Earth Science 11 - Week 7: May 25 – 29

Anticipated time required: 3 hours

New learning objective: **Monitoring water health, ocean currents and how they impact climate**

Goals to be completed:

1. Monitoring water health questions

2. Ocean currents read and respond

Please read through the lesson package and watch all of the videos included within it. The formal portions to submit are indicated throughout the package. These can be sent to Charlie.feht@yesnet.yk.ca either as a scanned and uploaded PDF attachment to email, or as a jpeg image file.

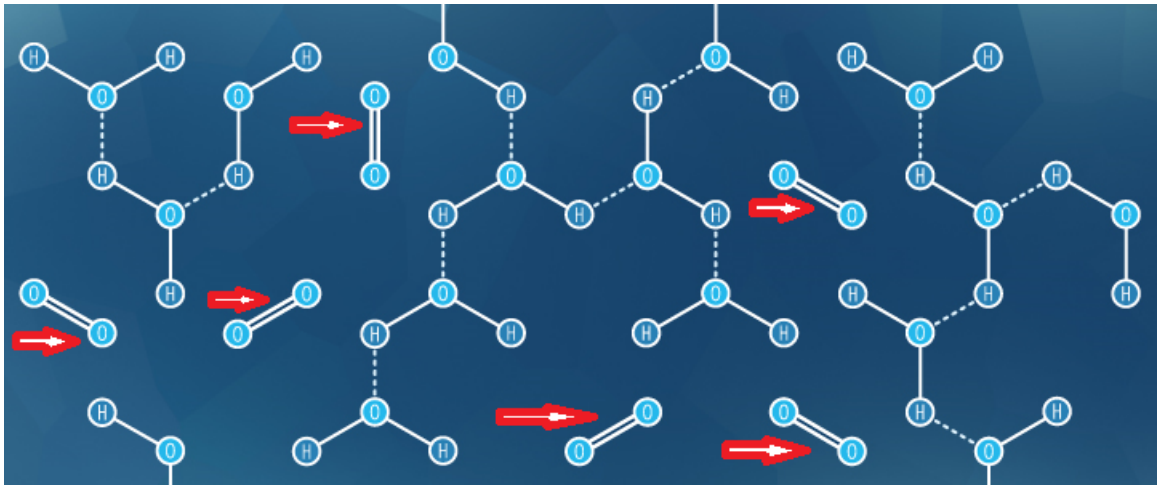
Upcoming next week:

Course Summary Assignment

Section 1: Monitoring Water Health

Dissolved Oxygen Content

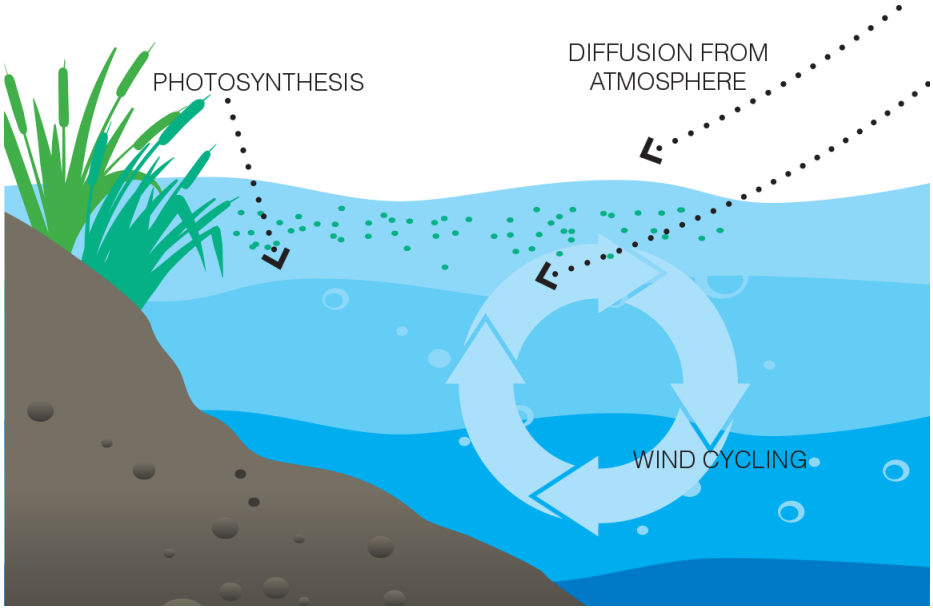
Measuring the amount of free floating oxygen molecules suspended in a body of water is one of several methods scientists can use to measure the health of a body of water. It is an extremely reliable measure of water system health. Too much or too little dissolved oxygen can have adverse effects on a variety of marine life.



