

Global Kelp Location

Teaching Notes

Unit Overview:

In this lesson students use MyWorld GIS to look for connections between Physical and Biological factors in the ocean. The lesson begins with students reading a short paragraph about the needs of the kelp forest. They then predict where in the ocean kelp forests should exist. After this prediction students begin by examining ocean depth for suitable kelp forest habitat. In the second part of the lesson, students look at ocean temperature and select regions of water that is cold enough for kelp forest life. In part 3, students look at upwelling regions and view a short explanatory video clip of how upwelling occurs. Upwelling helps to bring nutrient rich waters to the kelp forest so students are asked to in part 4, connect upwelling and the kelp forest.

Key Questions

- ✓ How does the physical environment affect the biological environment?
- ✓ What are the factors that control the location of kelp forests?

California Standards

Grade: Nine through Twelve

Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size. (Life Sciences, 6b)

Students know properties of ocean water, such as temperature and salinity, can be used to explain the layered structure of the oceans, the generation of horizontal and vertical ocean currents, and the geographic distribution of marine organisms. (Earth Sciences, 5d)

Student Learning Objectives:

GIS and Map Skills

Students who complete this project will be able to:

- Open a MyWorld GIS project
- Turn layers on and off
- Create selections using the Analyze mode
- Use the Zoom tools
- Use the Identify tool
- Turn legends on and off
- Edit a layer's appearance
- Use the Link tool

Content Knowledge

Students who complete this project will know:

- Kelp forest locations and their relationship to
 - Ocean depth
 - Upwelling zones
 - Ocean temperature zones
- Global wind patterns and their relationship to upwelling

Background Information:

Kelp forests are important biological habitats for many fish and invertebrates. They produce oxygen and food products for humans. Like all plants, kelp requires both light and nutrients to grow. They prefer water that is cool and nutrient-rich. These plant-like algae, which are anchored to the bottom by a holdfast or haptera, prefer a rocky seafloor on which to anchor. In ideal conditions giant kelp can grow 10-12 inches per day. In this lesson students will look for ideal locations for kelp forest growth. These locations occur a where there are combinations of physical factors including water depth, temperature, wave action and nutrient availability.

Prerequisite Background Knowledge

Students should have a basic understanding of the kelp and ocean plants. Reading materials and activities to achieve this understanding can be found in JASON XIV – From Shore to Sea, or on Web sites, listed below. Students will also need to have had some introduction to physical oceanography.

Grade Levels: Grades 5-12

Lesson Duration:

Preparation and computer lab time: 2 - 40 minute class periods.
Follow-up and extensions: 1 - 40 minute class period

Materials:

Computers with MyWorld GIS Software
Lesson handouts for students
Activity recording sheets and World Maps

Optional:

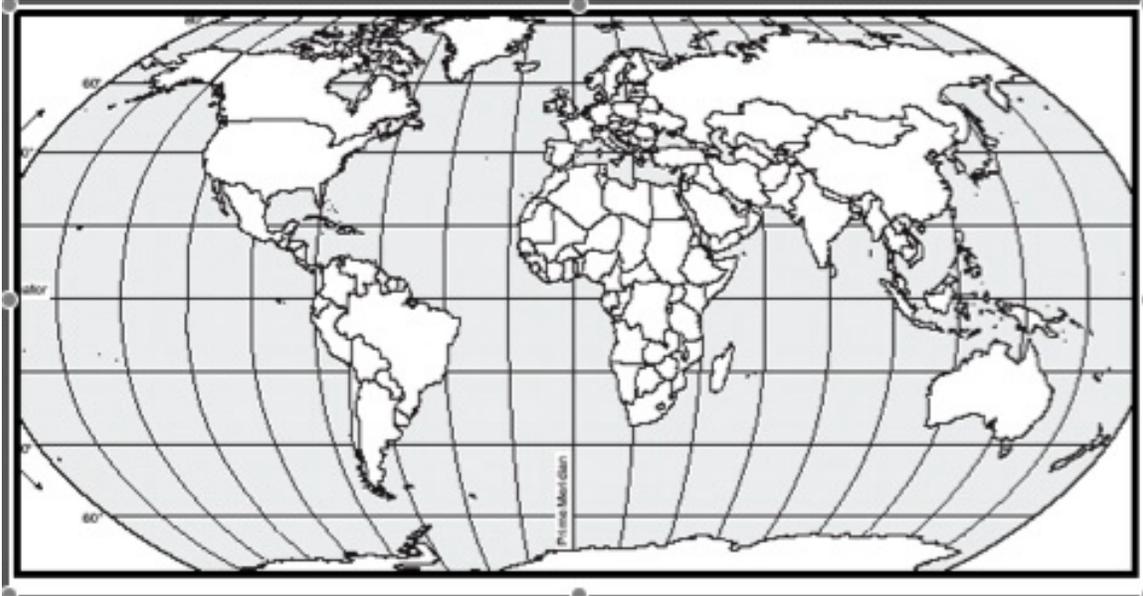
Lab materials
Globes
Additional Videos or Pictures of the Kelp Forest

Answers:

1. Answers will v ary.

General Location	Reason Kelp Would Grow in this Region.	Correct?
<i>Near coasts</i>	<i>Shallow</i>	
<i>Arctic</i>	<i>Cold</i>	

Answers will vary. Students should shade the areas they believe kelp forests will grow on the map below.



