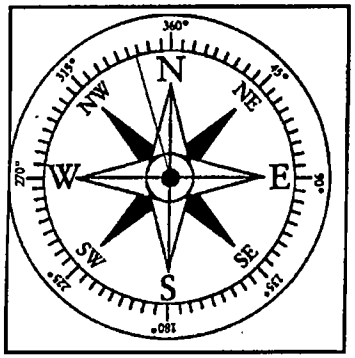
II

The Science of the Sea

Navigating and Charting the Sea



Since the earliest time people drew pictures to represent the world around them. The first pictures were of animals or people hunting or dancing. People also drew pictures to represent the shape of the land. The shapes drawn were of the coastline, rivers, mountains or villages. These types of pictures were used as a **guide** for traveling safely from one place to another and back home. These guides were called charts when they were drawn for the sea and maps when drawn for land. A chart or map is always drawn from a **bird's-eye view** looking down on the land and sea.

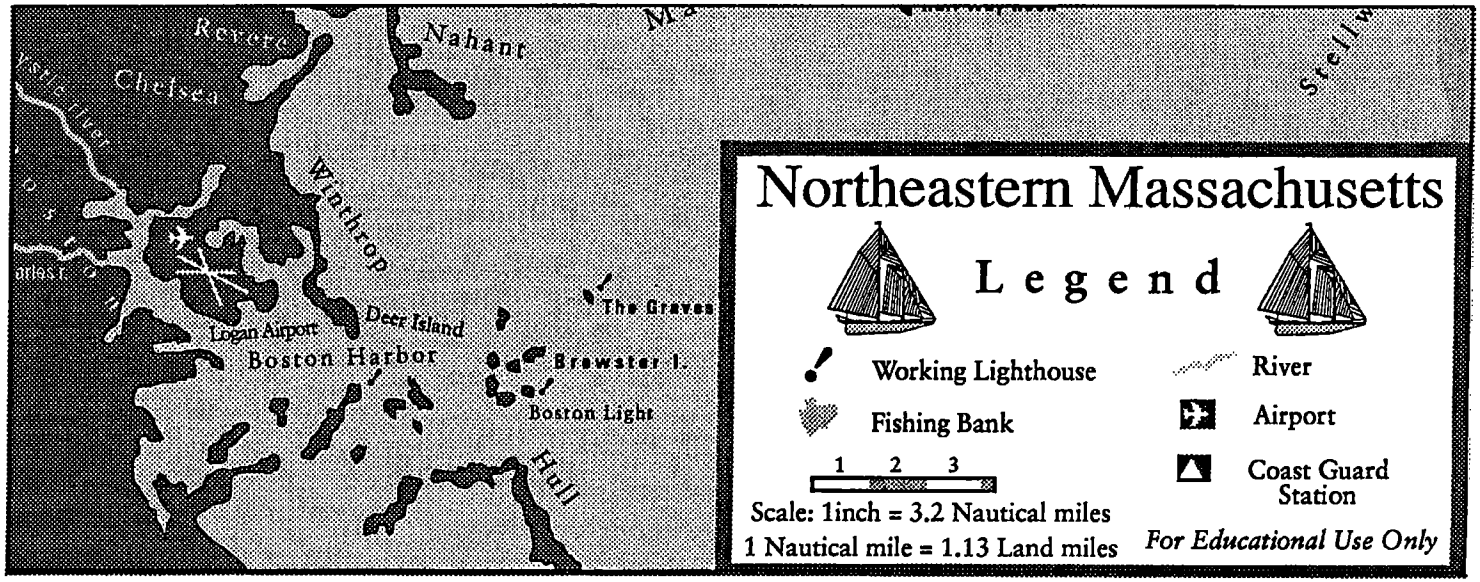
The Adventure traveled hundreds of miles in all kinds of weather conditions to reach the fishing **banks** off of Nova Scotia and Newfoundland, Canada. In order to safely reach their destination, the crew needed accurate **charts** to help them **navigate** from Gloucester to Canada. The charts for the North Atlantic Ocean showed how the **coastline and islands of Maine and Canada** would appear to a person sailing a ship. Charts also show the depth of water in the sea and other important **landmarks such as** lighthouses.