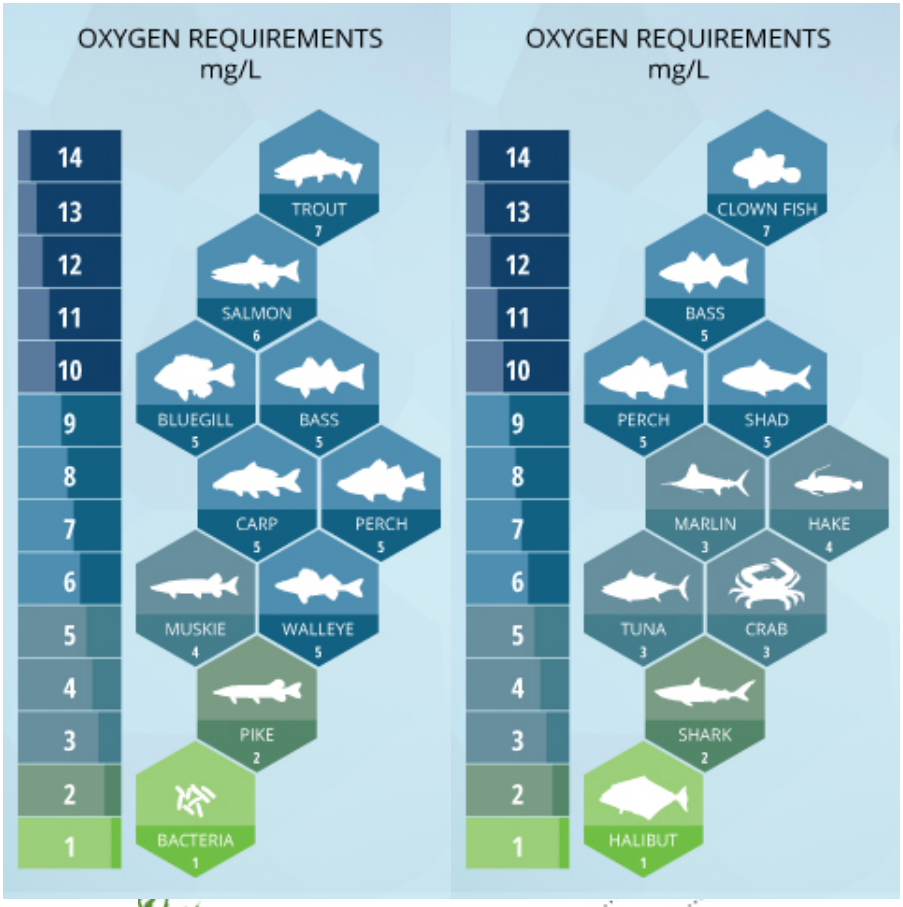
Sources of Dissolved Oxygen

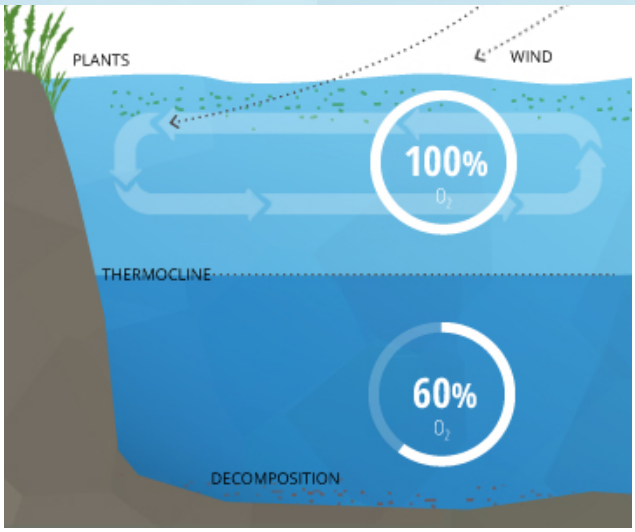
There are three methods through which aquatic environments can become saturated with oxygen:

1. Atmospheric air may be dissolved into water through surface turbulence (waves crashing, hydro plants and dams pumping water, etc.)
2. Aquatic plants undergoing photosynthesis filling the surrounding water with oxygen
3. Oxygen producing bacteria found throughout a marine system



Typically, upper levels of water systems have higher dissolved oxygen content, and are very close to 100% saturated. That means that the body of water contains the full amount of oxygen molecules it is capable of holding. Colder, deeper layers of water usually have less dissolved oxygen. Certain fish species like halibut can survive close to the ocean floor where there is less dissolved oxygen, but other species like salmon are more sensitive to low dissolved oxygen levels and cannot survive in deep areas of the ocean.