2.
 - a. What is the highest elevation on your map? *5750*
 - b. What is the lowest elevation on your map? *-5750*
 - c. What units are being used? (Hint: Look at the legend.) *meters*
 - d. What do the negative numbers mean? *Below sea level*

3. Answers will vary. Students should add check marks to their table above showing areas kelp grow.

4. What ocean temperature is the most common? *23.5*

5. You have studied histograms in math. What type of information do histograms give you about data? *The distribution, or spread, of the data. What data is most common.*

6. Answers will vary. Students describe the areas of warm and cold water including any locations that surprised them.

7.
 - a. What color represents a temperature between 14° and 16° C? *yellow*
 - b. What part of the ocean is the warmest? *Near equator*
 - c. What temperature is this? *28 -30 °C*
 - d. What regions of the ocean are ideal temperatures for kelp? Does this fit your predictions? *The cool regions are ideal*

8. Respond to the following questions.
 - a. Are there areas of the kelp forest that are in warmer/colder water than you would expect? Describe these areas. *Areas near south America and Africa are warmer than expected.*
 - b. What is the warmest temperature that you find kelp in? *18°C*
 - c. The coldest? *0° C*

9. In what depth of water does kelp appear most often? *Less than 50 m deep*

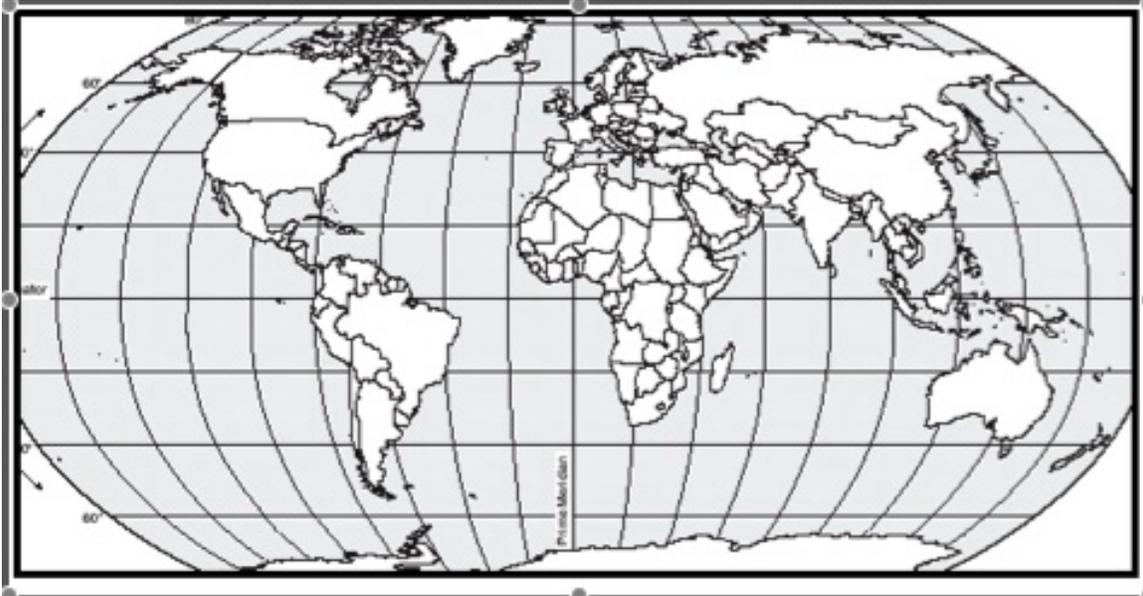
10. Fill in the data table below. The point of this question is to look for patterns.

Continent name	Hemisphere	Ocean Basin	Coast kelp is found on. (N,S,E,W)
<i>North America</i>	<i>N</i>	<i>Atlantic</i>	<i>E</i>
<i>North America</i>	<i>N</i>	<i>Pacific</i>	<i>W</i>
<i>South America</i>	<i>S</i>	<i>Pacific (mostly)</i>	<i>W</i>
<i>Africa</i>	<i>S</i>	<i>Atlantic</i>	<i>W</i>
<i>Australia</i>	<i>S</i>	<i>Pacific</i>	<i>E</i>
<i>Asia</i>	<i>N</i>	<i>Pacific</i>	<i>E</i>
<i>Europe</i>	<i>N</i>	<i>Arctic</i>	<i>E / N</i>

11. Wind patterns that blow parallel to coasts create upwelling. The water that is cool is pulled up by the force of the wind. The upwelling is perpendicular to the wind direction. Explained in the movie.

12. Wind currents that are over upwelling areas are blowing parallel relative to the coastline.

13. Color the World Map below *green* where kelp forests appear.
Put **xx**'s in black over where kelp forests are in upwelling areas.



