

Introduction

Mummichogs (<u>Fundulus</u>) are found in nearly all salt marshes, tidal creeks and shallow pools. These hardy fish burrow under the mud 6-8 inches to survive the drying out of shallow pools in summer and the cold of winter.

The dorsal (upper) surface of the males is dark green to steel blue with yellow and white spots, and their ventral (lower) surface is white, pale yellow or orange. Females are uniformly olive green with a lighter ventral surface.

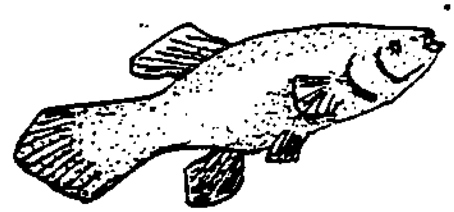
Mummichogs may be caught easily with a hand net in tidal pools of local salt marshes and placed in a salt water aquarium filled with Instant Ocean artificial sea water. The pH should be between 7.0 and 7.4, the temperature between 18° and 20° C. Mummichogs are omnivorous and may be fed brine shrimp, boiled lettuce and regular fish food.

Purpose

To investigate several adaptive features of mummichogs, *Fundulus sp.*, by designing experiments based on the following suggestions.

Procedure

1. Find the range of temperatures mummichogs can tolerate by placing them in tanks of different water temperatures. Is there a water temperature at which the fish will not eat? What happens when the temperature is lowered?
2. Can mummichogs adapt from living in salt water to freshwater? Record the speed at which the adaptation takes place.
3. Can mummichogs change colors to match their surroundings? Why are males different in coloration than the females?
4. What is the mummichog's range of tolerance to different levels of dissolved oxygen in their water?



5. Can a fundulus swim a maze or be conditioned to swim through hoops or come to the side of the aquarium to be fed?

6. Do mummichogs school, and if so, do they have a special order?

(From Mr. Sandy Wiper of Newton (MA) North High School)

How to Age Fish

Introduction

Fisheries biologists collect data on sex, weight, length, and age of fish. They make surveys at sea by random sample methods. They also use data collected from fishermen at the docks when the catch is unloaded. Management of fish stocks depends on the knowledge of age and weight in order to determine how to get the greatest yield with the least amount of human effort and without depleting the stocks.

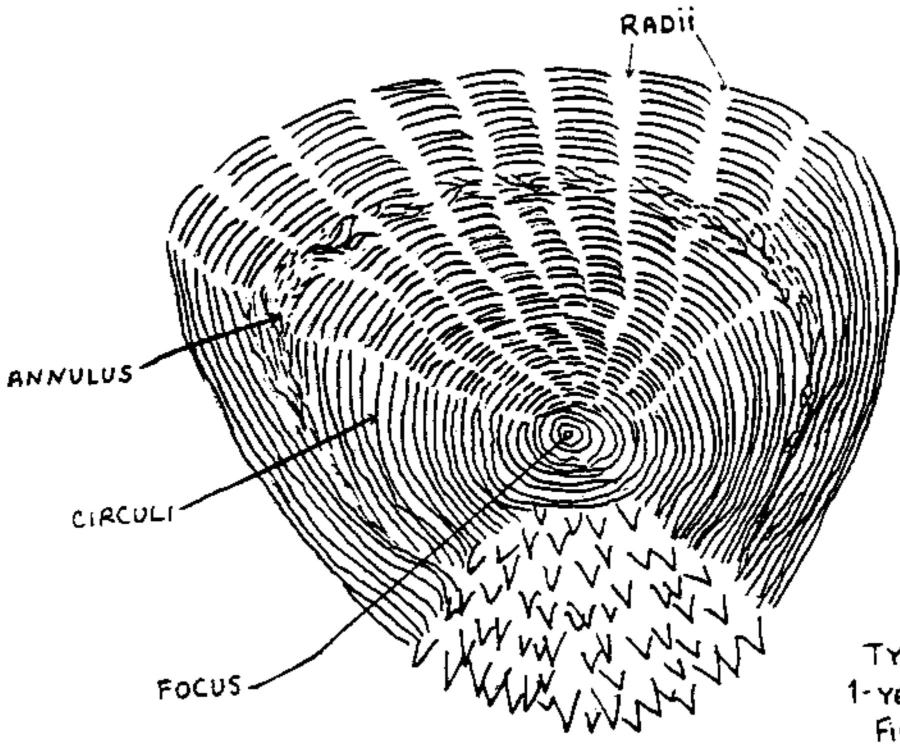
Materials

Fish (whole, uncleaned; ask local fish store for scrap fish), gram balance, metric ruler, microscope, glass slides, tape, dissecting equipment, graph paper.

Procedure

1. Weigh fish to nearest 1/100th of a gram. Record.
2. Measure the fish using fork length, i.e., from the tip of the nose to fork in the tail. Record to the nearest centimeter.
3. Gently squeeze the body cavity of the fish. Note color of emission from anal opening. White indicates sperm, orange indicates eggs. If in doubt, carefully open the body cavity and locate gonads.
4. The parts of a fish commonly used in aging are the scales and bones. Obtain a few scales from your fish, being careful to avoid the lateral line. Place the scales between two slides; tape them together. Label the slide with sex, weight, and length. Observe the scales under the microscope at low power.
5. A fish's growth is not continuous over the entire year. During the winter the circuli get closer together indicating slower growth. When the circuli get so close they don't reach all the way around the scale, it is called an annulus or year mark. A consistent bend in each radius of the scale may also indicate a year mark.
6. Using the diagram on the next page, examine the fish scale to determine the age of the fish.
7. Record the age of your fish. The central point to first annulus equals "zero" year growth; first annulus to second is first full year growth; second to third is second full year growth, etc. We are assuming that a winter represents a full year, but a more accurate interpretation would require information such as when the fish was hatched, when the first scales formed and when the fish was collected.

Fish	Sex	Age	Weight (g)	Length (cm)
1				
2				
3				
4				
5				



TYPICAL
1-YEAR OLD
FISH SCALE

8. Pool your data with your classmates' and organize a data table (sex, length, weight, age). Compare male versus female growth rate. Is there a correlation between age and length or between age and weight? Graph data to show relationships.

Squid Dissection

Introduction

Squids and octopi are among the most highly evolved invertebrates. They are active, fast-moving, seemingly intelligent animals with highly developed eyes.

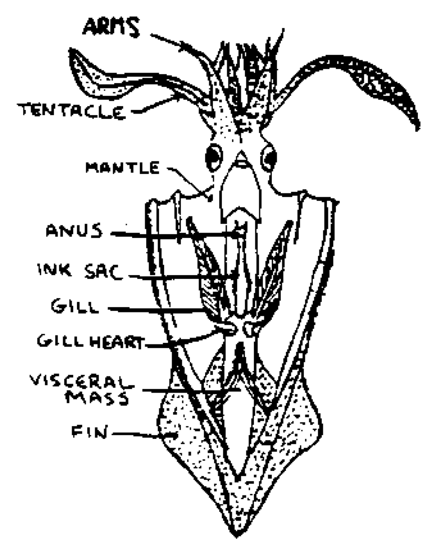
Although the prehistoric cephalopod (head-foot mollusk) had a strong shell, the squid has a plastic-like "pen," an internal shell-like structure, inside its body.

The mouth is armed with a strong beak, similar to a parrot's, and is surrounded by eight arms and two tentacles. The body has a mantle cavity which is used to draw in water and push it out quickly for "jet" propulsion. When danger threatens, the squid covers its escape with a "smoke screen," a cloud of dark liquid squirted from its ink sac.

Squid are an inexpensive way to get acquainted with "head-foot" mollusks. Squid are available at most fish markets in frozen packages.

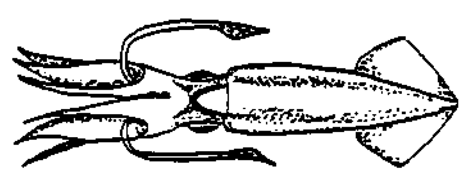
Purpose

To dissect a "head-foot" mollusk and study its internal structure.



Procedure

1. Lay squid on newspaper, ventral side up.
2. Remove pen (long, thin cartilage) from dorsal side by pulling away from mantle.
3. Diagram and label structures.
4. Remove a small piece of arm and observe under the microscope.
5. What special adaptations have squid developed to: capture food; protect themselves; move in the water?



Mussel Dissection and Feeding Behavior

Introduction

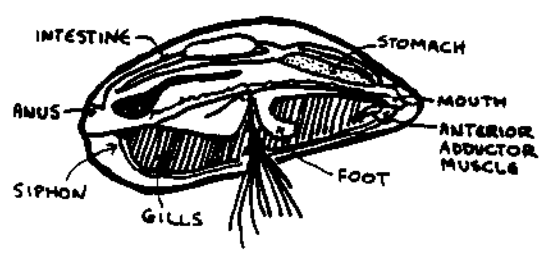
The blue mussel, *Mytilus edulis*, is the common edible mussel found in large numbers on rocks and in tide pools in the New Hampshire intertidal zone. It ranges in size from tiny "seed" mussels up to large animals ten centimeters in length. The horse mussel, *Modiolus modiolus*, is larger than the blue mussel and is found deeper down the tide line. Its heavy wedge-shaped shell is from ten to fifteen centimeters in length. Both animals have a bluish shell with a lining of beautiful mother-of-pearl. They attach themselves to the substrate by means of byssal threads which anchor them securely in even the most exposed areas. These threads become so entangled that debris collects in them, and they become specialized environments for brittle stars, worms, and small mollusks.

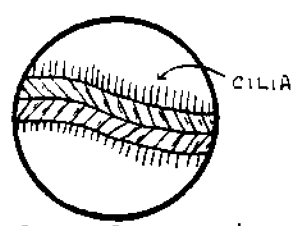
Purpose

To observe the mussel's gill tissue and how the gill collects food for the animal.

Procedure

1. Obtain fresh mussels (either collect or buy at market.
2. Separate shells by cutting through adductor muscles.
3. Use tweezers to pick out one section of gill and cut it free with scissors. The gills are thin, long and feathery.
4. Prepare a wet mount slide of gill tissue using seawater. Place the section of gill on the slide. Add one drop of seawater. Place cover slip on top.
5. Observe gill under low and high microscopic power and draw a diagram. The cilia are most easily seen at the edges of the gill section.





GILL SECTION
(MAGNIFIED)

6. Using a second mussel, place a small light piece of material (preferably organic) on posterior section of gill structures.

7. Ciliated gill structures collect food as water is pumped through the mussel, and the food is moved by ciliary action to the mouth area. Observe movement of material towards mouth.

<u>Questions</u>

1. Do the cilia move in an organized way?

2. Can you see movement around the cilia?

3. How fast does the material move over the gills?

4. Do mussels take in other things besides food?

Snail Activities

Introduction

Collect Littorina littorea, common periwinkles, which are found in great numbers intertidally. They are easily kept alive in a marine aquarium or in a jar filled with salt water in a refrigerator.

Purpose

To observe various behaviors of common periwinkles.

Activity A: Snail Behavior

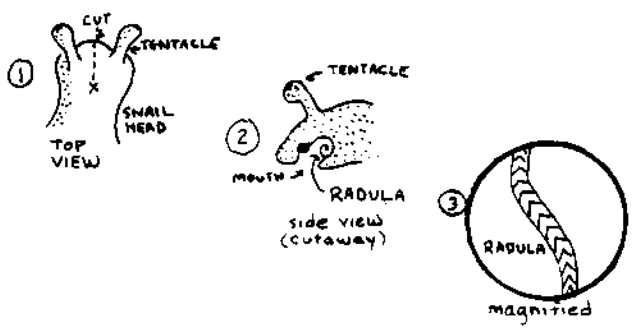
Procedure

Put snails in a salt water tank or large jar with fresh sea water and observe their behavior. Where do the snails congregate? Where are they in the morning? Do they move around the container?

Activity B: Radula Dissection

Procedure

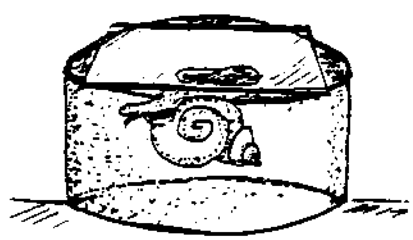
1. Place snail in boiling water.
2. After a few minutes remove the snail from its shell. (You can simply crush the shell with a rock.)
3. a. Carefully cut along the top of the head between the tentacles (1).
   b. Locate a long, coiled thread-like structure attached to a small red tissue. This is the radula (2). Remove with tweezers.
4. Mount radula on slide. Observe at low power. (Stain with methyl blue if possible.) (3)



Activity C: Observation of Feeding Behavior

Procedure

1. Place snail in wash-bowl with glass plate on the bottom.
2. After snail has attached itself, take the plate out. Observe the reverse side of the plate under dissecting scope.



3. Put the snail back in the bowl. Add some sea lettuce. Does the snail eat it?

Questions

1. How is the radula used?

2. Are snails herbivores, carnivores or omnivores?

Identifying Some Common Crustaceans

Introduction

The shape of a crustacean's carapace (main hard part of the body) is an indication of its species.

Purpose

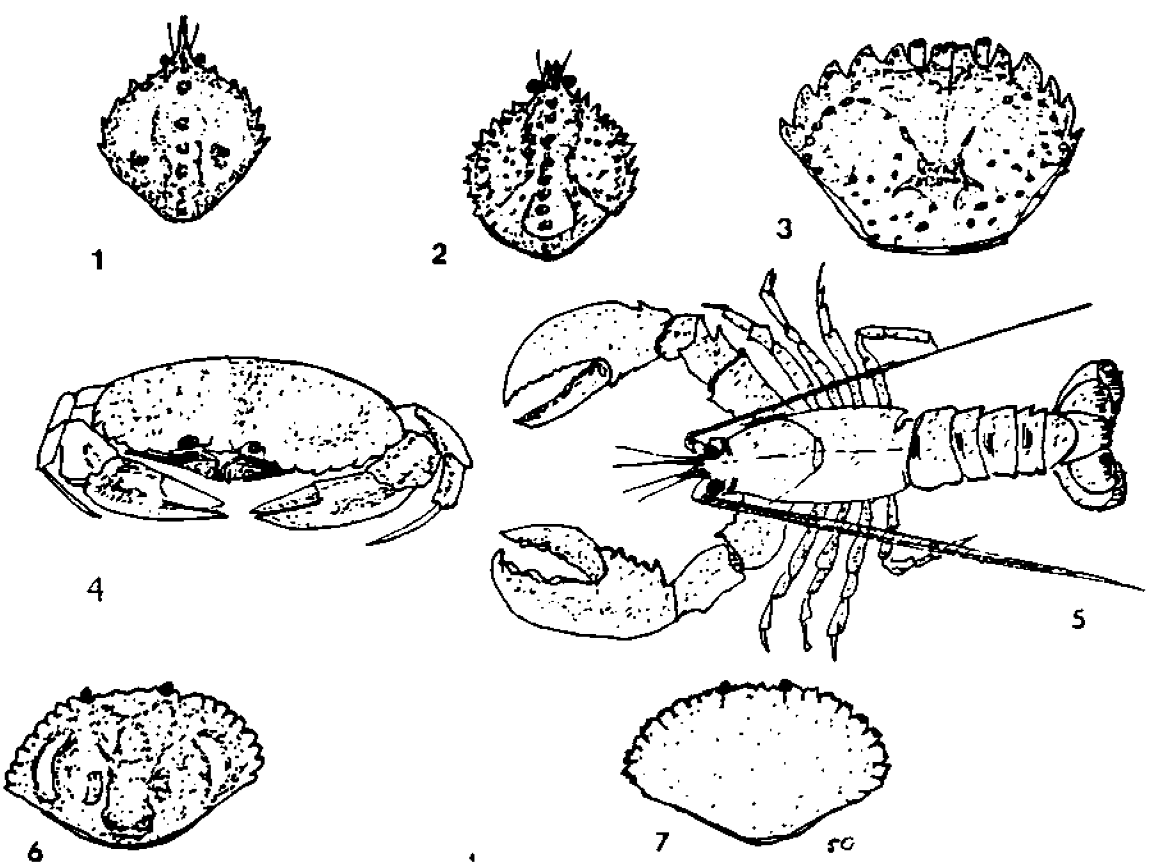
To identify crustaceans using body shape.