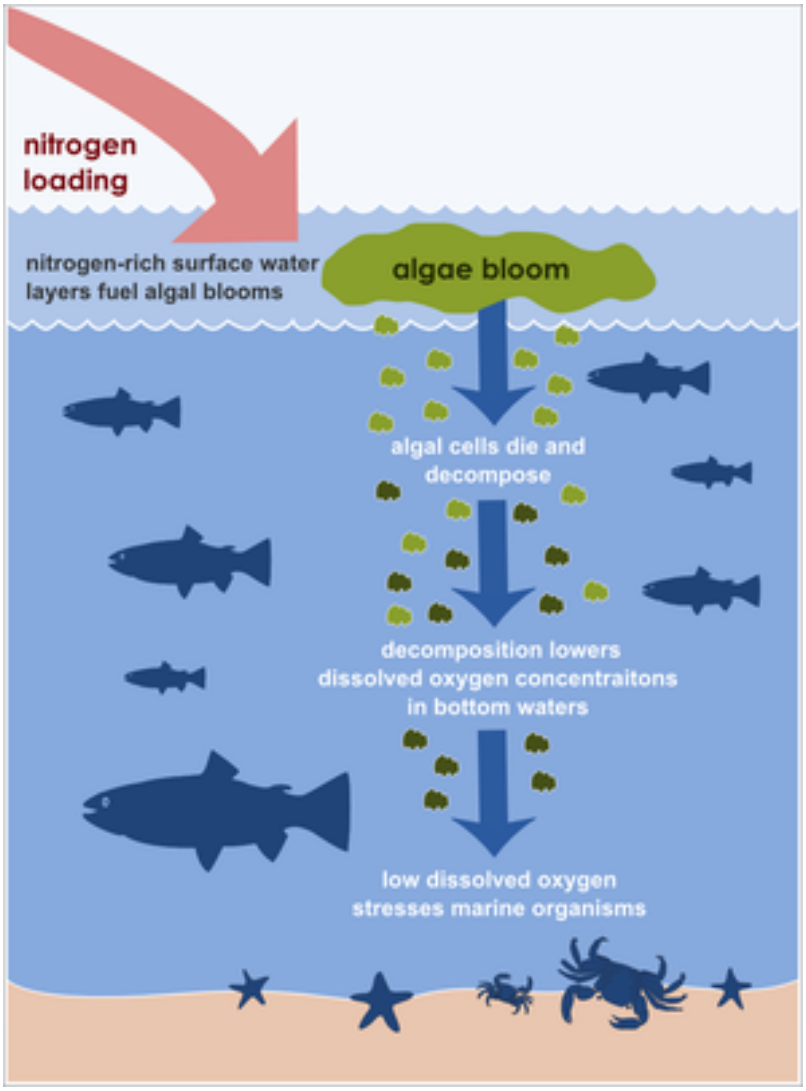




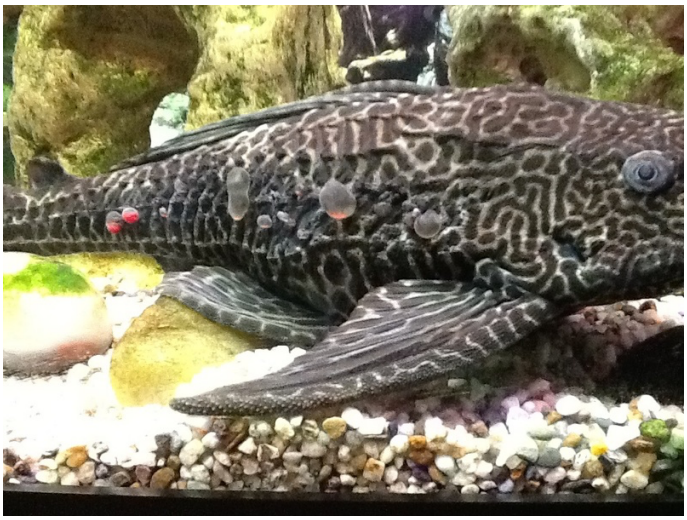
Consequences of Unusual Dissolved Oxygen Levels

1. Fish Kill - This occurs when large amount of fish species die off due to reduced dissolved oxygen levels.

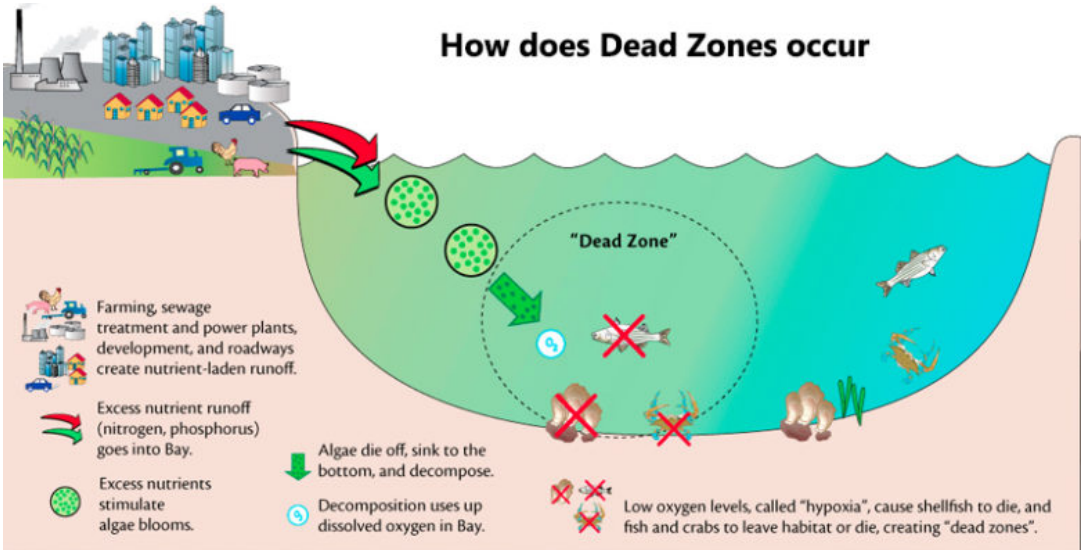
    - Can be caused by prolonged ice coverage on a lake or pond due to extremely cold and long winters. The ice coverage prevents atmospheric oxygen from dissolving into the water.
    - Overstocked lakes can also lead to low dissolved oxygen levels when many organisms are competing for a finite amount of dissolved oxygen in the water.
    - Algae blooms can also lead to reduced dissolved oxygen levels which puts stress on marine life.