14. Upwelling brings cool water and can include nutrients.

15. Label the Venn diagram below with the three factors that create ideal conditions for kelp forest survival.

Kelp in the center
Upwelling
Shallow water where light can penetrate
Cool water <18°C

16. Other factors may also be important to kelp forest growth and survival include:

Nutrients in the water.
Light and lack of turbidity.
Wave action

17. Answers will vary. Students review their “preview” table to identify any patterns that that they hadn’t predicted.

Alternative Assessment:

MyWorld Skills Assessment
Venn Diagram of Kelp Habitat Factors in the lesson
Discussion of Kelp Forests and Terrestrial Forests

Extensions:

A complete suite of lessons entitled “Forests Under the Sea” by Paul Sperry can be found here: <http://teachnet-lab.org/santab2003/sperry/index.htm>

Student research projects on life in the kelp forest an example described here:
http://projects.edtech.sandi.net/grant/kelpbeds/kelpbeds_-_teacher_page.htm

Activities from the Monterey Bay Sanctuary: <http://www.mbnms-simon.org/sections/kelpForest/education.php?sec=kf>

Build a kelp forest model from COAST : http://www.coast-nopp.org/resource_guide/elem_mid_school/ma_habitats_acts/kelp.html

Teacher Background and Supplemental Resources

Books and Print Resources:

JASON XIV – From Shore to Sea: A complete unit on the Kelp Forest of the Channel Islands.

Life In A Kelp Forest
by Mary Jo Rhodes, David Hall

The Hidden Forest
by Jeannie Baker

The Amber Forest: Beauty and Biology of California's Submarine Forest
by Ronald H. McPeak

Kelp Forests (Monterey Bay Aquarium Natural History Series)

Hands-On Activities:

JASON online at the Texas Instruments Web site.
JASON: Mixing Soil And Water--Let's Settle This?

Upwelling Mini- lab
<http://www.oceanoasis.org/teachersguide/activity6.html>

Web Links:

Kelp Forests:

Site with links http://www.pcds.org/share/sci8/usefullinks/kelp_forest.htm

Monterey Bay Aquarium Kelp Cam - <http://www.mbayaq.org/efc/kelp.asp>

Monterey Bay Aquarium Field Guide -
http://www.mbayaq.org/efc/living_species/default.asp?hOri=0&hab=5&inhab=479

Kelp Forests, Rainforests of the Sea -
http://www.lincoln.smmusd.org/staff/Vanderveen_Web/Ecology/Kelp%20Reading/kelpreadings.htm

Ocean Realm - <http://www.pbs.org/oceanrealm/seadwellers/>

Kelp Watch - http://www.geol.utas.edu.au/kelpwatch/facts_i.html

Australian Museum Online - Who Lives in Kelp Forests
http://www.amonline.net.au/factsheets/kelp_forests.htm

American Museum of Natural History
http://www.amnh.org/exhibitions/permanent/ocean/02_ecosystems/02c2_algae.php

Background Info Kelp - <http://life.bio.sunysb.edu/marinebio/kelpforest.html>

Articles on Catalina Kelp by Bill Bushing
<http://gis.esri.com/library/userconf/proc95/to250/p247.html>
http://www.starthrower.org/research/kelpmisc/kelp_mp.htm

Pictures of Kelp - <http://www.oceanlight.com/html/kelp.html>

Jewels of the Sea - <http://www.abc.net.au/oceans/jewel/kelp/default.htm>

Student research page - <http://projects.edtech.sandi.net/grant/kelpbeds/>

Upwelling:

<http://oceanexplorer.noaa.gov/explorations/02quest/background/upwelling/upwelling.html>

What Conditions Favor Kelp Forest Growth?

Key Questions:

- ✓ How does the physical environment affect the biological environment?
- ✓ What are the factors that control the location of kelp forests?

Skills and Knowledge:

Students who complete this project will be able to:

- Open a MyWorld GIS project
- Turn layers on and off
- Create selections using the Analyze mode
- Use the Zoom tools
- Use the Identify tool
- Turn legends on and off
- Edit a layer's appearance
- Use the Link tool

Students who complete this project will know:

- Kelp forest locations and their relationship to
 - ocean depth
 - upwelling zones
 - ocean temperature zones
- Global wind patterns and their relationship to upwelling

Background Information:

Preview - *Kelp Forest Regions*

Kelp forests are important biological habitats for many fish and invertebrates. They produce oxygen and food products for humans. Like all plants, kelp requires both light and nutrients to grow. They prefer water that is cool and nutrient-rich. These plant-like algae, which are anchored to the bottom by a holdfast or haptera, prefer a rocky seafloor on which to anchor. In ideal conditions giant kelp can grow 10-12 inches per day.

Given this information, where would you expect to find kelp forests in the ocean environment?

1. List the regions on Earth you think would be ideal for kelp forests growth in the table in your packet like the one below. Shade the your **world** map on your answer packet.

Location	Reason Kelp Would Grow in this Region.

