



## MARINE NAVIGATION LESSON PLAN

# Do You Need a Map?

### Theme

Marine Navigation

### Links to Overview Essays and Resources Needed for Student Research

<http://oceanservice.noaa.gov/topics/navops/marinenav/>

### Subject Area

Earth Science

### Grade Level

9-12

### Focus Question

How can people obtain accurate, real-time observations and forecasts on oceanographic and weather conditions in specific locations?

### Learning Objectives

- Students will understand and explain three ways in which marine navigation is important in modern society.
- Students will explain the importance of being able to access and retrieve real-time oceanographic and meteorologic data.
- Students will use the nowCOAST information retrieval tool to obtain real-time information on tides, winds, weather conditions, and weather forecasts in specific geographic areas.

### Materials Needed

- Computers with internet access; if students do not have access to the internet, please see “Learning Procedure” Step 1.
- Copies of “Introduction to nowCOAST Worksheet,” one copy for each student or student group

### Audio/Visual Materials Needed

- None

### Teaching Time

One or two 45-minute class periods, plus time to complete worksheet problems

### Seating Arrangement

Classroom style or groups of two to four students

### Maximum Number of Students

30

### Key Words

nowCOAST  
Marine navigation  
Nautical chart  
United States Coast Pilot®  
Weather  
Weather forecast  
Tides  
Tide prediction

### Background Information

“Man hoisted sail before he saddled a horse. He poled and paddled along rivers and navigated the open seas before he traveled on wheel along a road. Watercraft were the first of all vehicles.”

– Thor Heyerdahl, *“Early Man and the Ocean”* (Doubleday, 1979)

Coasts and seaports have been important throughout human history, and anyone who has been to sea understands the importance of accurate information about coastal geography and ocean conditions. Today, more than 98% of cargo shipped to and from the United States is transported by water. Effective tools for marine navigation are essential for safe and efficient marine transportation, offshore engineering projects, naval operations, and recreational activities such as fishing and boating. The navigational chart is one of the most fundamental tools available to the mariner, providing a graphic portrayal of the marine environment including general configuration of the sea bottom, water depths, currents, locations of dangers to navigation, and information about man-made aids to navigation (e.g, buoys, lighthouses, radar beacons, etc). The task of charting U.S. coastal waters began in 1807 when President Thomas Jefferson ordered the first survey of the coast of the

United States. The Office of Coast Survey (OCS) was charged with this task, and is now the oldest scientific organization in the U.S. Some of the nation's earliest nautical charts still exist in the OCS Historical Map & Chart Collection which contains over 20,000 documents that also include topographic and geodetic surveys, city plans and Civil War battle maps. Images of documents in the collection are free to the public via the Coast Survey Web site (visit <http://historicals.ncd.noaa.gov/historicals/histmap.asp> for an Image catalog and link to software for viewing downloaded maps).

In addition to traditional paper charts, OCS also produces nautical charts in electronic formats that can be used by computers and electronic navigation instruments (visit <http://chartmaker.ncd.noaa.gov/staff/charts.htm>). Because some information is difficult to include in a chart format, OCS produces the United States Coast Pilot®, a series of books that contain supplemental information such as channel descriptions, anchorages, bridge and cable clearances, currents, tide and water levels, weather, ice conditions, wharf descriptions, dangers, routes, traffic separation schemes, small-craft facilities, and Federal regulations applicable to navigation (visit <http://chartmaker.ncd.noaa.gov/nsd/coastpilot.htm> for more information or downloads).

Weather and sea conditions are a major concern to marine navigators, particularly since these conditions can vary significantly from place to place and can change dramatically in a short period of time. To meet the need for real-time information in specific locations, OCS has created nowCOAST, a map-based internet gateway to real-time observations and forecasts of marine weather and oceanographic conditions. In this lesson, students will learn how the nowCOAST tool can be used to retrieve various kinds of data for locations of interest.

### Learning Procedure

1.

To prepare for this lesson, visit the nowCOAST Web site (<http://nowcoast.noaa.gov>) and work through some of the exercises on the "Introduction to nowCOAST Worksheet" until you are familiar with the processes for locating various types of oceanographic and meteorological information.