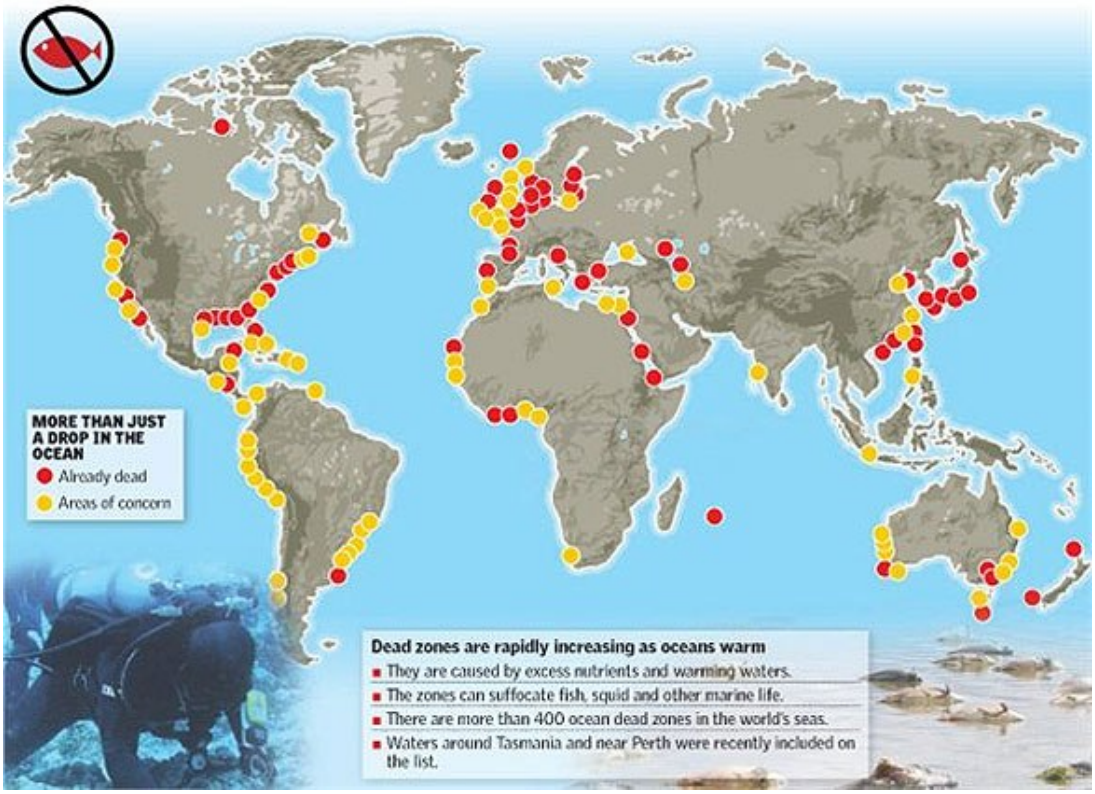


2. Gas Bubble Disease - A disease that causes fish death due to increased dissolved oxygen levels.
    - This results in air pockets forming over the fish's body and gills which can suffocate them.
    - Fish found near hydroelectric dams are particularly susceptible because of high surface turbulence adding oxygen to the water.



3. Dead Zones - Areas where little or no dissolved oxygen is found
    - These regions occur near heavily human populated areas.
    - Agriculture runoff, sewage, sediment erosion and other things can seep into a water source which block the sun's light from penetrating into the water, and prevents atmospheric oxygen from reaching the water.
    - Chemicals disposed of in the water that contain nutrients like nitrogen act as a food source for bacteria which as a result, flourish and consume all of the oxygen found in the water.





To Submit **Dissolved Oxygen Summary Questions**

1. Why do you think fisheries biologists might be concerned with the health of salmon populations migrating near the Whitehorse fish ladder?

2. After a long winter where lakes remained frozen for longer than normal, would you expect there to be regulations on catch limits for fish? Why or why not?

3. Why do you think it is possible to find pike in smaller, shallower lakes, but not find a fish species like lake trout?

4. How do dead zones occur?

Name _____ Class _____ Date _____

CHAPTER 14 The Movement of Ocean Water

SECTION 1

Currents

Only Answer the section 1 review questions

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What factors affect ocean currents?
- Why are ocean currents important?

National Science Education Standards

ES 1j

What Are Surface Currents?

Imagine that you are stranded on an island. You write a note and put it into a bottle. You throw the bottle into the ocean to communicate with the outside world. Can you predict where the bottle will end up? If you understand ocean currents, you can! The oceans contain many streamlike movements of water called **ocean currents**. There are two main kinds of ocean currents: surface currents and deep currents.

Surface currents are horizontal, streamlike movements of water that are found at or near the surface of the ocean. Surface currents can be up to several hundred meters deep. They can be as long as several thousand kilometers. Three factors affect surface currents: global winds, the Coriolis effect, and continental deflections. ☑

STUDY TIP

Summarize As you read, make a diagram showing the types of ocean currents and the factors that affect them.

READING CHECK

1. Define Write your own definition for *surface current*.

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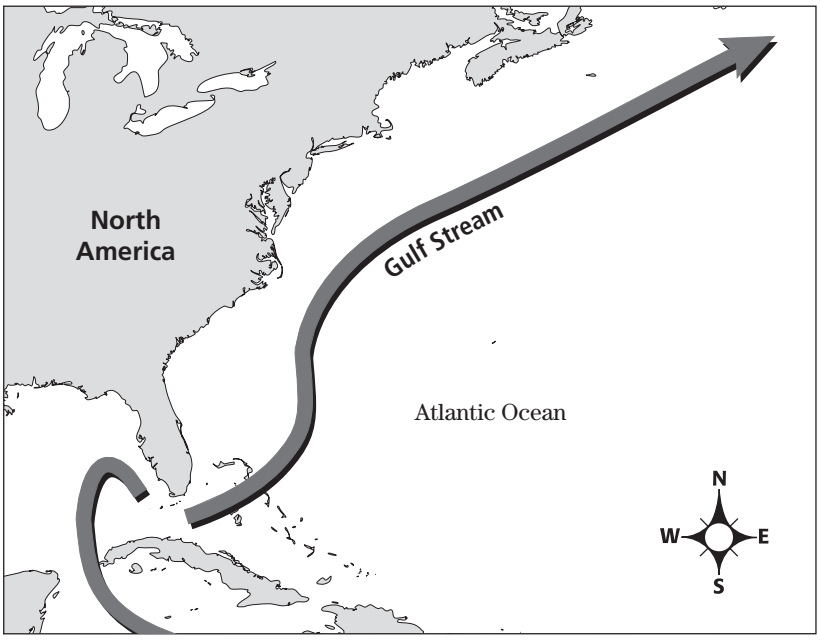

The Gulf Stream is one of the largest surface currents in the world. Every year, it transports at least 25 times as much water as all of the rivers on Earth combined!

TAKE A LOOK

2. Read a Map In what direction does the Gulf Stream flow?

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GLOBAL WINDS

Have you ever blown across a bowl of hot soup? You may have noticed that your breath pushes the soup across the surface of the bowl. In much the same way, winds that blow across the surface of Earth's oceans push water across Earth's surface. This process causes surface currents in the ocean. ☑

Many winds blow across Earth's surface, but they do not all blow in the same direction. Near the equator, the winds blow mostly east to west. Between 30° and 60° latitude, the winds blow mostly west to east.

