Grade Level: 6-8
Time Estimate: 1-3 days

INTRO TO CARTOGRAPHY / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, examples, and activities to help students learn and understand the science of mapping, also known as cartography. Students will collect real data from the OCEARCH Global Shark Tracker™ and implement basic mapping practices to create a map showing the migration patterns of sharks.

Part 1. Introduction
Part 2. Parts of a Map
Part 3. Types of Maps
Part 4. How Does OCEARCH Use Maps?
Part 5. Review
Activity 1. Mapping Skills

Goals & Objectives

The students will:

- Identify the five basic elements of a map;
- Collect data and construct maps using key features; title, compass, legend, symbols, scale, grid system, etc.;
- Use a gridline system to locate items on a map;
- Use a map to calculate the distance between two points;

// STANDARDS

This lesson aligns with the following TEKS:

6th Grade Science: 1B, 2A, 2B, 2C, 2D, 2E, 3A, 3D, 4A
7th Grade Science: 1B, 2A, 2B, 2C, 2D, 2E, 3A, 3D, 4A
8th Grade Science: 1B, 2A, 2B, 2C, 2D, 2E, 3A, 3D, 4A

This lesson aligns with the following Next Generation Science Standards:

Framework

1. Asking questions and defining problems
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Obtaining, evaluating, and communicating information

MS. Interdependent Relationships in Ecosystems – MS-LS2-2;

Science and Engineering Practices
Constructing Explanations and Designing Solutions

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)

Crosscutting Concepts
Patterns

- Patterns can be used to identify cause and effect relationships. (MS-LS2-2)

Helpful Tips

1) The content in this lesson is based on the conservation work of OCEARCH™ and the Global Shark Tracker™. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker™ is also available as an app for iPhone and Android.
2) This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3) Vocabulary words will be underlined as they first appear in the lesson plan. A complete list of vocabulary words is included as well.
4) Answers to questions and prompts for discussions will appear in *italics*.
5) Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6) Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
7) Email all questions about this lesson to info@OCEARCH.org.

Vocabulary

Cardinal Directions – The directions of north, south, east, and west.
Cartographer – A person who makes maps.
Cartography – The study and practice of making maps.
Climate – The long term description of weather conditions, including temperature and precipitation.
Compass Rose – A printed symbol used to find direction on a map.
Coordinates – A set of numbers or letters located on a grid.
Elevation – Height above the earth's surface.
Geographic Coordinate System – A coordinate system covering the entire globe, typically uses latitude and longitude.
Grid System – A system of imaginary lines (known as latitude and longitude) used to find the location of any place on the surface of the earth.
Hadley circulation – Hot air rises at the equator and moves north and south toward the poles. As the warm air from the equator moves toward the poles, it loses heat and then sinks. The warm, sunken air then circulates back to the equator where the cycle repeats. Key (or Map Legend) – A list of words or phrases that explain the meanings of symbols used on a map.
Intercardinal Directions – The directions of northeast, southeast, southwest, and northwest.
Latitude – Gridlines that run in an east-west direction in the geographic coordinate system.
Longitude – Gridlines that run in a north-south direction in the geographic coordinate system.
Map – A drawing or a picture of selected features of an area.
Natural Resources – Material or substance that occurs naturally in the environment. For example, minerals, water, and trees.
Scale – A line on a map or chart that shows a specific unit of measure (such as an inch) used to represent a larger unit (such as a mile). Helps the map reader determine distance.
Symbol – A drawing or sign that represents an object or a place.
Topography – The study of surface shape and features of the earth.
Weather – The short term description of the air, including temperature, precipitation, humidity, wind, and pressure.

Grade Level: 6-8
Time Estimate: 5-15 mins

INTRO TO CARTOGRAPHY / PRE-LESSON ASSESSMENT

Use the following true/false, fill in the blank, and multiple choice questions as an introduction/warm-up to the lesson topics. You can do this in a verbal or written format, as a game, individually, in groups, or as a whole class! A handout is provided if you wish to hand the questions out in a quiz format.

The questions do not need to be graded. They are intended to give the students an idea of what they will be learning and to see what they already know.

1) True or False A key (or legend) is used to explain the meaning of symbols on a map.

Answer: *True*

2) True or False Which type of map depicts physical features on the ocean floor?

a. physical map
b. topography map
c. bathymetry map
d. climate map

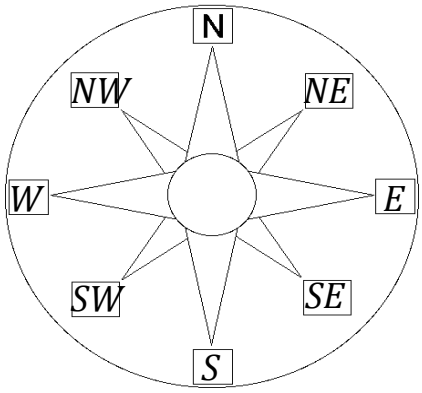
Answer: *c*

3) True or False Which feature do you use to measure the distance between two objects or places?

a. Scale b. Legend c. Compass d. Grid

Answer: *a*

4) Fill in the missing directions:



5) True or False Latitude is an imaginary set of lines that run north and south.

Answer: *False*

6) True or False Lines that run east and west are called longitude.

