What is a Freshwater Ecosystem?

Freshwater ecosystems have water that contains little salts and minerals. Freshwater ecosystems include wetlands, such as swamps and marshes as well as ponds, lakes, and rivers. They have diverse ecosystems that depend and are affected by many biotic and abiotic factors.

Biotic factors can include mangroves, water lilies, cattails, black spruce, cypress, fungus, bacteria, and many others. Animal life, another biotic factor, includes many amphibians, reptiles, birds, insects, and mammals. There are also abiotic factors in ecosystems as well. Abiotic factors are nonliving components such as temperature, pH, salinity, light, and atmospheric gas.

What may be the most biologically diverse type of freshwater ecosystem-(a community of living and non-living things that work together)?

Notice the abundance of vegetation mixed with water in the picture below? There are many biotic and abiotic factors working together to keep this ecosystem healthy. These are wetland marshes in eastern Finland. Wetlands are a vital part of our water cycle and are very important in cycling nutrients and removing pollutants from our waterways. However, wetlands can only absorb so many pollutants. Once this occurs biotic factors, such as plants and animals, suffer.

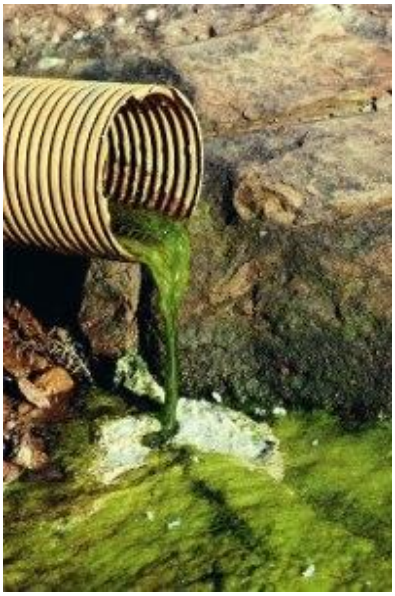
The pond above has a thick mat of duckweed plants. They cover the surface of the water and use sunlight for photosynthesis. The cattails grow along a streambed. They have tough,

slender leaves that can withstand moving water. What are the biotic and abiotic factors mentioned here? (biotic: plants; abiotic: water, sunlight, moving water)

Section 1: What is your part in water pollution?

Lesson Objectives

- List ways to reduce water pollution.
- Describe how water is treated.
- Identify ways to conserve water.



Introduction

The water supply can be harmed in two major ways. It can be polluted, and it can be overused. Protecting the water supply must address both problems. We need to reduce how much pollution ends up in the water supply. We need to treat water that's already polluted. We need to conserve water by using less.

Reducing Water Pollution

In the mid 1900s, people were startled to see the Cuyahoga River in Cleveland, Ohio, burst into flames! The river was so polluted with oil and other industrial wastes that it was flammable. Nothing could live in it.

Controlling Water Pollution

Disasters such as rivers burning led to new U.S. laws to protect the water. For example, the Environmental Protection Agency was established, and the Clean Water Act was passed. Now, water is routinely tested. Pollution is tracked to its source, and polluters are fined. They also must fix the problem and clean up the pollution. Industries, agriculture, and communities may still pollute water, but much less than before.

What You Can Do

Most water pollution comes from industry, agriculture, and municipal sources. But even individuals can pollute the water supply if they aren't

careful. What can you do to reduce water pollution? Read the tips below.

- Properly dispose of motor oil and household chemicals. Never pour them down the drain. Also, don't let them spill on the ground. This keeps them out of storm sewers and bodies of water.

- Use fewer lawn and garden chemicals. Use natural products instead. For example, use compost instead of fertilizer. Or grow plants that can thrive on their own without any extra help.

- Repair engine oil leaks right away. A steady drip of oil from an engine can quickly add up to gallons. The oil can wash off driveways and streets. It can end up in storm drains and pollute the water supply.

- Don't let pet litter or pet wastes get into the water supply. The nitrogen they contain can cause overgrowth of algae. The wastes may also contain bacteria and other causes of disease.