A person using a chart could recognize important features or landmarks as they were approached or passed. The chart features would assure travelers that they were on the correct course and would lessen chances of getting lost. As charts became more detailed, **symbols** were used to represent features such as lighthouses, hilltops and important cities. The symbols were simple drawings. Thus, a chain of mountains could be represented as triangles; lighthouses as circles with light rays; cities as stars. An area that translated the symbols for land and sea features placed on the chart is called a **legend.**

lighthouse built around 1800

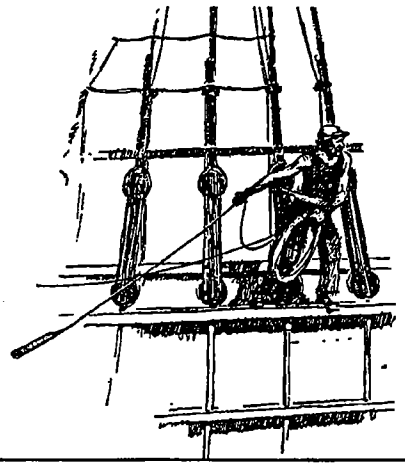
lighthouse symbol

Section of a chart for Massachusetts showing shape of coastline, landmarks, islands and a milage scale for the area around Boston Harbor. See page 47 for complete chart. North is towards the top of the chart, south towards the bottom.



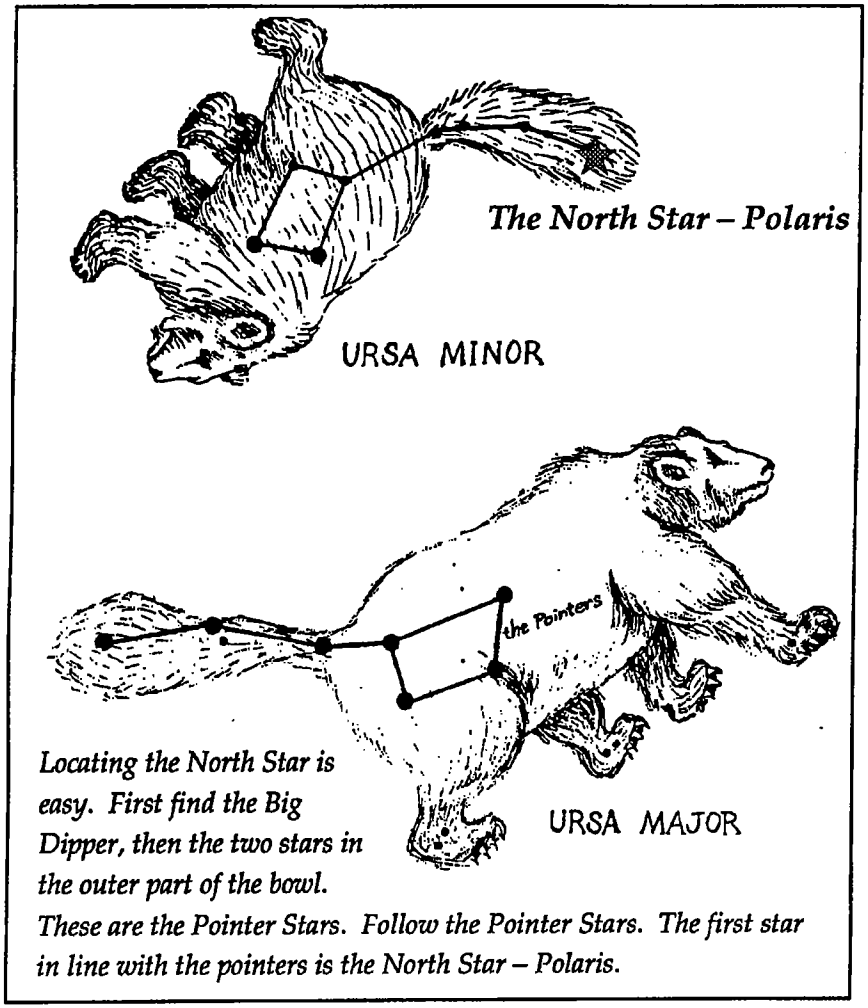
To assure safe passage at sea or to find the best fishing areas, water depths were measured at different locations and added to chart. Water depths are called **soundings** and were first made with a lead weight and a line dropped overboard. When the lead weight hit the sea bottom the line would be marked and then measured. Today, water depths are measured by a machine which uses sound waves called **sonar**. A deep area of water within a harbor is called a **channel**. Shallow fishing areas at sea are called **banks**. **Shoals, ledges** or **sandbars** are places where rocks or water depths might so shallow that a ship might become grounded or sunk from a punctured hull.