Procedure

1. Match the crustacean to its outline on the key.
2. Concentrate on the shape of the carapace, not color or size.
3. Use references (e.g., Seashore, Zim) to help further identify crustaceans.

KEY: Some Common Northern Atlantic Crustaceans

1. Six spine spider crab
2. Nine spine spider crab
3. Green crab (Carcinus)
4. Red crab
5. Lobster (Homarus)
6. Rock crab (Cancer irroratus)
7. Jonah crab (Cancer borealis)



Core Sample Analysis

(This should be done with core samples from the Floating Lab.)

Date________________Location____________Station____________

School__________________________Grade__________________________

Teacher__________________________Recorder__________________________

core depth (centimeters)	Centimeters 5	10	20	30	40	50	60
1) Core Sketch							
2) Color*							
3) Odor*							
4) Sediment Types (clay, sand, etc.)							
5) Grain Size							
6) Minerals							
7) Animals							
8) Shells, Fossils							

*Color and odor should be checked immediately after sample is taken.

Chromatography

Introduction

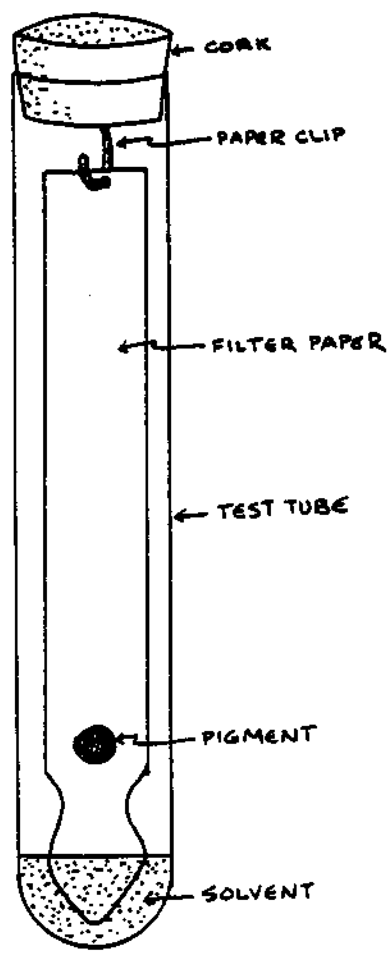
Is the green color of leaves the result of more than one pigment? To answer this we must have a method of separating pigments from leaves. One method used is chromatography.

Purpose

To investigate pigmentation of marine algae.

Procedure

1. Bend a paper clip into a "J" shape and force the long end into a cork stopper.
2. Cut a piece of filter paper so that it is narrower than the test tube and will hang without touching the bottom.
3. Pour alcohol into the test tube to a depth of 1.5 centimeters.
4. Place the cork on the test tube so the alcohol won't evaporate, and stand the tube up in a rack.
5. Place two or three spinach leaves, a little fine sand, and 5 ml. of acetone in a mortar and grind thoroughly.
6. Filter the acetone mixture and collect the filtrate.
7. Using a pipette, apply the pigment extract to the filter paper. Continue until you have a heavy residue. Let it dry.
8. Place the filter paper on the hook and put it into the test tube. Watch the solvent rise. When it almost reaches the top, remove the paper and let it dry.
9. Examine the filter paper. How many bands of color are there? What are they made up of?
10. Repeat the procedure using red, green, and brown algae. Compare the results.



Collecting and Pressing Algae

Introduction

Set up a plant press before the trip so that the algae you collect can be pressed promptly. For pressing, living plants are the best, but freshly washed plants are also good. Try to get a sample of each algae group: red, green, brown, blue-green. Take only one or two specimens of each type.

Purpose

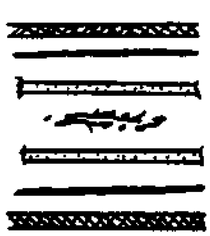
To collect and press representative samples of marine algae from the study site.

Materials

Shallow pans, newspaper, blotter paper, wax paper or sheeting, corrugated cardboard, two pieces of plywood with holes bored through at 2" intervals, two belts or rope, and any heavy paper on which to mount specimens (index cards are good, but herbarium paper is better).

Procedure

1. Rinse algae to rid it of debris.
2. Fill shallow pan with fresh water.
3. Submerge mounting paper in pan, lay one alga on the paper, and carefully arrange the plant with dissecting needle or small, soft camel's hair brush.
4. Slowly slide the paper and alga arrangement out of the water.
5. Place paper on newspaper to drain. Blot, if necessary, with paper towel.
6. Place sheeting or wax paper over specimen.
7. Make a sort of sandwich:



Cardboard
Newspaper
Blotter paper
Specimen (covered with sheeting or wax paper)
Blotter paper
Newspaper
Cardboard

8. Repeat all above steps for each specimen or group of specimens.

9. Place the plywood on each end of the stack and secure tightly with belts or rope.
10. Set press in warm place where air circulates freely.
11. Change layers of blotting paper once a day so drying is thorough.
12. When dry, some seaweeds will stick by themselves; others may need to be glued. Label specimens. List the name, the collector, place of collection and date.

Some Ideas

1. Take large index cards, fold them in half and press your seaweed on one side to make note cards.
2. Make a picture using different colored seaweeds. Press, mount and frame.

Sea Water Aquaria

Introduction

A seawater aquarium can be an effective vehicle for developing students' observational and recording skills. A method for keeping the seawater cold is needed; some use coolers for aquaria. Others set aquariums on a shaded window sill during winter. You can also place the aquarium in a pan of water and put burlap on three sides to generate the evaporation needed to keep the temperature down.

Purpose

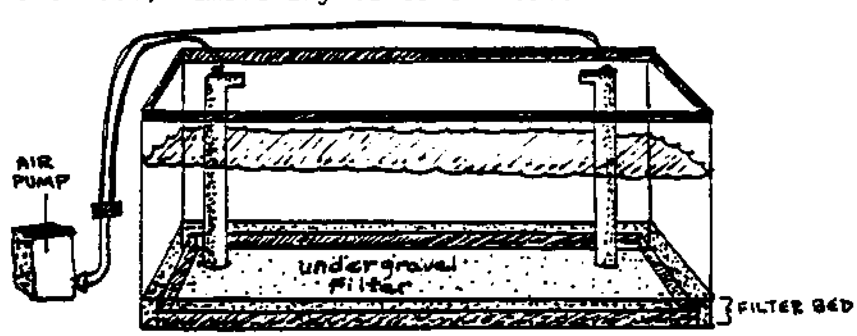
To develop students' observational powers.

Materials

All glass aquarium (10 gal.); under gravel filter; air pump; gravel for filter bed (beach gravel); salt water; hydrometer/thermometer.

Procedure

1. Set up aquarium as shown.
2. Add seawater.
3. Mark level of water and add fresh tap water or distilled water daily to maintain level. You may want to freeze it and add a few cubes each day.
4. Populate the tank with animals that can tolerate fluctuations in temperature and salinity. Use hydrometer and thermometer to maintain levels. Examples of easily kept animals are periwinkles, mummichogs and mussels.
5. Don't overload the aquarium.
6. Feed animals small pieces of fish, squid, brine shrimp or commercial foods such as Tetramin Flake Food or Shrimp-elettes. The latter two will not foul the tank. Be careful not to overfeed; remove any leftover meals.



Seashore Birds Activity

Following are descriptions of several common coastal birds. Study the drawings and text; note similarities and differences in appearance, eating habits, nesting locations, migratory patterns, etc. Then try to answer the questions below, using references to help you. Make a chart of information that you find out.

Questions

1. Why do different species have different sized and shaped bills, wings, feet, etc?
2. Do any of these birds live in the same area all year round? Which do not?
3. Which birds nest on offshore islands? Why?
4. Describe carefully where these birds lay their eggs.
5. Which of these birds are protected by law? Why do we have laws protecting some birds and not others?
6. Do all water birds have oil on their feathers? Why or why not?

Gulls

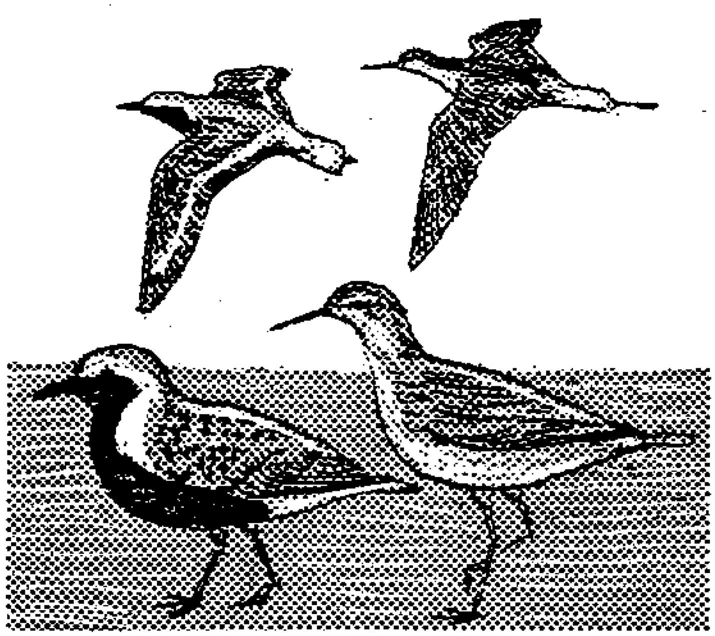
The great blackbacked gull is larger than the herring gull and has an obvious charcoal back. Both species are brownish-colored when

GULLS

immature. Swimming birds with long, pointed wings, the two species breed and nest on the Isles of Shoals. Both are scavengers, eating crabs, sea urchins, and the like, as well as refuse from dumps and garbage cans. Year-round residents of our shores, great blackbacked and herring gulls both have webbed feet adapted for swimming on the surface, and short, rather straight bills.

Plovers and Sand Pipers

The black-bellied plover--Squatarola squatorola--is a stocky bird with a short stout bill. Pale gray above, with a black breast, and white rump and tail, this plover has a bold white stripe on each wing. It feeds on the clam flats at low tide, eating small crabs and sand worms. Late in the year, black-bellied plovers migrate from the Arctic to their winter homes along the New England coast.

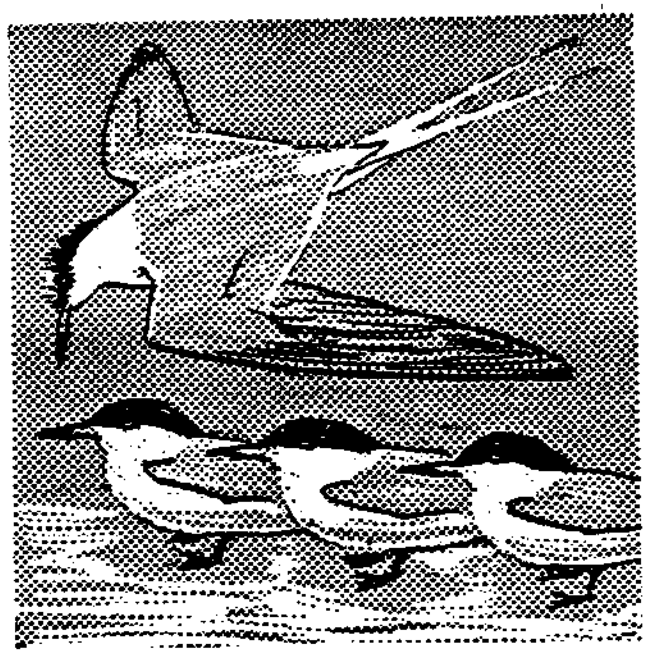


PLOVERS & SANDPIPERS

The lesser yellowlegs--Totanus flavipes--is a small to medium sized sandpiper with a long, slender bill and longer legs than the plover. Its legs are bright yellow, and its coloring mottled gray and white. Its feeding habits are similar to the plover's, but the lesser yellowlegs is a year-round resident of our shores.

Terns

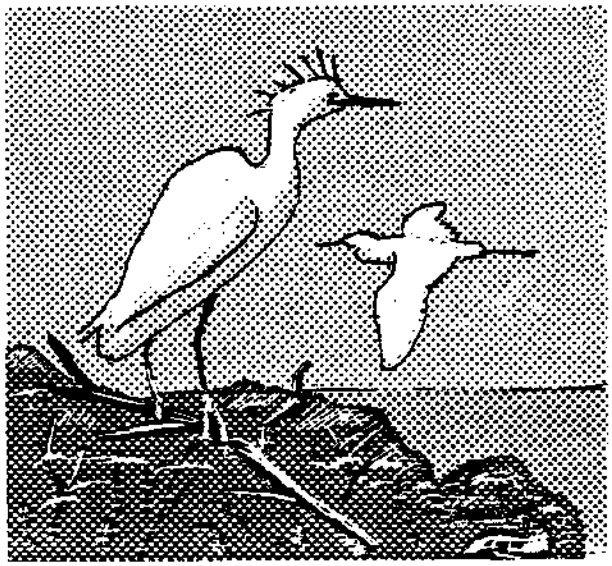
The common tern--Sterna hirundo--is a small gull-like bird, white with a black cap, a bright orange beak and orange feet. It is commonly seen bobbing gracefully through the air, plunging head first into the water to feed on schools of small fish. The common tern is a year-round resident of the estuary.



TERNS

Snowy Egret

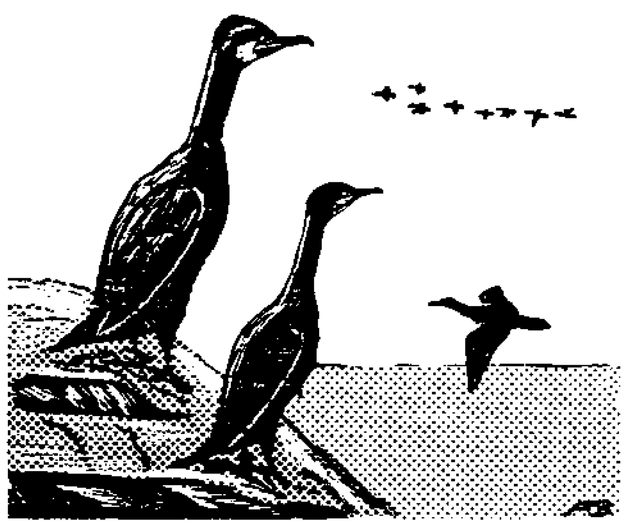
The snowy egret is a white, stork-like wading bird with long legs and neck, yellow feet ("golden slippers"), and a pointed bill. The egret tucks its head back to its shoulders in a "S"-shaped curve as it flies with slow, steady wing beats. When feeding in the marshes, it shuffles its feet to stir up the small crustaceans that make up its food.