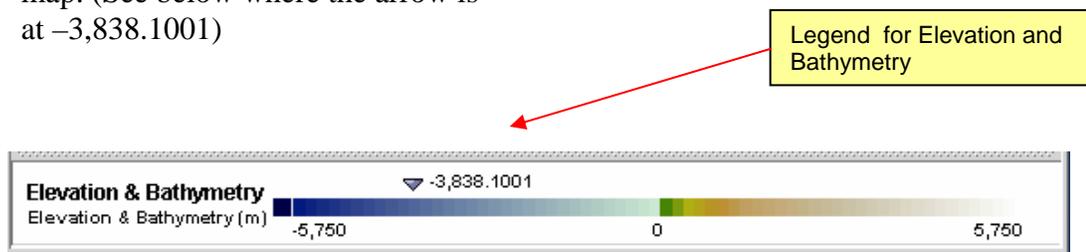
- Launch the program **MyWorld** by double-clicking on the globe icon  in the Dock.
- Open the project **Global Kelp Location2.m3vz** from the list of “**All Projects**” in the data library by double-clicking its name. The first view you will see will have only a world map with the **Elevation & Bathymetry** (depth) layer.

To learn a little more about kelp and it’s habitat, use the link tool  to click on the **project link** flag  in the lower left hand corner of the map window. Chose the NOAA movie about Kelp. The project tour window also has an Internet link to a web site where you can investigate kelp forest information.

Bathymetry and Kelp Forests

Light is an important factor in the growth of all plants. Water filters light. For this reason, kelp can only grow in shallow water, less than 100 meters deep. Kelp grows best in water that is less than 30 meters deep.

- Change to **Visualize** mode, activate the **Elevation and Bathymetry** layer by single clicking on it and use the **Pointer Tool**  to click on the map. Observe the **Legend** below the map.
- You will see a small arrow and the depth of the water as you click around the map. (See below where the arrow is at $-3,838.1001$)



- With **Elevation & Bathymetry** highlighted, double click on the **layer name** (pictured below) for **Elevation & Bathymetry** the edit the appearance dialog box for the layer with a data table with colors will appear.

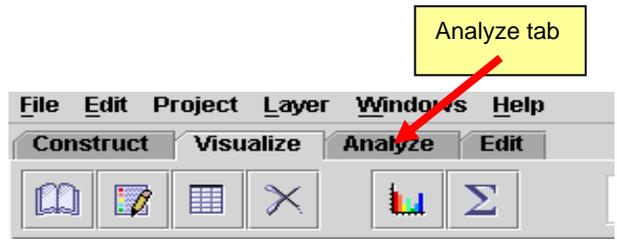
- Look at the data table for the **Elevation & Bathymetry**.



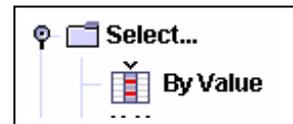
2. Respond to the following questions on your answer sheet.
 - a. What is the highest elevation?
 - b. What is the lowest elevation?

- c. What units are being used? (Hint: Look at the legend.)
- d. What do the negative numbers mean?

- Close the dialogue box.
- In the list on the left of the screen, click once the **Analyze** mode tab to select it. In this mode one can conduct many types of analysis of the data presented in a GIS project.

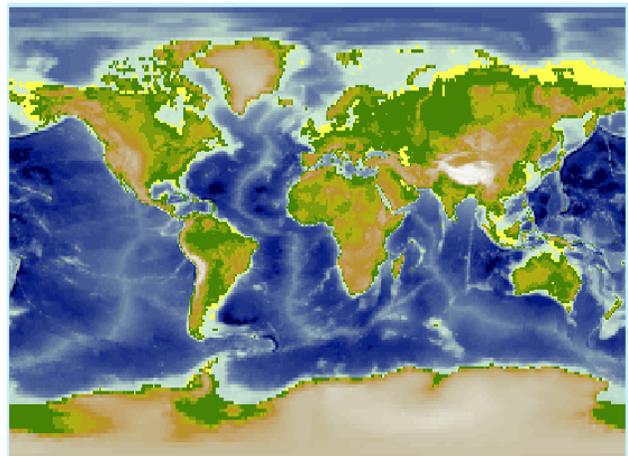


- Click on **Select by Values**. (pictured to the right) In the dialogue that appears, select the records from **Elevation & Bathymetry** whose elevation is *less than zero* and *greater than -50*.



- In the result field, type **Result = “shallow water < 50 m”**. Leave the “*make result a new layer*” box unchecked. It is not necessary to make this a new layer.

- Click OK.
- MyWorld will compute all the areas that are within your settings.



The new map will have the **selected** areas shaded in **yellow**. (like map to the right)

- Use the map with the areas highlighted yellow to predict where you would expect to find kelp based on depth.

3. Compare the locations of these areas to your predictions. Record your observations.

- Turn off **Elevation & Bathymetry** by clicking in the check box once.