Since nowCOAST is an internet-based tool, students must have some form of internet access to complete this worksheet. If students do not have classroom internet access, this worksheet may be done as a homework assignment using home, library, or other internet resources.

2.

Briefly review the historical and present-day importance of marine navigation. While the prevalence of air travel and advances in aerospace technology may cause some students to assume that the ability to safely navigate Earth's oceans is of diminishing importance, consideration of oceans' role in freight transportation, energy production, and recreation should alleviate this misconception. Highlight the importance of real-time information to safe navigation, and have students brainstorm the types of information that would be useful to a present-day mariner. Ask students where and how they could acquire this information. While there are many such sources, many people are unaware of how to access them. Tell students that their assignment is to use an internet gateway tool to obtain real-time answers to questions that are often asked by marine navigators.

3.

Provide a copy of the "Introduction to nowCOAST Worksheet" to each student or student group, and have students use the nowCOAST tool to answer questions on the worksheet.

4.

Lead a discussion of students' answers to worksheet questions. Because nowCOAST emphasizes real-time data, specific answers will vary depending upon the dates on which students complete the assignment. Students may need to use an atlas if they are unsure of the geographic locations of the sites referred to in the questions. In most cases, there are several ways to locate the data needed to answer the questions. The "Jump Bar" on top of the nowCOAST map is intended to be a "user friendly" interface for beginning users, while the "Map Layers" interface is likely to be familiar to those who have used geographic information systems (see, for example, the "Bottom Watching" lesson plan at [http://nos.noaa.gov/education/classroom/lessons/11\\_cmonitor\\_benthic.pdf](http://nos.noaa.gov/education/classroom/lessons/11_cmonitor_benthic.pdf))

### The Bridge Connection

<http://www.vims.edu/bridge/> – In the “Site Navigation” menu on the left, click on “Ocean Science Topics,” then “Human Activities,” then “Maritime Heritage” for links to resources about the historical development of marine navigation.

### The Me Connection

Have students write a brief essay describing how information retrieved using nowCOAST could personally benefit themselves or someone who is not a marine navigator.

### Extensions

Have students use NOAA’s On-Line Chart Viewer (<http://www.nauticalcharts.gov/viewer/#OnLine>) to examine the nautical charts for an assigned area of the U.S. coast, and develop a written plan for a “cruise” between two designated locations, including important features (landmarks, hazards, etc) noted from the chart(s). Have students use nowCOAST to obtain relevant oceanographic and meteorological information for their cruise.

### Resources

Heyerdahl, T. 1979. *Early Man and the Ocean: A Search for the Beginnings of Navigation and Seaborne Civilizations*. Doubleday. New York. 438 pp.

<http://historicals.ncd.noaa.gov/historicals/histmap.asp> – OCS Historical Map & Chart Collection which contains over 20,000 documents that also include topographic and geodetic surveys, city plans and Civil War battle maps.

<http://chartmaker.ncd.noaa.gov/insd/coastpilot.htm> – Description and links for downloading the United States Coast Pilot®

<http://chartmaker.ncd.noaa.gov/staff/charts.htm> – Information and links for nautical charts

<http://www.ruf.rice.edu/~feegil/index.html> – Links and resources about 15th century navigation from Rice University

<http://www.usm.maine.edu/maps/lessons/nrindex.htm> – “Charting Neptune’s Realm: From Classical Mythology to Satellite Imagery,” a series of lesson plans from the Osher Map Library and Smith Center for Cartographic Education at the University of Southern Maine, Portland

### National Science Education Standards

#### Content Standard B: Physical Science

- Motions and forces
- Interactions of energy and matter

#### Content Standard D: Earth and Space Science

- Energy in the Earth system

#### Content Standard E: Science and Technology

- Abilities of technological design

#### Content Standard F: Science in Personal and Social Perspectives

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

### Links to AAAS "Oceans Map" (aka benchmarks)

5D/H2 – Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change when climate changes or when one or more new species appear as a result of migration or local evolution.

5D/H3 – Human beings are part of the Earth's ecosystems. Human activities can, deliberately or inadvertently, alter the equilibrium in ecosystems.