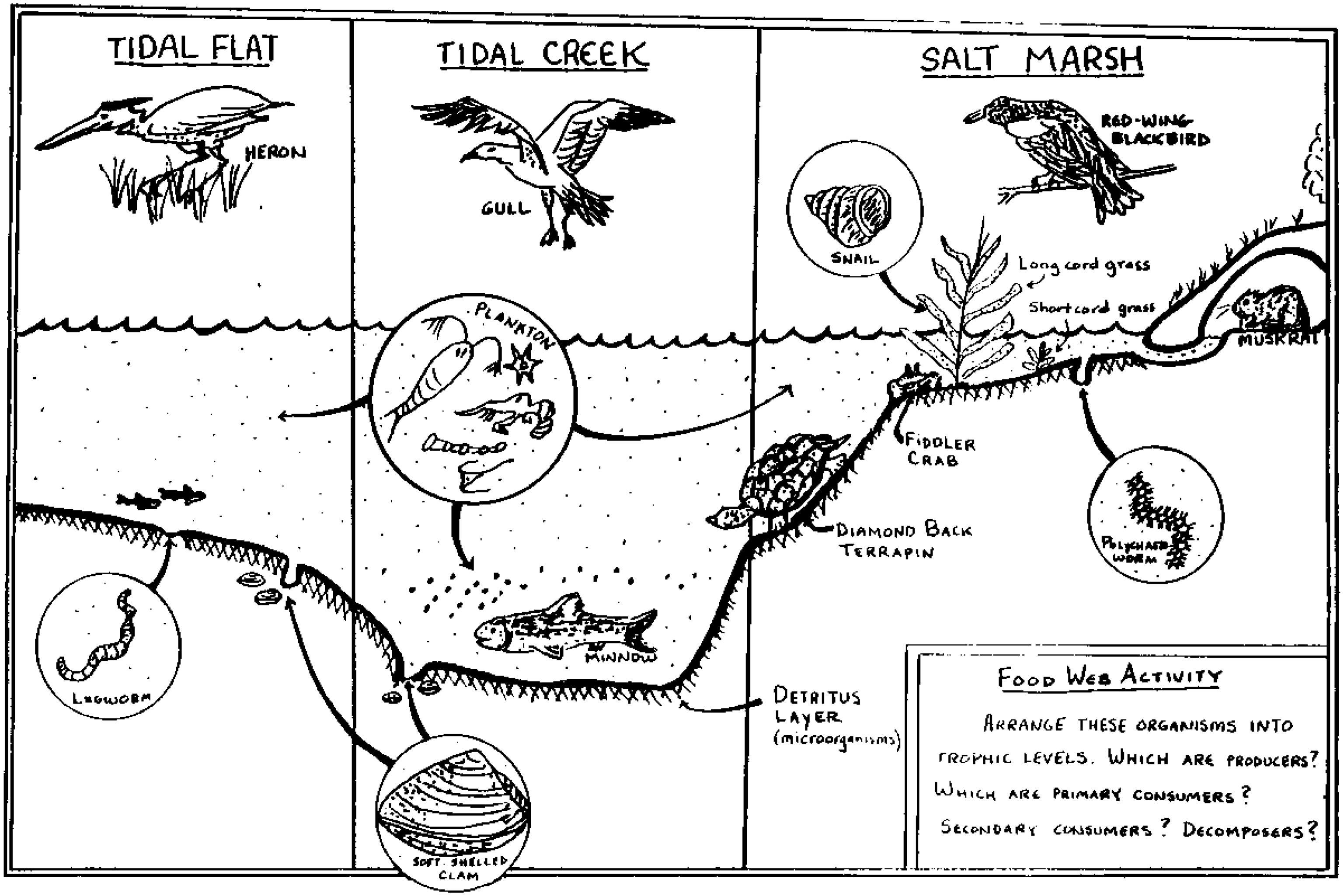
SNOWY EGRET

Cormorant

Both the great cormorant and the double-crested cormorant are seasonal residents of our coast and may be seen standing on offshore rocks in their characteristic "clothesline" position, that is, with wings fully extended to catch the wind so as to dry their feathers. The great cormorant arrives in New Hampshire from more northerly waters in November, just as the double-crested cormorant is beginning its southward migration to Florida for the winter.



CORMORANTS


TIDAL FLAT
TIDAL CREEK
SALT MARSH
HERON
GULL
RED-WING BLACKBIRD
SNAIL
Long cord grass
Short cord grass
MUSKRAT
PLANKTON
FIDDLER CRAB
DIAMOND BACK TERRAPIN
POLYCHAETE WORM
MINNOW
LUGWORM
DETRITUS LAYER (microorganisms)
SOFT SHELLED CLAM
FOOD WEB ACTIVITY
ARRANGE THESE ORGANISMS INTO TROPHIC LEVELS. WHICH ARE PRODUCERS? WHICH ARE PRIMARY CONSUMERS? SECONDARY CONSUMERS? DECOMPOSERS?

Coastal Zone Management
Case Study in Marine Development

(This is an excellent follow-up to the Floating Lab experience because it requires that information gained during the past few weeks be synthesized with additional research.)

Background

Hampton Beach, a precinct of the town of Hampton, has a year-round population of about 2,000 which swells to many times that number during the summer, as vacationers flock to the magnificent sandy beaches. Across the bridge lies Seabrook Beach (permanent population: about 3,000), which also attracts tourists in large numbers. Recently, however, many motels and restaurants have begun staying open all year, with more and more apartments and cottages being rented year-round.

Many of the townspeople work in the tourism industry, but many have found steadier work at the Seabrook nuclear power station which is being constructed on the western shores of the estuary. Others work at fishing, lobstering, or in the recreational fishing industry, many supplementing their incomes with part-time jobs during the winter.

A variety of boats are moored on the Hampton and Seabrook sides of the harbor. At the Eastman wharf in Seabrook is a parking lot, a bait shop, and a beach ramp where fishermen can come ashore and trucks can load fish. Fishing boats are moored at the Hampton State Fish Pier; there is also a marina for recreational boats.

Case

This is a hypothetical case which reflects some of the problems associated with coastal development. A developer proposes to upgrade the local harbor area by:

- dredging a channel ten feet wide from the ocean to the marina in Hampton;
- increasing the length of the jetty by twenty feet;

- building a condominium on the marsh just south of Eastman's pier and using dredged materials for "fill" on which to build;
- applying to the towns of Hampton and Seabrook for permits to spray for mosquito control on the surrounding marshes;
- adding to the asphalt parking areas by the marina;
- building a combination restaurant/delicatessan and fish market adjacent to Eastman's pier, partially on pilings, and adding floats so guests can moor their boats;
- using the large pier in Seabrook for an amusement park;
- adding a sportfishing or boat brokerage business near the grocery store on Route 1 near Eastman's pier.

Procedure

Ask the students to react to the plan taking the roles of:

- a local commercial fisherman;
- a local owner of a fleet of recreational fishing boats;
- a prospective restaurant owner or store owner;
- chairman of the Hampton or Seabrook conservation commission;
- an established hotel owner in Hampton Beach;
- a local commercial clam-digger;
- a recreational boat owner;
- an Army Corps of Engineers employee who is developing an environmental impact statement for the dredging and the jetty reinforcement project.

Consider questions like the following. Add some of your own.

Dredging:

1. How will removal of soil from the channel affect habitats?
2. How can the effects of increased turbidity be reduced?
3. When should dredging take place to avoid conflicts with fish or shellfish development?
4. What is the composition of the dredged materials?
5. Where will dredged material be placed?
6. What are the effects of dredging the sand bar at the entrance to the harbor?
7. How will placing the dredged material as a foundation for the condominium affect the marsh?

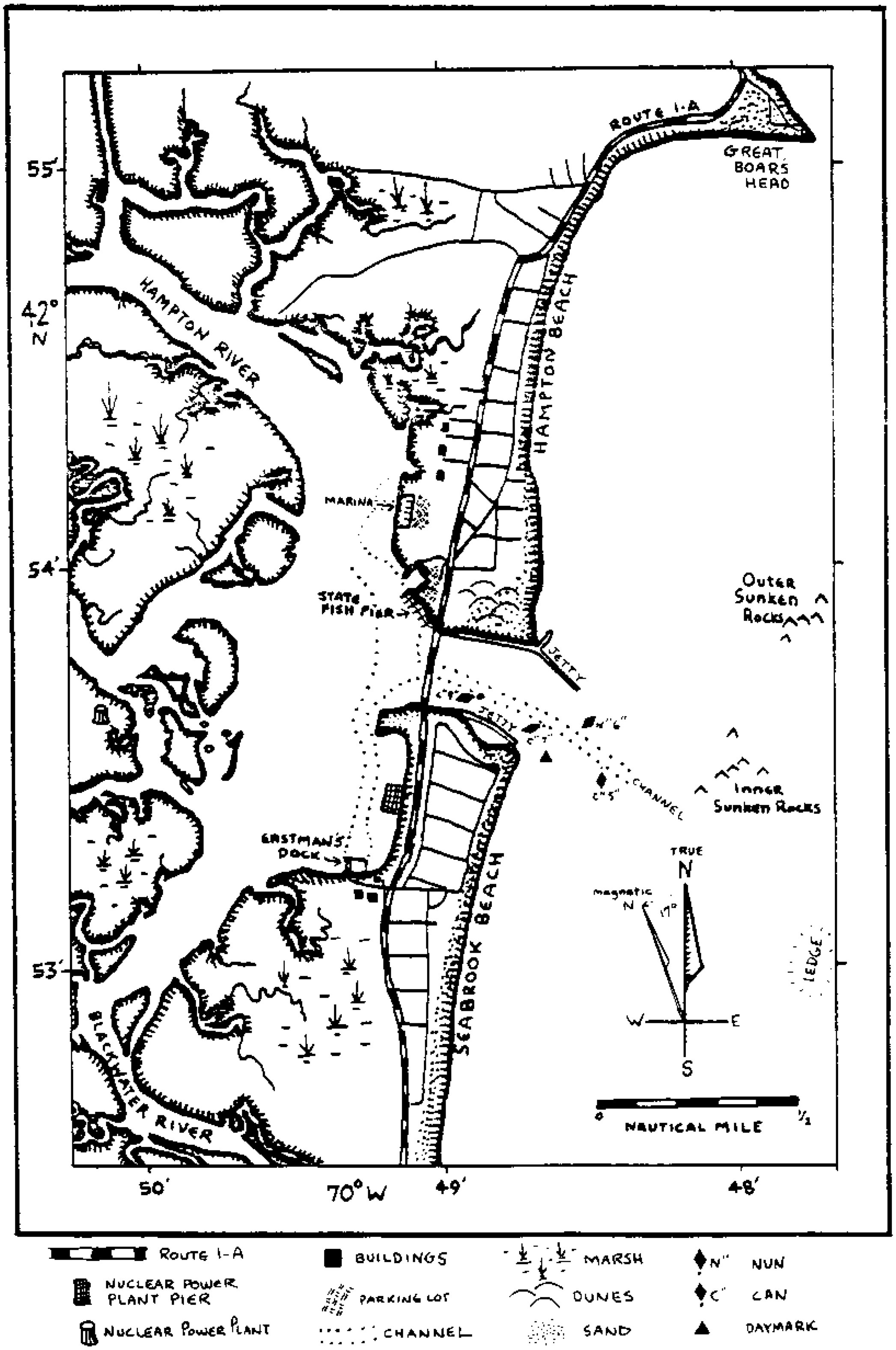
Jetties:

1. What are the effects of longshore currents on jetties?

Pier, Building, Parking and Marina:

1. What will be the effects of recreational boating on the area?
2. What will be the effect of runoff from the parking lot and pier?
3. Where would support facilities such as stores or restaurants be located? Why?

After the students have had a chance to research their roles, hold a mock public meeting where each point of view can be represented. (To carry this further, research into state and local permits required can be done, and students can make mock applications to be considered by the various agencies involved.)



ROUTE 1-A
GREAT BOARS HEAD
HAMPTON RIVER
HAMPTON BEACH
MARINA
STATE FISH PIER
JETTY
Outer Sunken Rocks
Inner Sunken Rocks
CHANNEL
EASTMAN'S DOCK
SEABROOK BEACH
BLACKWATER RIVER
LEDGE
TRUE
N
magnetic
17°
W
E
S
NAUTICAL MILE
55'
54'
53'
42° N
50'
70° W
49'
48'
Route 1-A
BUILDINGS
MARSH
NUN
NUCLEAR POWER PLANT PIER
PARKING LOT
DUNES
CAN
NUCLEAR POWER PLANT
CHANNEL
SAND
DAYMARK

Shore Processes

Introduction

The erosion of the beach and the movement of sand are due primarily to energy caused by wind and consequent wave effects. Observe the movement of sand in the laboratory, and apply those observations to real-life situations the next time you are at the shore.

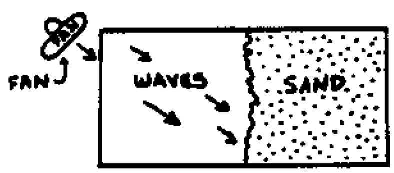
Purpose

To investigate the effects of wave action on beach sand

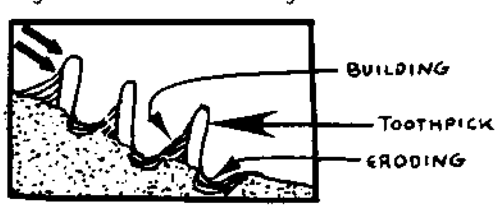
Procedure

1. Construct a shallow wave table.

2. Make any shoreline desired.
3. Generate a wave with a fan or a piece of wood.



4. Diagram the shoreline before wave generation, and then at intervals of five minutes, showing how it changes.
5. Generate waves and observe sand movement. (Add toothpicks to the sand. They will float away if the sand is eroded.)



6. Construct new shorelines, including bays, peninsulas, sand spits, etc. Then construct a jetty similar to the one at Hampton Harbor. How does the jetty affect the movement of sand? Where is sand deposited in relation to the jetty and the mouth of the harbor?

7. Simulate summer waves and notice their effect on a beach. Now, try to simulate a winter storm. What happens to the sand on the beach? Where does it go?

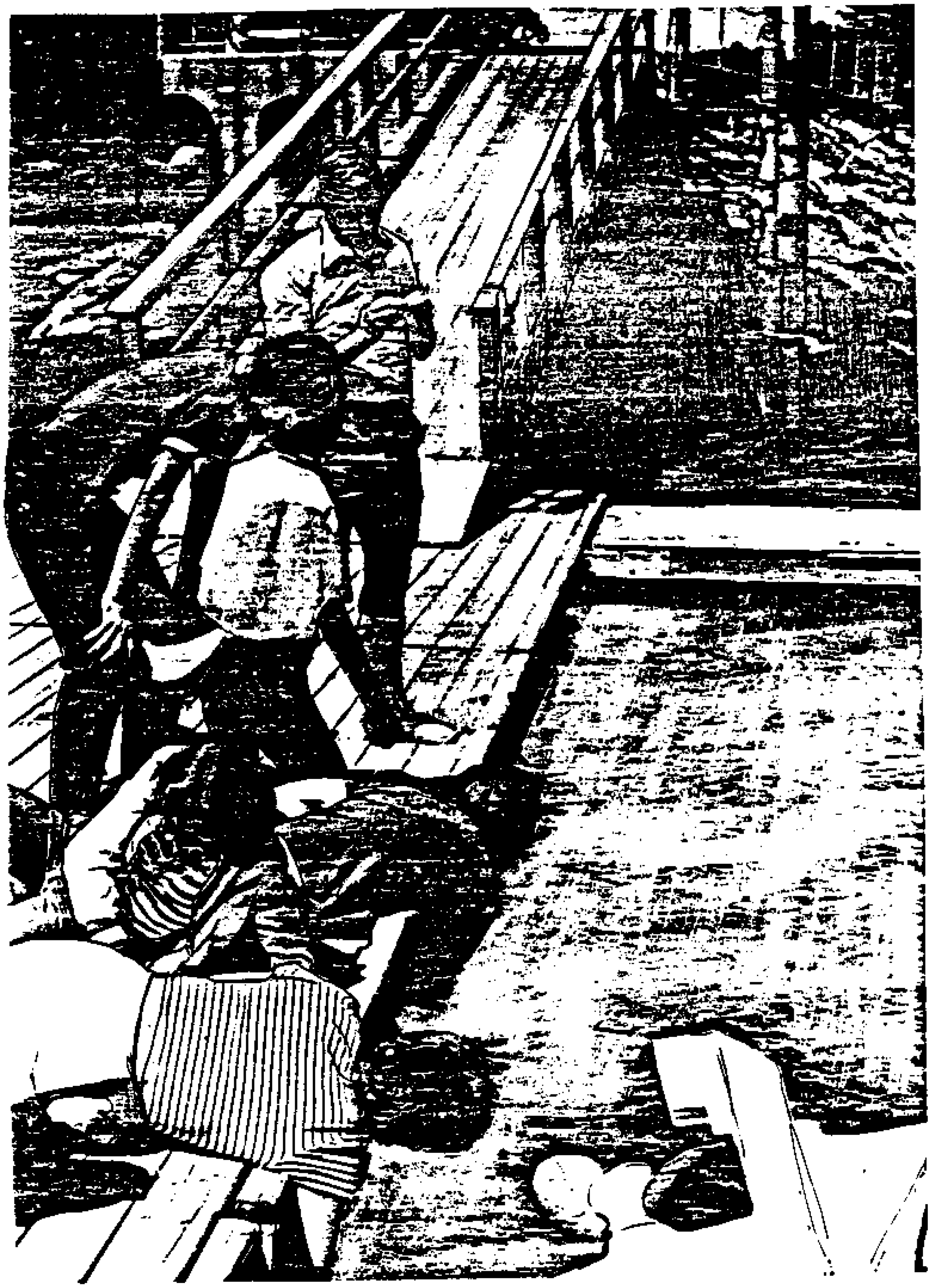
NOTE: This experiment can be done using a large clear pyrex or plastic pan. Set the pan on an overhead projector, and you can project shore processes on a screen for a large group to see.