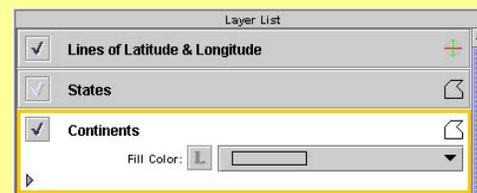
Temperature and Kelp Forests

Kelp grows best in water that is less than 16 °C but can tolerate warmer water for short periods of time (up to several weeks). (What temperature in °F is this? about 70 °F)

Global Kelp Distribution
B. Youngman

Show/Hide vs. Activating Layers Tip: Showing & hiding a layer is not the same as activating a layer.

Activate a layer by checking on the layer's name. The layer will change from gray to white and a yellow box will appear around the edges. In the example below, Lines of Latitude & Longitude and Continents are showing but only the Continents layer is active.

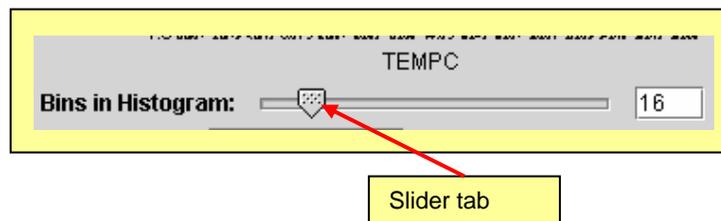


- Using the  check box, turn on **Average Annual Salinity and Temperature**.
- Turn on **Continents**.
- Click once in the **Avg Salinity and Temperature** layer name in the list to make it active. It will be highlighted white.
- Click the View Histogram  button for this layer. Make sure that you are viewing the histogram for the field “**TEMPC**.” Use the pull down menu to change to TEMP C if needed.
- Observe the histogram.

4. What temperature is the most common?

5. You have studied histograms in math. What type of information do histograms give you about data?

- Use the **slider tab** that is below the histogram to increase and decrease the number of bins in the histogram, observe.



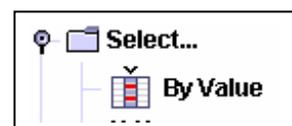
- Close the histogram box.
- Return to the map. Look at the map of **Sea Surface Temperatures**.

6. Describe the areas of warm and cold water. Are they where you would expect? Are there any areas that surprise you?

- Use the Pointer Tool  to click on areas in the ocean. The legend below the map will have a small arrow and a number. (*Hint: like the one you had on the bathymetry map*)

7. Respond to the following questions.

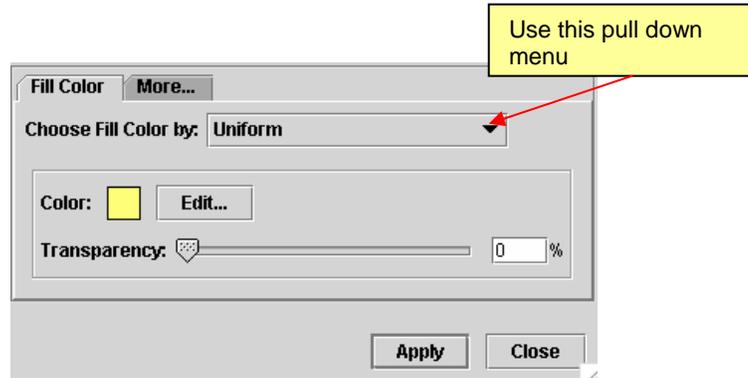
- a. What **color** represents a temperature between 14° and 16° C?
 - b. What part of the ocean is the **warmest**?
 - c. What **temperature** is this?
 - d. What regions of the ocean **are ideal** temperatures for kelp? Does this fit your predictions?
- Click once on the **Analyze** mode tab.
 - Choose the *Select By Value* menu.
 - Choose select records from **Average Annual Salinity and Temperature** that are less than **18° C**.



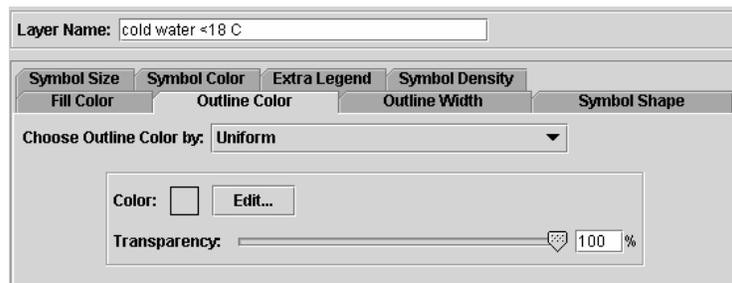
- Make this a new layer by checking the box “make selection a new layer.”
- Name the new layer “**Cold Water < 18° C**” in the results field.
- Click **OK**.

The new layer **Cold Water < 18° C** will appear on the map and in the layer list.

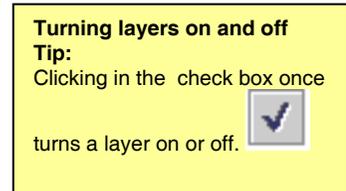
- Edit the new layers appearance by double - clicking on the label.
- Click on “**edit**” the color, **choose fill color by Temp C** and chose the color scheme of **Blue**. This should make the coldest water colored white.