READING CHECK

3. Explain How do winds cause surface currents?

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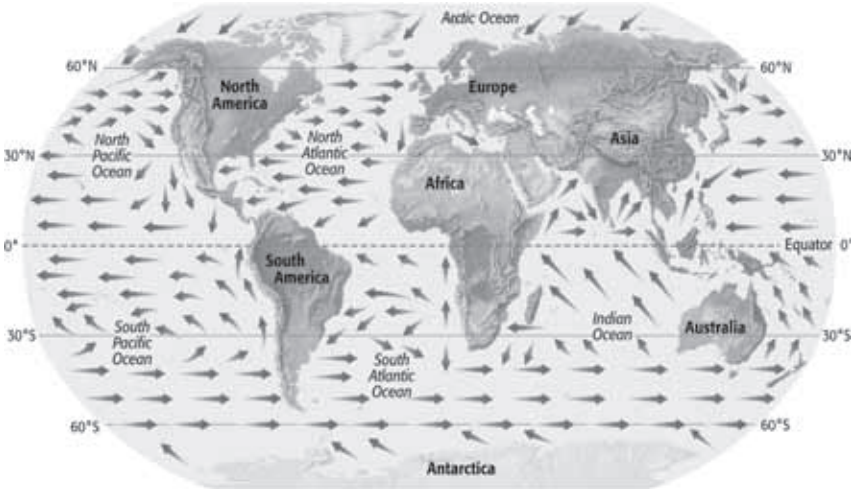

Winds are important in producing surface currents. The winds near Earth's surface do not all blow in the same direction.

CONTINENTAL DEFLECTIONS

If Earth's surface were covered only with water, surface currents would travel across the oceans in a uniform pattern. However, continents cover about one-third of Earth's surface. When surface currents meet continents, the currents *deflect*, or change direction. The figure below shows this process.

TAKE A LOOK

4. Predict Consequences What would probably happen to the South Equatorial Current if South America were not there?

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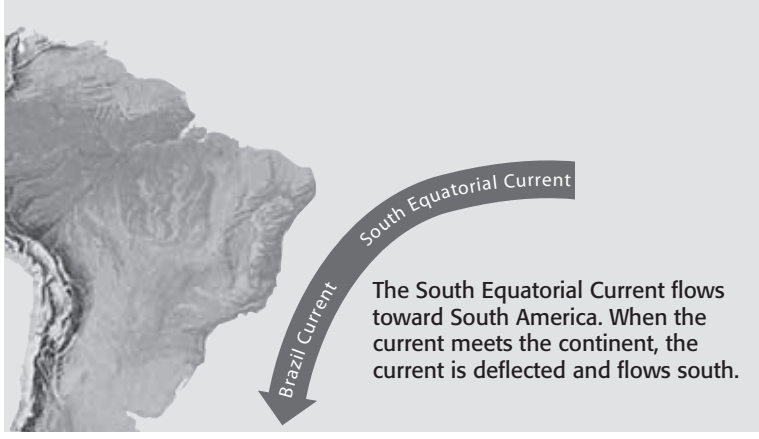
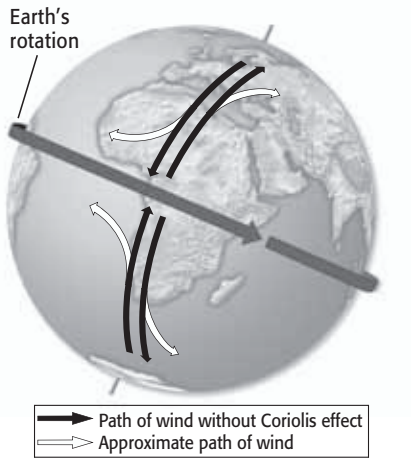


The South Equatorial Current flows toward South America. When the current meets the continent, the current is deflected and flows south.

THE CORIOLIS EFFECT

Earth's rotation also affects the paths of surface currents. If Earth did not rotate, surface currents would flow in straight lines. However, because Earth does rotate, the currents travel along curved paths. This deflection of moving objects from a straight path because of Earth's rotation is called the **Coriolis effect**. ☑

As Earth rotates, places near the equator travel faster than places closer to the poles. This difference in speed causes the Coriolis effect. Wind or water moving from the poles to the equator is deflected to the west. Wind or water moving from the equator to the poles is deflected east. The figure below shows examples of these paths.



The Coriolis effect causes wind and water to move along curved paths.

The Coriolis effect is most noticeable for things that travel very fast or travel over long distances. Over short distances or with slow-moving objects, the rotation of the Earth does not make much of a difference.

HOW SURFACE CURRENTS DISTRIBUTE HEAT

Surface currents help to move heat from one part of Earth's surface to another. Water near the equator absorbs heat energy from the sun. Then, warm-water currents carry the heat from the equator to other parts of the ocean. The heat from the warm-water currents moves into colder water or into the atmosphere. The figure on the next page shows Earth's main surface currents.

READING CHECK

5. Describe How does Earth's rotation affect the paths of surface currents?

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TAKE A LOOK

6. Apply Concepts A surface current starts at the equator near the west coast of Africa and begins moving north. In which direction will the current end up moving?

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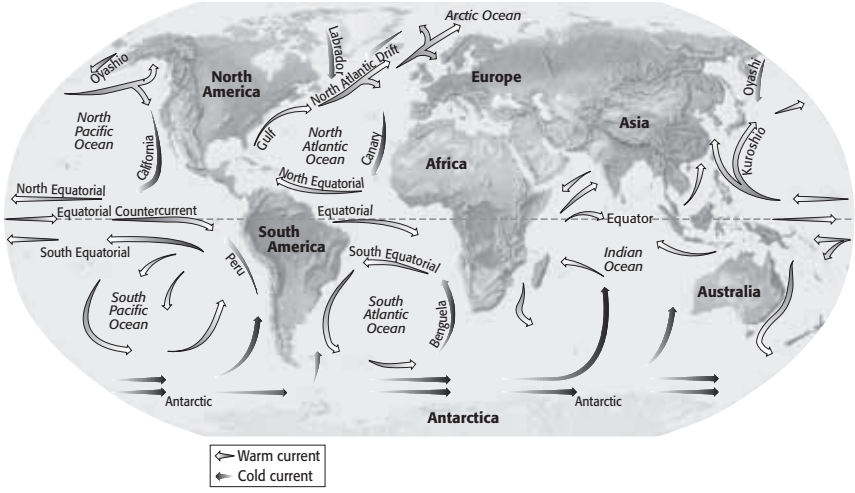

This map shows Earth's major surface currents. Surface currents help to distribute heat across Earth's surface.