Post-Cruise Suggestions

Have students:

1. Finish compiling data for all groups and combine in a graphic display.
2. Relate experimental results to written materials, principles, and common sense.
3. Draw possible conclusions with regard to the environment, e.g. effects of pollution, effects of nearby streams or power plant, prevailing winds, type of sediment, possible food items available, etc.
4. Discuss the physical and chemical factors.
   a. How did pH change with depth; what was the pH at the bottom and why?
   b. Make a T/S (temperature/salinity) plot and show how this relates to density.
   c. Identify depths at which dissolved oxygen content is the greatest; the least. How does oxygen change with depth and why?
5. Study fish specimens; practice using keys, and dissect the specimens.
6. Compare turbidity and water color with plankton concentration, red tides, etc.
7. Set up a marine aquarium.
8. Set up a marine natural history museum.
9. Consider the language arts possibilities which the at-sea experience may stimulate.
10. Invite other classes, teachers from other disciplines to participate through:
    a. Offering tours, guided by your students, of your marine exhibits.
    b. Setting up a marine speakers bureau and letting interested students develop marine topic reports to give to other groups.

SECTION V: APPENDICES



Appendices

Table of Contents

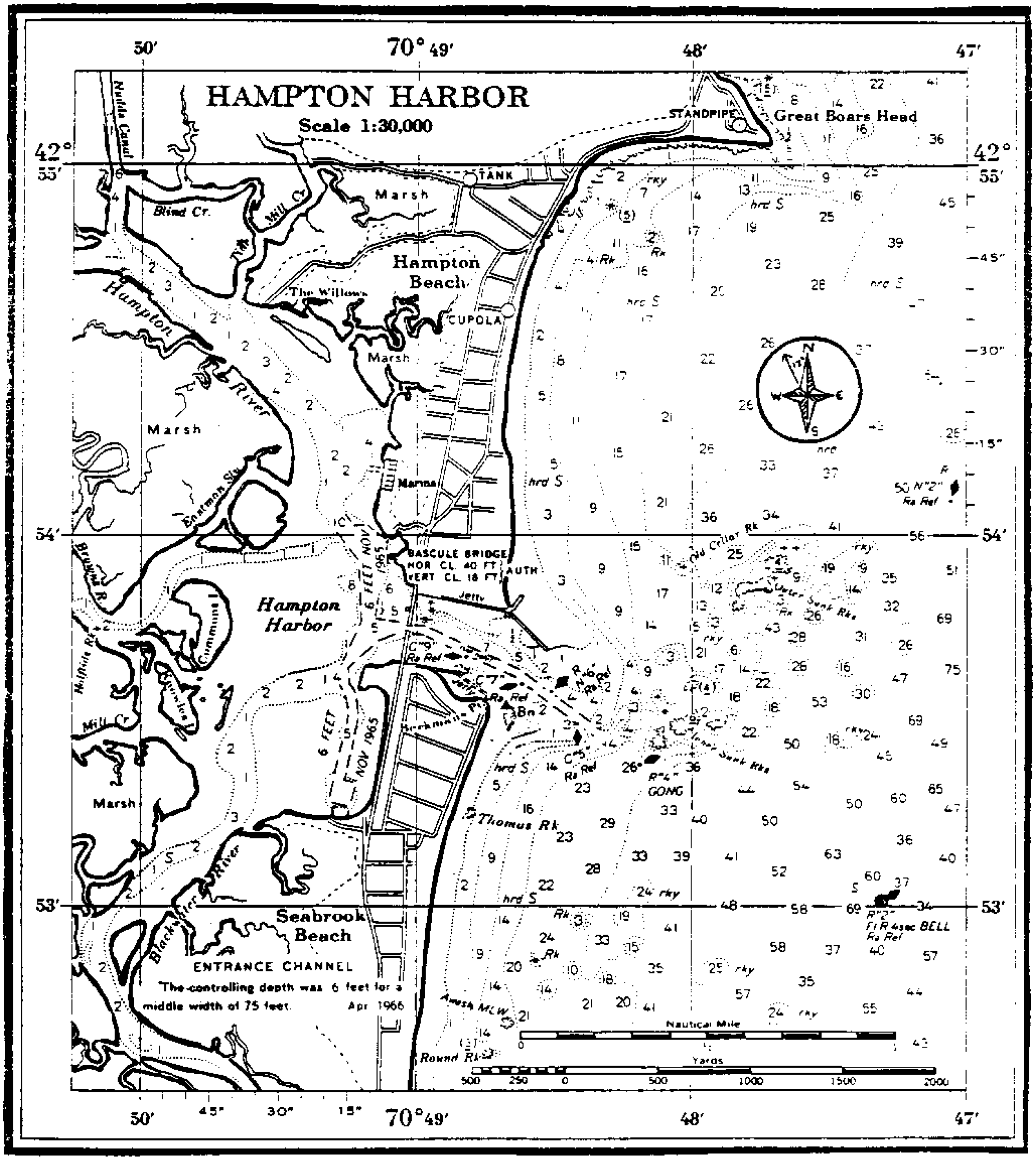
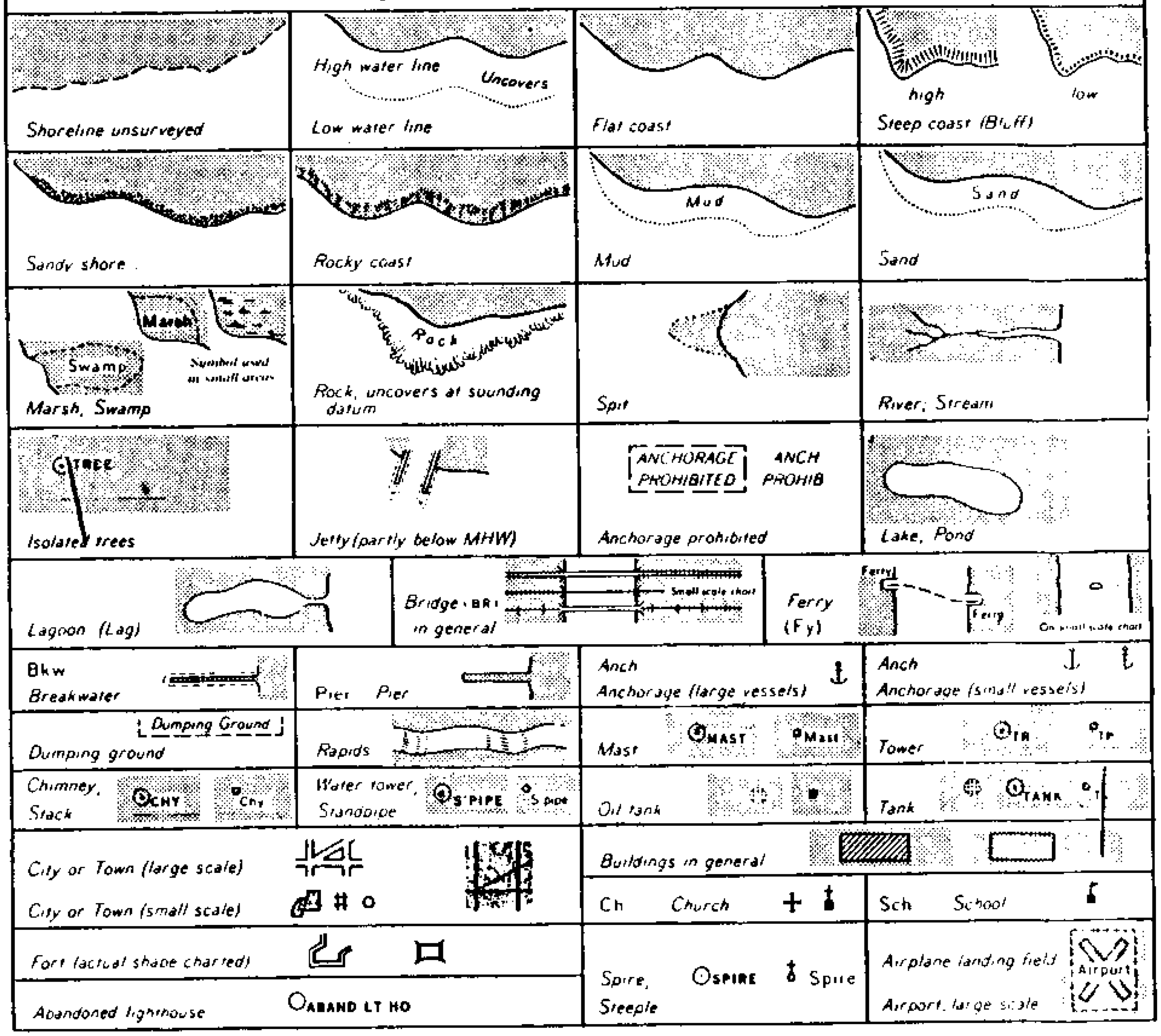

HAMPTON HARBOR
Scale 1:30,000
Great Boars Head
STANDPIPE
TANK
Marsh
Hampton Beach
The Willows
CUPOLA
Hampton River
Blind Cr.
Mill Cr.
Nudds Canal
Marina
BASCULE BRIDGE
HOR CL 40 FT
VERT CL 18 FT
AUTH
Jetty
Hampton Harbor
Browns R.
Hampton Harbor
Mill Cr.
Old Cellar Rk
Outer Sunk Rks
Inner Sunk Rks
Thomas Rk
Seabrook Beach
Blackwater River
ENTRANCE CHANNEL
The controlling depth was 6 feet for a middle width of 75 feet. Apr 1966
6 FEET NOV 1965
Round Rk
GONG
BELL
Nautical Mile
Yards
70° 49′
48′
47′
50′
42° 55′
54′
53′

Table 1 — Symbols for Landmarks and Natural Features



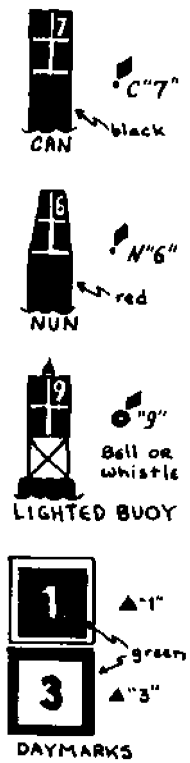
Navigation Symbols

Navigation charts contain information most important for safe navigation. Coastal features and bottom features are detailed. The following tables explain the various symbols which are used to show important features.

Symbols for Quality of the Bottom

S	Sand
M	Mud, Muddy
Cl	Clay
G	Gravel
P	Pebbles
St	Stones
Rk; rky	Rock, Rocky
Blds	Boulders
Co	Coral
Sh	Shells
Oys	Oysters
Ms	Mussels
Spg	Sponge
K	Kelp
Wd	Sea-weed
Grs	Grass
Fu	Fucus
fne	Fine
crs	Coarse
sft	Soft
hrd	Hard
dec	Decayed
vard	Varied
unev	Uneven

Symbols for Aids to Navigation



Symbols for Dangers, Channels, and Limits

(5) Rock which does not cover (elevation above MHW)	Subm piles Submerged piling
Uncov 2 ft Uncov 2 ft (2) (2) Rock which covers and uncovers, with height in feet above chart (sounding) datum	Wreck showing any portion of hull or superstructure (above sounding datum)
Rock awash at (near) level of chart sounding datum Dotted line emphasizes danger to navigation	Masts Wreck with only masts visible (above sounding datum)
Sunken rock (depth unknown)	Sunken wreck, not dangerous to surface navigation
Reef Reef of unknown extent	Wreckage Wks Wreckage
Rf Reef Le Ledge Shl Shoal	PA Position approximate PD Position doubtful ED Existence doubtful SD Doubtful sounding
Snags Stumps Snags, Submerged stumps	Tide Rips Overfalls or Tide rips Symbol used only in small areas

Measurements: Mini Math Review

The cruise offers many opportunities for students to use different systems of measurement, and to practice some simple math in converting from one system to another. In addition to the standard British and metric units, there are some "salty" measurements that may not be so well known (such as the fathom and the knot). A review of some of the measurements that will be needed on the cruise (particularly the conversions to the metric system) may help students to cope better with the problems of filling out data sheets, and to feel more confident when marine measurement terms are used by the crew and the cruise instructors.

Listed below are examples of measurements and conversions that will be part of the cruise experience.

a) Water and air temperatures are measured with thermometers in degrees Fahrenheit (°F) or in degrees Celsius or Centigrade (recorded as °C). Data sheets may require both.

To change from °F to °C: 5/9 x (°F - 32) = °C

To change from °C to °F: (9/5 x °C) + 32 = °F

b) <u>Water depth</u> may be measured by a handline, bathythermograph, or with the ship's fathometer. Measurement may be in feet, meters or fathoms.