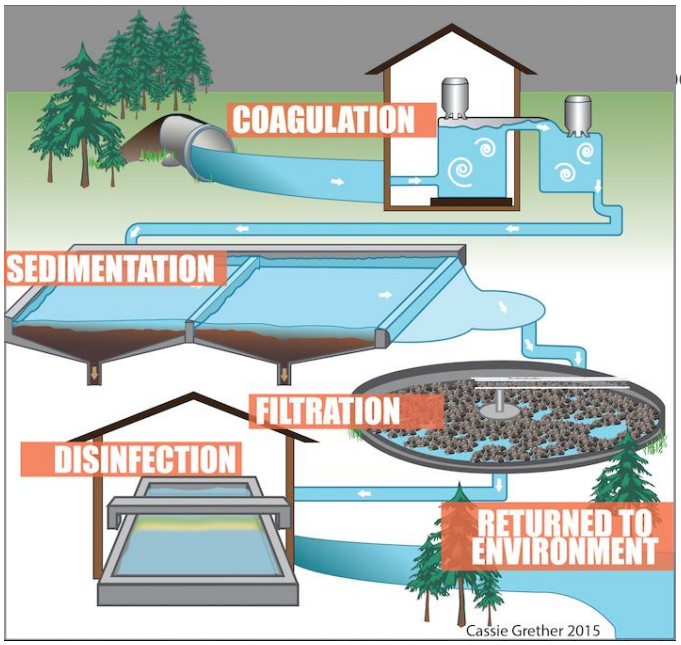
Natural Purification

As water moves between each stage in the water cycle, water undergoes natural purification. As water evaporates, other non-water and various contaminants are left behind. Sediments and pollutants are filtered out as water moves between layers of soil and loose gravel. This process of ground infiltration brings cleaner water to our aquifers. This natural cycling helps to purify water and has been copied, in part, by modern innovation in our water treatment facilities.

Many of the processes followed by water treatment facilities have been derived from natural purification processes. However, water treatment facilities also make use of biological and chemical purification processes.

Water Treatment

Water treatment is a series of processes that remove unwanted substances from water. It makes water safe to return to the natural environment or to the human water supply. You can see how drinking water is treated in the Figure to the left. Treating water for other purposes may not include all the same steps. That's because water



e as clean as drinking

Four processes are used to treat water to make it safe for drinking.

Conserving Water

Conserving water means using less of it. This applies mostly to people in richer nations. They have the most water and also waste the most. In other countries, people already use very little water. They can't get by with less.

Saving Water in Irrigation

Irrigation is the single biggest use of water. Overhead irrigation wastes a lot of water. Drip irrigation wastes less. Water pipes run over the surface of the ground. There are tiny holes in the pipes close to each plant. Water slowly drips out of the holes and soaks into the soil around the plants. Less water is needed. Very little of it evaporates or runs off the ground.

Rationing Water

Some communities save water with rationing. They ban the use of water for certain things. For example, they may ban lawn watering and car washing. People may be fined if they use water in these ways. You can

do your part. Follow any bans where you live. They are most likely to apply during droughts.

Saving Water at Home

It's easy to save water at home. You can save water every day of the year. Saving even a few gallons a day can make a big difference over the long run. The best place to start saving water is in the bathroom. Toilet flushing is the single biggest use of water in the home. Showers and baths are the next biggest use. Follow the tips below to save water at home.

Install water-saving toilets. They use only about half as much water per flush. A single household can save up to 20,000 gallons a year with this change alone!
Take shorter showers. You can get just as clean in 5 minutes as you can in 10. And you'll save up to 50 gallons of water each time you shower. That's thousands of gallons each year.

Use low-flow shower heads. They use about half as much water as regular shower heads. They save thousands of gallons of water.

Fix leaky shower heads and faucets. All those drips really add up. At one drip per second, more than 6,000 gallons go down the drain in a year – per faucet!

Don't leave the water running while you brush your teeth. You could save as much as 10 gallons each time you brush. That could add up to 10,000 gallons in a year.

Landscape the home with plants that need little water. This could result in a huge savings in water use. Look at the garden in the Figure below. It shows that you don't have to sacrifice beauty to save water.

This beautiful garden contains only plants that need very little water.