Answer: *False*

Name: _____ Date: _____

Introduction to Cartography

Select the correct answer(s) to each of the following questions.

1) True or False A key (or legend) is used to explain the meaning of symbols on a map.

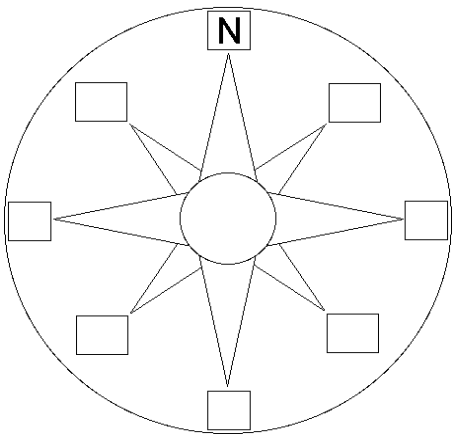
2) Which type of map depicts physical features on the ocean floor?

a. physical map
b. topography map
c. bathymetry map
d. climate map

3) Which feature do you use to measure the distance between two places?

a. Scale b. Legend c. Compass d. Grid

4) Fill in the missing directions:



5) True or False Latitude is an imaginary set of lines that run north to south.

6) True or False Lines that run east to west are called longitude.

Grade Level: 6-8

INTRO TO CARTOGRAPHY / LESSON PLAN

Part 1. Introduction (5-15 minutes)

Cartography is the study and practice of making maps. A cartographer is someone who makes the maps. A map is a flat drawing or a picture of selected features of an area. Whether travelling around your hometown or across the globe, maps are crucial for navigation!

The OCEARCH crew uses many different types of maps every day to navigate the ocean, locate sharks to tag, and track the migrations of sharks they have already tagged (Figure 1). Without maps, OCEARCH would not be able to study sharks the way that they do!

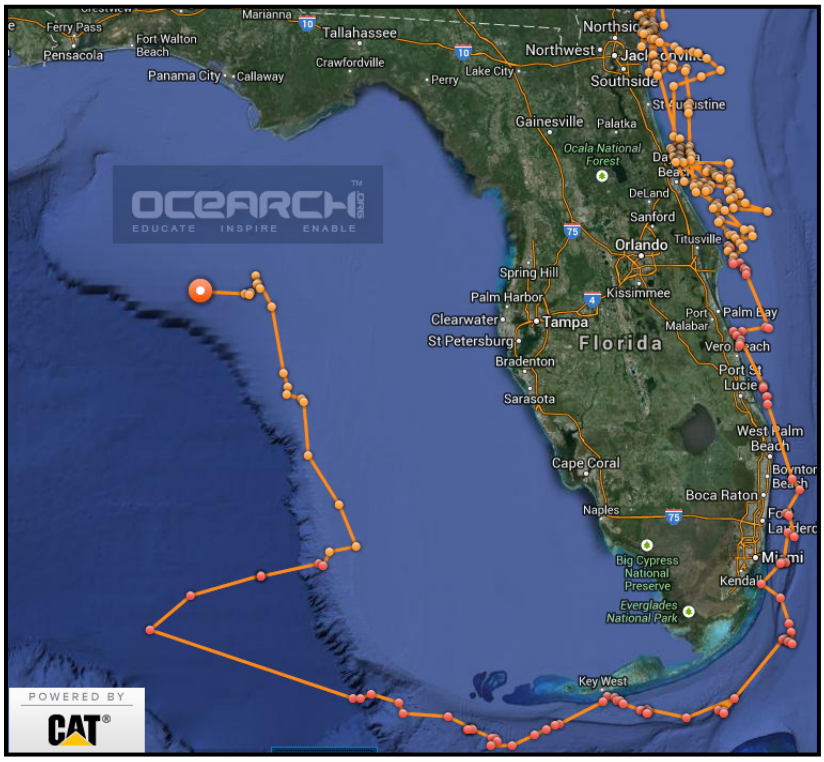


Figure 1. Map showing the migration pattern of Katharine, a great white shark.

There are many different types of maps, each with its own purpose. Climate maps show information about temperature and precipitation. Physical maps show Earth's physical features such as mountains, rivers, and lakes. Road maps show streets, highways, towns, and cities. Topographic maps that show the elevation of an area. Political maps show boundaries of cities, states, and countries.

Maps also come in many different forms. A globe is a spherical model of Earth and is most helpful in locating countries, large physical features such as oceans and mountain ranges, and in understanding where one place is located relative to another. Paper maps are more versatile and can show more details about a place than a globe. A paper map can show you the whole world or it can show you something on a smaller scale, like the inside of your classroom.

Activity – Similarities and Differences (optional) (10 minutes)

Materials – You will need one globe and one paper map, preferably a world map but any paper map will be fine.

Show the students the globe and the paper map side by side. As a class, discuss the similarities and differences. What map features do they share? Discuss the actual shapes of the globe and the paper map. What are the benefits of using each type of map?

Part 2. Parts of a Map (30-60 minutes)

Creating maps is easy and fun! In order to make a map we must first understand the basic parts. Each of these parts is vital to translating what is on a map into real world information. Maps can give you tons of information about places in some far off country or right down the block, but in order to understand it, you have to know what each basic part means.