1 fathom = 6 feet = 1.85 meters

1 meter = 3.27 feet

c) <u>Distance and speed</u> measurements are not usually needed during the cruise, but the terms are used so frequently aboard ship they are listed here:

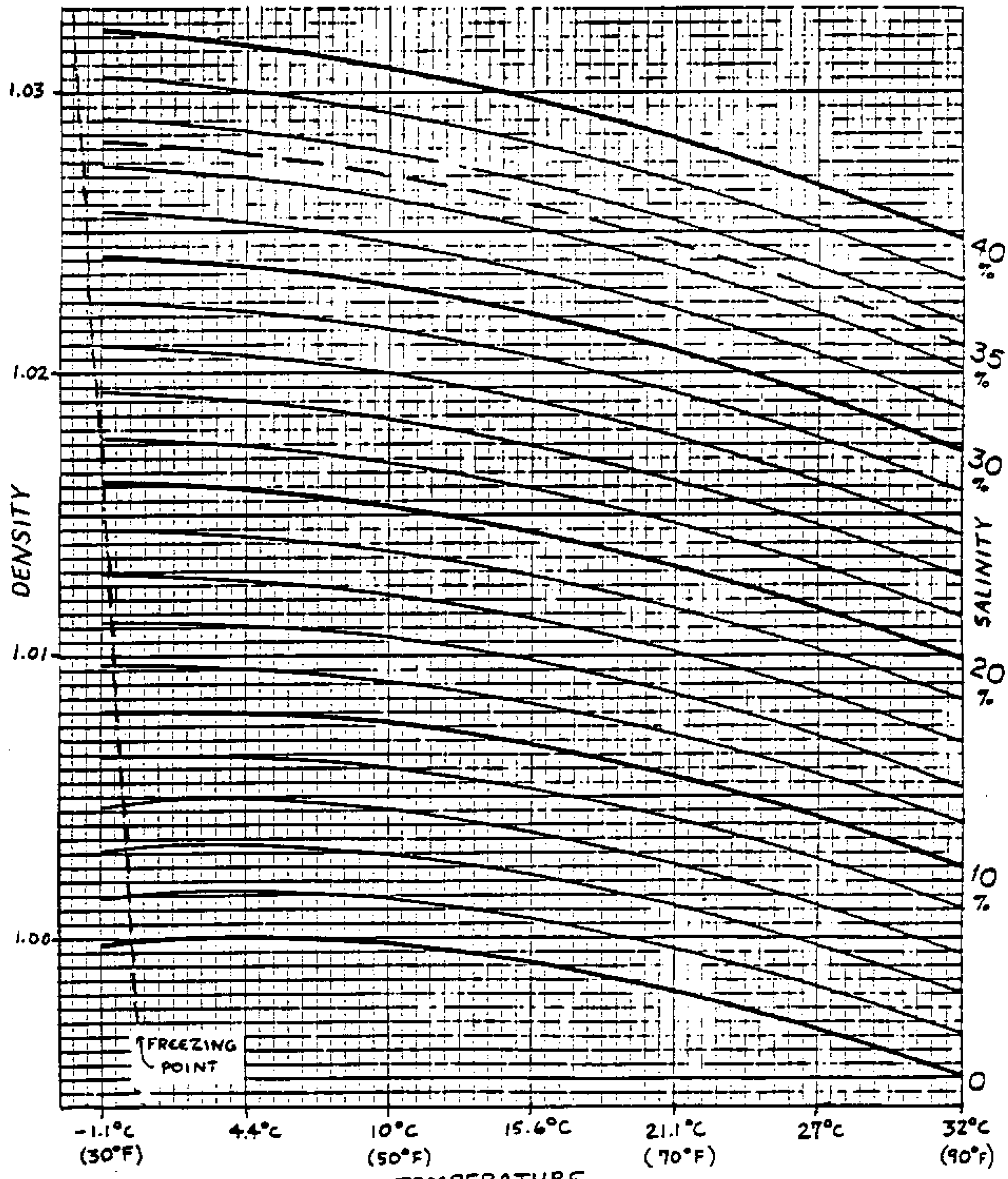
1 nautical mile = 1.2 statute miles = 6080 feet
= 1.85 kilometers
= 1 minute of latitude

1 knot = 1 nautical mile per hour

d) When recording measurements, we use the decimal system instead of fractions: 1/2 = 0.50, 1/3 = 0.33, 1/4 = 0.25, 1/5 = 0.20.

Estimates, such as might be made when using the Secchi disc (which is deployed on a line knotted at one-meter intervals), are best recorded using the general rule: "If it's half or more, add one; if it's less than half, forget it."

SALINITY DETERMINATION BY DENSITY



Common Invertebrate Checklist
(Genus and Common Name)

PORIFERA (sponges)

- X Halichondria (crumb of bread)
- ___ Haliclona (little white)
- X Leucosolenia (eyed finger)

COELENTERATES

- ___ Clava (club hydroid)
- X Sertularia (attached to seaweeds)
- ___ Tubularia (pink-hearted hydroid)
- ___ Metridium (sea anemone)
- ___ Cyanea (lion's mane)
- X Aurelia (moon jelly)

CTENOPHORA

- X Pleurobrachia (comb jelly)

PLATYHELMINTHES (flat worms)

- X Notoplana (flat worm)

RHYNCHOCOELA (nemertinean worms)

- ___ Cerebratulus (largest ribbon worm)
- ___ Lineus (green ribbon)
- ___ Micrura (small ribbon)

ANNELIDS (segmented worms)

- X Nereis (clam worm)
- ___ Clymenella (bamboo worm)
- ___ Glycera (beak thrower)
- X Lepidonotus (scale worm)
- X Nephtys (shimmy worm)
- X Spirorbis (coiled worm)
- ___ Cistenides (trumpet worm)

ARTHROPODA

- X Balanus (barnacle)
- X Idotea (isopod)
- X Gammarid (amphipod)
- X Crangon (sand shrimp)
- X Homarus (lobster)
- ___ Pagarus (hermit crab)
- X Cancer (rock crab)
- X Carcinus (little green)
- ___ Hyas (toad crab)
- ___ Limulus (horseshoe crab)

MOLLUSCS (snails)

- X Acmea (Chinaman's hat)
- X Ischnochiton (chiton-shell)
- X Littorina (periwinkle)
- X Thais (dog whelk)
- ___ Buccinum (wavy whelk)
- X Lunatia (moon snail)
- ___ Coleus (Stimpson's coleus)
- ___ Nepturea (ten-ridge whelk)
- ___ Melampus (marsh snail)

MOLLUSCS (clams)

- X Mercenaria (hard shell clam)
- X Arctica (mahogany clam)
- X Gemma (gem shell)
- ___ Spisula (surf clam)
- X Mya (soft shell clam)
- X Modiolus modiolus (horse mussel)
- X Mytilus (blue mussel)

_X_ Modiolus demissus (ribbed mussel)

___ Anomia (jingle shell)

___ Hiatella (red-nosed clam)

MOLLUSCS (no shell)

___ Clione (sea butterfly)

___ Coryphella (salmon gill slug)

___ Dendronotus (bushy back slug)

___ Onchidorus (white sea slug)

___ Aeolidia (plumed sea slug)

ECHINODERMS

___ Henricia (blood star)

_X_ Asterias (common star)

_X_ Ophiopholis (brittle star)

_X_ Strongylocentrotus (sea urchin)

___ Echinarachnius (sand dollar)

_X_ Cucumorin (northern cucumber)

___ Leptosynapta (burrowing cucumber)

BRYOZOA

___ Bugula (tufted bryzoan)

_X_ Membranipora (sea lace)

PROTOCHORDATE

_X_ Botryllus (star tunicate)

___ Amaruucium (sea pork)

___ Ciona (sea vase)

___ Boltenia (sea potato)

___ Molgula (sea grape)

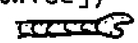
___ Halocynthia (sea peach)

X -- organisms likely to be found while on the Floating Lab Trip.

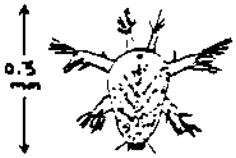
Marine Algae Identification Key

1. Plant body (thallus) distinctly green 2
1. Plant body not distinctly green 5
  2. Fronds long and threadlike 3
  2. Fronds not threadlike 4
3. Fronds branched . . . . Cladophora

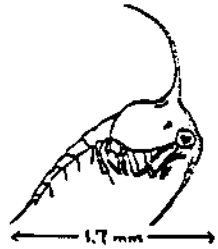
3. Fronds unbranched . . . . Chaetomorpha [Mermaid's Hair]
  4. Fronds paper thin and flat . . . . .Ulva [Sea lettuce]
  4. Fronds tubular and long . . . . .Enteromorpha [Entral grass, Link confettii]
5. Fronds yellowish brown to olive green or nearly black . . . 6
5. Fronds pink, red or reddish purple 21
  6. Fronds irregularly round, hollow and gelatinous . Leathesia [Rat's brains]
  6. Fronds not as above 7
7. Fronds forming a brown to black crust on rocks . . . Ralfsia [Tar spot]
7. Fronds not forming a crust 8
  8. Fronds tubular 9
  8. Fronds not tubular .13
9. Plant body branched throughout 10
9. Plant body little or not at all branched except perhaps at the base 11
  10. Axes and branches 2-5 mm. in diameter . . . . . . Dumontia
  10. Axes and branches usually 1 mm. or less in diameter (in part) . . . . Dictyosiphon
11. Plant body usually more than 1/2 meter long (1-5 meters). . . . . Chorda [Devil's shoelace]
11. Plant body usually less than 1/2 meter long 12
  12. Plant body constricted;  without groups of sporangia (reproductive organs) and hairs appearing as dark flecks . . . . Scytosiphon
  12. Plant body not constricted; covered with groups of sporangia (reproductive organs) and hairs appearing as dark flecks . . . . Asperococcus
13. Fronds filamentous (threadlike) 14
13. Fronds membranaceous (thin, pliable, sometimes transparent) and expanded 17
  14. Fronds capillary (long and thin); formed of a single row of cells . . . . .Ectocarpus [Brown mermaid's tresses]
  14. Fronds cylindrical .15
15. Branching of fronds pinnate (equal) and opposite  . . . . Desmarestia [Color changer]
15. Branching of fronds not pinnate and opposite 16
  16. Fronds tough and dense . . . . Chordaria
  16. Fronds soft and flaccid (limp) . . . . Dictyosiphon
17. Fronds simple (unbranched). 18
17. Fronds branching 20
  18. Midrib absent . . . . Laminaria [Ribbon kelp]
  18. Midrib present () 19

19. Fronds perforated with numerous holes; without lateral leaflets at base of blade . . . . Agarum [Sea collander; Devil's apron]
19. Fronds without holes; with lateral leaflets at base of blade . . . . Alaria [Wing kelp; Henware]
20. Fronds with a midrib; fruit terminal . Fucus [Rock Weed]
20. Fronds without a midrib; fruit born on short lateral branches . . . . . . Ascophyllum [Knotted wrack]
21. Fronds calcareous (made of calcium; hard) 22
21. Fronds not calcareous 23
22. Fronds erect, standing up, long and attached at joints, filiform and articulated . . . . . . Corallina [Coralline]
22. Fronds thick, horizontally expanded but often rising at intervals in irregular protuberances (encrusting) . . . . Lithothamnion
23. Plant encrusting rocks, forming their pinkish to reddish-brown crusts near low water mark . . .Hildenbrandtia
23. Fronds erect; not crustaceous 24
24. Fronds tubular . . . . Halosaccion
24. Fronds not tubular 25
25. Fronds filamentous 26
25. Fronds membraneceous 28
26. Filaments branching ( [splits twice]) dichotomously, with transverse (across ) bands; lobster claw at end . . . . Ceramium
26. Filaments pinnately branching; without transverse bands (on one side like a comb) 27
27. Filaments pectinately branching (with opposite branches of unequal length) . . . . Plumaria [Plume moss]
27. Filaments branching irregularly . . . . Polysiphonia
28. Fronds thin and delicate like tissue paper; purplish-red . . . . Porphyra [Laver]
28. Fronds not tissue paper thin 29
29. Fronds large and leaflike; simple to dichotomously or palmately (like the palm of your hand and fingers) divided . . . . Rhodymenia [Dulse]
29. Fronds dichotomously (branching two times each) branched with narrow divisions 30
30. Fronds covered with small papillae (bumps) . . . .Gigartina [Grape-stone]
30. Fronds without papillae . . . . . . .Chondrus [Irish moss]

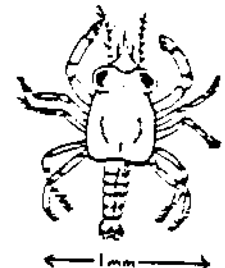
TEMPORARY ZOOPLANKTERS [LARVAE]



NAUPLIUS LARVA of CRAB (Decapoda: Crustacea)

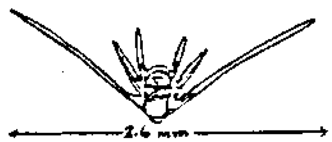


ZOEA LARVA of CRAB (Decapoda: Crustacea)



MEGALOPA LARVA of CRAB (Decapoda: Crustacea)

AURICULARIA LARVA of SEA CUCUMBER (Holothuroidea: Echinodermata)



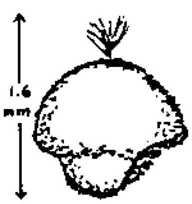
OPHIOPLUTEUS LARVA of BRITTLE STAR (Ophiuroidea: Echinodermata)

BRACHIOLARIA LARVA of STARFISH (Asteroidea Echinodermata)

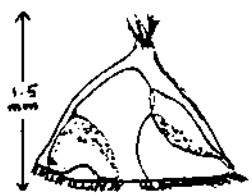
ECHINOPLUTEUA LARVA of SEA URCHIN (Echinoidea: Echinodermata)

TORNARIA LARVA of ACORNWORM (Enteropneuata: Hemichordata)

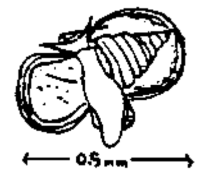
LEPTOMEDUSA (Coelenterata)



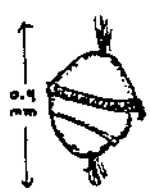
PILIDUM LARVA of RIBBON WORM (Nemertina)



CYPHONAUTAS LARVA of MOSS ANIMAL (Bryogoa)

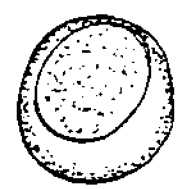


LATE VELIGER LARVA of SNAIL (Gastropoda. Mollusca)



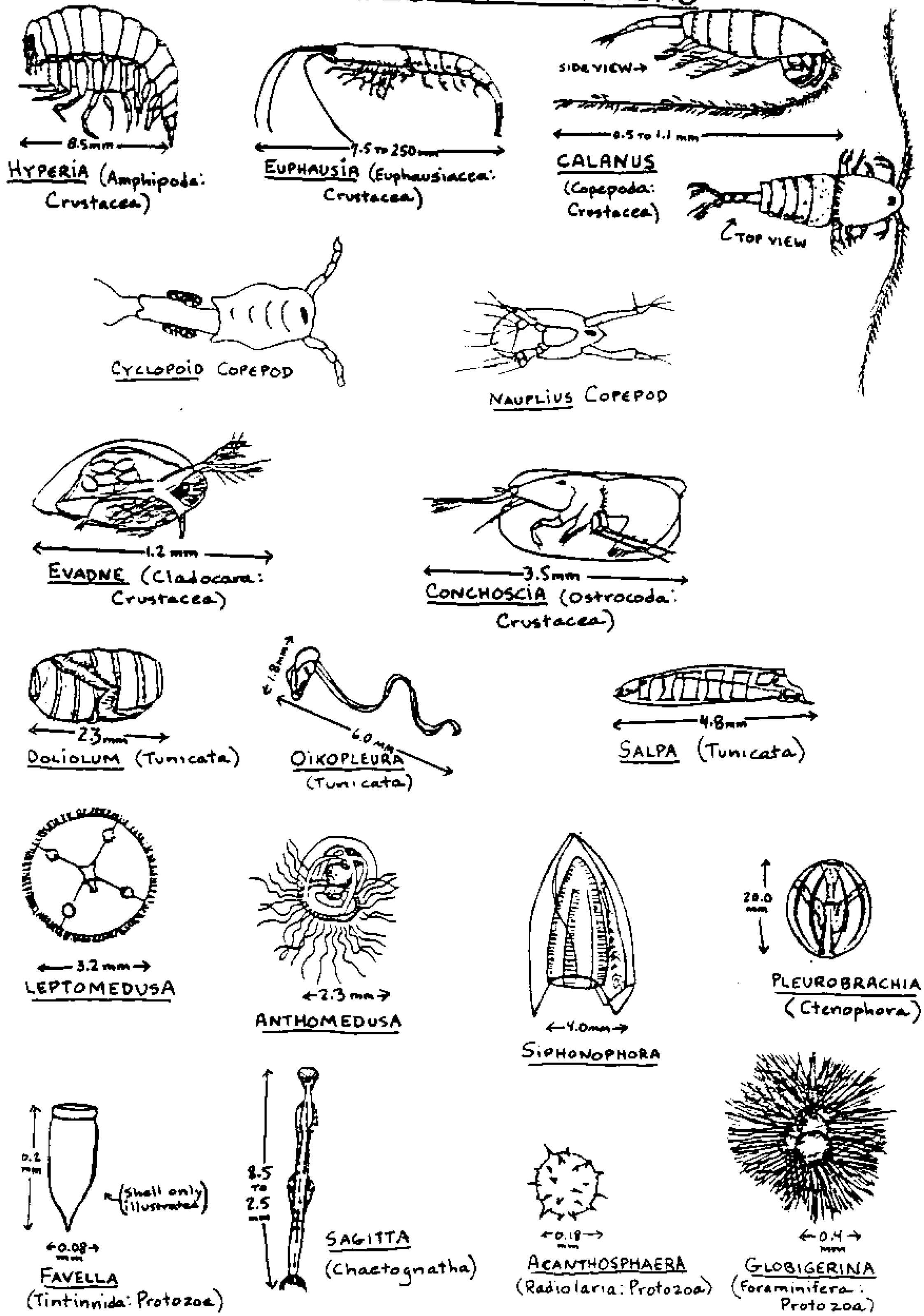
TROCHOPHORE LARVA of POLYCHAETE WORM (Polychaeta. Annelida)