- Click **Apply**.
- Move this new layer just above the **Average Annual Salinity and Temperature** layer.
- Click the **check box** to turn the new layer **Cold Water < 18° C** on.



- Turn off the **Average Annual Salinity and Temperature** layer, but leave your new layer on.
- Turn on the **Generalized Kelp Forest** layer.



Look at the relationship between the location of the **kelp forest** and **temperature**.

8. Respond to the following questions.

- Are there areas of the kelp forest that are in warmer/colder water than you would expect?
 - What is the warmest temperature that you find kelp in?
 - The coldest?
- Turn off the **Cold Water <18° C** layer that you made.

- Turn on the **Elevation and Bathymetry** layer with the shallow water highlights.

9. In what depth of water does kelp appear most often?
Give a range.

- Use the Pointer Tool  and legend to find out.
- Turn off the **Elevation & Bathymetry** layer.
- Turn off the **Generalized Kelp Forest** layer.

Legend Tip: You can toggle a layer's legend on and off by selecting the "Hide/Show Color Legend" button .

Upwelling and Kelp Forests

Some kelp forests are in areas that do not fit the "rules" of shallow and cold water. In the next section we will look at the process of **upwelling**, which brings cold, nutrient-rich water to the surface of the ocean.

- Turn on the **Upwelling** layer.
- Turn on the **Continents** layer.
- Look at the pattern of **Upwelling** locations.
- On which coasts of the **Continents** does **Upwelling** seem to occur? East ? West ?

10. Look for patterns of kelp forest location. Fill in the data table on your answer sheet like the one below.

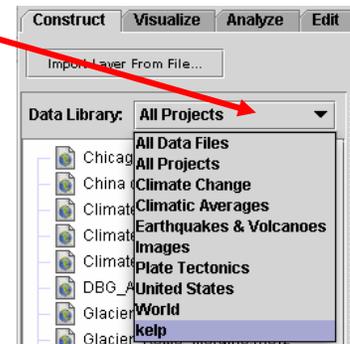
Continent name	Hemisphere	Ocean Basin	Coast kelp is found on. (N,S,E,W)
North America	N	Atlantic	E

- View the movie and picture links that explain **upwelling** by clicking anywhere in the **upwelling** layer with the link tool.  (*NASA movie*)

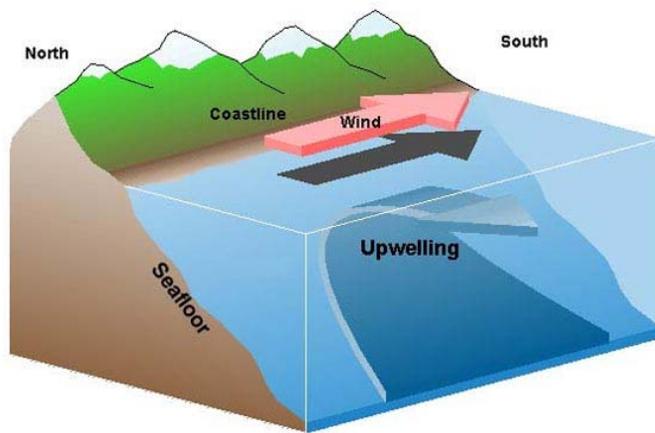
11. What creates upwelling?

- Click on the **Construct** tab
- Use the pull down menu to change to the **Climatology** data library from the **All Projects** library.
- From the **Construct** mode add the **Global Wind Pattern** layer by dragging it to the top of the layer list.

Pull down to change libraries



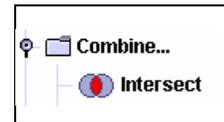
- Use the zoom tool  to zoom to the full extent of the **Global Wind Pattern** layer.



12. Wind currents that are over upwelling areas are blowing in which direction relative to the coastline? (*parallel* or *perpendicular*) Look at the graphic to the left for a hint.

Graphic source:
<http://oceanexplorer.noaa.gov/explorations/02quest/background/upwelling/upwelling.html>

- Click on the **Analyze** tab to switch back to the **Analyze** mode.
- Click on the Combine and *intersect* button to find areas where the **Generalized Kelp Forest** and **Upwelling** layers intersect. MyWorld will compute the areas where these two polygons intersect.
- Name the new layer **Upwelling and Kelp**.
- Click **OK**



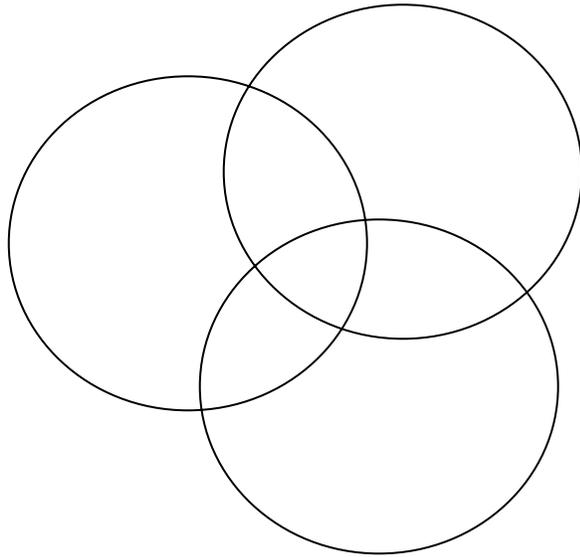
The new layer **Upwelling and Kelp** will appear at the top of your layer list.