There are five main parts of a map (Figure 2):

1. Title
2. Compass rose
3. Key
4. Scale
5. Grid

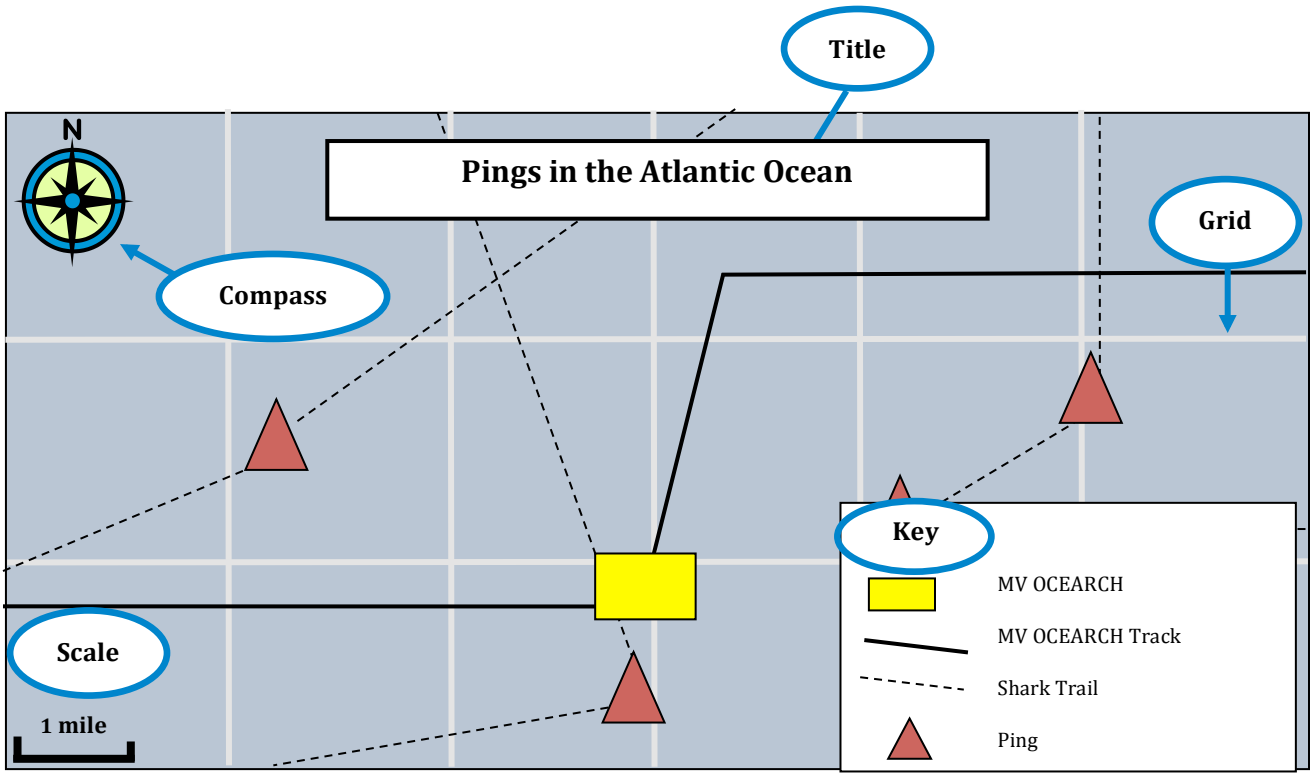


Figure 2. Basic Map depicting sharks and their pings.
Illustration Credit: Brittany Gates – Landry's Downtown Aquarium

A title is usually found at the top of the map and describes what the map is depicting. The title should describe both the location of the map and the content of the map. For example, let's say that we wanted to look at locations where data are collected from a shark's SPOT tag (Smart Position and Temperature Tag). The map would need to say "Pings" and inform the reader where the position of the pings were located (such as the Atlantic Ocean). The compass rose typically shows the four cardinal directions: north, south, east, and west as well as the four 'intercardinal' directions: northwest, southwest, northeast, southeast. An easy way to remember where the cardinal directions are located on the compass is with a simple mnemonic device. If you start at the top of the compass and go around clockwise, the directions are north, east, south, and west. Just remember: **N**ever **E**at **S**oggy **W**affles. The intercardinal directions fit in between the four cardinal directions (clockwise, starting at north): northeast, southeast, southwest, and northwest. All eight directions are usually abbreviated to N, S, E, W, NE, NW, SE, and SW (Figure 3).

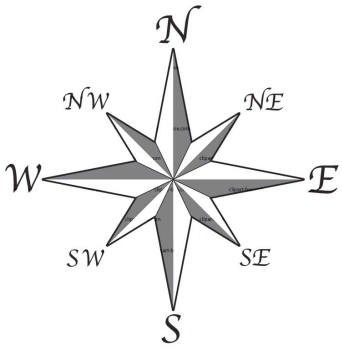
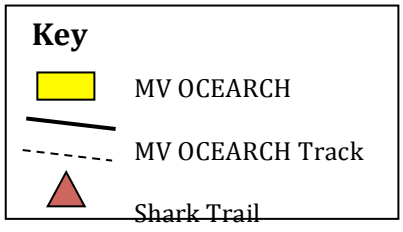


Figure 3. Compass Rose

Symbols are pictures on a map that represent real world objects. The key (sometimes called a legend) is a list that explains the meaning of these symbols (Figure 4). For example, in Figure 2, a red triangle marks a ping, a yellow rectangle marks the location of the M/V OCEARCH, a straight line marks where the M/V OCEARCH has traveled, and a dotted line is the shark's track. Keys and symbols are very important in maps. If we used words rather than symbols, the map would be very crowded and would be difficult to read.