PRE-SETTING LARVA of POLYCHAETE WORM (Polychaeta. Annelida)



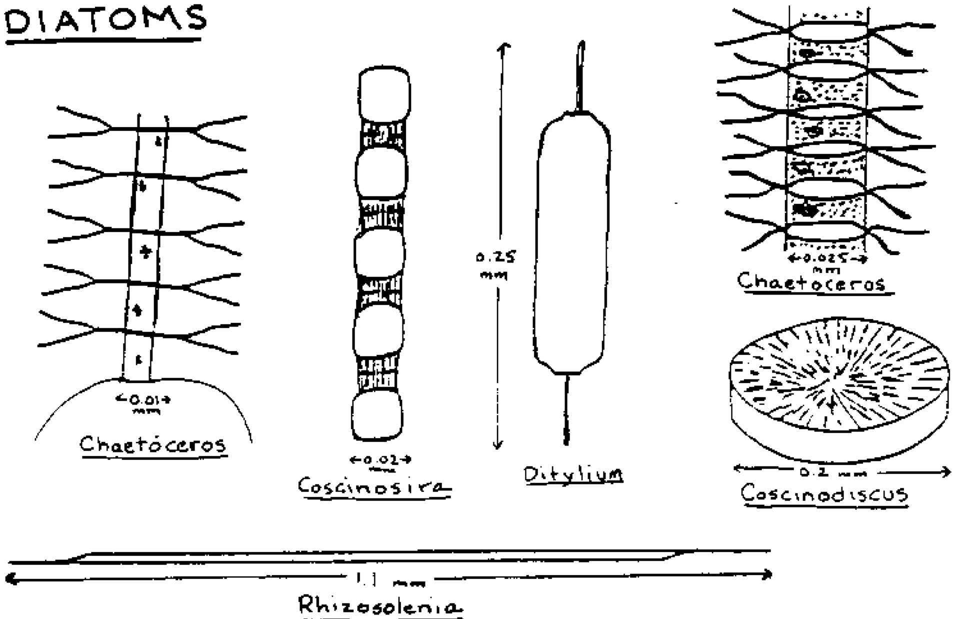
FISH EGG

PERMANENT ZOOPLANKTERS

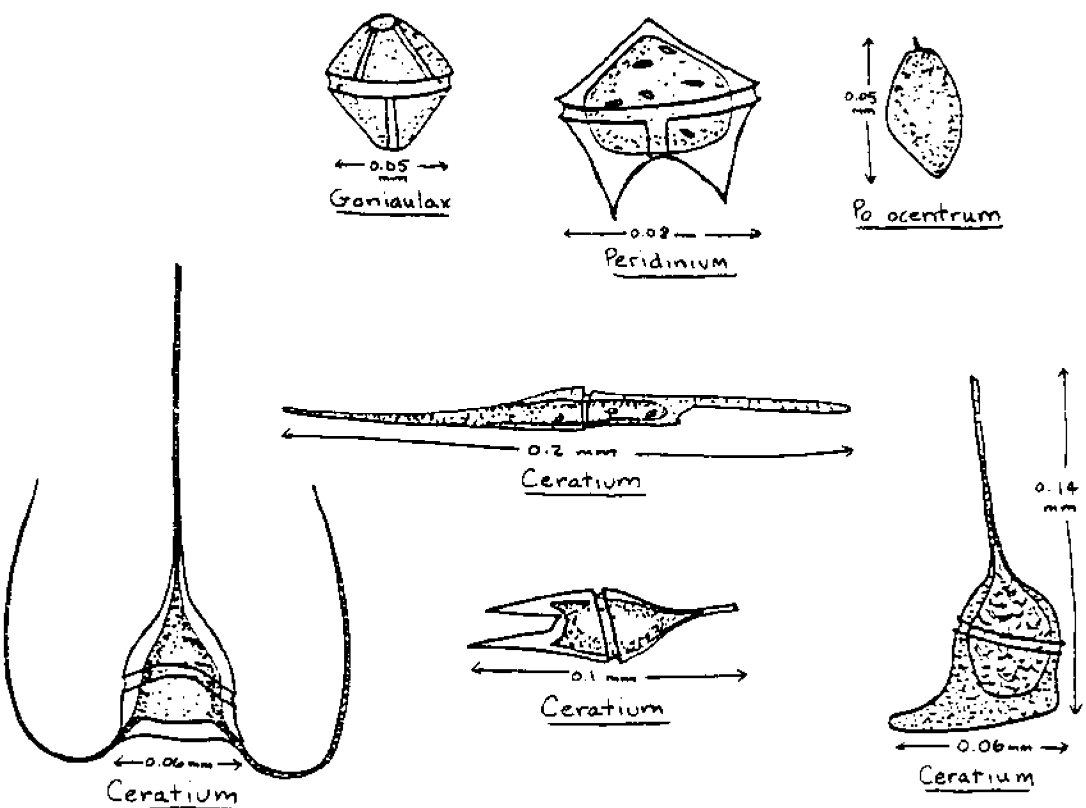


PHYTOPLANKTERS

DIATOMS



DINOFLAGELLATES

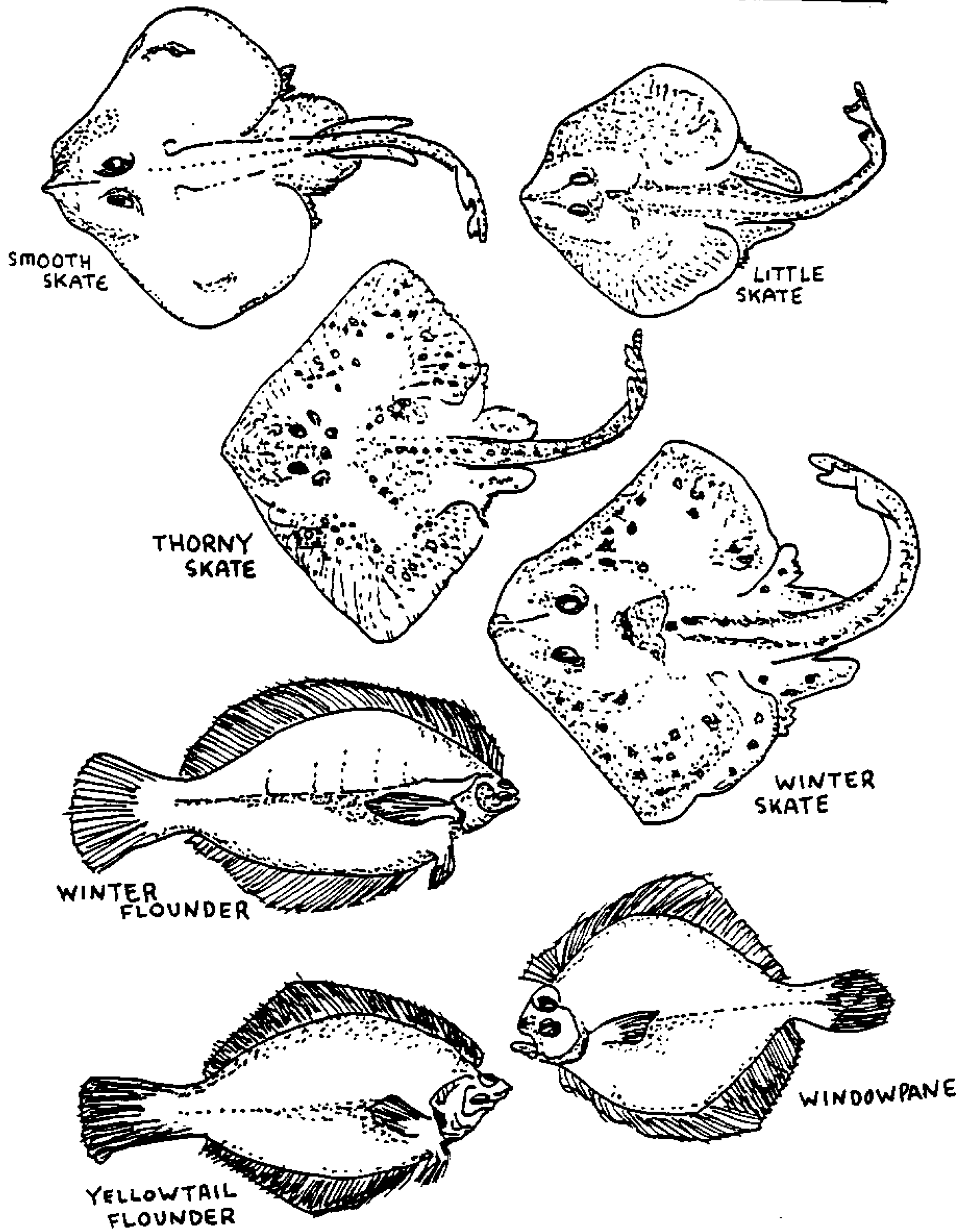


Fish Identification Key

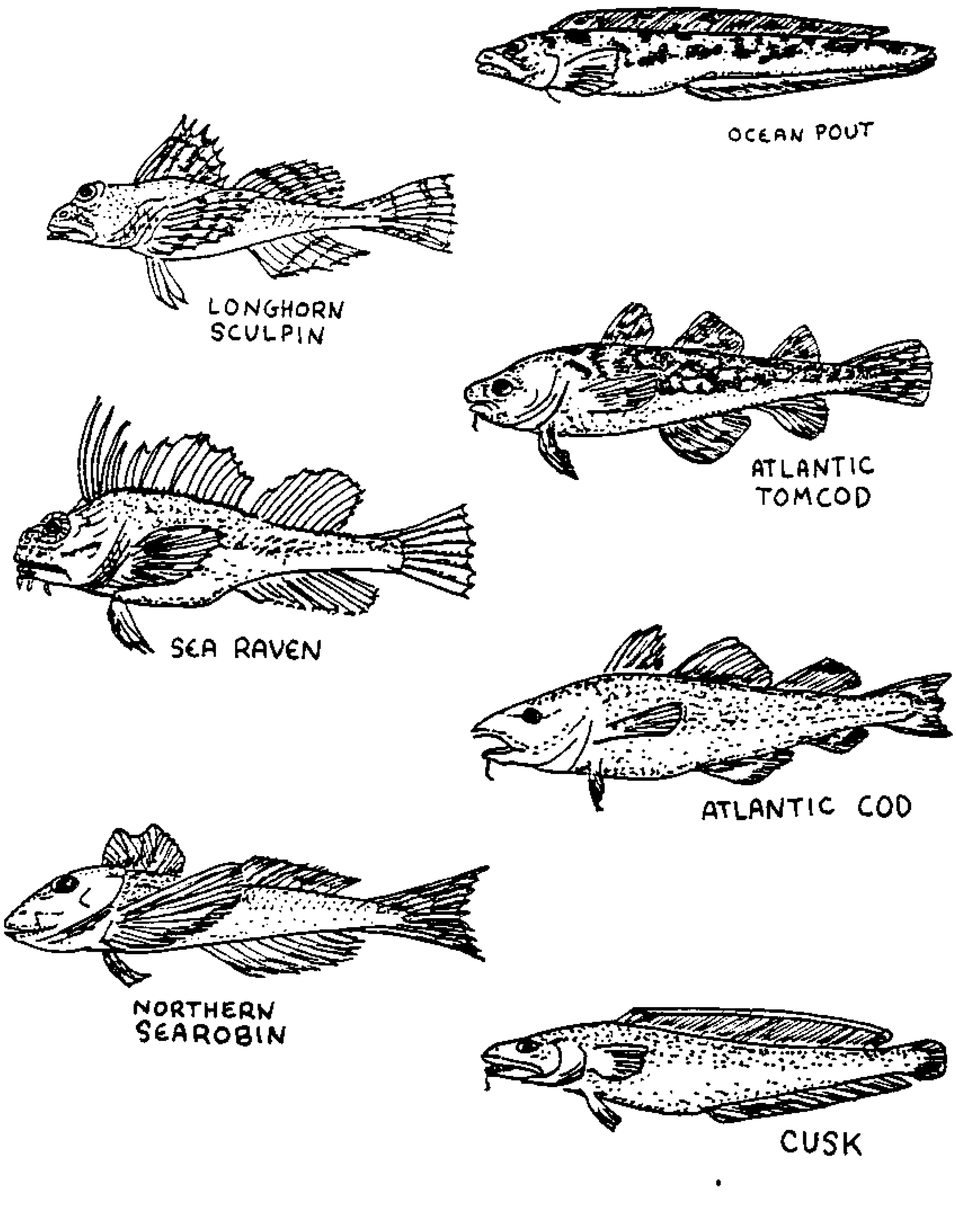
Carefully observe the fish you are trying to identify. Read the first pair of statements. Decide which statement most closely describes your fish. If the statement is followed by a number, go to that numbered pair of statements. Continue until a statement is followed by a name of the fish.