TAKE A LOOK

7. Identify Which surface current carries warm water along the equator toward the west coast of South America?

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What Are Deep Currents?

Not all ocean currents are found at the surface. Movements of ocean water far below the surface are called **deep currents**. Unlike surface currents, deep currents are not controlled by wind. Deep current movements are controlled by water density. ☑

Density is the amount of matter in a given space or volume. The density of ocean water is affected by temperature and salinity. *Salinity* is a measure of the amount of salts or solids dissolved in a liquid. Cold water is denser than warm water. Water with a high salinity is denser than water with a low salinity.

Deep currents form when the density of ocean water increases and it sinks toward the bottom of the ocean. There are three main ways that the density of ocean water can increase. The figure below shows one way. The figures on the next page show two other ways.

READING CHECK

8. Compare How are deep currents different from surface currents? Give two ways.

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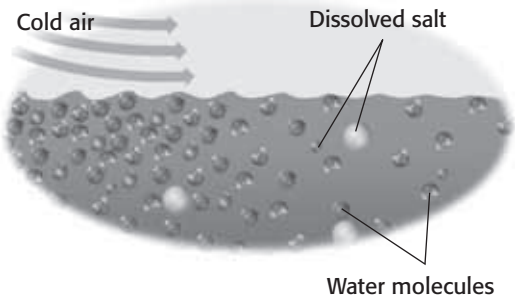
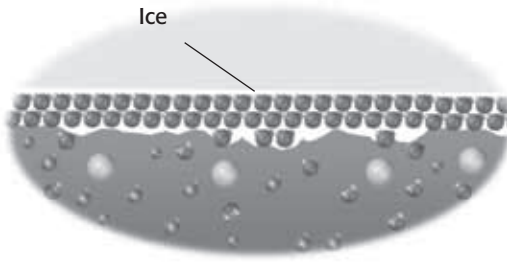
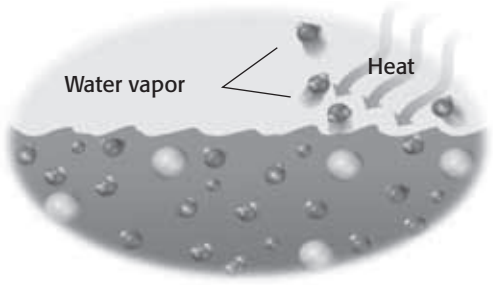


Decreasing Temperature Near the poles, heat moves from ocean water into the colder air. The water becomes colder. The particles in the water slow down and move closer together. The volume of the water decreases, which makes the water denser.

Increasing Salinity Through Freezing When ocean water freezes, the salt in the ocean water does not become part of the ice. The salt remains in the water that has not frozen. This process increases the salinity of the water, and the water becomes denser.



Increasing Salinity Through Evaporation When ocean water evaporates, the salt in the water remains in the liquid. This process increases the salinity of the water, and the water becomes denser.

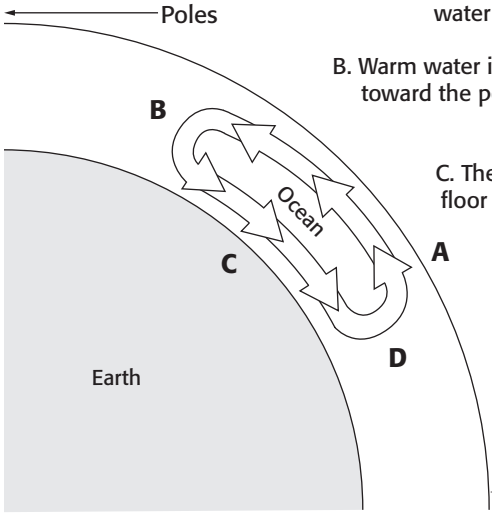


TAKE A LOOK

9. Explain How does freezing cause ocean water to become denser?

There are several main deep currents in the ocean. The deepest and densest water in the ocean is the *Antarctic Bottom Water*, which forms near Antarctica. *North Atlantic Deep Water* is less dense and forms in the North Atlantic Ocean. Water that is less dense stays above denser water. Therefore, North Atlantic Deep Water stays on top of Antarctic Bottom Water when the two meet.

Deep currents and surface currents are closely linked. The warm water in surface currents sinks as it cools and becomes the cold water in deep currents. The figure below shows how this happens.



A. Water near the ocean's surface absorbs heat from the sun. Surface currents carry the warmer, less-dense water from the equator toward the poles.

B. Warm water in surface currents cools as it moves toward the poles. As the water cools, it becomes denser and sinks.

C. The cold water moves along the ocean floor in deep currents. The deep currents carry cold water from the poles toward the equator.

D. Water in deep currents rises to replace water that moves away in surface currents. The cold water absorbs heat from the sun as it gets near the surface, and the cycle continues.

Critical Thinking

10. Infer Why do most deep currents form near the poles?

Name _____ Class _____ Date _____

Section 1 Review

To Submit

NSES ES 1j

SECTION VOCABULARY

Coriolis effect the curving of the path of a moving object from an otherwise straight path due to the Earth's rotation **deep current** a streamlike movement of ocean water far below the surface	**ocean current** a movement of ocean water that follows a regular pattern **surface current** a horizontal movement of ocean water that is caused by wind and that occurs at or near the ocean's surface

1. **Identify** What causes surface currents?

2. **Identify** What causes deep currents?

