3-D Bathymetric Chart Activity: An introduction to the Nautical Chart

Developed by the Channel Islands National Marine Sanctuary

Overview: A **nautical chart** is the type of map used by mariners and other people interested in navigating bodies of water. Just as you might use a road map when planning a trip over land in a car, you can use a nautical chart when planning a trip over sea in a boat. Nautical charts are different from other kinds of maps in that they primarily describe geological features that are for the most part underwater and impossible for us to see in their entirety. Information on points of interest to the maritime navigator that can be found on a nautical chart include:

- natural features;
- the depth and nature of the seabed;
- tides and currents;
- rocks, wrecks, and obstructions that could potentially pose a danger;
- ports;
- cultural features such as tunnels, airports, and bridges.

The development of 3-D **bathymetric** charts provides a clearer visual picture of what the relatively abstract lines and numbers on a traditional nautical chart truly represent.

Main Concept: 3-D bathymetric charts significantly aid us in our efforts to visualize the bathymetry of the ocean floor more accurately.

Objectives:

Students will:

- be able to identify and interpret key components of a nautical chart.
- be able to locate specific features on a nautical chart and compare the representation of those features to the 3-D bathymetric chart when given information on latitude and longitude.

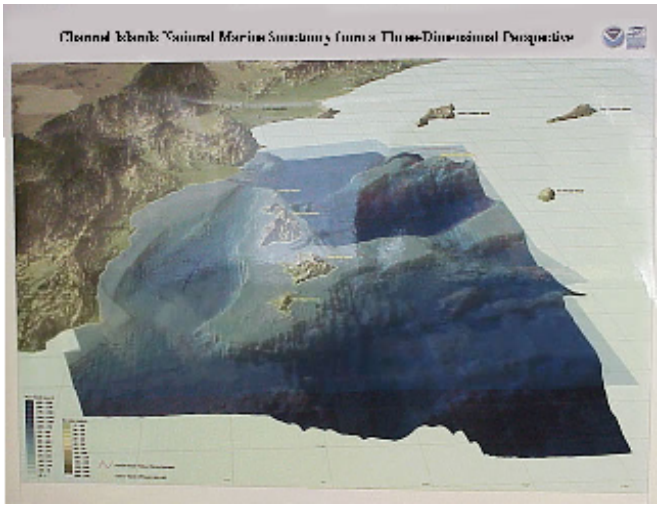
Materials:

Necessary

1. Nautical Chart #18720
2. 3-D Bathymeteric Chart
3. 11 X 17 chart copies enough for each student

Optional

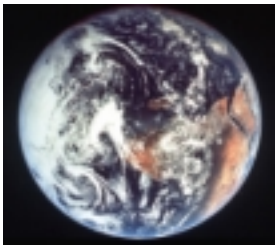
1. Parallel rulers
2. Compass
3. Other maps



Preparation time: 10 minutes

Lesson time: One to two class periods

Latitude and Longitude



Background: In common with virtually all other maps, nautical charts have lines of **longitude** (also called **meridian**s) and **latitude** (also called **parallel**s) expressed on them. Together these sets of lines create an imaginary grid that can be used to locate any point on earth.

The meridians of longitude run from north to south on a globe from pole to pole and are measured in degrees. Each degree is divided into 60 parts called minutes. Each minute is divided into 60 seconds of longitude. If you were to cut along the meridians of an orange you would be cutting wedges. 0 degrees longitude is called the **prime meridian** and is the longitude line that runs through Greenwich, England. The rest of the meridians run 180 degrees to the east and 180 degrees to the west of the prime meridian. For example, New York City has a longitude of 74 degrees west, which means, if you headed west from Greenwich you would reach the same longitude as New York once you had come to your 74th line of longitude.