- Double click the layer name it to edit its appearance.
- Click the empty box next to the word “color.”
- Choose *orange* as the color for the area where **upwelling and kelp** intersect.
- Click **Apply** and close the dialogue box.
- Zoom to this layer with the zoom to layer button. 
- Add your **cool water <18°C** layer back to your map. Look for patterns of water that is cool for the ocean region and latitude.

Zoom to Selected Layer Tip: Using the **Zoom to Selected Layer**  is a fast way to zoom to all of the records of the activated layer. To use this button be sure to make the layer active and make the layer visible by checking on the Hide/Show Layer checkbox.

Conclude:

13. On your answer sheet, color the World Map *green* where kelp forests appear.
Put **xx**'s in black over where kelp forests are in upwelling areas.
14. What might upwelling bring to the kelp forest?
15. Label a Venn diagram on your answer sheet like the one below with the three factors that create ideal conditions for kelp forest survival.



16. Do you suspect other factors may also be important to kelp forest growth and survival? What do you think they might be and why?
17. Review your “preview” table. Were there any patterns that you discovered in the kelp forest distribution that you hadn’t predicted?
 - Quit the My World project. **Do not save** any changes.

Extend:

1. Use the web to look at several web sites to learn more about *kelp forests* and how they are monitored.
2. Learn more about *how upwelling works*. Read online at the links included here or try the upwelling lab set up by your teacher. .

Name:
Section:
Date:

Global Kelp Location Student Answer Sheet

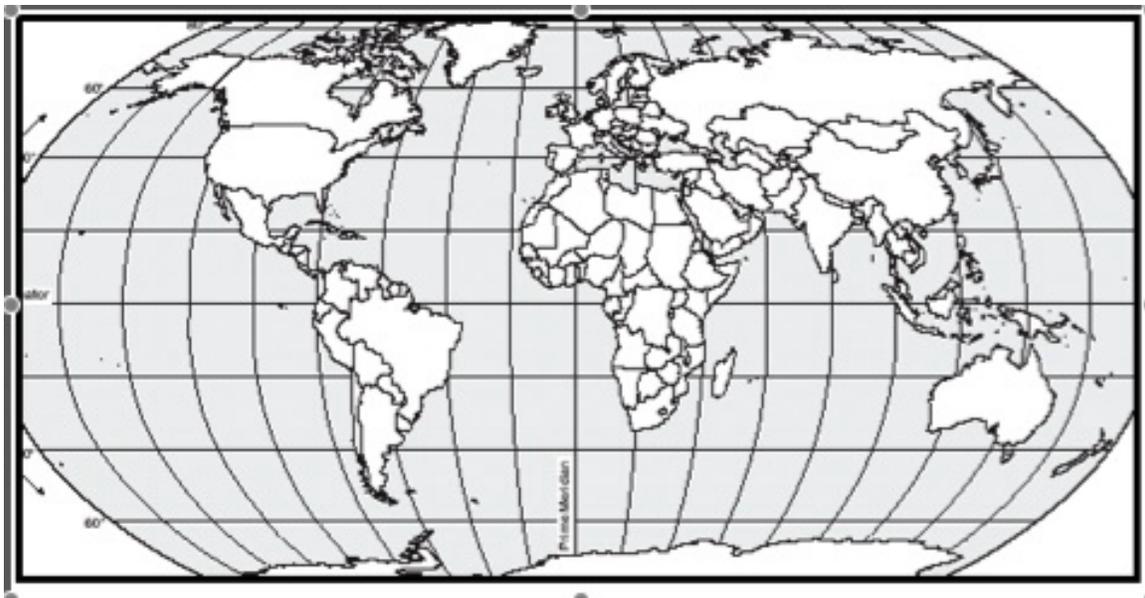
Preview:

Answer the next two questions before beginning the exercise.

1. List the regions on Earth you think would be ideal for kelp forest locations in the table below. You will return to your predictions at several points in the exercise to check off if you were correct, so leave that section blank for now.

General Location	Reason Kelp Would Grow in this Region.	Correct?

Shade on the **world map** the same areas listed above showing where you believe the kelp forest would grow.



Bathymetry and Kelp Forests

Answer these questions while looking at the map of **Bathymetry**.

2.
 - a. What is the highest elevation on your map?
 - b. What is the lowest elevation on your map?
 - c. What units are being used? (Hint: Look at the legend.)
 - d. What do the negative numbers mean?
3. Compare the locations of the shallow areas to your predictions in the chart above, put a  where you were correct.

Temperature and Kelp Forests

Answer these questions while looking at the map of **Sea Surface Temperatures**.

4. What ocean temperature is the most common?
5. You have studied histograms in math. What type of information do histograms give you about data?
6. Describe the areas of warm and cold water.
Are they where you would expect?