3. **Describe** What three factors control the path of a surface current?

4. **List** Give three ways that the density of ocean water can increase.

5. **Explain** What causes the Coriolis effect?

6. **Apply Concepts** Which type of water is more dense: cold, salty water or warm, less salty water? Explain your answer.

6. **Predict Consequences** If there were no continents on Earth, what paths would the ocean's surface currents take? Explain your answer.

Name _____ Class _____ Date _____

CHAPTER 14 The Movement of Ocean Water

SECTION 2

Currents and Climate

Only Answer the section 2 review questions

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- How do surface currents affect climate?
- How do changes in surface currents affect climate?

National Science Education Standards
ES 1j

How Do Surface Currents Affect Climate?

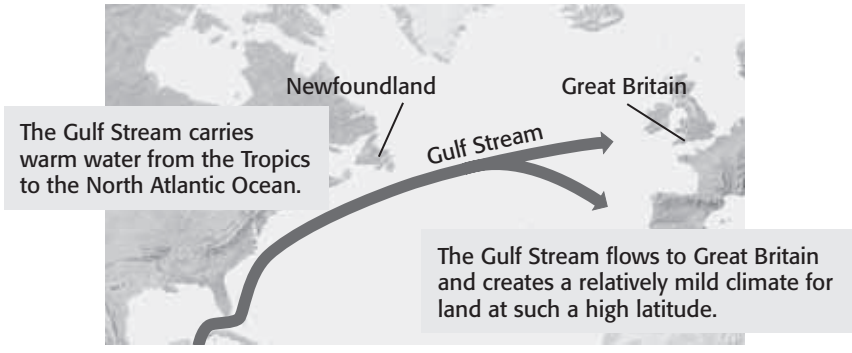
Surface currents can have a large impact on climate. The temperature of the water at the surface of the ocean affects the air above it. Warm water can heat air and produce warmer air temperatures. Cold water can absorb heat and produce cooler air temperatures.

STUDY TIP

Summarize in Pairs Read this section quietly to yourself. Then, talk about the section with a partner. Together, try to answer any questions that you have.

WARM-WATER CURRENTS AND CLIMATE

Surface currents can make coastal areas warmer than inland areas at the same latitude. For example, Great Britain and Newfoundland, Canada, are located at about the same latitude. However, the Gulf Stream flows close to Great Britain. The warm water of the Gulf Stream warms the air around Great Britain. As a result, Great Britain has a milder climate than Newfoundland.



STANDARDS CHECK

ES 1j Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.

Word Help: major
of great importance or large scale

1. Explain Why is Great Britain's climate milder than Newfoundland's?

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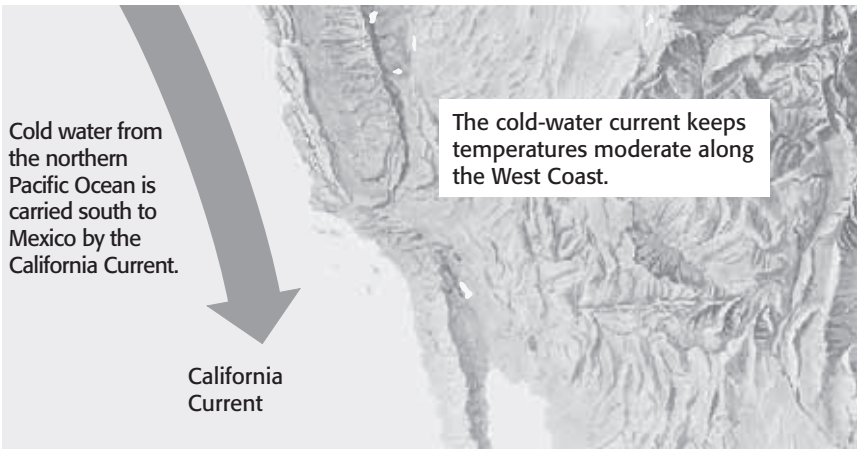
COLD-WATER CURRENTS AND CLIMATE

Cold-water currents also affect coastal areas. Coastal areas near cold currents tend to have cooler climates than inland areas at the same latitude. For example, the California Current is a cold-water current that flows near the West Coast of the United States. As a result, the climate along the West Coast is usually cooler than the climate of areas further inland. The figure on the top of the next page shows the location of the California Current.



TAKE A LOOK

2. Identify In which direction does the California Current flow?

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UPWELLING

Ocean **upwelling** happens when cold, nutrient-rich water from the deep ocean replaces warm surface water. Upwelling is caused by local winds. These winds blow toward the equator along the northwest coast of South America and west coast of North America. The winds cause the local surface currents to move away from the shore. Cold water then replaces the warm surface water. ☑

Upwelling is important for ocean life. Nutrients support the growth of *plankton*, which are the base of the food chain in the ocean. Climate disturbances, such as El Niño, can interrupt the process of upwelling. This causes the diversity of organisms near the ocean's surface to decrease.