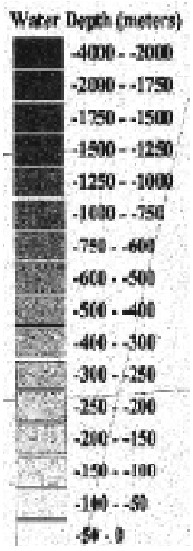
The latitude lines, or parallels, run around a globe from east to west. They are also measured in degrees, which in turn are divided into minutes, which in turn are divided into seconds. The parallel that lies at 0 degrees of latitude is also called the **equator**. The rest of the parallels run 90 degrees north of or 90 degrees south of the equator. If you were to cut along the parallels of an orange you would be cutting disks. To differentiate between the two you can remember that the lines that run parallel to one another are called parallels or lines of latitude.

Information on latitude and longitude is typically written something like this: 42° 57'N 94° 45'W. The latitude comes first (42° 57'N) and in this particular case lies 42 degrees and 57 minutes north of the equator. The longitude comes second (94° 45'W) and in this case lies 94 degrees and 45 minutes west of the prime meridian.

Procedure:

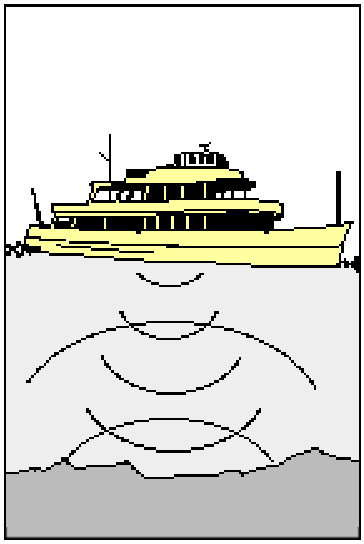
- After providing the students with a general overview of longitude and latitude ask the students to take out their nautical charts.
- After giving them some time to get oriented to their charts ask the students to find the lines of latitude and longitude.
- Ask the students to find what natural feature is found at 34°N 120° 15 W.
- Ask the students to find another feature of this type along the mainland coast and provide information on latitude and longitude.

Depth



Background: Information on depth is extremely important to the maritime navigator and is represented on a nautical chart in the form of numbers. Without access to this information it is increasingly likely that ships would run aground on shallow rocks and reefs or hit other submerged obstructions.

As well as finding depth on a nautical chart many ships and boats also find depth by carrying a depth sounder on board. A depth sounder is a device that determines the distance between a boat and the sea floor by sending a sound into the water and counting the length of time it takes for the sound to return. Imagine standing outside in front of a wall at night with a tennis ball in your hand, because it is dark you can't see the wall and



don't know how far you are from it. By throwing the tennis ball you can get an idea of how far you are from the wall by the amount of time it takes for the ball to bounce back. The closer you are to the wall the faster the ball will return, the further you are from the wall the longer it will take for the ball to bounce back. A depth sounder works in almost exactly the same way except that instead of sending a tennis ball through air to bounce off a wall a depth sounder sends a sound through water to bounce off the sea floor. Because sound bounces off of hard surfaces (like a ball does) the depth sounder can find depth by measuring the amount of time it takes for a sound to return back to the boat.

Before depth sounders were invented sailors determined depth by dropping a rope with a lead weight attached to one end into the water and measuring the length of rope needed for the lead weight to hit bottom. Early sailors measured depth in **fathom**s, which is the unit of measurement we often use to measure it today. In fact the fathom originates from those early sailors who would measure the length of rope they had dropped into the water by holding a section of the rope in each hand while extending their arms to either side. The distance between the average sized sailor's two hands when his arms were extended was considered one fathom. This distance which is equivalent to approximately 6 feet or 1.8 meters continues to be the length we call a fathom.

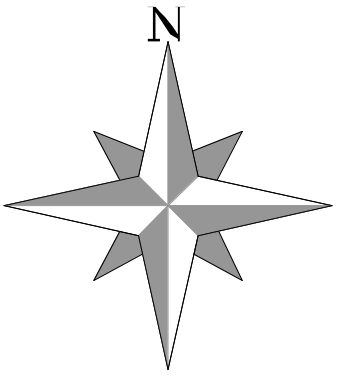
The way in which we measure depth is not the only thing that has changed over time. The depths of the oceans themselves not only change daily with tides, but fluctuate over years and thousands of years as well. For example some scientists believe that about 17,000 to 18,000 years ago the sea level was approximately 300 ft. lower than it is today. As a result of this scientists also believe that during this time San Miguel, Santa Rosa, Santa Cruz, and Anacapa Island were all joined together in one landmass which is referred to as Santarosae Island.