Are there any areas that surprise you?
7.
 - a. What color represents a temperature between 14° and 16° C?
 - b. What part of the ocean is the warmest?
 - c. What temperature is this?

d. What regions of the ocean are ideal temperatures for kelp? Does this fit your predictions?

Look at the relationship between the location of the **kelp forest** and **temperature**.

8. Respond to the following questions.

a. Are there areas of the kelp forest that are in warmer/colder water than you would expect? Describe these areas.

b. What is the warmest temperature that you find kelp in?

c. The coldest?

9. In what depth of water does kelp appear most often?

Upwelling and Kelp Forests

Answer these questions while looking at the map of **Upwelling and Kelp Forests**

10. Fill in the data table below.

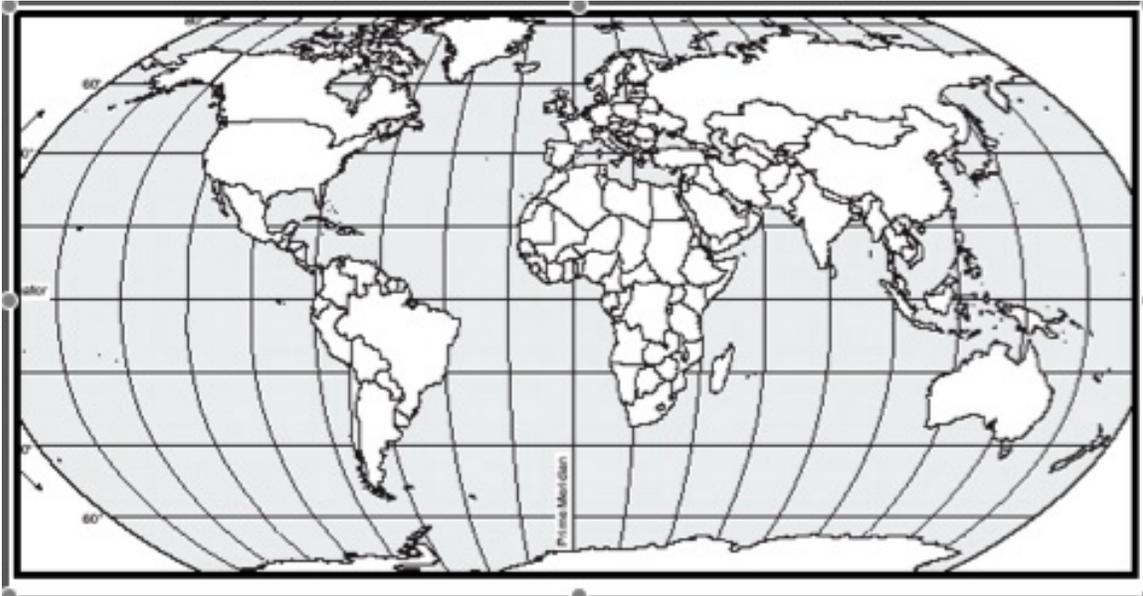
Continent name	Hemisphere	Ocean Basin	Coast kelp is found on. (N,S,E,W)
North America	N	Atlantic	E

11. What creates upwelling?

12. Wind currents that are over upwelling areas are blowing in which direction relative to the coastline?

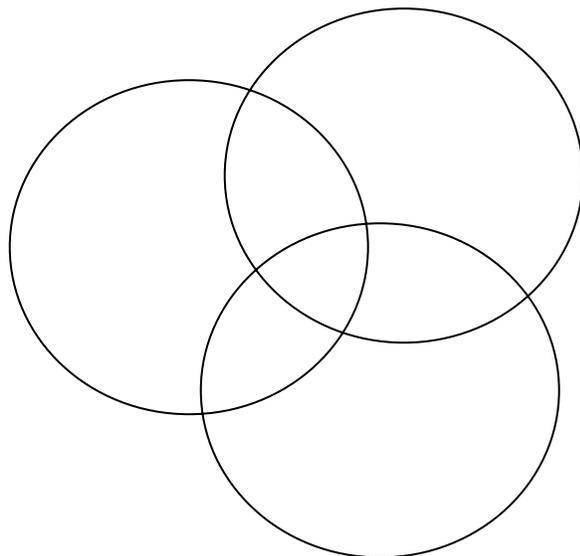
Conclude:

13. Color the World Map below *green* where kelp forests appear.
Put **xx**'s in black over where kelp forests are in upwelling areas.



14. What might upwelling bring to the kelp forest?

15. Label the Venn diagram below with the three factors that create ideal conditions for kelp forest survival.



16. Do you suspect other factors may also be important to kelp forest growth and survival? What do you think they might be and why?

17. Review your “preview” table. Were there any patterns that you discovered in the kelp forest distribution that you hadn’t predicted?

Extend:

1. Use the web to look at several web sites (listed below) to learn more about *kelp forests* and how they are monitored.
2. Learn more about *how upwelling works*. Read online at the links included here or try the upwelling lab set up by your teacher.