READING CHECK

3. Define What is upwelling?

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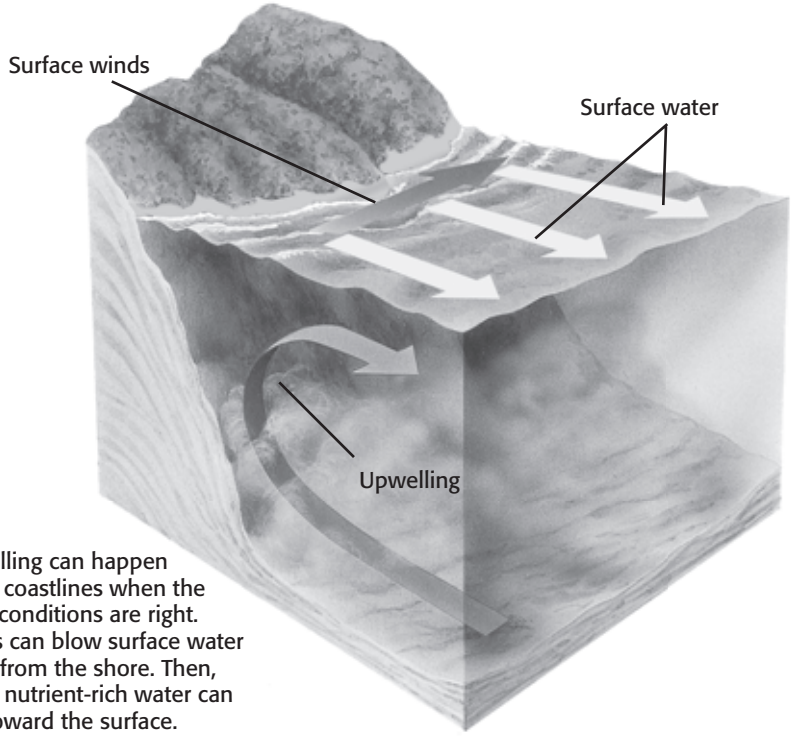

Upwelling can happen along coastlines when the wind conditions are right. Winds can blow surface water away from the shore. Then, deep, nutrient-rich water can rise toward the surface.

TAKE A LOOK

4. Explain How do winds cause upwelling?

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How Do El Niño and La Niña Affect Climate?

Every 2 to 12 years, the South Pacific trade winds move less warm water to the western Pacific than usual. As a result, surface-water temperatures along the west coast of South America rise. Over time, this warming spreads westward. This periodic change in the location of warm and cool surface waters is called **El Niño**. El Niño events can last a year or longer.

Sometimes, El Niño is followed by **La Niña**. La Niña happens when surface-water temperatures in the eastern Pacific become unusually cool. La Niña also affects weather patterns.

Discuss You may have heard news reports about the effects of El Niño. In a small group, talk about some of the effects of El Niño that you heard about on the news.

Name	When does it happen?
El Niño	
La Niña	

TAKE A LOOK

5. Describe Fill in the blank spaces in the table.

EFFECTS OF EL NIÑO

El Niño can have a major effect on weather patterns. Flash floods and mudslides may happen in areas of the world that usually receive little rain, such as Peru. Other areas of the world, such as Indonesia and Australia, may receive less rain than usual.

El Niño changes the way the ocean and atmosphere interact. Changes in the weather during El Niño show how the atmosphere, ocean, and weather patterns are related. Scientists can predict the changes in the weather on land that might be caused by El Niño by studying the atmosphere and the ocean.

To study El Niño, scientists collect data with buoys anchored to the ocean floor along the equator. The buoys record data about water temperature, air temperature, currents, and winds. The data sometimes show that the South Pacific trade winds are weaker than usual. The data may also show that the surface-water temperatures in the oceans have increased. Either of these changes can tell scientists that El Niño is likely to happen.

Critical Thinking

6. Apply Concepts El Niño happens when there is warmer water near the west coast of South America. Why do scientists collect information about air temperatures in order to help them predict El Niño and La Niña?

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Name _____ Class _____ Date _____

Section 2 Review

To Submit

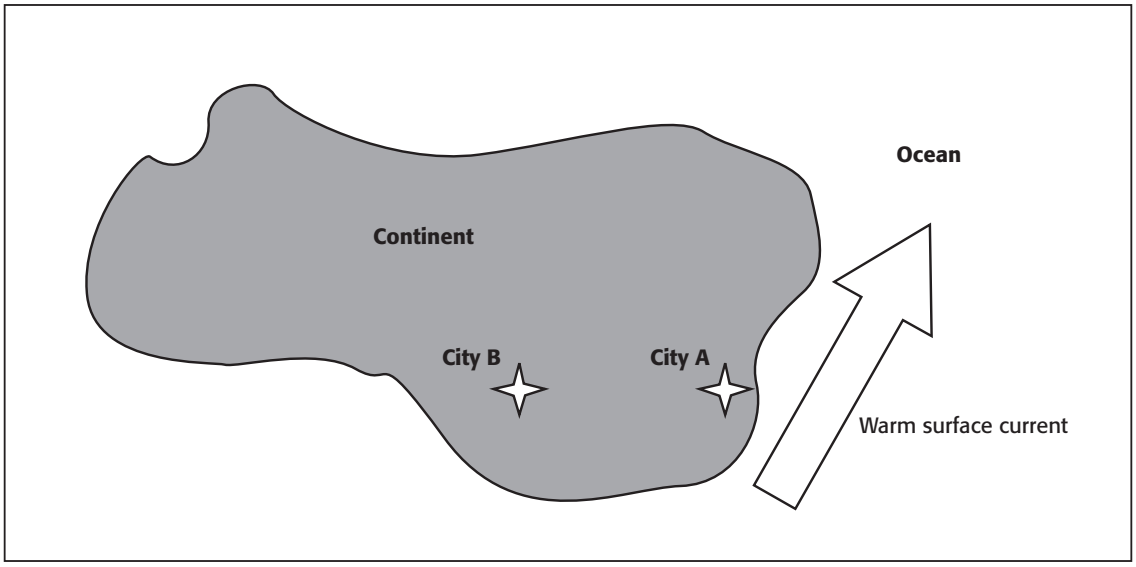
NSES NSES ES 1j

SECTION VOCABULARY

El Niño a change in the surface water temperature in the Pacific Ocean that produces a warm current	**La Niña** a change in the eastern Pacific Ocean in which the surface water temperature becomes unusually cool **upwelling** the movement of deep, cold, and nutrient-rich water to the surface

1. **Explain** Why do surface-water temperatures on the west coast of South America rise during El Niño?

2. **Apply Concepts** City A and City B are the same height above sea level. Based on the figure below, make a prediction about the average temperature in City A compared to City B. Explain your answer.



3. **Explain** Why is upwelling important for marine life?