Lesson Summary

- Freshwater biomes include standing water and running water biomes.
- Biotic and abiotic factors affect fresh water ecosystems
- Laws have been passed to control water pollution. In many places, water is cleaner now than it used to be. Everyone can help reduce water pollution. For example, they can keep motor oil and pet wastes out of the water supply.
- Water treatment is a series of processes that remove unwanted substances from water.
- More processes are needed to purify water for drinking than for other uses.
- There are many ways to use less water. For example, drip irrigation wastes less than other methods. Water-saving toilets and shower heads can save a lot of water at home.

Think like a Scientist

1. Identify three ways that people can reduce water pollution at home.

2. List the four major ways water is used by humans. How is water used differently in the United States compared to the rest of the world?

3. What are the 3 main sources of water pollution?

4. Why is thermal pollution a problem?

5. Describe 3 things you can do to help reduce water pollution.

6. Explain the effects changing the temperature of water would have on an ecosystem.

Was there always water on Earth?

Standard 4, Objective 3: Analyze the physical, chemical, and biological dynamics of the oceans and the flow of energy through the oceans.

Lesson Objectives

- Describe how the oceans formed.
- State how the oceans influence Earth.
- Describe the makeup of ocean water.
- Identify ocean zones.

Terms to know

- outgassing
- comets
- salinity
- chemical properties
- physical properties
- energy flow

Introduction

Much of Earth's surface is covered with oceans. That's why Earth is called the "blue planet." Without all that water, Earth would be a very different place. The oceans affect Earth's atmosphere. They also influence its climate. They are home to many living things as well. You might think that oceans have always covered Earth's surface. But you would be wrong!

How the Oceans Formed

When Earth formed 4.6 billion years ago, it would not have been called the "blue planet." There were no oceans then. In fact, there was no liquid water at all. Early Earth was too hot for liquid water to form. It consisted only of molten rock.

Water on Early Earth

Over time, Earth cooled. The surface hardened to become solid rock. But volcanic eruptions, like the one in image below, kept bringing magma and gases to the surface through a process called **outgassing** (release of gas that was trapped in some material, i.e. gasses released during a volcanic eruption). One of the gases was water vapor. More water vapor came from asteroids and **comets (**an icy small solar system body) that crashed into Earth. As Earth cooled still more, the water

vapor condensed. This was Earth's first liquid water. At last, the oceans could start to form.

Volcanoes were one source of water vapor on ancient Earth. What were other sources?

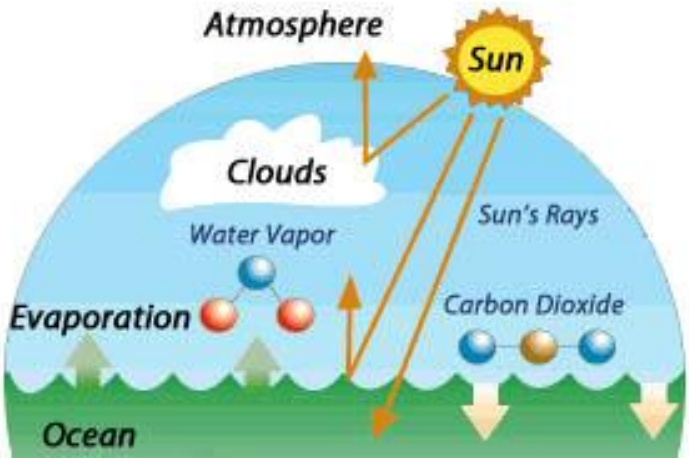
Section 1: How does the ocean influence the Earth?

Oceans cover more than 70 percent of Earth's surface. They make up 97 percent of its surface water. It's no surprise that they have a big influence on the planet. They affect the atmosphere, climate, and living things.

Oceans and the Atmosphere

Oceans are the major source of water vapor in the atmosphere. Sunlight heats water near the surface, as shown in the diagram below. As the water warms, some of it evaporates. The water vapor rises into the air. It may form clouds and precipitation. Precipitation provides the freshwater needed by plants and other living things.

Gas Exchange Between Oceans and Atmosphere



The oceans and atmosphere exchange gases. Why does water vapor enter the atmosphere from the water?