Direction is another important feature of a chart. Charts were drawn with the top of the chart pointing to the north direction. South is at the bottom of the page, east is to the right, and west is to the left. To properly use the map travelers turn or **orient** the map to their direction of travel. Thus if you were traveling South you would turn the chart upside down so it would represent the land or seascape as you would see it.



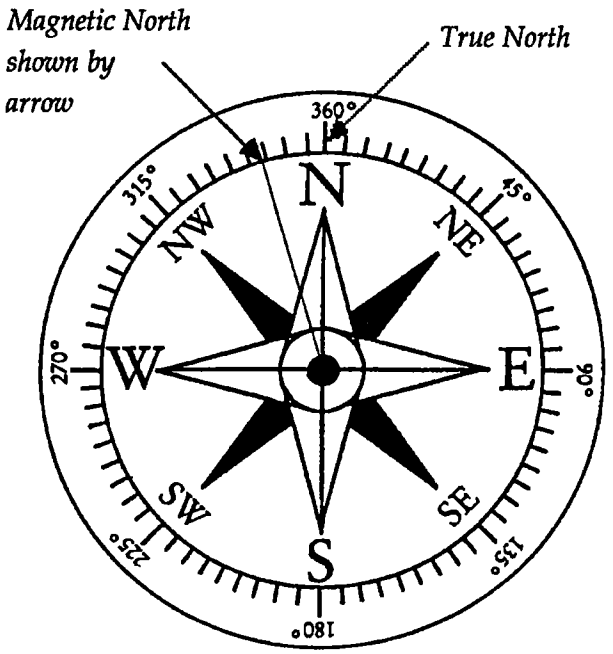
Heaving a lead line overboard to measure the depth of the water.

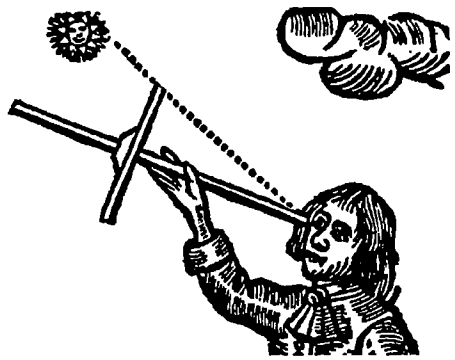
The directions of north, south, east and west are based on the sighting of the **North Star** which lies directly above the North pole of the Earth. The North Star is part of a grouping of stars called the Little Dipper or Little Bear constellation. This star is an important navigation aid to sailors. The direction of the North Star would become known as **true north.**



Locating the North Star is easy. First find the Big Dipper, then the two stars in the outer part of the bowl. These are the Pointer Stars. Follow the Pointer Stars. The first star in line with the pointers is the North Star – Polaris.

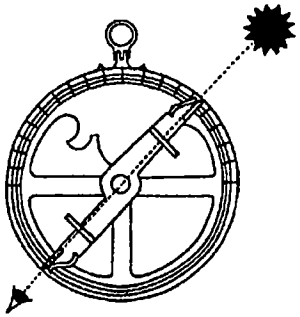
Another navigation aid is the **compass.** The invention of the compass allowed sailors to navigate the ocean in bad weather when the North Star could not be seen through the clouds. The Vikings used a primitive compass made of a magnetized needle inserted into something which would float. The needle was then placed into a bowl of water. The magnetized needle when floated in water would point in a northerly direction. The northerly direction that a magnetic compass points to is known as **magnetic north.** In New England, magnetic north lies about 16 degrees to the west of true north.



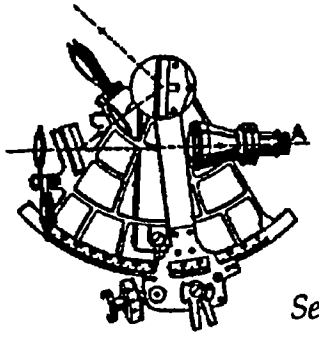


Cross-Staff

All dotted lines indicate path of light from the sun or a star to the navigator's eye.