The map's scale displays a ratio for measurement on the map. Since the map is smaller than real life, the size of items, or distance between items, on the map must be translated so that we can know their actual size or distance, respectively. If the scale line on a map is one inch long and is labeled 'one mile', then one inch on the map equals one mile in real life. Therefore, if two pings on the map are 2 inches apart, we can assume that, in real life, the shark's pings are two miles apart.



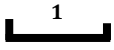


Figure 4. Map key and a map scale from Figure 2.

The grid, a pattern of imaginary lines, exist so that specific places or objects can be located on a map using coordinates. Coordinates are a set of numbers or letters located on the grid. The system of latitude and longitude, or the geographic coordinate system, is the largest global grid system because it covers the entire earth. Latitude consists of lines that run east to west on the globe and longitude consists of lines that run north to south on the globe. The most commonly recognized line of latitude is the equator (Figure 5). It splits the Earth in half horizontally. This separates the globe into two hemispheres, the northern hemisphere, and the southern hemisphere. This division of the globe is very important to marking locations on the earth as well as in navigation. When coordinates for this system are written they are listed latitude first and longitude second. For Example, Houston, TX would be stated as 29.7˚ N (Latitude), 95.4˚ W (longitude). This system can help people identify locations accurately all over the world.

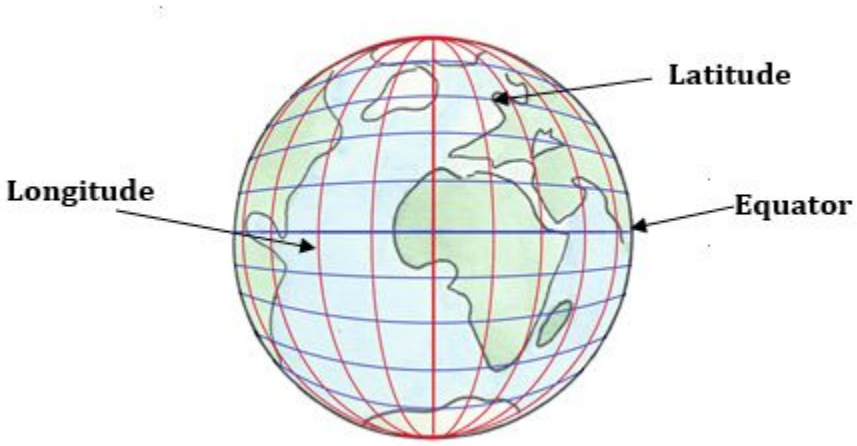
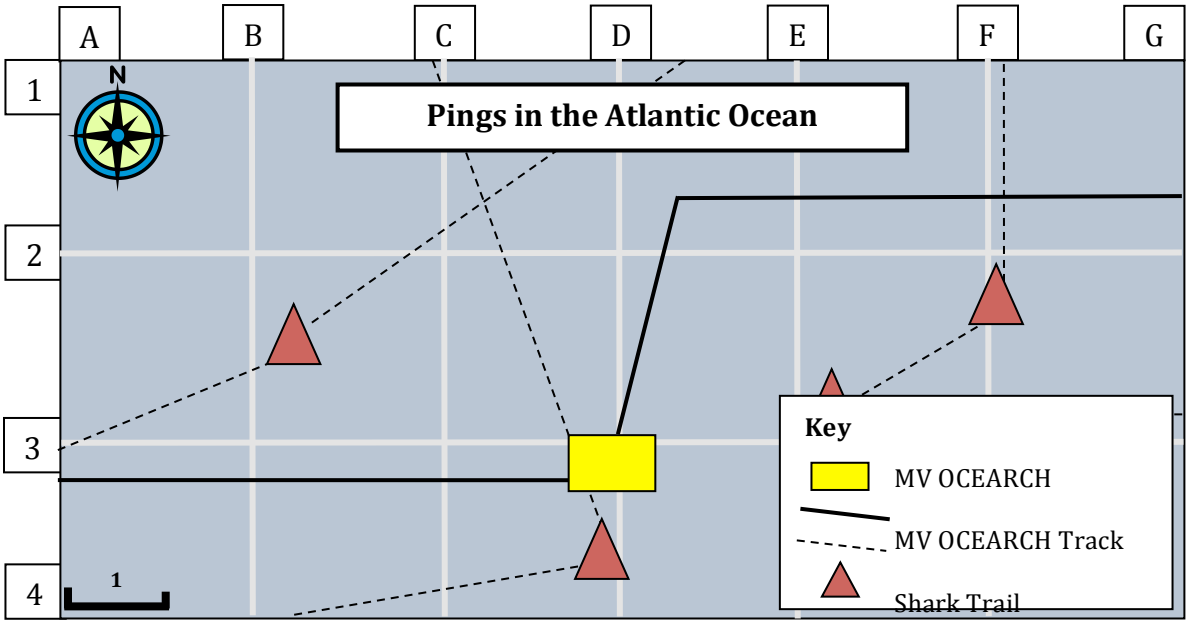