Ocean water also absorbs gases from the air. It absorbs oxygen and carbon dioxide. Oxygen is needed by living things in the oceans. Much of the dissolved carbon dioxide sinks to the bottom of the water. Carbon dioxide is a major cause of global warming. By absorbing carbon dioxide, the oceans help control global warming. However, by absorbing more carbon dioxide the oceans become more acidic. The consequence of this acidification negatively impacts marine organisms.

Oceans and Climate

Compared with inland areas, coastal areas have a milder climate. They are warmer in the winter and cooler in the summer. That's because land near an ocean is influenced by the temperature of the water. The temperature of ocean water is moderate and stable. Why? There are two major reasons:

- Ocean water is much slower to warm up and cool down than land. As a result, it never gets as hot or cold as land.
- Water flows through all the world's oceans. Therefore, warm water from the equator mixes with cold water from the poles. The warm and cold water tend to "cancel each other out."

Even inland temperatures are milder because of oceans. Without oceans, there would be much bigger temperature swings all over Earth and life would not be able to exist as it does now.

Oceans and Living Things

The oceans also provide a home to many living things. In fact, a greater number of organisms live in the oceans than on land. Coral reefs have more living things than almost anywhere else on Earth.

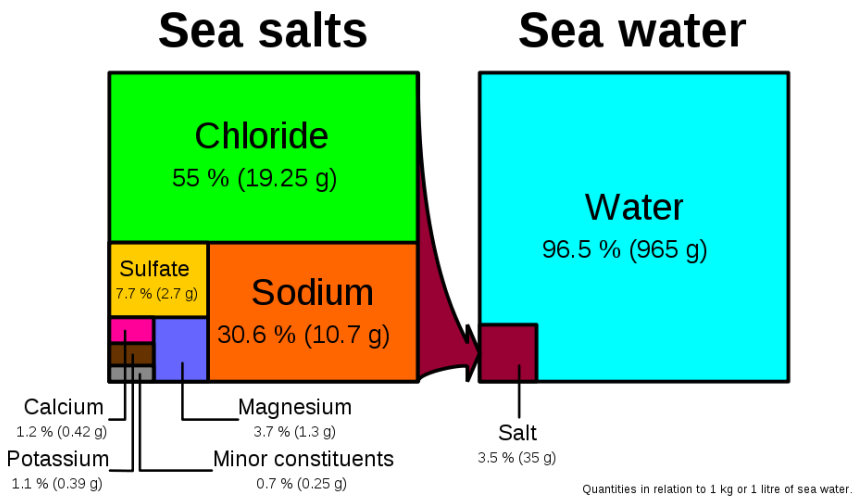
Why Is Ocean Water Salty?

Ocean water has **salinity** (the amount of salt dissolved in a body of water) or is salty because water dissolves minerals out of rocks. This happens whenever water flows over or through rocks. Much of this

water ends up in the oceans. Minerals dissolved in water form salts. Mineral salts become more concentrated in ocean water. That's because a lot of the water evaporates. When it does, it leaves the salts behind. As a result, ocean water is much saltier than other water on Earth.

How Salty Is Ocean Water?

Did you ever go swimming in the ocean? If you did, then you probably tasted the salts in the water. By mass, salts make up about 3.5 percent of ocean water.



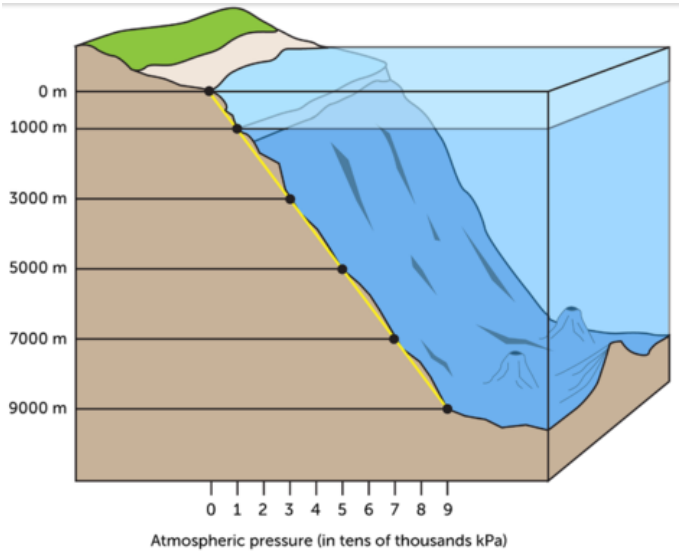
What percentage of the salts in ocean water is sodium chloride?