1	Dorsally compressed (flattened top to bottom)	2
1	Not dorsally compressed	6
2	Mouth found in front (flounder)	3
2	Mouth found on ventral, bottom side (skate)	5
3	Eyes found on left side of dorsal fin	window pane
3	Eyes found on right side of dorsal fin	4
4	Lateral line arched behind gill	yellow tail
4	Lateral line not arched behind gill	winter flounder
5	Single row of thorns down back and tail (entire)	thorny skate
5	Single row of thorns; none on last 1/3 of tail	smooth skate
5	More than one row of thorns on back	little skate
6	Eel shaped fish	7
6	Not eel shaped	8
7	Anal fin and caudal fin separate, chin barbed	cusk
7	Anal fin and caudal fin complete (attached)	ocean pout
8	Torpedo-shape body; three separate dorsal fins	9
8	Large head; wide gill openings; broad mouth; slender body; large pectoral fins; small caudal fin	10
9	Upper jaw projects beyond lower	cod
9	Lower jaw protrudes beyond upper	pollock
10	Several large spines on gill cover	sculpin
10	No spines; many fleshy flaps on head	sea raven
10	First few rays of pectoral fins adapted as feelers	sea robin

Some Common Flat Fish of the North Atlantic

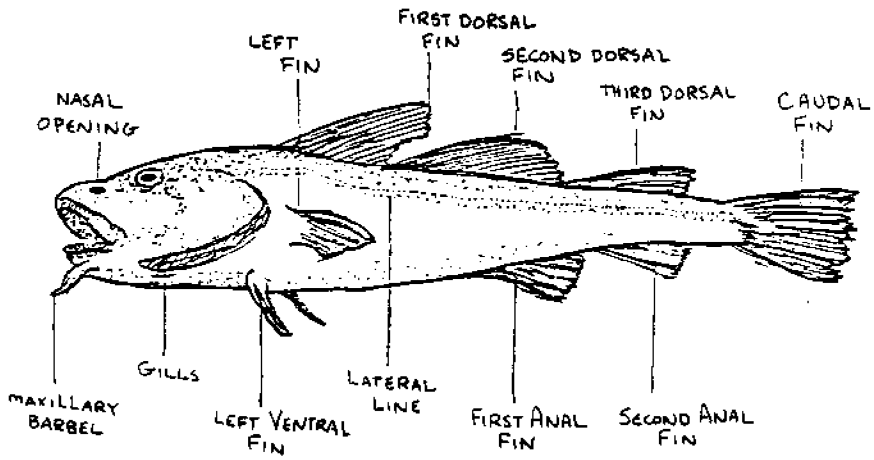


Some Common Sculpins & Cod-like Fish of the North Atlantic

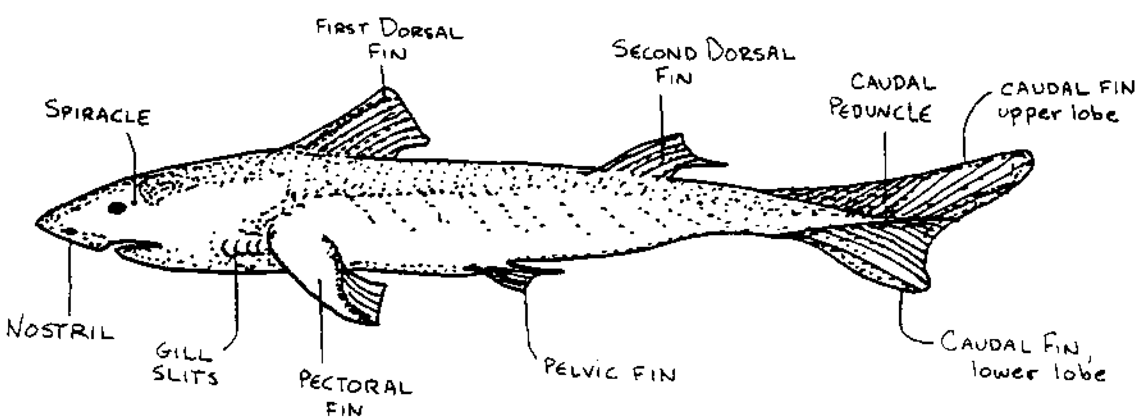


Fish: External Structure

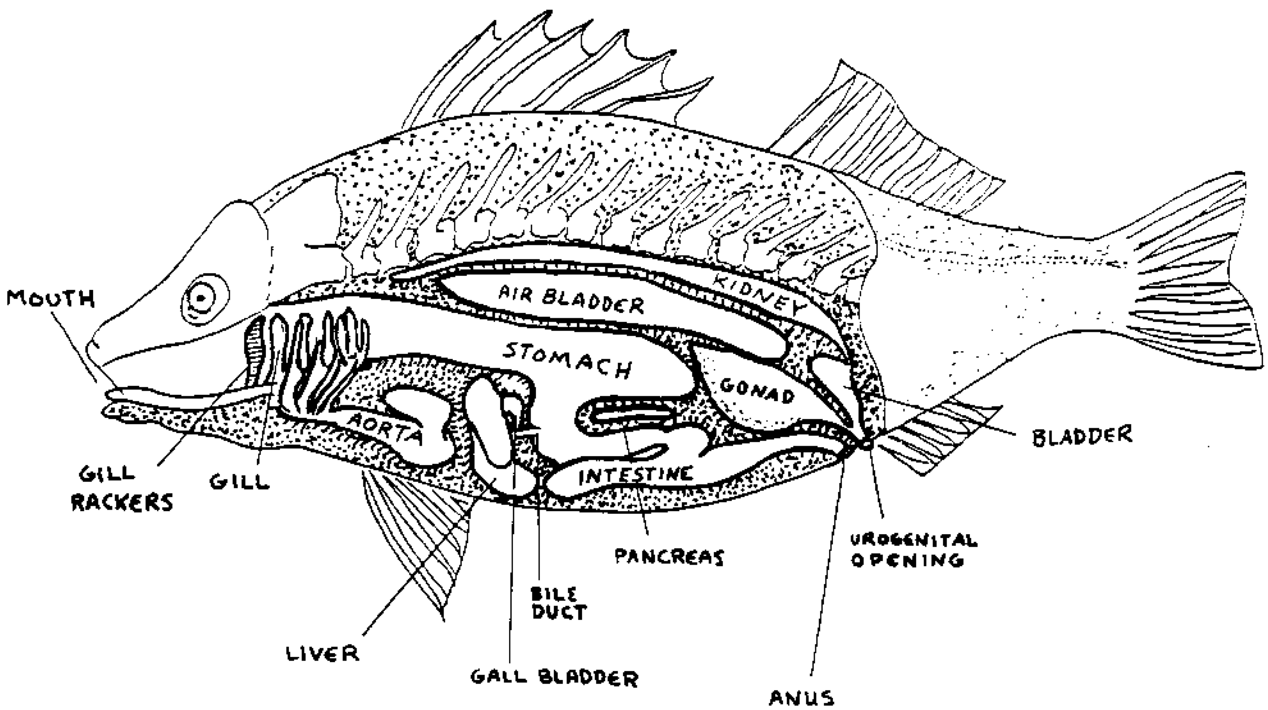
1. The jawless (Class: Agnatha) fishes: lampreys and hagfish.
2. The bony (Class: Osteichthyes) fishes to which most species belong: flounder, cod, salmon, haddock, herring.



3. The cartilaginous (Class: Chondrichthyes) fish: sharks and rays.



Typical Internal Anatomy of a Bony Fish



Field Trips and Resources

1. Bellamy River Sanctuary, Dover, NH. Contact Audubon Society of New Hampshire in Concord at (603) 224-9909.
2. National Sea Products, Rt. 101, Portsmouth, NH -- fish processing plant. Call Robert Wright at (603) 431-6863.
3. Gundalow, docked off Heritage Pier near Sheafe Warehouse, Portsmouth, NH. Contact Alex Herlihy, Chair, Gundalow Project, 25 Lang Lane, Rye, N.H. (603) 964-9079.
4. Jackson Estuarine Laboratory, Adam's Point, Durham, NH -- visits to research lab on Great Bay with volunteer Docent guides. Contact Sharon Meeker, Sea Grant Marine Advisory Program, UNH, (603) 862-1255.
5. Kittery Historical and Naval Museum, Kittery, Maine -- tours given, group rates available. Call (207) 439-3080.
6. Mr. and Mrs. Fish Program, Southern Maine Vocational-Technical Institute, Fort Road, South Portland, ME 04106. Call (207) 799-6234 for more information.
7. New England Aquarium, Central Wharf, Boston, MA -- extensive exhibits and activities. Call (617) 742-8830 for more information.
8. New Hampshire Port Authority, 555 Market Street, Portsmouth, NH -- tours available. Contact George Smith at (603) 436-8500.
9. Piscataqua Marine Laboratory, 15 Pickering Avenue, Portsmouth, NH -- tours of actual laboratory operations. Contact Karen Pierce at (603) 431-5270.
10. Star Island, Isles of Shoals -- trip to island on Viking Queen, a large passenger vessel making guided cruises late May through September. Call (603) 431-5500 for reservations.
11. Strawbery Banke, Portsmouth, NH -- before April 15, two-hour tours of colonial homes and craftsman shops, for groups of ten or more; after April 15, self-guided tours available. Fees: $2.00 per person. Call (603) 436-8010 for reservations.
12. United States Coast Guard Station, New Castle, NH -- tours of Coast Guard cutters. Contact Ensign Charlie Diaz at (603) 436-8781.
13. Viking Enterprises -- whale watches. Call (603) 431-5500.
14. Whales on Wheels, College of the Atlantic, Museum of Natural History, Bar Harbor, ME. Call (207) 288-5015 for more information.
15. Whale Watch, Hampton, NH -- half-day or full day guided boat trips. Contact Scott Mercer at (603) 926-4010 for reservations.

References

Anderson, Franz E., Laboratory Manual for Introductory Oceanography, Burgess Publishing Co., Minneapolis, Minnesota, 1979 (lab exercises to be done on land).

Apollonio, S., The Gulf of Maine, Courier of Maine Books, Rockland, Maine, 1979 (geological and oceanographic processes).

Arnold, Augusta F., The Sea Beach at Ebb Tide, Dover Publications, Inc., New York, 1968.

Assessment of Anticipated Impacts of Construction and Operation of Seabrook Station on the Estuarine, Coastal and Offshore Water of Hampton-Seabrook, New Hampshire, Summary Document, Normandeau Associates, Inc., Bedford, NH, December, 1977.

Barnes, Robert D., Invertebrate Zoology, W. B. Sanders and Co., Philadelphia, PA, 1974.

Burtis, William S., Ocean Opportunities: A Guide to What the Oceans Have to Offer, Marine Technology Society/Institute of Electrical and Electronics Engineers, New York, 1982. (Available from UNH Marine Program at a cost of $2.00.)

Berrill, Michael and Berrill, Deborah, The North Atlantic Coast, Cape Cod to Newfoundland, Sierra Club Books, San Francisco, 1980.

Bigelow, Henry B. and Schroeder, William C., Fishes of the Gulf of Maine, Fishery Bulletin 74, U.S. Fish and Wildlife Service, Vol. 53, U.S. Government Printing Office, 1953.

Borror, Arthur C., "Birds of the Odiorne Point Area," included in Odiorne Point State Park, Natural Science and Historical Studies, 1973.

Buchsbaum, Ralph E., Animals Without Backbones, University of Chicago Press, Chicago, 1976.

Carson, Rachel, The Sea Around Us, Simon and Schuster, 1958.

Dawson, E. Yale, How to Know the Seaweeds, Wm. C. Brown Co., Dubuque, Iowa, 1956.

Gosner, Kenneth L., Guide to Identification of Marine and Estuarine Invertebrates, Cape Hatteras to the Bay of Fundy, Wiley-Interscience Division of John Wiley and Sons, Inc., New York, 1971 (Chapters 1 & 2).

Gusey, William F., The Fish and Wildlife Resources of the Georges Bank Region, Shell Oil Co., 1978.

Katona, S., Richardson, D., and Hazard, R., A Field Guide to the Whales and Seals of the Gulf of Maine, Marine Coast Printers, Rockland, Maine, 1975.

Korporall, Arie and McDonough, Stephen, Student Manual, Los Angeles Marine Science Floating Laboratory, Office of Superintendent, Los Angeles County.

Marine Science Programs, Floating Marine Laboratory Programs, Orange County Department of Education, Santa Ana, California, 1976.

Northern New England Marine Education Project (NNEMEP), directed by John Butzow, University of Maine, Orono, Maine (eight units on the marine environment available at $4.00/unit).

Odum, Eugene P., Fundamentals of Ecology, Third Edition, W. B. Sanders Co., Philadelphia, PA, 1971.

Peterson, Roger T., A Field Guide to the Birds: A Completely New Guide to All the Birds of Eastern and Central North America, Houghton Mifflin Co., 1980.

Petsy, Loren C., A Beachcomber's Botany, The Chatham Conservation Foundation, Inc., Chatham, MA, 1968.

Robbins, C. S., Bruun, B., and Zim, H. S., Birds of North America, Golden Press, New York, 1966.

Robbins, Sarah Fraser and Yentsch, Clarise, The Sea Is All About Us, The Peabody Museum of Salem (MA) and the Cape Ann (MA) Society for Marine Science, Inc., 1973.

Ross, S. R., Hollis, G. N., Brakoniecki, T. F., and Benner, D. A., The Value of the Hampton-Seabrook Saltmarsh, UNH Sea Grant Ocean Project Report, University of New Hampshire, Durham, 1977.

Slijper, E. J., Whales and Dolphins, University of Michigan Press, Ann Arbor, Michigan, 1976.

Swensen, Eric and Lull, Wendy, A Preliminary Teacher's Guide for the 1977 UNH Floating Lab, UNH Sea Grant, University of New Hampshire, Durham, 1977.

Taylor, William R., Marine Algae of the Northeastern Coast of North America, University of Michigan Press, Ann Arbor, 1978.

Teacher's Guide, Orange County Marine Science Floating Laboratory Program, Orange County Department of Education, Santa Ana, California, revised September 1973.

Teal, John and Teal, Mildred, Life and Death of the Salt Marsh, Little, Brown, Boston, 1969.

Thorson, Gunnar, Life in the Sea, McGraw-Hill Book Co., New York, 1971.

Weiss, Howard M. (ed.), Investigations in the Marine Environment, Project Oceanology, Avery Point, Groton, CT, Vol. I, II, & III.

Student Floating Lab Questionnaire

School ____________________ Lab trip: ______AM ______PM

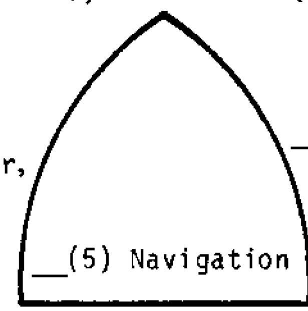
Teacher ____________________ Date of trip: ______________

Class ____________________

A. 1. Check the stations you participated in on the boat.

__(1) Water sampling (Van Dorn bottle, etc.)

__(2) Turbidity and temperature (Secchi disc, etc.)



__(4) Invertebrates and sediments (Grabber, corer)

__(3) Plankton and fish (Plankton nets, etc.)

__(5) Navigation

__(6) Between locations (Otter trawl, dredge)

(Use station numbers to answer the following questions.)

2. Which station did you learn the most from? ____

3. Which station did you learn the least from? ____

4. List the stations you felt well prepared for. __________

B. The Floating Lab instructors: (check one)

1. were easy to understand and knew their subject ___
2. explained clearly and could answer most questions ___
3. were hard to understand and could not answer questions ___

C. Because of the Floating Lab trip, will you: (check as many as you want to)

--consider a career in the marine environment ___
--read a book about a marine subject in the next six months ___
--urge other classes to go on the Floating Lab ___
--watch more TV programs about marine subjects ___
--visit the coastal area in the next six months ___
--take a class in oceanography and/or marine biology in the next 2-3 years ___

D. Would you recommend the Floating Lab trip to other students? ___

E. What was the highlight of the Floating Lab trip (for you)? _____

____

F. How could the lab trip be improved? ______________________

____

Teacher's Floating Lab Questionnaire

School ________________________ Lab trip: ___AM ___PM
Teacher ________________________ Date of trip ________
Class ________________________

So that we may incorporate your suggestions for future Floating Lab experiences, please fill out the following.

	low				high
A. The reactions of my students to the onboard activities were:	1	2	3	4	5
B. Please rate the stations according to student interest and amount learned.					
1. Water sampling (Van Dorn bottle, etc.)	1	2	3	4	5
2. Turbidity, currents, water color	1	2	3	4	5
3. Plankton and fish	1	2	3	4	5
4. Invertebrates and sediments	1	2	3	4	5
5. Navigation (pilot house)	1	2	3	4	5
6. Between locations (otter trawl, dredge)	1	2	3	4	5

C. In addition to the Floating Lab cruise, please check other techniques used in your class to study the marine environment.

reading from texts ____
studying duplicated material from manual ____
classroom lectures ____
activities ____
lab experiments ____
guest lectures ____
films, filmstrips ____
other: ________________________________

D. Please rate the following aspects of the Floating Lab experience from "1" (low) to "5" (high).

brochure ____
communications with teachers and chaperones ____
teacher workshops ____
Floating Lab Resource Manual ____
safety procedures and precautions ____
lab equipment aboard the boat ____
opportunities for specimen collection ____
instruction aboard the boat ____

E. Are you interested in the Floating Lab program for your next year's class? ____Yes ____No

F. How could the Floating Lab program be improved? ________________

____

____

Teacher's Floating Lab Resource Manual Questionnaire

1. Reading level of most materials: (circle one)

   too high okay too low

2. Was there enough variety in ability-level of most information and activities to meet the needs of your class? ___Yes ___No

3. Is the manual's organization helpful? ___Yes ___No
   If no, please suggest other types of organization:__________
   ____

4. Were drawings, figures, and maps generally clear and understandable to you and your students? ___Yes ___No

5. General Program Information:
   a. After reading this section, did you have a clear idea of the program aboard the boat? ___Yes ___No
      If no, please comment:______________________
   b. Should anything be added or deleted? (List page numbers)
      ____
   c. Please list the numbers of pages duplicated for students.
      ____

6. Site Environment:
   a. Was the information accurate and complete? ___Yes ___No
   b. Should anything be added or deleted? (List page numbers)
      ____
   c. Please list the numbers of pages duplicated for students.
      ____

7. Onboard Activities:
   a. Are descriptions and drawings of each activity clear?
      ___Yes ___No
   b. If no, please comment:______________________
   c. Please list the numbers of pages duplicated for students.
      ____

8. Pre- and Post-Cruise Activities: (Remember: there is great variety in ability level here, intentionally.)
   a. Are descriptions and drawings of each activity clear?
      ___Yes ___No
   b. If no, please comment:______________________
   c. Please list page numbers of those you used with your class.
      ____

9. Appendices:
   a. Should anything be added or deleted? (List page numbers)
      ____
   b. List the page number of those you used with your class.
      ____

Suggested Activity

We are interested in updating the manual and would like to use some activities contributed by teachers who have participated. Please send us one of your best on the form below.