Astrolabe



Sextant

A Cross-Staff, Astrolabe and a Sextant are navigational tools used to measure the height of the sun or a star above the horizon. From this reading a navigator could locate his postion on the earth or tell the time of day.

Fishermen aboard the *Adventure* often used a compass to help find the best fishing grounds and guide them safely back to Gloucester harbor. Other tools that help the navigator are **cross-staffs, astrolabes** and **sextants.**

Charts also have a **mileage scale** to show the distances between any two places. The mileage scale on charts converts chart inches to actual **nautical miles** in the real world. The nautical mile is longer than a mile measured on land. A nautical mile is equal to 6080 feet whereas a land mile equals 5280 feet. The chart of the north coast of Massachusetts in this section uses a scale that represents one inch on the chart to 3.2 nautical miles in the world

In the activity on the next page you will use the following aids to navigate a course from the Cape Ann to Boston and to the Stellwagen fishing bank in the Atlantic Ocean.

- Shape of the coastline and rivers
- Landmarks
- Compass Direction
- Water depths
- Mileage scale

Charting & Navigating

Activities & Discussion

1. On pages 47 and 48 are two charts representing the Massachusetts coastline: The first chart shows the land and sea from Salisbury to Boston Harbor and about 30 miles out into the ocean (Northeastern Massachusetts). The second chart is a detail of Gloucester Harbor. Your task as Captain of *Adventure* will be to navigate a course from:

A. Gloucester Harbor to Boston.
B. Gloucester to Stellwagen fishing bank.
C. Rockport or Ipswich to Boston or Stellwagen Bank

Note: If you are navigating from Gloucester you will need to use both charts. Begin with the chart for Gloucester to navigate out of the harbor. If you are leaving Rockport or Ipswich just use the chart for Northeastern Massachusetts.

2. As Captain you must record the following on your chart and log worksheet:

A. When navigating out of Gloucester Harbor, draw a course with a pencil on the chart so that you are always in water with a depth of at least 18-20 feet. This will assure that Adventure will not hit any rocks or ledges that are under the water. These places are named on the Gloucester Harbor chart.

B. List all changes in direction on your log worksheet using the compass on the chart. List the compass direction changes in sequence. Use either of 8 directions. North, Northeast, East, Southeast, South, Southwest, West, Northwest.

C. Record at least 5 landmarks on your log worksheet that you will pass for each trip.

D. Record the total distance traveled on your log by using a ruler and the mileage scale.

3. Examine the chart of Gloucester Harbor drawn by Champlain in 1606 with the current chart of the same area on page 48. Make a list of the features that are different and those that are the same. Discuss why there are differences. What caused these changes – nature or human actitivity?

4. Make your own maps of your room, neighborhood or a local beach or woods. Maps can be drawn to represent any size area.

5. Bring in charts or maps of places they would like to travel to and describe a course. Use maps of the USA or the world. List the roads you would take and important landmarks you would pass such as the Mississippi river or the Rocky Mountains.

6 Display a map of the World and place pins on the countries where your parents or grandparents came from.

7. Take a field trip to the following locations and draw a map of the coastline:

- Stage Fort Park, Gloucester – Looking East and South
- Eastern Point or Niles Beach, Gloucester – Looking West and SW
- Halibut State Park, Rockport – Looking Northwest

8. Bring in examples of different types of maps to discuss. Include: Weather maps, Road maps, Star maps, Street maps, Geological Survey maps, Treasure maps, Chromosome maps, an Atlas.

9. Research and write reports on the use of navigation tools such as the compass, sextant, astrolabe, nocturnal.

10. Find the geographic north pole and the magnetic north pole on a map. Hint: The magnetic north pole is located on the Queen Elizabeth Islands in Canada.

11. Making a simple compass

Materials: • petri dishes • needles • cork or styrofoam
• several strong magnets • silicone gel
• copies of the compass rose in next column

A. Divide the class into pairs. Each pair of students should have a petri dish, magnet, needle and a small piece of cork. Water should be accessible.