The Figure above shows the most common minerals in ocean water. The main minerals are sodium and chloride. They form the salt known as sodium chloride. You may know it as table salt.

The amount of salts in ocean water varies from place to place. For example, near the mouth of a river, ocean water may be less salty. That's because river water contains less salt than ocean water. Where the ocean is warm, the water may be more salty. Can you explain why? (Hint: More water evaporates when the water is warm.)

Water Pressure and Depth

Pressure is the amount of force acting on a given area. As you go deeper in the ocean, the pressure exerted by the water increases steadily. That's because there is more and more water pressing down on you from above. The figure below shows how pressure changes with depth. For each additional meter below the surface, pressure increases by 10 kPa. At 30 meters below the surface, the pressure is double the pressure at the surface. At a depth greater than 500 meters, the pressure is too great for humans to withstand without special equipment to protect them. At nearly 11,000 meters below the surface, the pressure is tremendous.



Lesson Summary

- Early Earth was too hot for liquid water to form. Eventually Earth cooled. Water vapor from volcanoes and objects in space condensed. Oceans finally formed.
- Oceans have a big influence on Earth. They exchange gases with the atmosphere. They prevent very hot and very cold temperatures. They are home to many living things.
- Dissolved mineral salts wash into the ocean. As ocean water evaporates, it leaves the salts behind. This makes the water saltier. Ocean water is about 3.5 percent salts. The main salt is sodium chloride.
- The ocean is divided into many zones. Some are based on distance from shore. Some are based on depth of water. The ocean floor is another zone.

Think Like an Oceanographer

1. State why there was no liquid water on ancient Earth.

2. Describe 2 ways the oceans influences Earth's atmosphere.

3. Describe how ocean water properties change as you go deeper in the water.

4. Describe how water pressure in the ocean changes as depth increases.

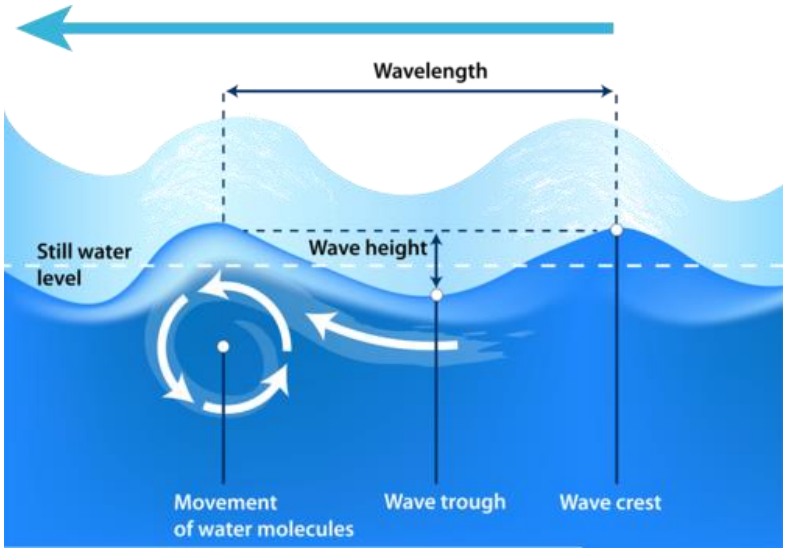
What causes water to move in the ocean?

Lesson Objectives

- Describe how waves move through water.
- Explain what causes tides.
- Give an overview of surface currents.
- Identify the cause of deep currents.
- Describe upwelling.

Section 1: Waves

Most ocean waves are caused by winds. A wave is the transfer of energy through matter. Ocean waves transfer energy from wind through water. The energy of a wave may travel for thousands of miles. However, the water itself moves very little. The Figure below shows how water molecules move when a wave goes by.