Figure 5. Image depicting the lines of latitude and longitude patterned on the earth.
Illustration Credit: Sarah Rich – Landry's Downtown Aquarium

Grids vary in what they represent from map to map, but all are read in generally the same way. For example, lines that run north and south are labeled with letters and lines that run east and west are labeled with numbers (Figure 6). To state where an object is located using this coordinate system, you would first locate the intersection on the grid closest to the object. Next, follow the lines north/south and east/west to find the associated number and letter for that part of the grid. For example, if you wanted to describe the location of the shark ping farthest to the east (the right) you would say that it is just south of the coordinates 2,F. Also, if someone were to say, "The MV OCEARCH is at coordinates 3,D" you could follow the gridlines associated with line D and line 3 and find where they intersect. The point of intersection for gridlines D and E is where you will find the MV OCEARCH on the map! For more practice on this topic see worksheet 1 on following page.


A
B
C
D
E
F
G
1
2
3
4
N
Pings in the Atlantic Ocean
1
Key
MV OCEARCH
MV OCEARCH Track
Shark Trail

Using Map Grids

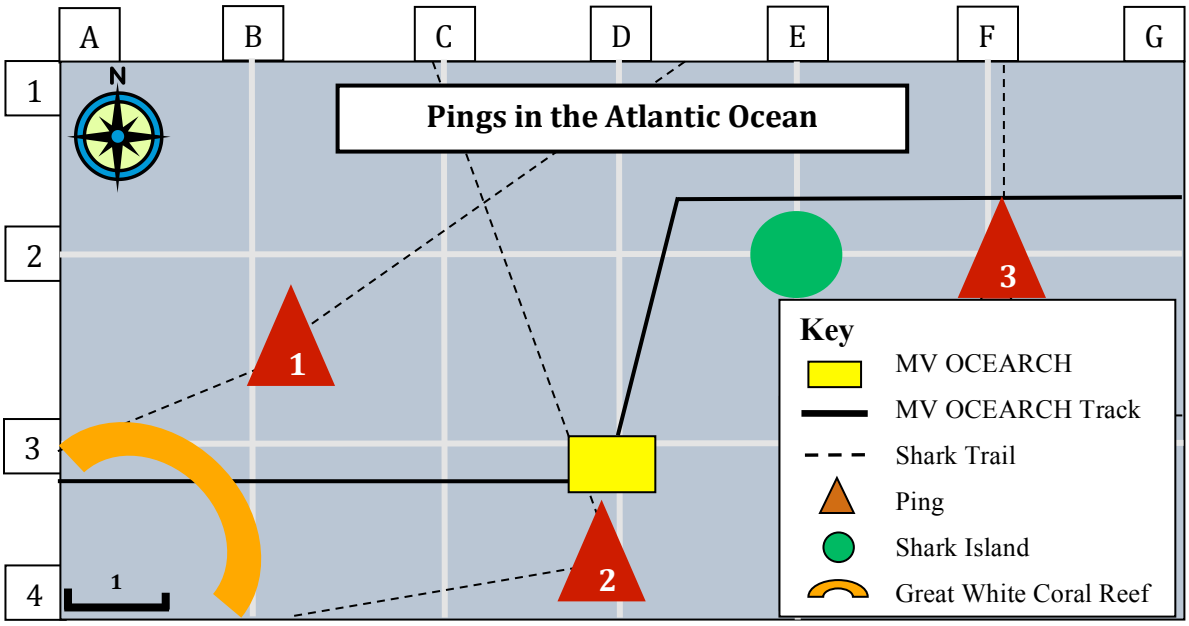
Finding objects on a map using coordinates.

Name: _____

Date: _____

Using what you just learned about map grids and coordinates, find the following items on the map provided.

Instructions:
Write the correct coordinates next to each item. The first is completed for you as an example.



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1. _____ MV OCEARCH

2. _____ Great White Coral Reef

3. _____ Shark Ping 1

4. _____ Shark Ping 2

5. _____ Shark Ping 3

6. _____ Shark Island

Part 3. Types of Maps (30–40 minutes)

Climate Maps

Climate maps provide basic information about climate and precipitation of a specific region. So, what exactly is climate? Is climate the same thing as weather? Climate and weather are *not* the same thing! Weather is a *short term* description of the air, including temperature, precipitation, humidity, wind, pressure, and other external factors. On the otherhand, climate is the *long term* description of weather conditions (e.g., temperature, precipitation, etc.). Climate maps usually use color to depict the changes in temperature or precipitation. Blues usually represent cooler temperature, whereas oranges and reds usually represent warmer temperatures.

So what factors affect climate? Well, there are a lot of factors that affect climate!

Latitude is a major factor that affects climate (Figure 7). The closer you are to the equator, the warmer it gets. In contrast, the closer you get to the poles, the colder it gets. So why is this true? It has to do with the way the earth sits on its axis and rotates around the sun.The earth rotates at an angle on it's axis, which gives us our night and day. The earth also revolves around the sun, giving us our seasons. Since the earth rotates at an angle, the angle of incident sunlight determines the intensity of the solar energy hitting the earth. At the equator, the rays of the sun are hitting the earth at a nearly 90° angle, which means the sun's rays are concentrated. In contrast, at higher latitutdes near the poles, the sun's rays are hitting the earth at a shallower angle, thus spreading the rays over a larger area. In other words, heat from the sun is greater at lower latitidue compared to higher latitude.