Another example of a way in which some scientists believe that sea levels might be changed is by the greenhouse effect. The greenhouse effect is a theory that suggests various pollutants (like car emissions), when released in large quantities, effect our planet's atmosphere in such a way as to cause the climate to rise. Some people believe that if global warming happens or is happening one of the consequences will be that as temperatures rise polar icecaps will melt and increase the level of the oceans not unsubstantially.

Procedure:

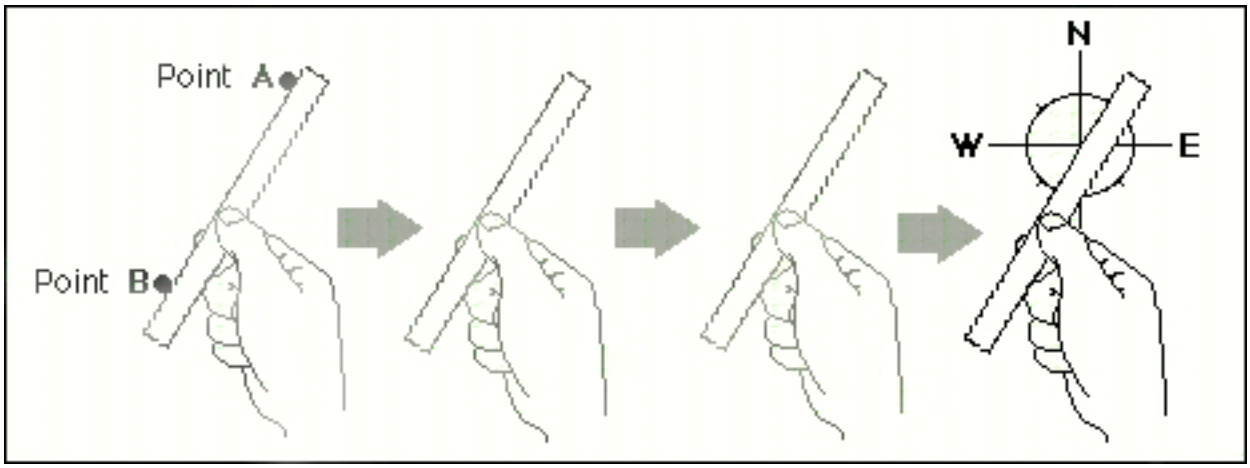
- Ask the students to find a well known reef that lies at 33° 58 N 119° 29 W
- Ask the students to find it's depth is in fathoms, meters, and feet
- Scientists believe that during the ice age the sea level was about 300 ft. lower than it is today. Ask the students to find out how that converts to fathoms and how that might have affected the appearance of the Channel Islands and the mainland.
- Discuss Santarosae Island theory

Compass Rose



Background: A compass rose is a symbol on nautical charts that consists of two or three concentric circles a couple of inches in diameter. Each circle is marked in degrees. The degrees correspond to what is called a compass **heading**. For Example: O°/360° corresponds to North, 90° corresponds to East, 180° corresponds to South, and 270° corresponds to West. All vessels and almost all objects move in more than just the four directions of North, South, East, and West. It is for this reason that the compass rose is divided into 360°. The outer circle on a compass rose is aligned with 0° at true north and is usually subdivided in intervals of one degree. The next circle has 0° aligned with local **magnetic north** and is also subdivided — but usually in a different interval. On the smaller chart used in this activity the compass rose consists of only one circle and is aligned with magnetic north.

The purpose of the compass rose is to give a person a sense of direction when looking at an area on a map that they are interested in. The compass rose is most often used in determining the direction needed to travel to get from one point to another. This is also called finding your heading. Finding your heading is actually quite easy if the center of the compass rose lies directly on the line between your departure point and your arrival point (Example: The third activity under the compass rose procedure) most often though this is not the case. To find a heading when the compass rose does *not* lie directly on the line between where you are and where you want to go many navigators use parallel rulers. In the absence of parallel rulers one can find a heading by aligning your strait-edge so that it passes through your departure and arrival points and then sliding your strait-edge to the compass rose as illustrated in the picture below. Be careful not to let the angle of the strait-edge change as you slide it.