The energy of a wave travels through the water as a medium.

Tsunamis

Not all waves are caused by winds. Earthquakes also send waves through water. A tsunami is a wave caused by an underwater earthquake. It may be a very big wave, but can also be very small.

Terms to know

- convection current
- Coriolis effect
- deep current
- density
- El Nino
- La Nina
- surface current
- tide
- upwelling
- wave

When a tsunami reaches shallow water near shore, it could potentially flood the land. Tsunamis can cause deaths and destroy property.

Section 2: Tides

Tides are changes in the rise and fall of sea level caused by the gravitational pull of the Moon and Sun. They occur all around the globe. High tides occur when the water reaches its highest level. Low tides occur when the water reaches its lowest level. Tides keep cycling from high to low and back again. The water level rises and falls twice a day. As a result, in most places there are two high tides and two low tides every 24 hours. In the figure below, you can see the difference between high and low tides. The difference between the high and low tide is the tidal range.

Where is the intertidal zone in this picture?

Why Tides Occur

The main reason is the pull of the moon's gravity on Earth and its oceans. The pull is greatest on whatever is closest to the moon.

As a result:

- Water on the side of Earth facing the moon is pulled hardest by the moon's gravity. This causes a bulge of water on that side of Earth. This creates a high tide.
- Earth itself is pulled harder by the moon's gravity than is the ocean on the side of Earth opposite the moon. As a result, there is bulge of water on that side of Earth as well. This creates another high tide.
- With water bulging on two sides of Earth, there's less water left on the rest of Earth. This creates low tides on the other sides.

Surface Currents

Another way ocean water moves is in currents. A current is a stream of moving water that flows through the ocean. Surface currents are caused mainly by winds. Major surface currents are shown in the figure to the right. Because of the Coriolis Effect, they flow in a clockwise direction in the Northern Hemisphere. In the Southern Hemisphere, they flow in the opposite direction.

Coriolis Effect

The Coriolis Effect describes how Earth's rotation deflects winds and surface ocean currents. Coriolis causes freely moving objects to appear to move to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. The objects themselves are actually moving straight, but the Earth is rotating beneath them, so they seem to bend or curve. That's why it is incorrect to call Coriolis a force. It is not forcing anything to happen!

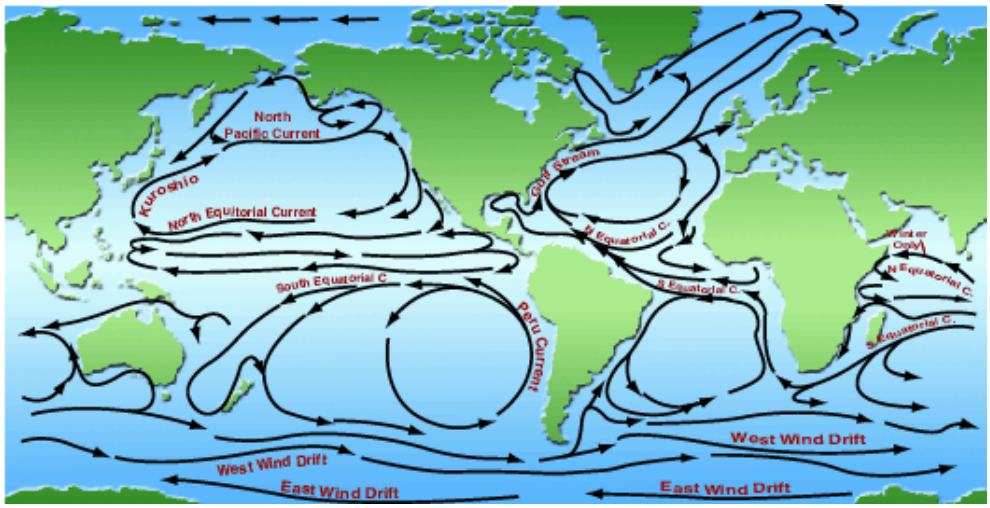
To see the Coriolis Effect in action, see

http://teachertube.com/viewVideo.php?video_id=195342

An example might make the Coriolis Effect easier to visualize. If an airplane flies 500 miles due north, it will not arrive at the city that was due north of it when it began its journey. Over the time it takes for the

airplane to fly 500 miles, that city moved, along with the Earth it sits on. The airplane will therefore arrive at a city to the west of the original city (in the Northern Hemisphere), unless the pilot has compensated for the change. So to reach his intended destination, the pilot must also veer right while flying north.