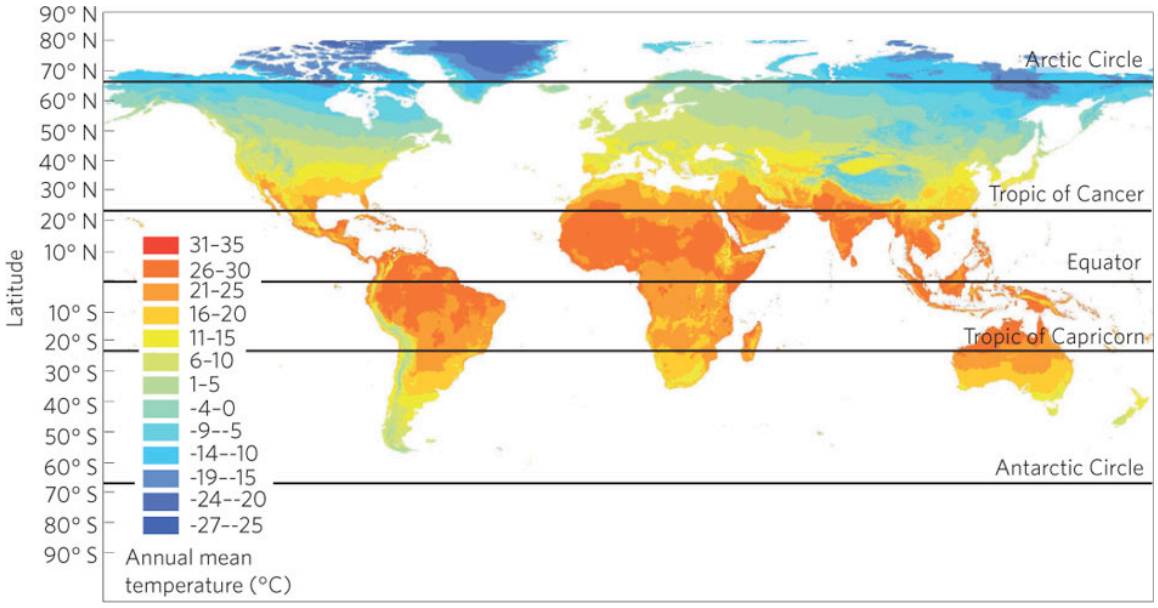


Figure 7. World Climate Map Described by Latitude

In Class Demonstration (optional) (5 minutes)

Teachers can demonstrate how light rays (sun rays) spread out on a spherical object, by using a large ball (e.g., basketball, soccer ball) and flashlight. Slightly tilt the ball and shine the flashlight in the middle of the ball where the equator would be located. What happens? How is the light distributed? Light should be more concentrated at the equator position and more spread out at the poles.

Elevation can also affect climate. Elevation refers to how high the land is above sea level. The general trend is, the higher the elevation, the cooler the temperature. Therefore, it is cooler in the mountains than at the beach!

Ocean and wind currents can also affect climate (Figure 8). You've already learned that the earth is tilted on it's axis and that this orientation causes an uneven heating on the earth's surface. The effect of this uneven heating gives rise to what is known as the Hadley circulation. Hot air rises at the equator and moves north and south toward the poles. As the warm air from the equator moves toward the poles, it loses heat and then sinks. The warm, sunken air then circulates back to the equator where the cycle repeats. Large bodies of water can increase precipitation as well, which in turn affects temperature. The terrain, such as mountains can alter temperature. Remember, it is cooler the higher you go in altitude.

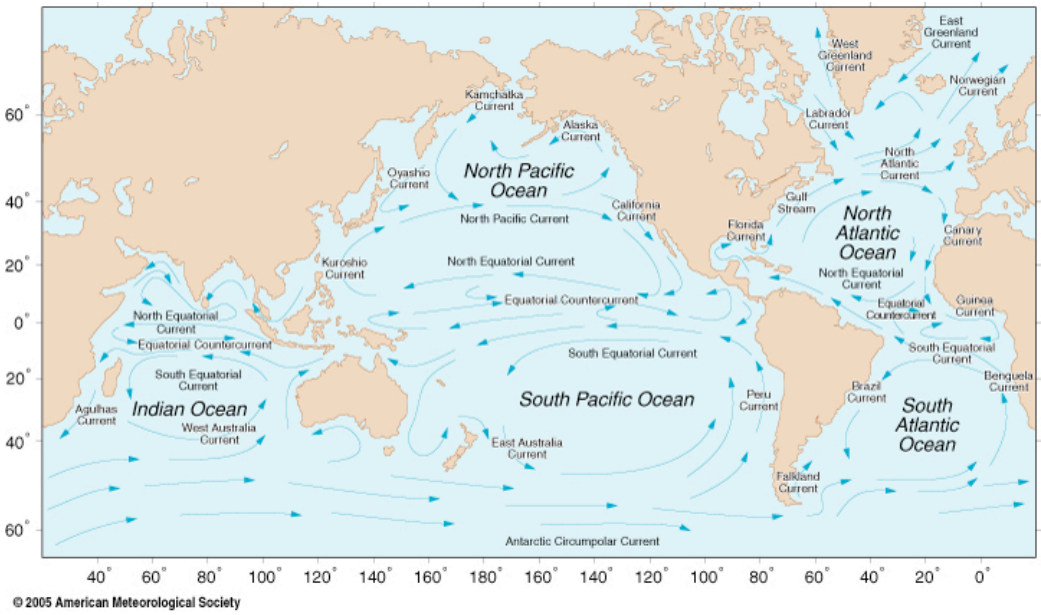


Figure 8. Global wind and current patterns.