C. Have the students rub the needle over the magnet in one direction repeatedly.

D. Insert the needle through a small piece of cork and float it in a petri dish half filled with water.

E. To discover which end of the needle is north seeking, take the bar magnet and place it near the needle. The end that moves away from the magnet will be north.

F. Mark the north end of the needle with an indelible marker.

G. Glue the compass rose to the outside bottom of the petri dish so north on the rose is lined up the north end of the needle.

H. Line the outside edge of the top of your petri dish with a thin stream of silicone gel. Place the top gently over the bottom. Your compass is now ready for a navigation exercise.

I. Using your compass have one member of each pair follow this course.

Steer 340 degrees – 12 paces
Steer due West or 270 degrees – 5 paces
Steer 150 degrees – 1 pace

J. Make up courses for your partner to follow.

Compass Rose for Reproduction

Geography Worksheet

Destination: _____

Starting Location _____

Compass Direction sequence

1.
2.
3.
4.
5.
6.
7.
8.
9.

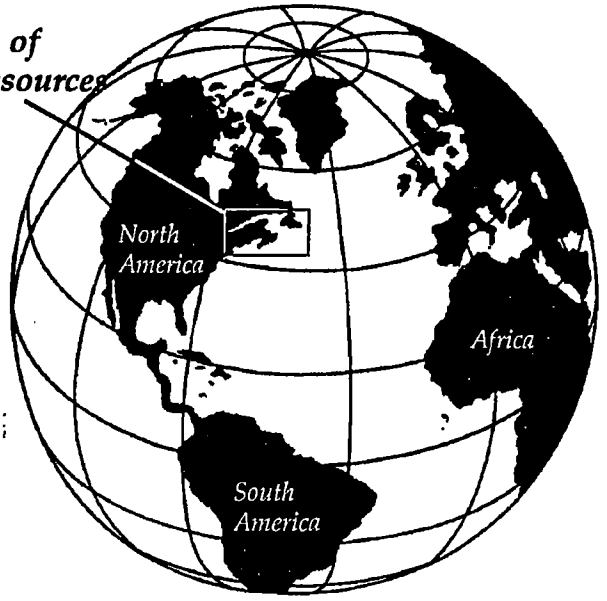
Landmarks

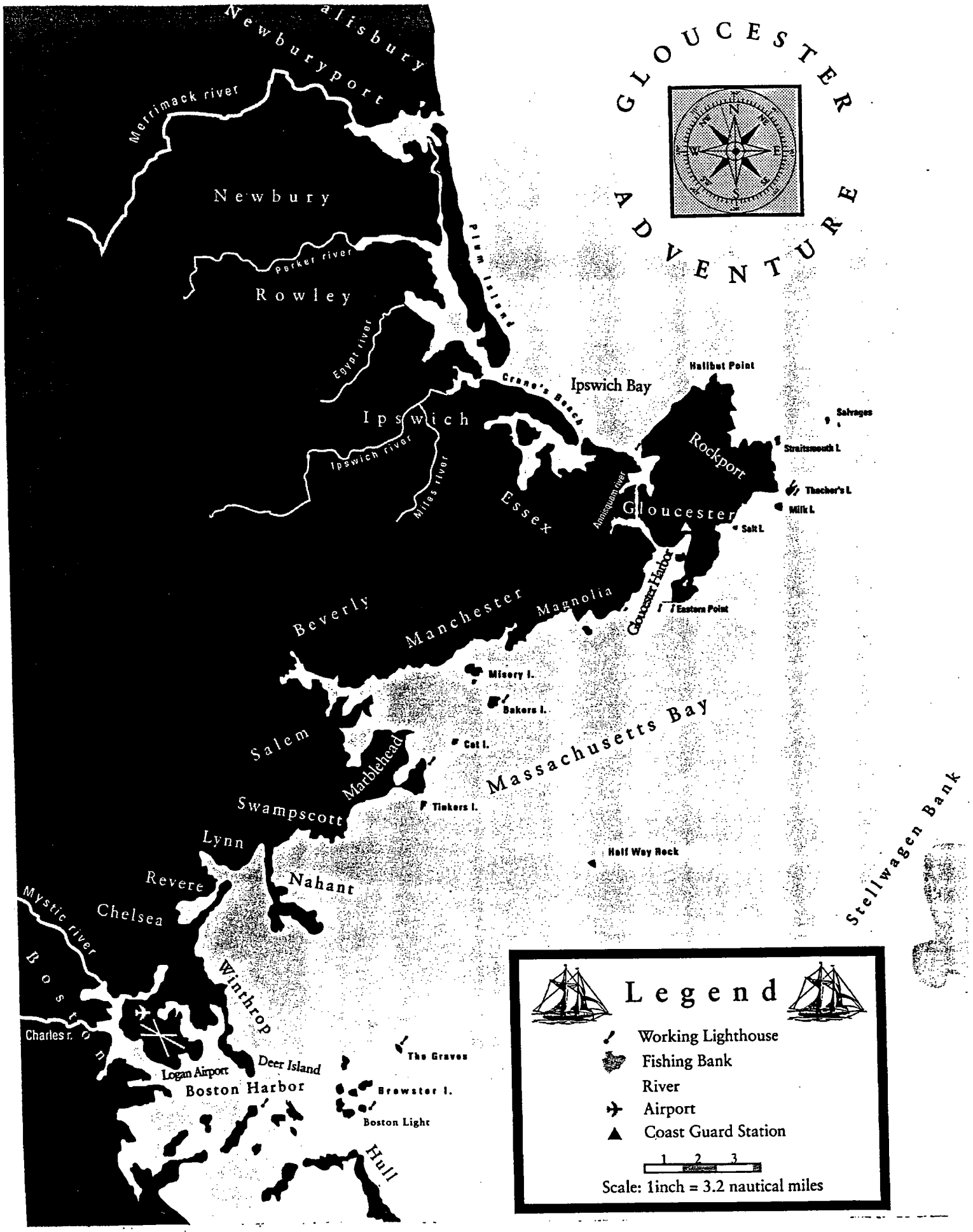
1.
2.
3.
4.
5.
6.
7.
8.
9.