As wind or an ocean current moves, the Earth spins underneath it. As a result, an object moving north or south along the Earth will appear to move in a curve instead of in a straight line. Wind or water that travels toward the poles from the equator is deflected to the east, while wind or water that travels toward the equator from the poles gets bent to the west. The Coriolis effect bends the direction of surface currents to the right in the Northern Hemisphere and left in the Southern Hemisphere.



SURFACE CURRENTS AND CLIMATE

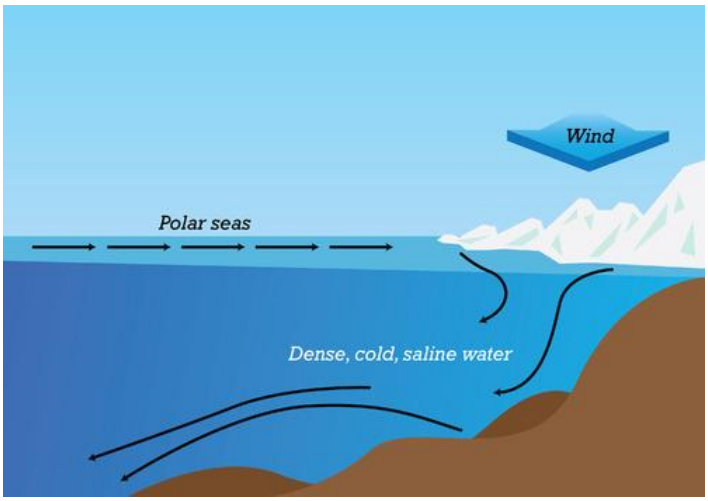
Large ocean currents can have a big impact on the climate of nearby coasts. The Gulf Stream, for example, carries warm water from the Gulf of Mexico up the eastern coast of North America and into Europe. This keep the temperatures in these regions more moderate.

Deep Currents

Currents also flow deep below the surface of the ocean. Deep currents are large convection currents. A convection current is a vertical current that flows because of differences in density at the top and

bottom. Density is defined as the amount of mass per unit of volume. More dense water takes up less space than less dense water. It has the same mass but less volume. This makes denser water heavier and so it sinks. Less dense water rises. Rising and sinking water creates a convection current.

Water becomes more dense when it is colder and when it has higher concentration of salt. In the North Atlantic Ocean, cold winds chill the water at the surface. Sea ice forms from fresh water. This leaves behind a lot of salt in the seawater. This cold, dense water sinks to the bottom of the North Atlantic. Downwelling can take place in other places where surface water becomes very dense (see Figure below).

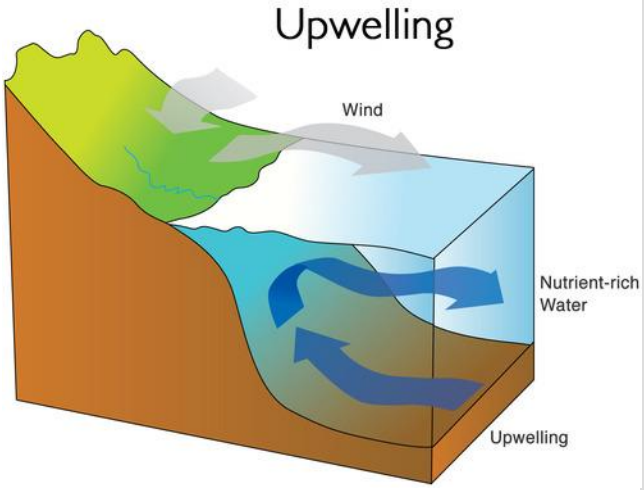


Deep currents flow because of differences in density of ocean water.