ACTIVITY TITLE:

CONTRIBUTED BY (Your name, school, etc.):

CONCEPT:

INTRODUCTION:

PURPOSE:

EQUIPMENT (Please list):

PROCEDURE:

ADDITIONAL INVESTIGATIONS OR QUESTIONS:

CORRELATED CONCEPTS, READINGS, ACTIVITIES
for the Floating Lab

Educators: In designing your own curriculum for the Floating Lab experience, the following concepts site environmental readings, keyed in with Stations aboard the boat, and cruise activities may be of assistance. Note that these are based only on resources in the Floating Lab Resource Manual. You may want to use several other resources as well.

GENERAL BACKGROUND, INCLUDING SPECIFIC READINGS AND ACTIVITIES TO AID PREPARING FOR THE CRUISE

Site Environment Readings:

Program Information	No Activities
Introduction p. 3	Be sure to have a release form for each student on the day of the cruise.
Directions p. 5	
Student Information p. 9	
Data Sheet p. 11-12	
Sampling Stations p. 13	
Equipment Inventory p. 14	
Shipboard Activity Schedule p. 15	

NOTE: These pages give the student an overview of what will be expected on the cruise itself in terms of: record-keeping, clothing, food, equipment, etc.

STATION	EQUIPMENT	GENERAL SITE BACKGROUND READINGS, CONCEPTS & ACTIVITIES	ACTIVITIES
		<u>Site Environment Readings:</u> Beaches p. 31 Estuary p. 33 Salt March p. 35 Algae p. 37 Birds of Coastal New Hampshire 51 Marine Mammals of Coastal New Hampshire p. 53 Ecology p. 55 Pollution p. 66 CONCEPTS: 1. Hampton-Seabrook barrier beaches dominate our coastline & protect inner areas such as marshes. 2. The beach is a harsh environment because of extreme changes in temperature, as well as constant erosion by wind and water. 3. Beaches are moving constantly. 4. Man's activities may increase or interupt that natural movement. 5. Estuaries are semi-enclosed bodies of water with both fresh and salt water connections. 6. Estuaries are important as source of food and as a home for many plants and animals who live together in a complex "web of live". 7. Salt marshes are a part of our Hampton estuarine system. 8. Marshes were formed when the glaciers melted. 9. Salt Marsh grasses decay to form a very important food source for small animals living in the estuary and ocean. 10. People often destroy marshes, because they don't understand their value. 11. Algae are the dominant plants of the sea. 12. Algae is valuable to man as a food, as an experimental medium, and in many other ways.	<u>Pre & Post Activities</u> Shore Processes p. 151 Food Web Activity p. 145 Seashore Birds Activity P. 141 **Chromotography p. 135 **Collecting and Pressing Algae p. 137 Sea Water Aquaria p. 139 Post-Cruise suggestions **(may be done with samples taken on-board the Floating Lab)

STATION	EQUIPMENT	GENERAL SITE BACKGROUND READINGS, CONCEPTS & ACTIVITIES	ACTIVITIES
		<u>Concepts</u> .../continued 13. Algae is categorized by color: red, green, brown and blue-green. 14. Many birds inhabit N.H. shores, mainly gulls with cormorants, terns, geese, ducks, and wading birds being abundant, also. 15. Most birds are seasonal visitors. 16. Birds play an important role in the ecosystem as predators, and distributors of vegetation. 17. Marine Mammals such as harbor seals, humpback and minke whales, dolphins and porpoises can be seen off-shore. 18. The sun provides the energy for most marine ecosystems. 19. Every plan and animal in the ecosystem has its own "job" and is dependent on others. 20. Pollution of the marine environment affects people in many ways.	

STATION	E(?MENT	SITE ENVIRONMENT BACK 'UND AND CONCEPTS	ACTIVITIES
1 Water I	Van Dorn Bottle D.O. Kit pH Kit Hydrometer Thermometer	Readings: SEA WATER p. 21 Ecology p. 55 Pollution p. 66 Concepts: Sea Water: 1. Temperature: warm, surface water is less dense than cold lower layers of water. Winds cause mixing and layers occur. Variation in temperature affects plant and animal life. 2. Salinity: Variations affect plant and animal life; is the amount of dissolved solids in the water; Sea water is about 34 o/oo. It can change drastically in the estuary, depending upon season, weather, etc. 3. Dissolved gasses: dissolved oxygen and carbon dioxide are particularly important for marine life. 4. pH: a measure of acidity. The estuary is slightly acid, while the ocean is slightly alkaline. This has an effect on plant and animal life. 5. Light: absorbed, reflected and scattered by particles in the water and the water itself. 6. Turbidity: the amount of particles in the water influences photosynthesis. 7. Nutrients: nitrites, nitrates, ammonia, phosphate result from decayed plant and animal matter and are distributed by currents. They are essential for plant growth. Ecology: The sun provides energy for our ecosystem 1. Biomas is the living matter of the sea, most of which is the primary producers: the plants 2. The abundance of primary producers makes the North Atlantic the richest sea environment in the world Pollution: often attacks the lowest member of the food chain and its effects are magnified as they are incorporated into higher levels of the chain.	<u>ON BOARD</u> Van Dorn Bottle..........69 Hydrometer, Thermometer & Salinity..71 pH Test Kit..............74 Dissolved Oxygen Kit.....73 <u>PRE & POST</u> Homemade Hydrometer......97 Davy Jones Locket........99

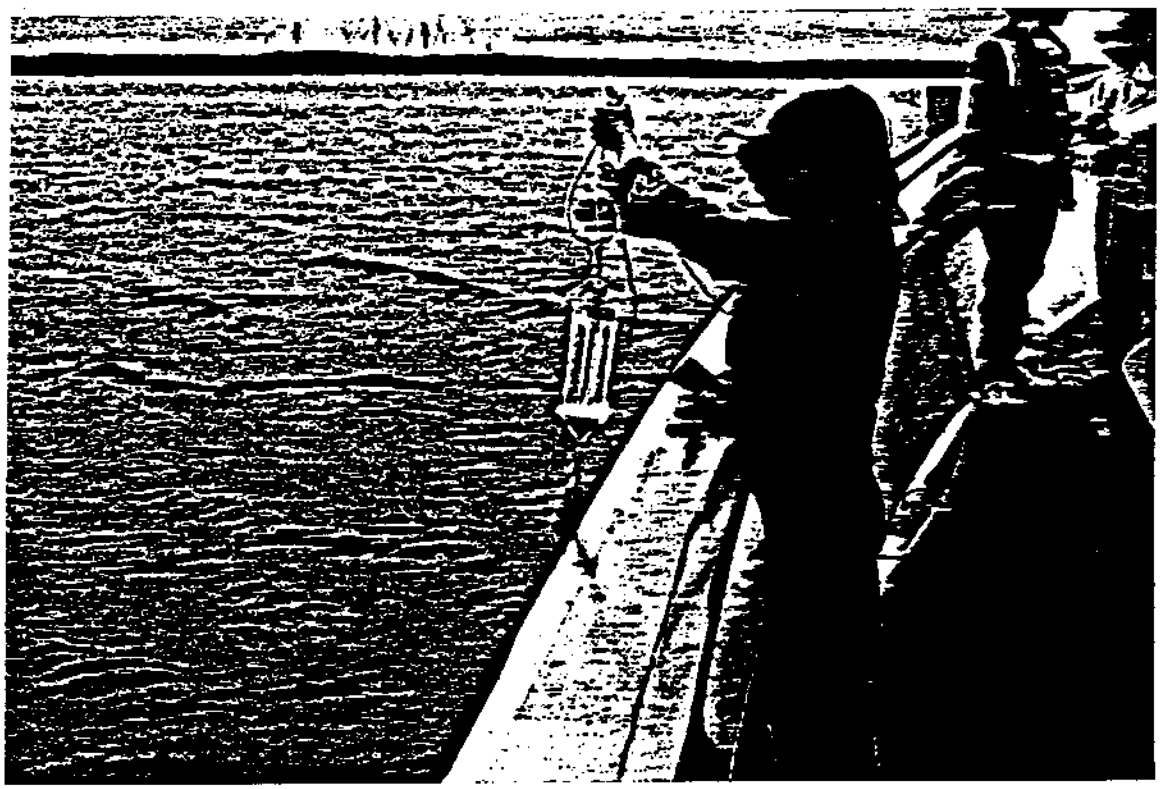
STATION	EQUIPMENT	SITE ENVIRONMENT BACKGROUND AND CONCEPTS	ACTIVITIES
2 Water II	Secchi Disc Forel/Ule Scales Drift Bottles Current Meter	READINGS: CURRENTS p. 23 WAVES p. 27 TIDES p. 29 CONCEPTS: 1. Currents are motions of water masses caused by differences in density and by winds. 2. Three factors affect sea currents: the sun's heat, winds and the Coriolis effect. 3. Fresh water run-off also influences currents, i.e. the counter-clockwise motion of the Gulf of Maine Gyre. 4. There are also special vertical currents called upwellings which bring colder, nutrient-rich waters from great depths into the light zone. 5. Waves are caused by wind and pressure exerted by the atmosphere. 6. As a wave moves toward the shore, it begins to "feel" the bottom and drag as it moves on the up-rising shoreline. 7. Longshore currents move sand along the beach in New England in a North South direction. 8. Longshore currents form when waves approach the beach at an angle, with the end closest the shore starting to "feel the bottom" first. 9. Tides are caused by two forces: the gravitational pull of the moon and the sun on the earth, and centrifugal force which moves water away from the side of the earth opposite the moon. 10. Spring or extremely high and low tides occur when the sun, moon, and earth are lined up. Neap or tides that don't rise and fall as much as usual result when the sun and moon pull on the earth at right angles to each other.	<u>Onboard</u> (These activities have good introductory write-ups, in the activity descriptions) Secchi Disc..........75 Forel/Ule Scales......77 Drift Bottles.........78 Current Meter.........79 <u>PRE & POST ACTIVITIES</u> *Making Current Bottles101 *Tide Chart & Graphing.103 Simple Wave Machine....105 Water Currents.........107 Wave Frequency.........109 Contour Maps...........111 **Sand Investigations...113 *Do before the cruise **Can be done with samples gathered aboard the Floating Lab

STATION	EQUIPMENT	SITE ENVIRONMENT BAKCGROUND AND CONCEPTS	ACTIVITIES
3 Pelagic	Plankton nets Scopes Fish Species	READINGS: PLANKTON p. 43 WHAT MAKES A FISH A FISH p. 48 FISH & FISHING IN THE NO. ATLANTIC p. 57 CONCEPTS: 1. Plankton are usually microscopic; some are permanent forms, and some are temporary, being only a larval form of an animal. 2. Plankton live suspended in water and are influenced by wind, waves, tide and light. Plant plankton are phytoplankton and animal plankton are zooplankton. 3. Two major kinds of phytoplankton are dinoflagellates (sometimes bioluminescent) and diatoms. Red tide occurs when the dinoflagellate Gonyaulax becomes too numerous. Diatoms are the most important members of the food chain, are the primary producers, and account for 90% of all photosynthesis in the ocean. 4. There are 3-4 times as many species of fish as there are mammals. 5. Fish range in size, survival adaptations, habitats, shapes is extremely wide. 6. Most fish caught commercially are the bony-skeleton type. 7. Georges Bank, a part of New England's continental shelf is one of the most productive fishing grounds in the world. 8. Most New Hampshire fishermen use gillnets to catch fish because they are easier and cheaper to use. 9. Commercially important species caught locally include cod, flounder, as well as hake, haddock, cusk, halibut and herring.	ONBOARD Plankton Net..........81 PRE & POST **Gyotaku.............115 **Checklist for Plankton............117 Guppy Observations....119 *Homemade Plankton Net.................121 Fun with a Fundulus...123 How to Age Fish.......125 *Do before cruise **Can be done with samples gathered on the Floating Lab

STATION	EQUIPMENT	SITE ENVIRONMENT BACKGROUND AND CONCEPTS	ACTIVITIES
4 Benthic	Invertebrate traps Grab Core Sampler	READINGS: Benthic Communities Benthic Communities of the Hampton-Seabrook Estuary p.45 Animal Classification p.39 Lobsters and Lobstering p.61 Clams and Clamming p.63 CONCEPTS: 1. A community is a group of interacting organisms commonly found living together. 2. Benthic (bottom-dwellers) communities are influenced by the type of sediment in which they live. 3. The anaerobic and aerobis layers of sediments vary in depth and because of oxygen content or lack of it, determine what organisms can live there. 4. Most organisms that can be examined aboard the Floating Lab live in the aerobic layer. 5. There are 15 major groups of animals in the marine environment grouped mainly according to structural features. 6. An animal's structure helps to determine the habitat in which he lives. 7. Layers of sediment can reveal recent and historical changes in climate and biological activity. 8. Lobstering is hard work, and it is expensive to outfit oneself if you have to do it from scratch (which most lobstermen don't). 9. Lobstering, like commercial fishing, is strictly regulated with licensing and size requirements. 10. Clams are harvested commercially in Maine, but are dug only for recreation in New Hampshire. 11. Clams are filter feeders and are very sensitive to pollutants concentrating them in their bodies. Red Tide can cause paralytic shellfish poisoning in humans, and can be concentrated in clams and other filter feeders' bodies.	<u>ON BOARD</u> Invertebrate traps.....83 Gravity corer..........84 Bottom grabber.........85 <u>PRE & POST</u> **Core Sample Analysis.134 Squid Dissection.......127 Mussel Dissection......129 Snail Activity.........131 Identifying Crustaceans133 **Can be done with samples collected during the cruise

STATION	EQUIPMENT	SITE ENVIRONMENT BACKGROUND AND CONCEPTS	ACTIVITIES
5	Compass Dividers Chart	READINGS: Seamanship and Navigation p.87 Navigation Aboard the Floating Lab p.65 Navigation Aids p.64 CONCEPTS: 1. Sky conditions, air temperature, wind speed and direction, and barometric pressure have an influence on sea vessels. 2. Although most fishing and commercial vessels carry much electronic equipment, the captain must still know how to navigate using simple equipment: the compass, dividers, and parallel rules. 3. A navigational chart gives many different kinds of information necessary to safely navigate a vessel in the ocean.	ON BOARD ACTIVITIES Seamanship and Navigation..........87

INDEX



Index