## MARINE NAVIGATION WORKSHEET

### Introduction to nowCOAST

nowCOAST is a map-based gateway to real-time observations and forecasts of marine weather and oceanographic conditions. Using nowCOAST, you can quickly link to information about specific locations from many different sources. This exercise introduces the nowCOAST tool and provides some examples of how it can be used to retrieve various kinds of data for locations of interest.

1. Link to the nowCOAST Web site at <http://nowcoast.noaa.gov/>. This opens the “Map Viewer,” which is one of the two main components of nowCOAST. You should see a map of the continental U.S. with an introductory message containing basic instructions superimposed on the map. To get started, disable popup blockers for the nowCOAST Web site (if you aren’t sure how to do this, click on “More Information” in the upper right corner of the nowCOAST window, then click on “Help/Frequently Asked Questions”, and then select “Turning Off Popup Blockers” from the list on the left side of the screen).

Now hide the introductory window by clicking “Instructions On/Off” in the upper right corner of the nowCOAST window.

## 2.

The map of the continental U.S. will probably have some colored areas, and may also have some light gray areas. The colored areas represent “Weather Radar Mosaic” data. A radar is an instrument that transmits a pulse of electrical energy in a particular direction and then measures the amount of energy that is returned to the transmitter location. The intensity of the returned energy is called “reflectivity,” and is related to the distance and composition of objects that reflect the transmitted energy pulse. The Weather Radar Mosaic shows combined information from many pulses transmitted at various angles, and provides an indication of precipitation, storms, and other atmospheric features.

The gray areas on the map represent visible images obtained from geostationary operational environmental satellites (GOES) that sense radiant energy and reflected solar energy from the Earth’s surface and atmosphere. The images show the location of clouds and storms, and also can be used to estimate temperature at various points in the atmosphere (for more information about GOES, visit <http://www.oso.noaa.gov/goes/index.htm>).

## 3.

Notice the two boxes at the right and bottom of the map. The “Map Layers” box on the right contains a catalog of the various kinds of data that can be accessed through nowCOAST. Using the square boxes, you can control which data set locations are displayed on the map. Notice that the boxes next to “Weather Radar Mosaic” and “GOES Visible Image” contain check marks. This means that these data are visible. If you click on one or both of these boxes, the check mark will disappear, the map will be redrawn, and the data will no longer be visible.

The “Map Tools” box at the bottom of the page can be used to manipulate the map display and select data in locations of interest. Let’s suppose that you are interested in oceanographic data near the island of Puerto Rico. Click on the “Zoom In” tool at the bottom left, then place your cursor near Puerto Rico



and click once. The map will redraw, zoomed in toward Puerto Rico. Notice that the scale bar near the bottom left of the map reads about 515 mi. Zoom in again so the scale is about 256 mi. If your cursor wasn't close enough to Puerto Rico, you can use the "Pan" tool to move the map around, or use the "Zoom Out" tool to go back and try again.

Now let's find what oceanographic data are available for this area. In the "Map Layers Box," scroll down to "Geo-Referenced Links:" and click in the square box next to "Oceanographic" under the heading "Observations – In-Situ Stations." The map should redraw, with little blue triangles scattered around the coast. Notice that the round box next to "Oceanographic" now contains a black dot. This means that the Oceanographic Stations boxes are now the "Active Layer," which means that you can use the "Link to Data" map tool to click on one of these triangles to link directly to a Web page containing data for that location.

Select the "Link to Data" map tool and click on the triangle near the southwest coast of Puerto Rico. A new window should open titled "9759110 Magueyes Island, PR" that contains graphs of water level, winds, barometric pressure, and air/water temperature. Below these graphs is a link to a table containing the numeric data for these parameters. You are now in the "Data Browser," which is the other main component of nowCOAST. As you link to different data sources from the Map Viewer, the Data Browser keeps track of what you've seen so that you can browse backward and forward through the various pages of data.

#### 4.

The "Jump Bar" at the top of the nowCOAST map page provides an alternative way to locate data. Using the same Puerto Rico example:

- a. Open a new nowCOAST page (repeat Step 1), turn the instructions off, and uncheck the square boxes next to "Weather Radar Mosaic" and "GOES Visible Image."
- b. From the pull-down menu under "1) Location" select "Southeast" under "---Coastal Regions ---" (this is closest to Puerto Rico)
- c. From the pull-down menu under "2) Information" find the heading "GEO-REFERENCED LINKS", and select "-

- Oceanographic” under “Observations - In-Situ Stations:”
- d. From the pull-down menu under “3) Variable,” select “Sea Surface Temp.”
  - e. Since there is only one choice (“Real Time”) under “4) Time” click on the “GO” button next to “5).”

You should now have a zoomed in map of the southeastern U.S. coast with lots of yellow dots that correspond to stations that collect data on sea surface temperature. You should also see some blue triangles in locations of in-situ oceanographic observation stations. If you scroll down the “Map Layers” box, you’ll see that the boxes next to “Oceanographic” under “Observations - In-Situ Stations” are selected, making these stations visible and active.

Use the “Pan” tool to move the map to make Puerto Rico visible. Click on the triangle near the southwest coast of Puerto Rico with the “Link to Data” tool to link to the Web page containing data for this location. Again, you should see the window titled “9759110 Magueyes Island, PR.”

#### 5.

Suppose that you are about to deliver a 55 ft-long power yacht from Puerto Rico to Bar Harbor, Maine, and want to know about weather conditions along the way. The big decision is whether to take an offshore route (which is most direct), or go via the Intracoastal Waterway (which is more protected). To check out the conditions and forecasts for the offshore option, use the “Zoom Out” and “Pan” tools to make the coast of eastern North America visible (the scale should be about 926 mi). Scroll down the “Map Layers” box and click in the square and round boxes next to “High Seas” (under “Surface Forecasts:”) to make this visible and active. Now you should see two polygons extending from the east coast of North America to about half-way across the Atlantic Ocean (alternatively, you could simply select “- High Seas” under “Surface Forecasts” in the “2) Information” pull-down menu and click “GO” to display the two polygons).

If you click inside the lower polygon with the “Link to Data” tool, a window will open containing the High Seas Forecast for the portion of the Atlantic Ocean west of longitude 35°W

between latitude 7°N and 31°N, including the Caribbean Sea and the Gulf of Mexico. Clicking inside the upper polygon with the “Link to Data” tool will open a window that contains the High Seas Forecast for the portion of the Atlantic Ocean west of longitude 35°W between latitude 31°N and 67°N. Considering the 48-hour forecast high seas forecasts, would you recommend an offshore route or the Intracoastal Waterway?

6.

Use nowCOAST to find:

- a. The maximum winds forecast for the next 48 hours at a location approximately 150 miles east of Washington DC [HINT: Try the “Forecast Model Guidance: Meteorological” layer. Abbreviations are: DT = Date; HR = Time (24-hour clock); TMP = Temperature (°F); WD = Wind Direction (tens of degrees); WS = Wind Speed (knots); WS10 = Wind Speed at a height of 30 meters.]
- b. The maximum significant wave height forecast for the next 48 hours at approximately the same location as (a) [HINT: Try the “Forecast Model Guidance: Oceanographic” layer.]
- c. The highest water level predicted during the next week at station 8761720, Grand Isle, LA. [HINTS: Make the “Station ID” layer visible and zoom in so you can read the numbers. Use “Astronomical Tidal” predictions. Data are given in meters above mean lower low water (MLLW)]
- d. The five-day weather forecast for Curry County, OR. [HINT: Be sure the “Coastal Labels” layer (under “Map Background”) is visible, then zoom in until the county labels are visible; Curry County is the southernmost county on the Oregon coast.]
- e. The coastal waters forecast for San Diego, CA
- f. The offshore waters forecast for California waters from 60 nautical miles to 250 nautical miles offshore (Point Conception to Guadalupe Island).

- g. Most recent water temperature measured at NOMAD buoy (station 41002) located 250 nautical miles east of Charleston, SC.
  
- h. The particulate matter concentration at the webcam located at Point Reyes National Seashore (near San Francisco, CA). [HINT: The station ID for this camera is PNTRE-CAM]