Economic or Resource Maps

Economic or resource maps illustrate the type of natural resources or economic activity that dominates a region. Like other maps, economic maps use symbols or colors to depict what is being described on the map. For example, Figure 9 illustrates the renewable energy potential and major electric power plants in Texas. Renewable energy potentials are shown by using different colors and patterns, whereas the major electric power plants are depicted by symbols.

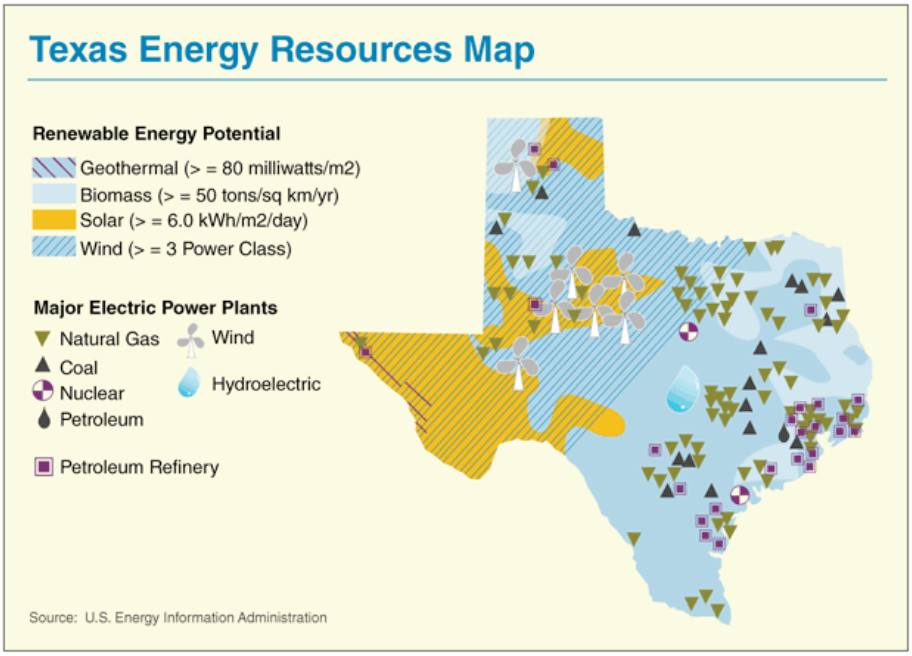


Figure 9. Energy Resource Map for the State of Texas

Physical Maps

Physical maps are used to describe the physical features of a specific area (Figure 10). Physical features include, mountains, rivers, lakes, ponds, and oceans. Water is generally shown in blue. Darker blue colors depict deeper water, whereas lighter blue usually depicts shallower water. The different colors on land represents differences in land elevations.

Figure 10. Physical Map of the United States.

Political Maps

Political maps illustrate regional, state, and national boundaries (Figure 11). State capitals are usually represented by a star within a circle and usually only major cities are displayed.

Figure 11. Map of State Capitals of United States.

Road Maps

Road maps show major roads such as highways, railroad tracks, and major cities (Figure 12). Regional road maps may include a few minor roads and smaller towns for local reference. These maps are used to provide directions for short and long distance trips.

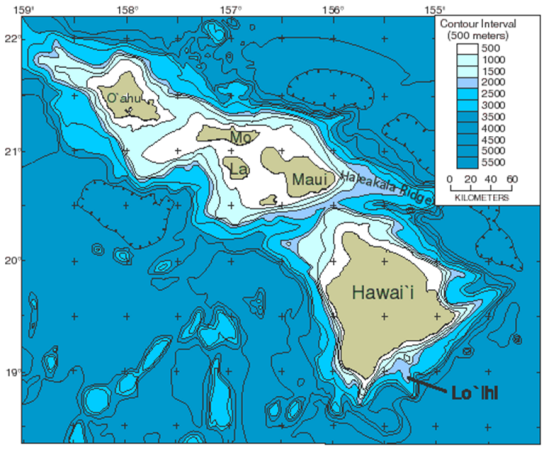
Figure 12. Major road map for United States.

Topographic Maps

Topography is the study of surface shape and physical features of the earth. Topographic maps are used to illustrate the shape and elevation of a region. There are many ways to depict changes in the earth's surface. For example, elevation (e.g., mountains) can be shown using darker colors with mountain ridges, showing almost a 3D appearance (Figure 13). Another way to illustrate changes in elevation is to use contour lines (Figure 14). Contour lines connect points of equal elevation. In other words, if you were to follow a line on the map, elevation would remain constant. Steep terrain (land) are illustrated by lines that are in close contact, whereas flat terrain is illustrated by lines that are far apart (Figure 14).

Figure 13. Topographic Map of Montana.

Bathymetric Maps



Bathymetry is the study and mapping of seafloor topography (Figure 14). Bathymetric maps or charts is underwater equivalent to an above-water topographic map. In other words, bathymetric maps illustrate a 3D view of the land underwater. Variations in the land underwater can be depicted by color and/or contour lines called depth contours.