Upwelling

Sometimes deep ocean water rises to the surface. This is called upwelling. This figure shows why it happens. Strong winds blow surface water away from shore. This allows deeper water to flow to the surface and take its place.

When water comes up from the deep, it brings a lot of nutrients with it. That's because nutrients settle to the bottom over time. The nutrients brought to the surface support many living things.



An upwelling occurs when deep ocean water rises to the surface.

El Niño

During an **El Niño**, (an abnormal weather pattern that starts in the Pacific Ocean) the western Pacific Ocean is warmer than usual. This causes the trade winds to change direction. The winds blow from west to east instead of east to west. The change in the trade winds also causes the jet streams to be north of their normal location. The warm water travels east across the equator, too. Warm water piles up along the western coast of South America. This prevents upwelling. Why do you think this is true?
These changes in water temperature, winds, and currents affect climates worldwide. The changes usually last a year or two. Some places get more rain than normal. Other places get less. In many locations, the weather is more severe. In Utah this can mean an increase in the amount of snow we receive.

La Niña

La Niña generally follows **El Niño.** It occurs when the Pacific Ocean is cooler than normal. The trade winds are like they are in a normal year. They blow from east to west. But in a La Niña, the winds are stronger than usual. More cool water builds up in the western Pacific. These changes can also affect climates worldwide.

LESSON SUMMARY

- Most ocean waves are caused by winds. The size of a wave depends on how fast, how far, and how long the wind blows. Tsunamis are waves caused by earthquakes.
- Tides are changes in the rise and fall of sea level caused by the gravitational pull of the Moon and Sun.
- Surface currents are like streams flowing through the surface of the ocean. They are caused mainly by winds. Earth's rotation influences their direction. This is called the Coriolis Effect. Surface currents may affect the climate of nearby coasts.
- Deep currents are convection currents that occur far below the surface. They are caused by differences in density of ocean water.
- Upwelling occurs when deep ocean water rises to the surface. It brings nutrients with it. The nutrients support many organisms.

Think Like an Oceanographer

1. Identify two causes of ocean waves.

2. What is the Coriolis effect?

3. Define density. How is the density of water related to its temperature?

4. Describe upwelling. State why it occurs.

5. Explain how the moon and sun cause Earth's tides.

6. Compare and contrast surface currents and deep currents.

7. Compare and contrast El Niño and La Niña.

8. Why were there no oceans on early Earth?

9. Where did the water come from that formed the oceans?

10. What caused the salinity of the oceans?

11. Describe how ocean currents affect local climates?

Points to Consider

12. Upwelling brings nutrients to the surface from the ocean floor. Nutrients are important resources for ocean life. However, they aren't the only resources on the ocean floor. What other resources do you think might be found on the ocean floor?

13. It's hard to get resources from the ocean floor. Can you explain why?

Going Further

This animation shows the effect of the Moon and Sun on the tides:

`http://www.onr.navy.mil/focus/ocean/motion/tides1.htm.`

Glossary

- **abiotic** - – non living things
- **adhesion** - the ability of water molecules to be attracted to other substances
- **aquifers** -porous rock and sediment with water trapped in between
- **biotic** – all living or once living things
- **cohesion** –water molecules sticking to other water molecules
- **comet** - an icy small solar system body
- **condensation** -the process of changing phase from a gas to a liquid
- **ecosystem –** a community of living and non-living things that work together
- **El Niño,** - an abnormal weather pattern that starts in the Pacific Ocean
- **evaporation –** the process of going from a liquid to a gas
- **groundwater**–water that infiltrates the ground
- **outgassing –** release of gas that was trapped in some material, i.e. gasses released during a volcanic eruption
- **precipitation** –water that falls to the ground as rain, hail, snow, etc
- **reservoir** –a place where a substance is stored for a certain period of time
- **salinity** – the amount of salt dissolved in a body of water
- **The Hydrologic (Water) Cycle** – the cycle of processes by which water circulates between Earth's reservoirs
- **transpiration** –Plants take up water from the soil and release large amounts of water vapor into the air through their leaves
- **water vapor** –water in a gas state that is diffused in the atmosphere