Total mileage for trip: _____

Chart Index

Location of Chart Resources




GLOUCESTER ADVENTURE
Newburyport
Merrimack river
Newbury
Parker river
Rowley
Plum Island
Egypt river
Ipswich Bay
Halibut Point
Crane's Beach
Ipswich
Ipswich river
Miles river
Essex
Annisquam river
Rockport
Gloucester
Salvages
Straitsmouth I.
Thacher's I.
Milk I.
Salt I.
Gloucester Harbor
Eastern Point
Beverly
Manchester
Magnolia
Misery I.
Bakers I.
Cat I.
Massachusetts Bay
Salem
Marblehead
Swampscott
Tinkers I.
Lynn
Half Way Rock
Revere
Nahant
Stellwagen Bank
Mystic river
Chelsea
Winthrop
Boston
Charles r.
Logan Airport
Deer Island
Boston Harbor
The Graves
Brewster I.
Boston Light
Hull
Legend
Working Lighthouse
Fishing Bank
River
Airport
Coast Guard Station
1 2 3
Scale: 1inch = 3.2 nautical miles

Geography Worksheet 2

Destination: _____

Starting Location _____

Compass Direction sequence

1.
2.
3.
4.
5.
6.
7.
8.
9.

Landmarks

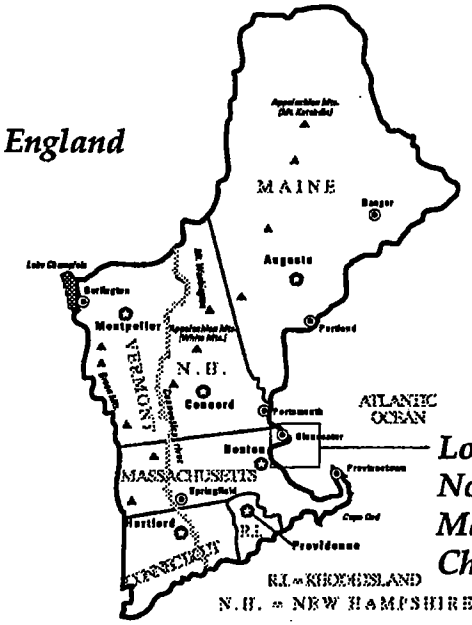
1.
2.
3.
4.
5.
6.
7.
8.
9.

Total mileage for trip: _____

New England

United States

New England



Location of Northeastern Massachusetts Chart