Figure 14. Bathymetric Map of Hawaii's Coast

Part 4. How Does OCEARCH Use Maps? (5-10 minutes)

Not only are maps very helpful for navigating the M/V OCEARCH all over the world, but maps are also an integral part of OCEARCH's shark tracker and their research on shark migration patterns (Figure 15). When the tag on a shark's dorsal fin breaks the surface of the water, a signal is sent to a satellite. This then creates a "ping" or dot on the map. This information allows the OCEARCH crew, other scientists, and students just like you to study where the sharks have been and make hypotheses about where the sharks might be going and why.

Figure 15. OCEARCH shark tracker showing migratory patterns of multiple sharks.

Part 5. Review (5-10 minutes)

Students should now know and understand the five basic elements of a map, how to use a grid system to find objects on a map, and how to construct their own map.

Ask some questions to review the lesson material:

1. What does a compass rose display on a map? *The cardinal and intercardinal directions.*
2. How is a key used on a map? *To identify symbols used on a map.*
3. What are the four cardinal directions? *North, South, East, West.*
4. What are latitude and longitude? *Imaginary lines that help locate objects and places on a map; latitude runs east to west direction and longitude runs north to south.*
5. What part of a map helps to determine the actual size or distance of an object on a map? *A scale.*
6. What different types of maps are there? Name and describe each of them.
   Climate maps provide basic information about climate and precipitation of a specific region.
   Economic or resource maps illustrate the type of natural resources or economic activity that dominate a region.
   Physical maps are used to describe the physical features of a specific area such as mountains, rivers, lakes, and oceans.
   Political maps illustrate regional, state, and national boundaries.
   Road maps show major roads such as highways, railroad tracks, and major cities.
   Topographic maps are used to illustrate the shape and elevation of a region.
   Bathymetric maps is the underwater equivalent of an above-water topographic map that illustrates the physical properties of the seafloor.

Introduction to Cartography

ACTIVITY 1. Mapping Sharks

(30 – 60 minutes)

Introduction

This activity will help students understand how to create a map using the journey of a shark from the OCEARCH website. They will organize data collected from the OCEARCH Global Shark Tracker and create a map of where the shark traveled. Students will incorporate all aspects of a map. If desired, students can do additional research and add weather, elevation, and the migration patterns of other animals (e.g., whales and sea lions).

Materials

- Computer with internet access
- Unlined paper
- Colored pencils or markers
- Rulers

Instructions

Students may work individually or in small groups.

First, students will need to choose a shark whose journey they will plot on a map. To chose a shark have the students:

- Go to the Global Shark Tracker ™ at www.ocearch.org
- On the left hand side under "Sharks" click on any name and record the name and information in the table provided.
- Under "Tracking Activity" click on "All Activity". This will show the migratory pattern of that one individual shark.

Each dot on the map represents a "ping," or a signal sent from the shark's tracker when the shark's dorsal fin came above the surface of the water. To find the date of each ping, hover the mouse pointer over a specific dot.

By choosing "All Activity" under Tracking Activity, you will see all of the shark's pings. To filter the information, click on the Tracking Activity and choose "Last 24 hours," "Past week," or "Past month." If

more than 10 pings show up, students can use anywhere from 3-10 pings or certain dates, depending on the time allowed for the activity.
Once students have chosen a shark, they will then create a map of the area where the shark traveled. For example, if the shark "Judy" had pings near the Galapagos Islands, students would create a map of the ocean surrounding the Islands. Be sure to include the *closest* landmass for reference as well as the names of any places or bodies of water.

On the map, they will draw *approximate* locations for each ping, labeling them with a date. Using a ruler, they will connect the pings to make straight lines, in a color of their choice. Because the sharks only "ping" when the dorsal fin comes above the surface of the water, some of the pings on the OCEARCH website are connected with straight lines through land mass.

Each map should include a title, a grid with the location of each ping according to the grid, a key (explaining the ping symbol), a scale with approximate distance, and a compass. See the worksheet below to get the students started.

Activity 1.

Mapping Sharks

Name: _____

Date: _____

Instructions

1. Go to the Global Shark Tracker ™ at www.ocearch.org
2. On the left hand side under "Sharks" click on any name.
3. Under "Tracking Activity" click on "All Activity". This will show the migratory pattern of that one individual shark. To filter the information, click on the Tracking Activity and choose "Last 24 hours," "Past week," or "Past month."

Questions to answer before mapping migratory pattern.

1. What is the name of the shark you are following?

   _____

2. What species of shark are you following?

   _____

3. Is your shark

   _____

4. What tracking activity are you following (All Activity or Last 24 hours)?

   _____

Questions to answer after mapping the migratory pattern.

1. How often did your shark report in (ping in)? Was your shark a "pinger", meaning they pinged in, or surfaced, often.

2. Did your shark follow a predictable pattern? Did he/she follow the coastline, swim in the open ocean, or both? Why do you think he/she swam in this pattern? Was your shark feeding on fish in the shallow waters, or feeding on fish (or other prey) along the deep ridges of the open ocean, or was your shark following the coastline where there is a colony of pinnipeds (seals and sea lions)?

3. What predications can you make about your shark? Where do you think he/she is heading next and why?