Procedure:
Ask the Students:

- To locate the compass rose on their Nautical charts
- To determine if the Channel Islands run north-south or east-west
- To align their rulers so they pass through Loon Point (near Summerland on the mainland) with the center of the compass rose (indicated by a small cross in the center of the circle) and the 165° marker on the compass rose.

- What is their heading from Loon Point.
- If you traveled in this direction from Loon Point would you hit land? If so where?
- If you were to turn around and head back what would your compass heading be to reach Loon Point

Navigation

Procedure:

Ask the Students:

- to find the oil rigs Heritage and Gail given their latitude and longitude of 34° 21'N 120° 17'W and 34° 08'N 119° 24'W respectively. (Hint: oil rigs are represented by a small black square)
- to locate the Channel Islands National Marine **Sanctuary** Boundary (Hint: 6 **Nautical Mile**s off of the four northern Islands and Santa Barbara Island)
- if there are any oil rigs within the sanctuary boundary
- to find the approximate latitude and longitude of the East Santa Barbara Channel Weather Buoy
- to find either Santa Barbara or Ventura on their charts and then plot a course to Prisoners Harbor on Santa Cruz Island.

The following activity's purpose is to give each student a chance to create directions which other students will then follow as well as a chance for each student to follow the directions someone else has made.

- Organize students into even numbered groups or pairs.
- Split each group or pair into two teams.
- Ask each team or student to identify a place of departure from the mainland and two destinations on or around the Channel Islands.
- Then ask the students to translate those locations into latitude, longitude, and a heading for their partner or group to follow.
- After students have written directions they can try following the directions that their partner or the other half of their group have created for them.

Key Words:

Bathymetry (Bathymetric): the science of measuring the depths of the oceans, seas, etc. or the topographic maps of the sea floor that result from such measurements
Depth contour: a line on a nautical chart connecting points of equal depth
Equator: 0… latitude; an imaginary line running east and west around the center of the earth.
Fathom: A fathom is a unit of length often used to measure depth of water and is equivalent to 6 feet or 1.8 meters.
Heading: The direction in which a vessel is pointed at any given moment
Latitude: Geographic distance north or south of the equator, measured in degrees, minutes, and seconds
Longitude: Geographic distance east or west of the Prime Meridian, which runs through Greenwich, England
Magnetic North: The direction a compass needle points when there are no local interfering influences

Meridian: lines of longitude
Nautical Chart: the type of chart used to navigate bodies of water
Nautical mile: A nautical mile is 1.15 statute miles (units used on land)
Parallel: lines of latitude
Prime Meridian: 0… longitude; runs through Greenwich, England; longitude is measured east or west of this meridian
Sanctuary: an area with special biological and/or cultural resources designated for protection management
Sea mount: an underwater mountain
Submarine canyon: an underwater canyon

Unit Conversion Information		
fathoms	**=**	**6 feet**
fathoms	**=**	**1.828 meters**

Additional Internet Resources:

Historic Charts: http://anchor.ncd.noaa.gov/\states/ca.htm (California Charts)
http://anchor.ncd.noaa.gov/states.htm (all nautical charts)
Glossary of Maritime Terms: http://www.sea-man.com/terms.html
History of Navigation: http://www.ruf.rice.edu/~feegi/
Channel Islands National Marine Sanctuary:
http://www.cinms.nos.noaa.gov
National Oceanic and Atmospheric Administration (NOAA):

Correlation of Activity to 6th grade science content Standards:

Investigation and Experimentation:
7. Scientific progress is made by asking meaningful questions and conducting careful investigations.
f. read a topographic map (in this case a bathymetric map) and a geologic map for evidence provided on the maps
h. identify changes in natural phenomena over time without manipulating the phenomena (i.e. ancient shorelines, submarine canyons etc.)

The following were incorporated: