

Water Systems on Earth



Trivia:
What is Earth's Nickname?



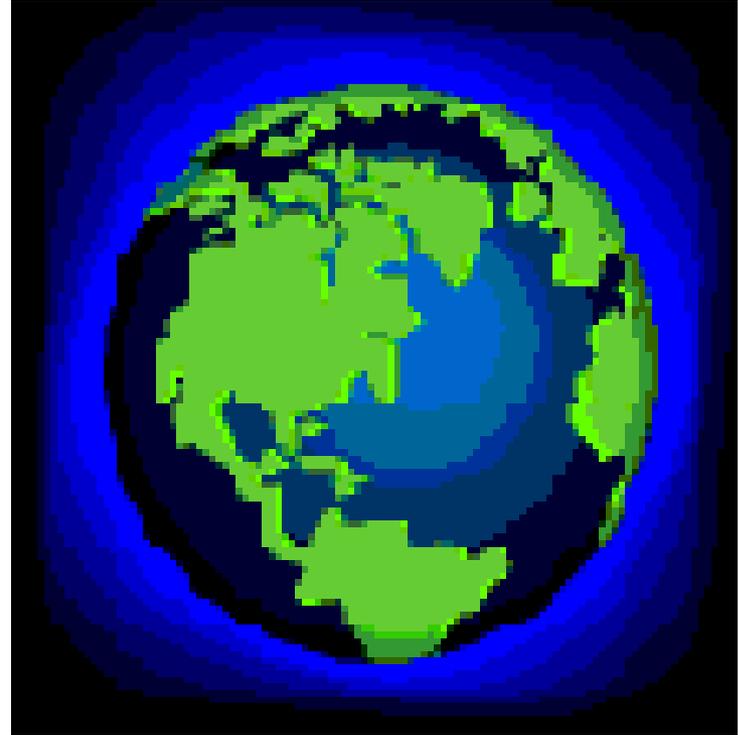
Trivia:
What is Earth's Nickname?



The Blue Planet!

Blue Planet

71% of
Earth's
surface is
covered by
water!



What is the Ocean?

The ocean is where water has collected at a low point of Earth's surface.

These low points are called *basins*.



Oceans

Oceans are the reason life on Earth is possible.

Oceans control Earth's temperature, weather and is the source of all water!



Water is Life



Living things,
including
humans,
need water
to survive!

Freshwater



Only 3 % of the world's water is freshwater! And, most of that is frozen.

Population

7 000 000 000

Over 7 billion!

A vibrant blue ocean with a large wave crashing, creating white foam and splashing water. The sky is a pale, hazy blue. The text is centered over the image.

**Have you ever
been to the
ocean?**

Alive or Not Alive?

The water in the ocean is constantly moving.

So is the water alive?

No!

So how is the water moving?

THINK ~ PAIR ~ SHARE

Waves



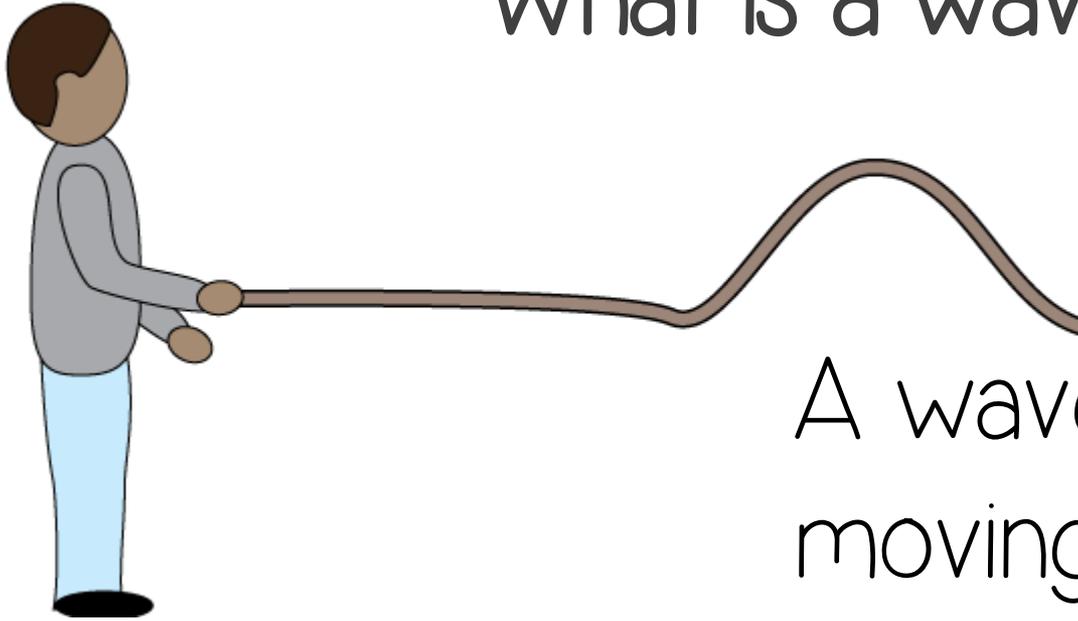
Waves

What is a wave?



Waves

What is a wave?



A wave is energy moving through a medium (like a rope or water)

Waves

Where does the energy come from in the ocean to create waves?



Waves



Waves



Most ocean waves are caused by wind.

Waves

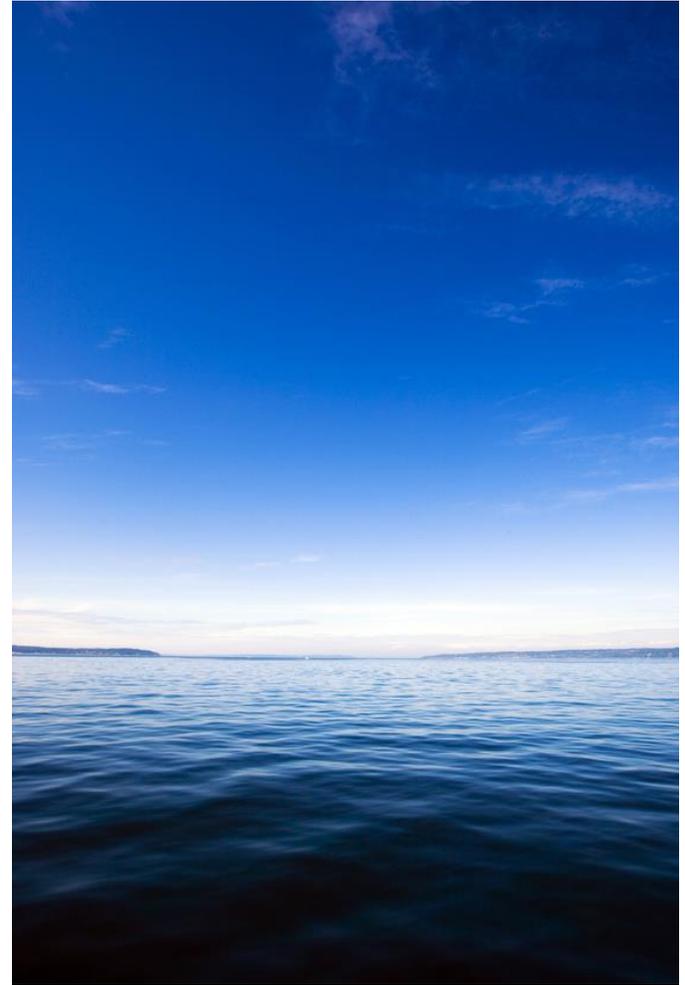
Waves come in many shapes and sizes. They might be a ripple on the water or a tsunami!



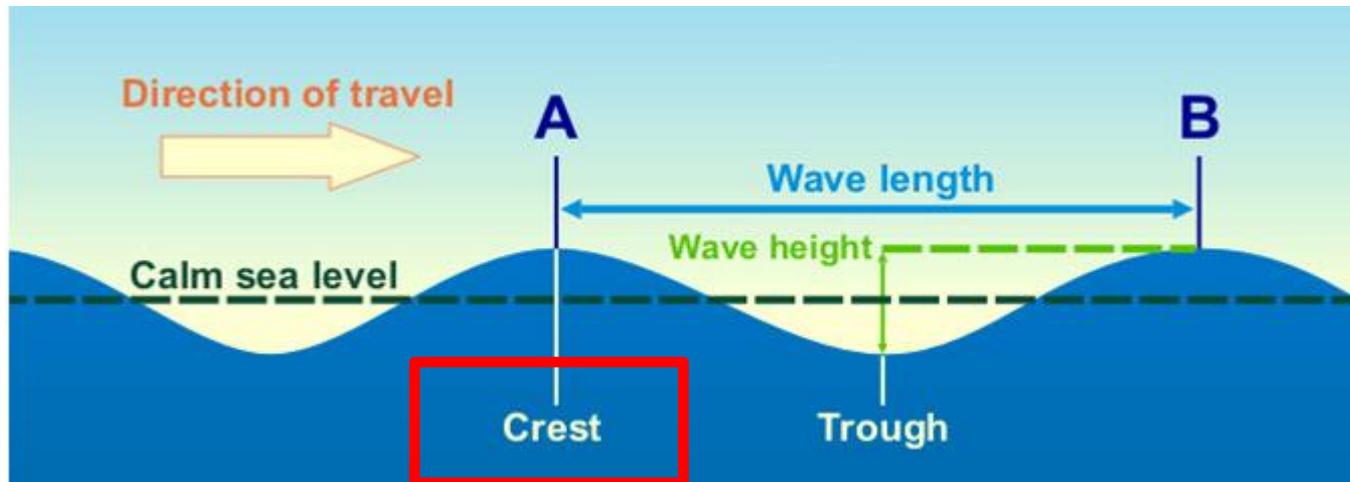
<http://www.sej.org/library/disasters/reporters-toolbox-covering-tsunamis>

Waves

Since waves are varied in their cause and size, scientists have named the parts of a wave so that we can accurately describe a wave.

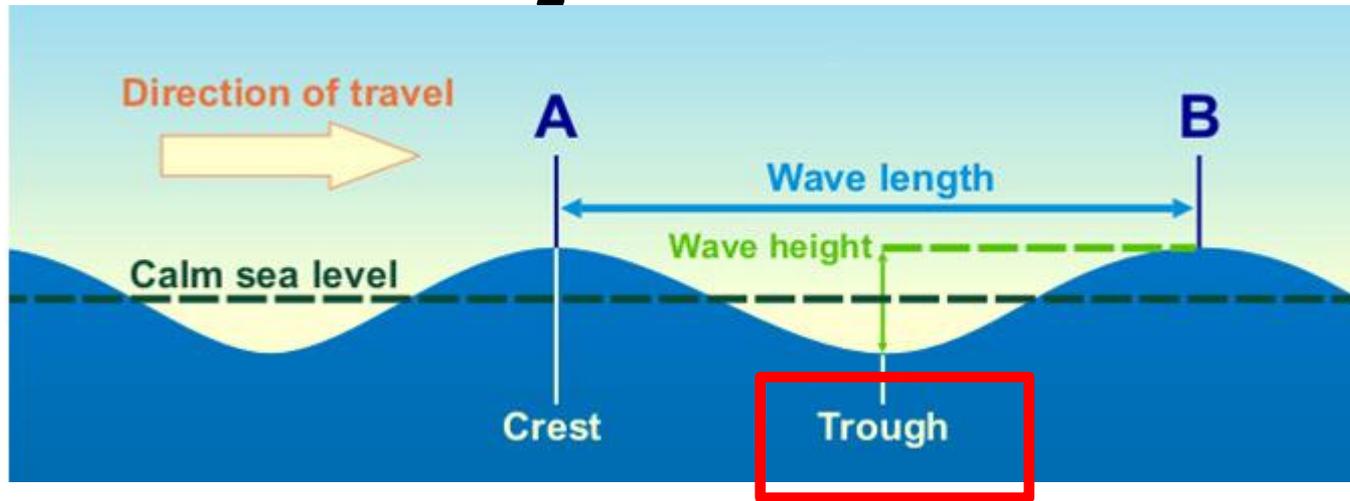


Anatomy of a Wave



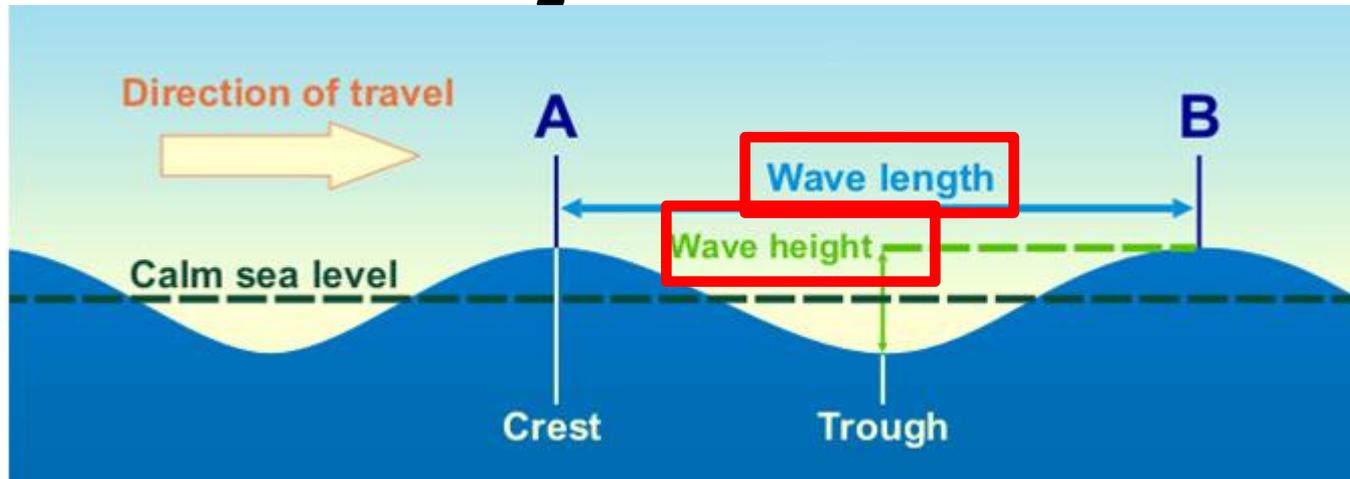
Crest: The highest point the medium (water) rises to from calm sea level.

Anatomy of a Wave



Trough: The lowest point the medium (water) sinks to from calm sea level.

Anatomy of a Wave



Wave Length: Distance from crest to crest.

Wave Height: Distance from trough to crest.

Rare and Unique Waves

There are some waves that are special or unique. These waves are often very destructive.

For example, a tsunami.



<http://www.tgdaily.com/general-sciences-features/50214-nasa-prototype-successfully-predicts-tsunami>

Tsunami

A tsunami occurs as a result of an earthquake. They are difficult to predict and impossible to spot until they reach land.



<http://news.nationalgeographic.com/news/2011/03>

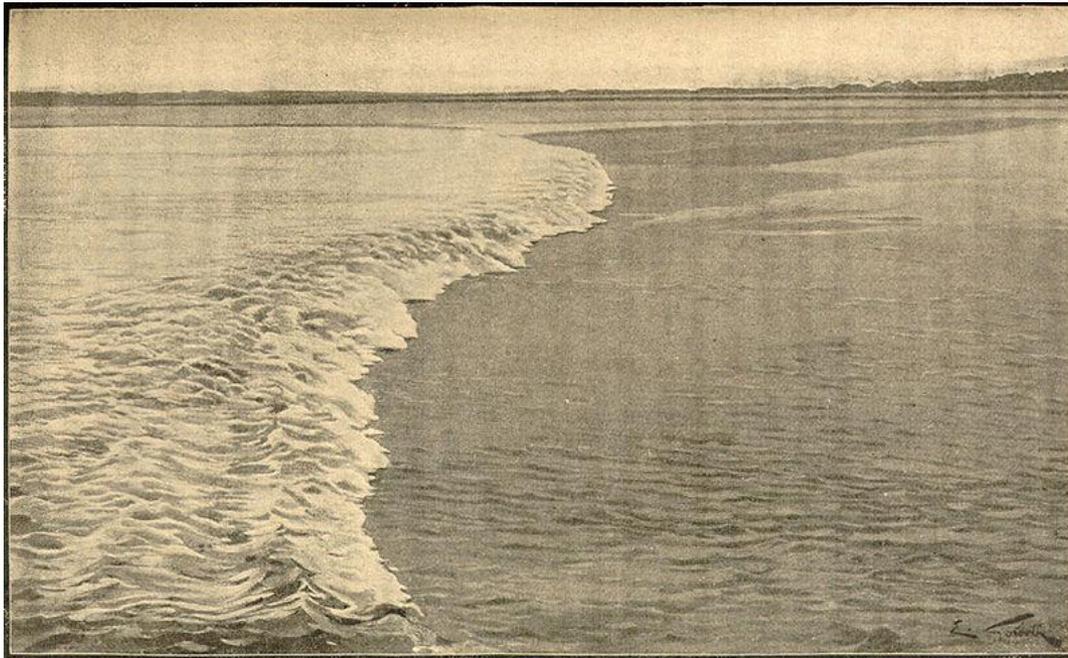
Rogue Waves

A large spontaneous surface wave. Impossible to predict. Scientists believe they are quite common. They have been known to sink ships.



Tidal Bore

The leading edge/wave of an incoming tide. They are common but can be very dangerous as they move very quickly and are extremely powerful.



<http://commons.wikimedia.org/wiki/File%3APetitcodiac-river-tidal-bore-1902.jpg>

Tides

Brainstorm Mat:

Tides

Think...

What are they?

What causes them?

When do they happen?

Tides

Tides are the rising and falling of sea level.



Twice each day,
water level in
the ocean rises
and falls again.

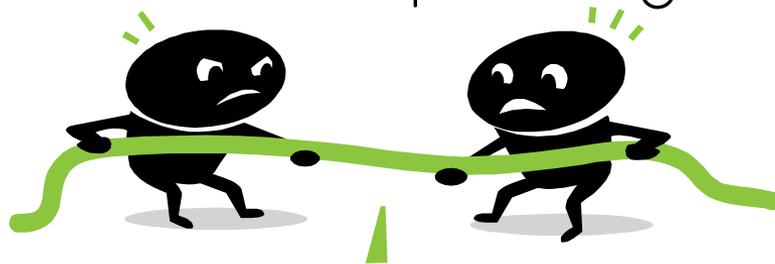
Tides

Tides are a very complex system but here are the basics...

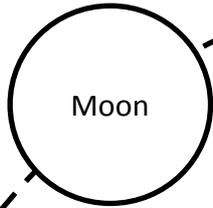
Tides are caused by the force of **gravity**.

Gravity is a force that pulls matter together. The Earth has gravity and the Sun and Moon also have gravity.

This means that the Earth pulls things toward it and the Sun and Moon also pull things toward them



Tides



The moon's gravity pulls on the water on Earth, creating a bulge of water on the side of the Earth closest to the Moon.

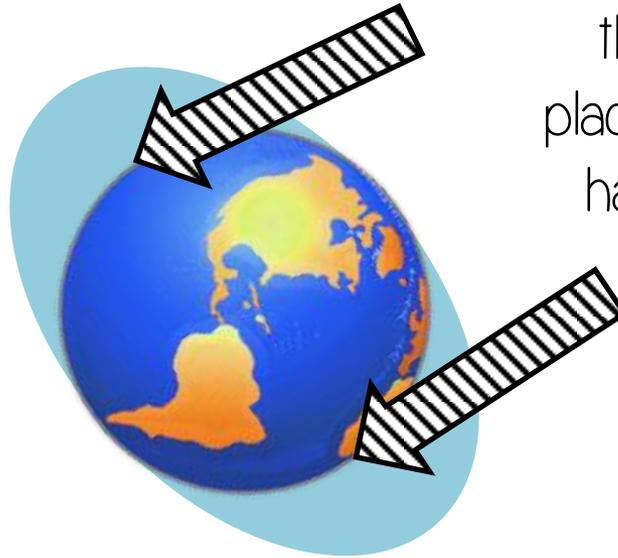
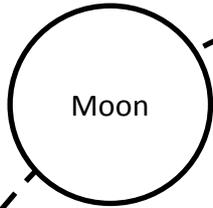


⋮

The moon's gravity also pulls on the Earth which pulls the planet closer to the moon, creating a bulge of water on the opposite side of the Earth.

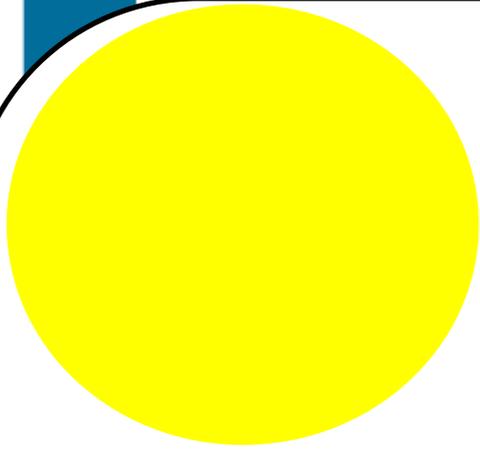


Tides

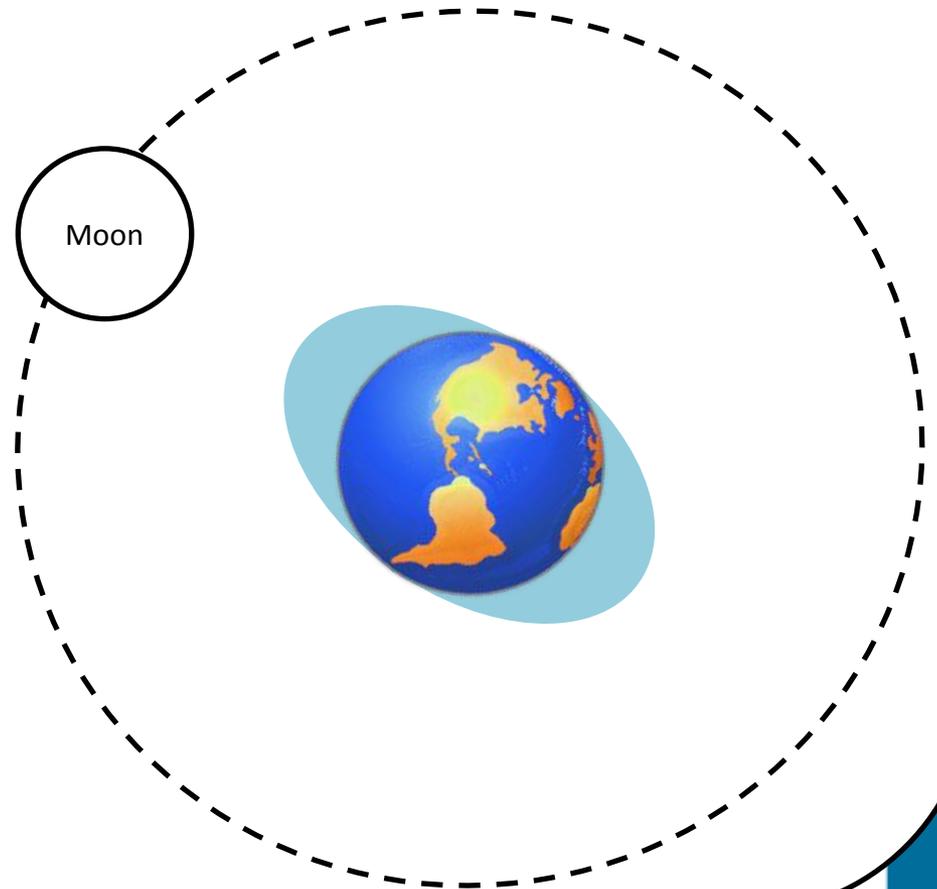


This means that two places on Earth have a high tide at the same time and two places have a low tide. This happens twice each day!

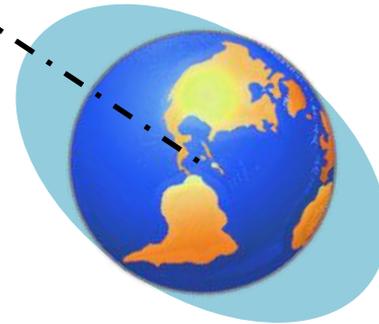
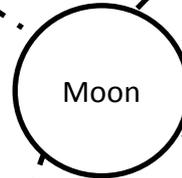
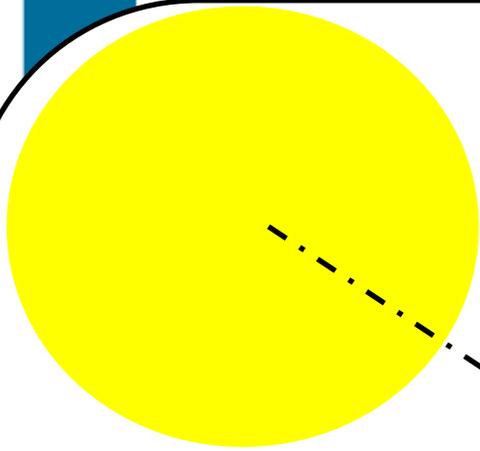
Tides



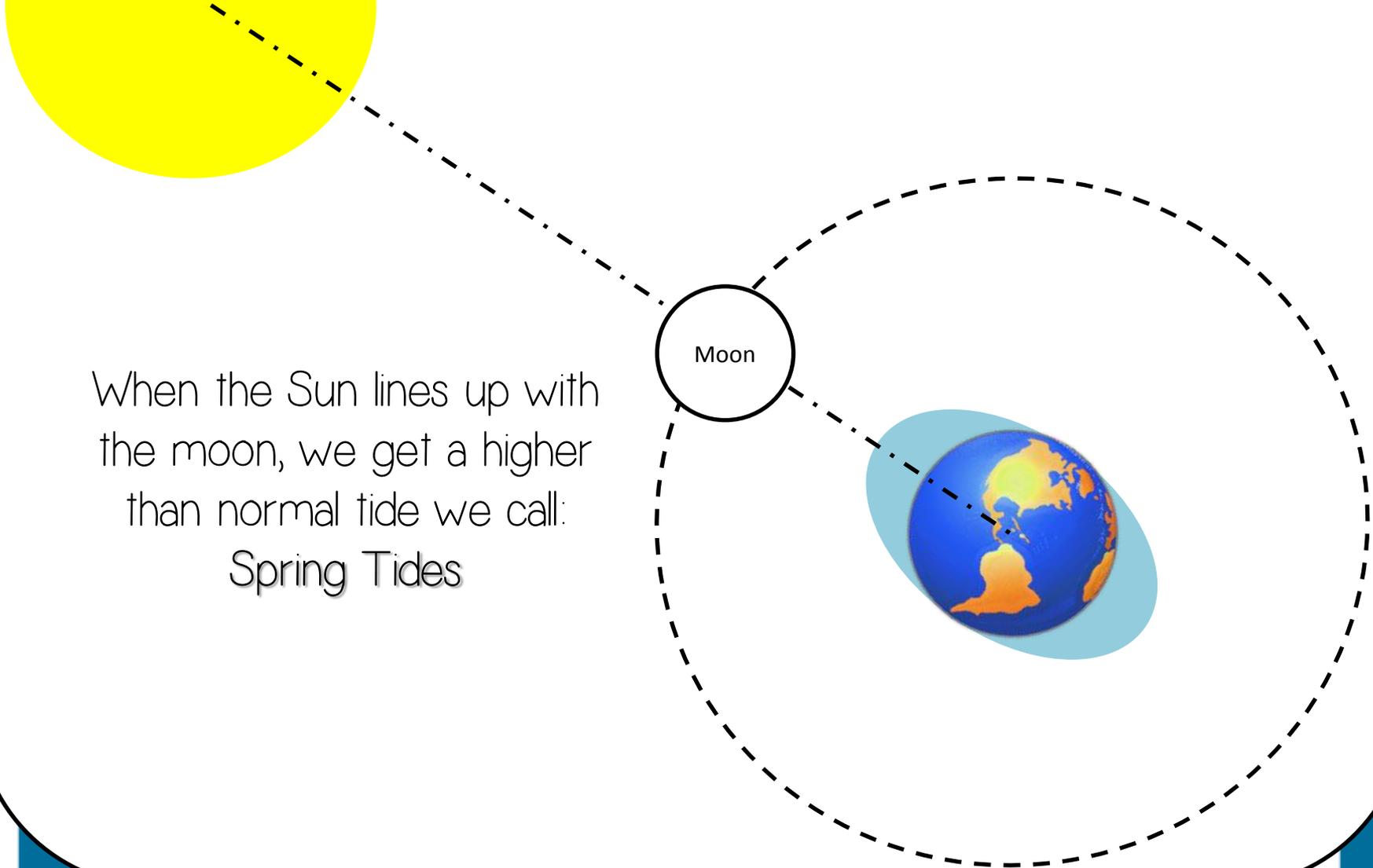
The Sun also has a gravitational pull on Earth. It is so far away that its force is weaker than that of the Moon, however, it still affects our tides.



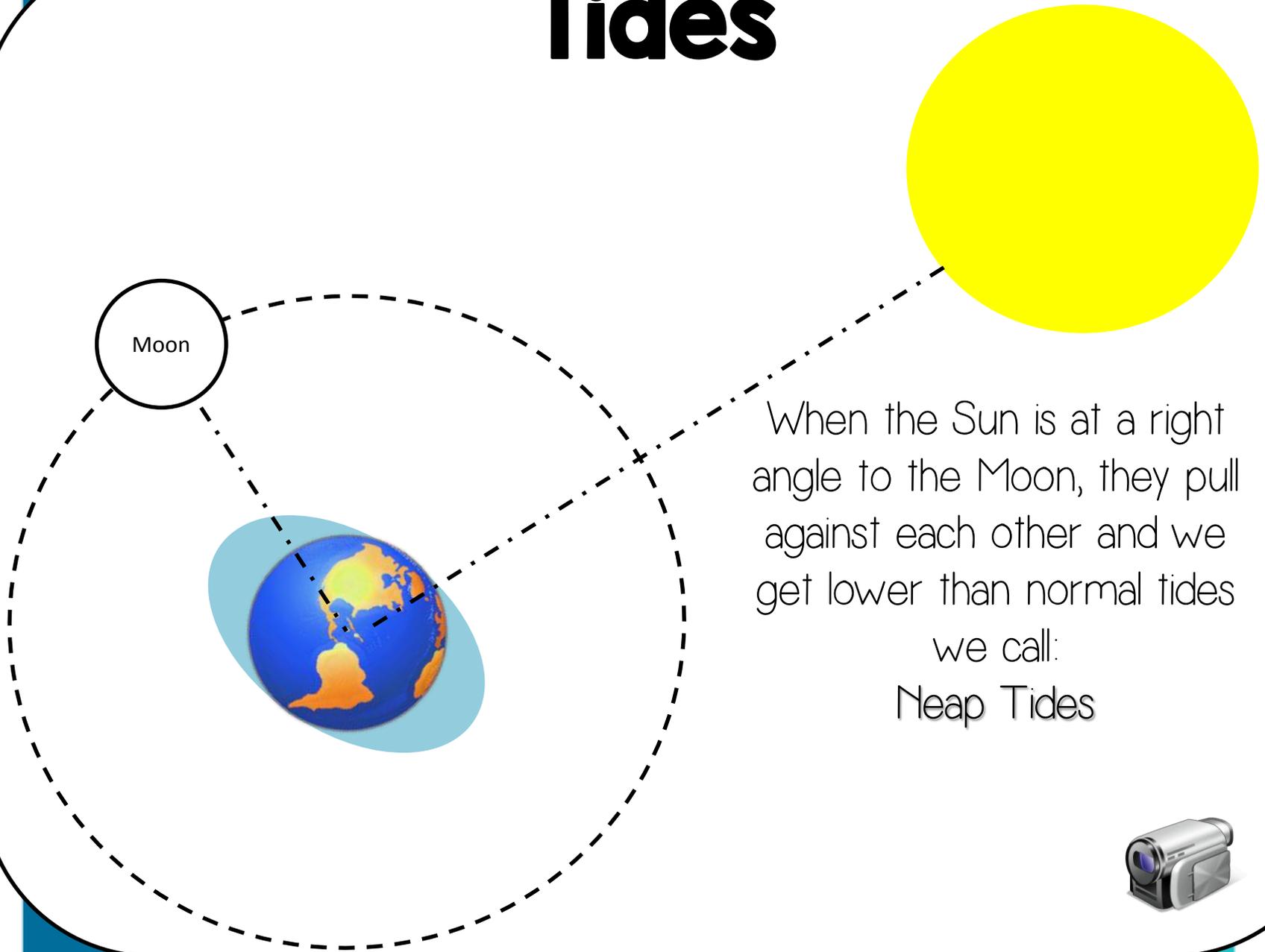
Tides



When the Sun lines up with the moon, we get a higher than normal tide we call:
Spring Tides



Tides



When the Sun is at a right angle to the Moon, they pull against each other and we get lower than normal tides we call:
Neap Tides



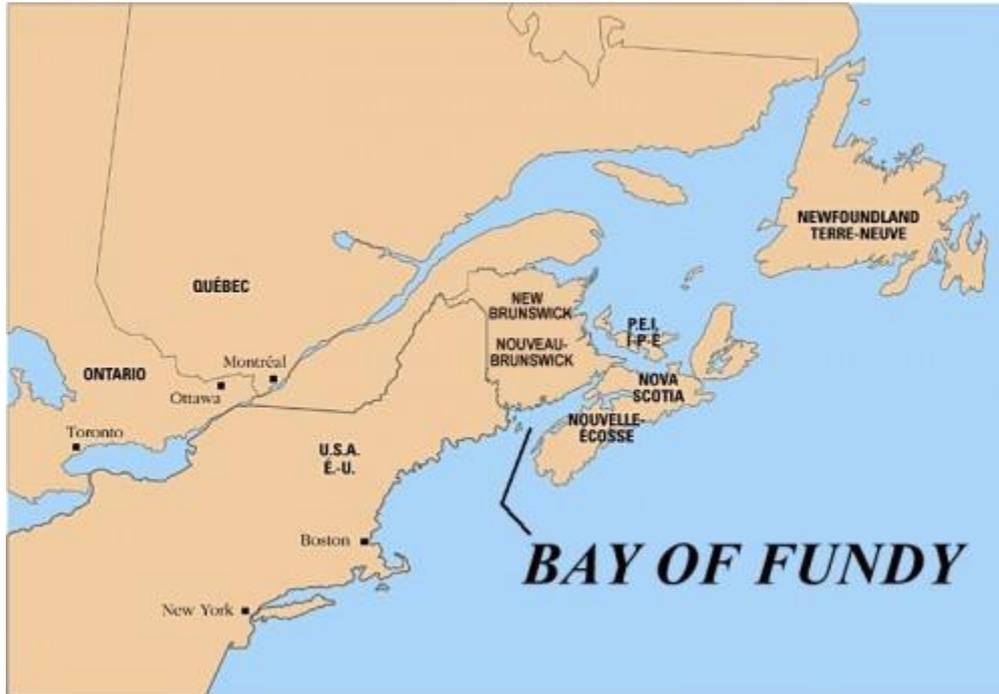
The Changing Tides



Some places have tides that change only by a few feet or meters. Other places have extreme changes in water height when the tides change.

Do you know where the highest tides in the world occur?

The Bay of Fundy

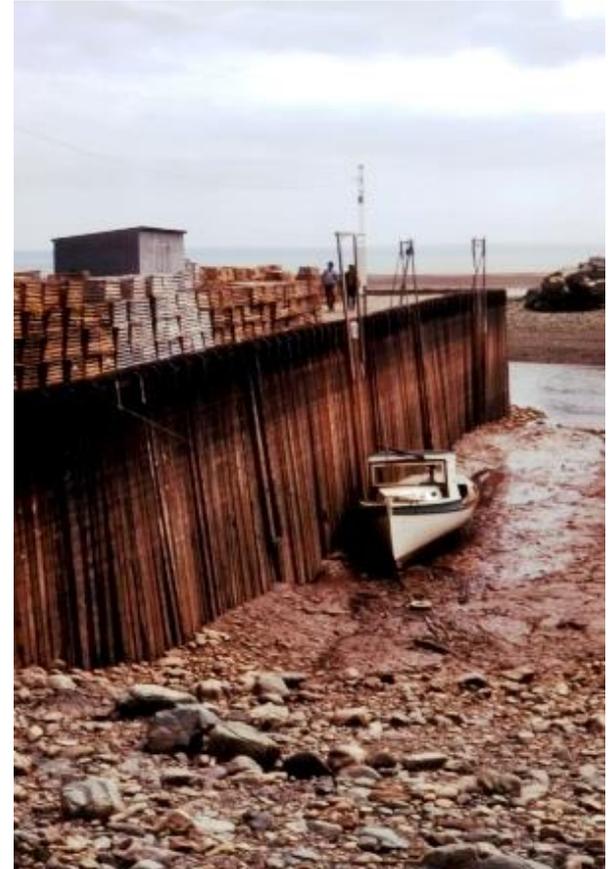


The Bay of Fundy is located around the provinces of New Brunswick and Nova Scotia in Canada

The Bay of Fundy



The tidal range of all oceans around the globe is 2 meters (3ft). In the Bay of Fundy, the tides change by 15 meters (50 ft) twice a day!



Bay of Fundy
Spring Tides

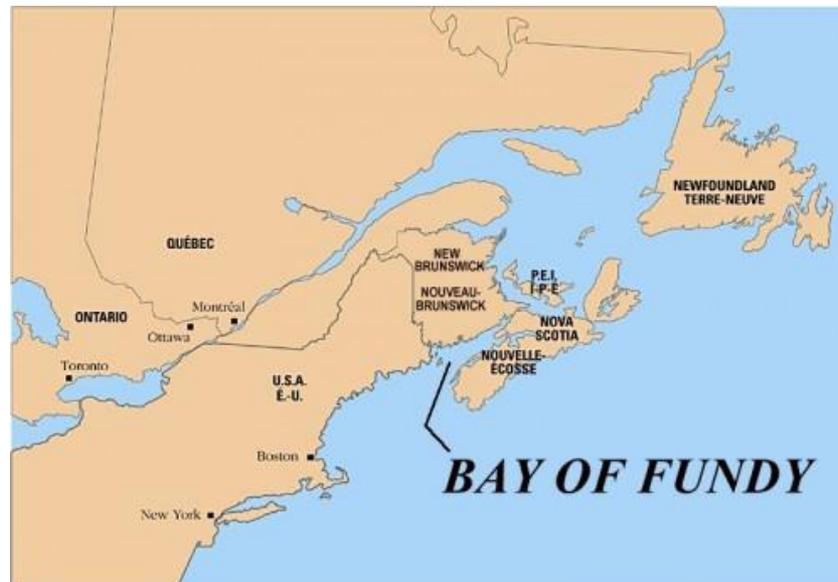
Bay of Fundy tidal range



Why?

Why do you think the tides in the Bay of Fundy are so much higher than other places in the world?

THINK ~ PAIR ~ SHARE



Bay of Fundy Tides



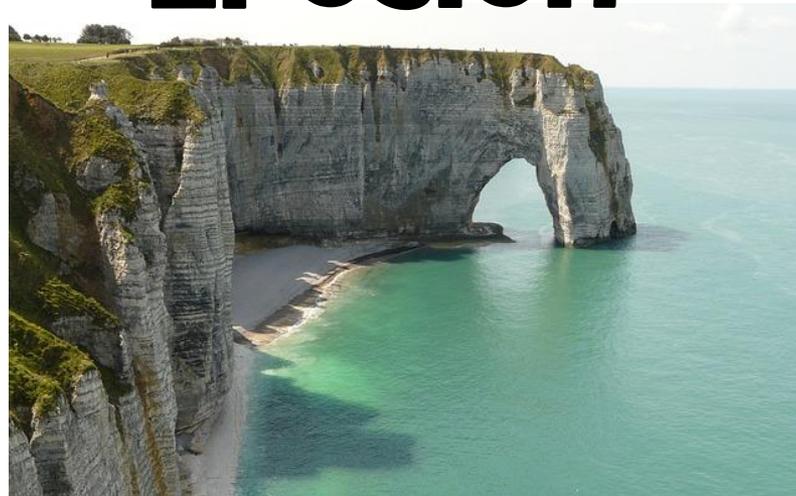
There are a number of factors that make Bay of Fundy tides so much different than other places in the world. There are two major factors.

The first, is a natural rocking motion in the Bay of Fundy we call resonance.

The second is the shape of the bay and the ocean floor.



Erosion



Investigation 1a

Shoreline Erosion

Discussion

What happened to your beach?



How might we prevent this?

Investigation 1b

Preventing Erosion

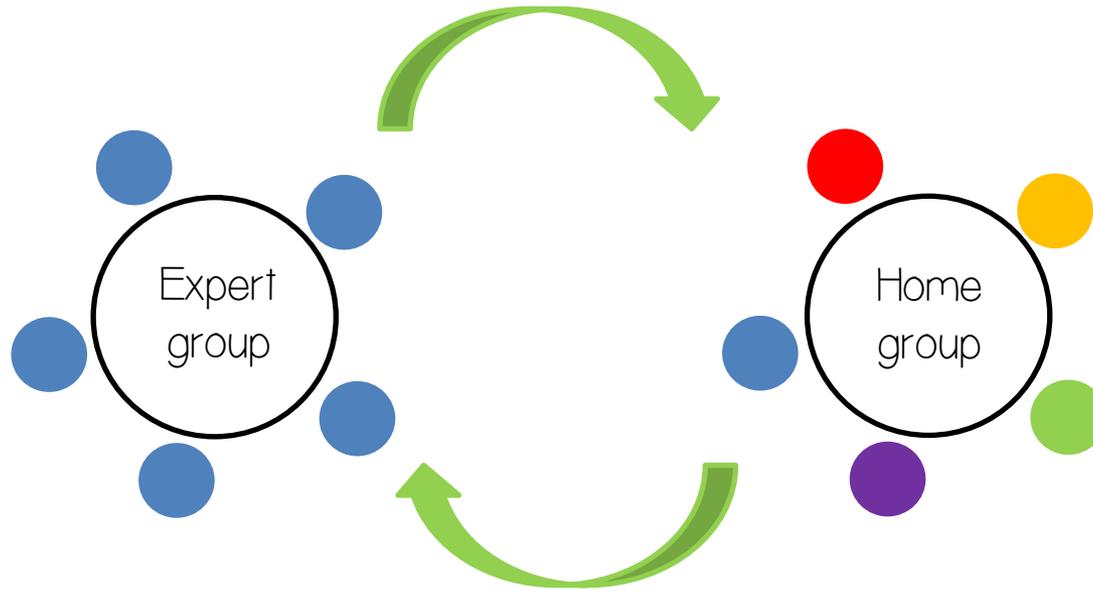
Discussion

What happened to your beach
after you put the rocks in
place?

Preventing Shoreline Erosion

Jigsaw

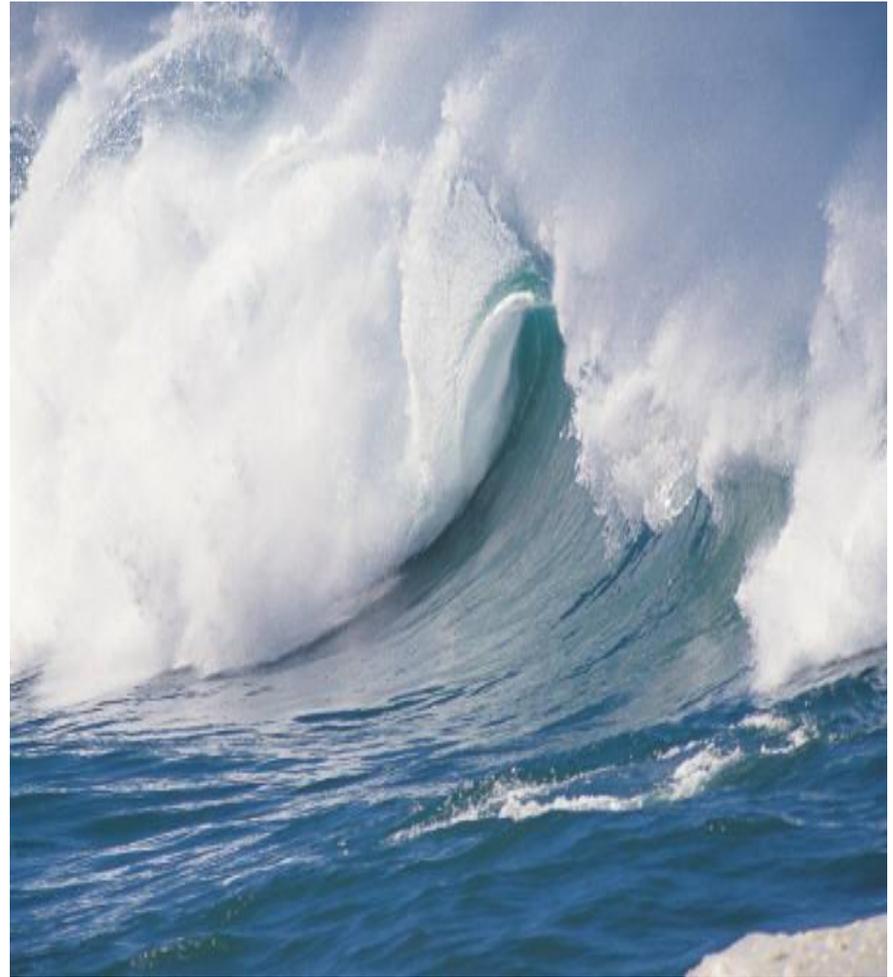
Report and
Discuss



Break Out
Group

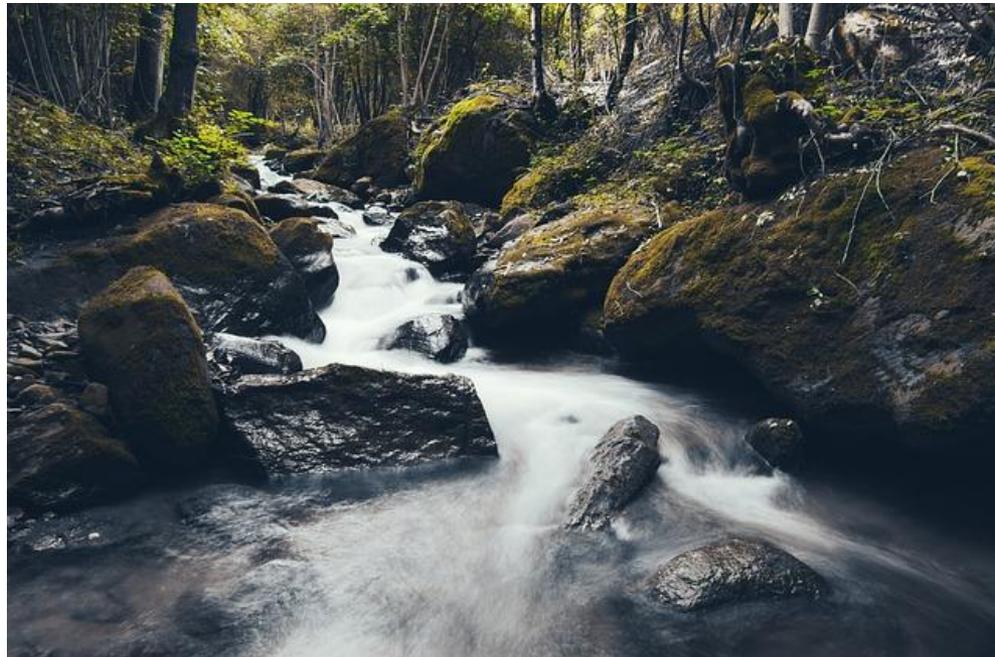
Ocean Currents

We know that waves and tides move the ocean water, but there are some other very powerful factors that affect the motion of the ocean!



Current

Have you ever felt the effects of current? Maybe you stood in a moving stream and felt the tug of the water. Maybe something more powerful in the ocean?



Ocean Currents

Ocean Current is simply a large amount of ocean water that moves in a particular and unchanging direction.



What could cause billions of tons of water to move in a particular direction constantly?

Let's find out!

Lake vs Ocean

How are lakes and oceans different?



Salinity

As we said, oceans have much saltier water than lakes do. In fact, oceans, on average, are 35 ppt and fresh water is just 0.5 ppt!



This means that in salt water for every 1000 grams of water you have, you would have 35 grams of salt.

So...how many grams of salt would be in 1000 grams of fresh water?

Salinity

As we said, oceans have much saltier water than lakes do. In fact, oceans, on average, are 35 ppt and fresh water is just 0.5 ppt!



This means that in salt water for every 1000 grams of water you have, you would have 35 grams of salt.

*So...how many grams of salt would be in 1000 grams of fresh water?
0.5 grams*

Salinity

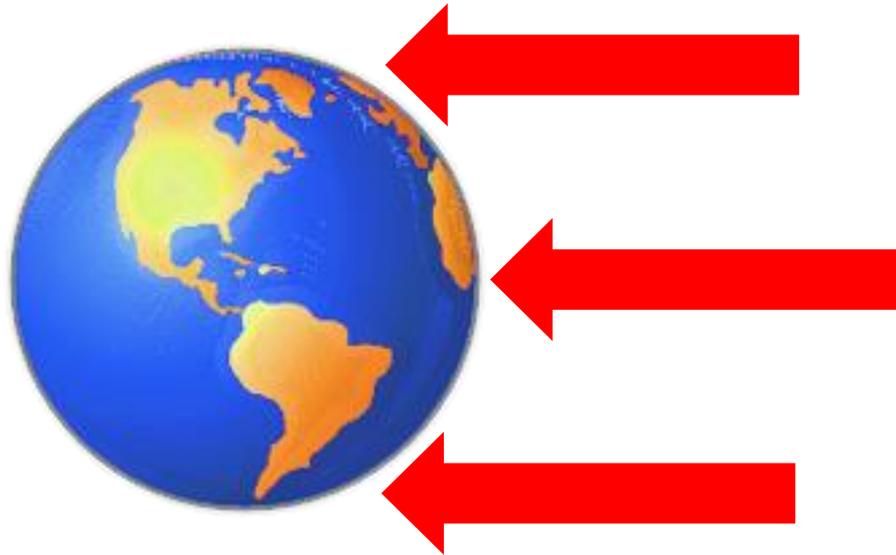
THINK~PAIR~SHARE



In what part of the ocean would you expect to find higher levels of salinity (more salt) and why?

Salinity

We would find higher salinity near the equator and the poles.



Salinity at the poles

At the poles, much of the water is frozen. Only the water molecules become solid and this leaves the salt behind.



Salinity at the equator

At the equator, it is hot! Water evaporates more rapidly, leaving salt behind.



Water Temperature

Where would you expect to find cold ocean water?



Warm ocean water?

Investigation #2: Water Density

Investigation #2 Discussion

In your investigation, you discovered that the water of various salinity and temperature layered themselves in the container like so.

Hot water
Cold water
High salinity



Investigation #2 Discussion

What is going on?

Hot water
Cold water
High salinity



Investigation #2 Discussion

The big idea here is **density**! As you know, cold water has a higher density than warm water. The water with the higher salinity has an even higher density than the cold water. The results is the layering effect you observed.

Hot water →
Cold water →
High salinity →



Density and Currents

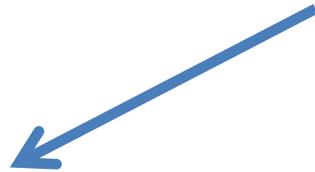
What does this have to do with ocean currents?

Let's find out!

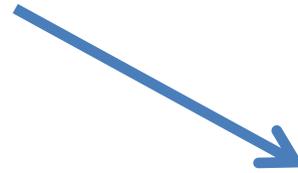
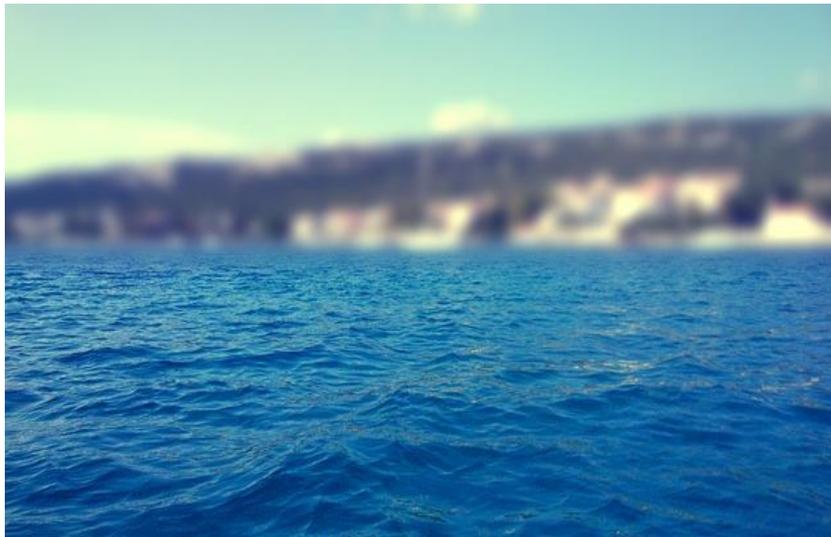


Ocean Currents

First, there are two types of ocean currents:



Surface Currents



Deep Water Currents



Surface Currents

Surface currents are caused by wind, the Earth's spin and the shape of the continents.



Wind

First, let's consider wind.

What causes wind?



Let's Watch this video:

<http://www.youtube.com/watch?v=uBqohRu2RRk>

Wind

As wind moves over the ocean, its energy is transferred to the water molecules on the surface which causes the ocean to move in the form of waves!



Coriolis Effect

As Bill Nye mentioned in his video, the Earth is spinning. This spinning motion also affects surface currents. We call this the Coriolis Effect. Here is how it works:

Let's Watch this video:

<http://video.mit.edu/watch/the-coriolis-effect-4407/>

How does this affect the ocean?

<http://www.youtube.com/watch?v=i2mec3vgeal>

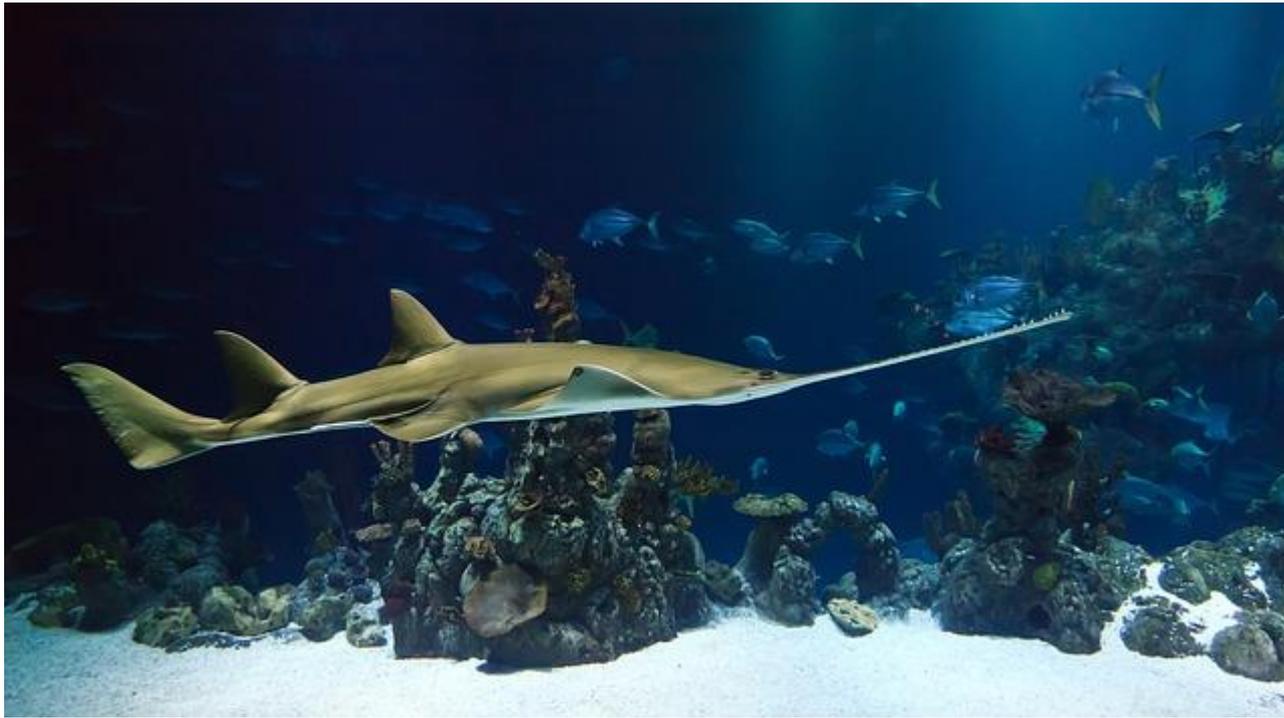
Shape of the continents

Water moving around the continents strikes the coastline and is diverted away. This affects currents.



Deep Water Currents

Deep water currents are caused by water temperatures and salinity.

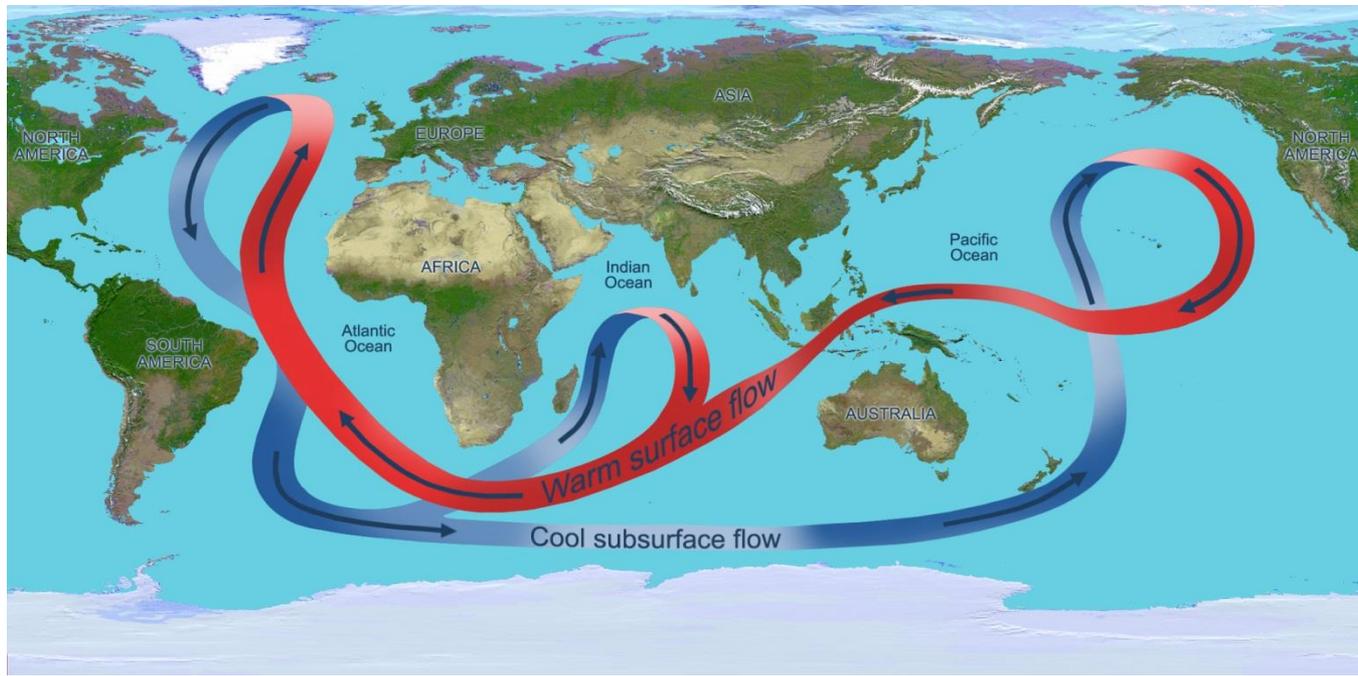


Temperature

As water cools in parts of the ocean, it sinks due to its increased density. This leaves space for the warmed water from other areas to move in. This movement creates what is referred to

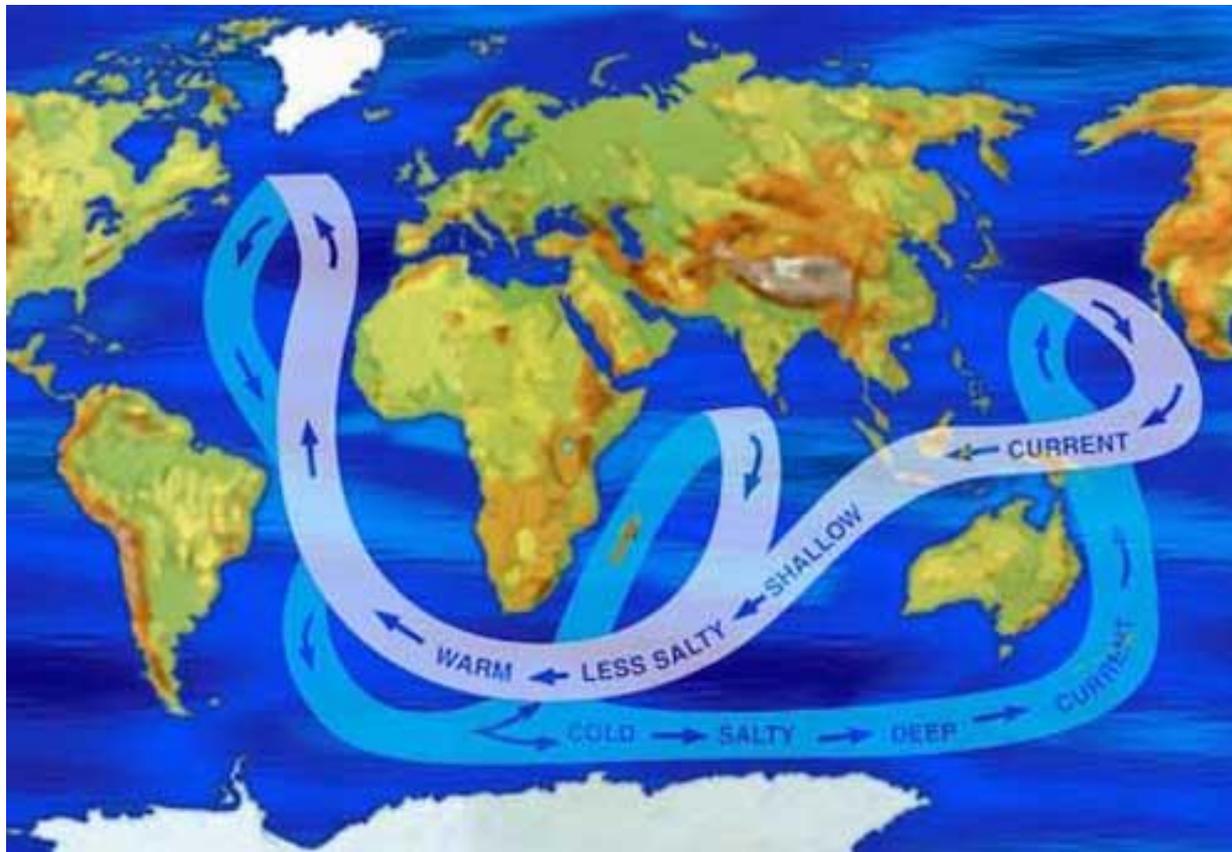
as

“The World’s Great Conveyor Belt”



Salinity

The salinity of the ocean follows a very similar pattern to the temperature differences.



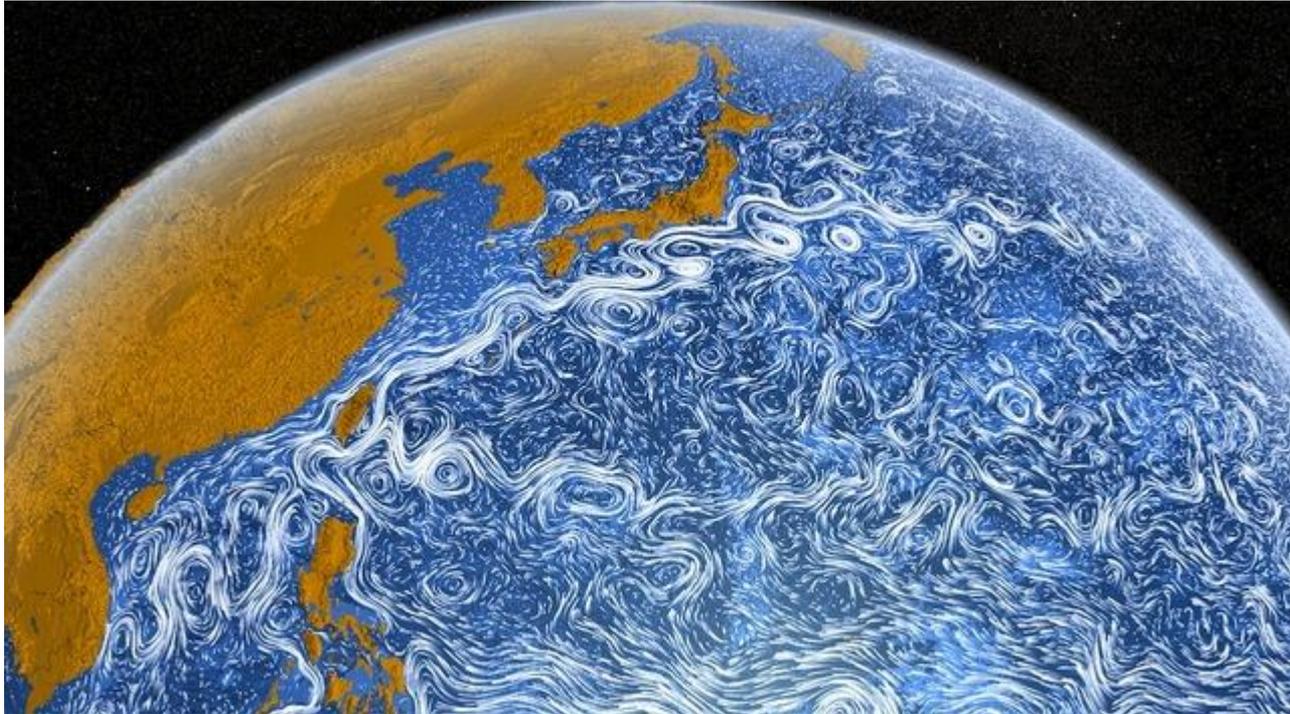
Tides

Tides are another factor in deep water currents.



Perpetual ocean

All of these factors lead to a complex systems of water movement that drives our weather and climate and supports life on Earth!



<http://www.youtube.com/watch?v=xusdWPuWAoU>

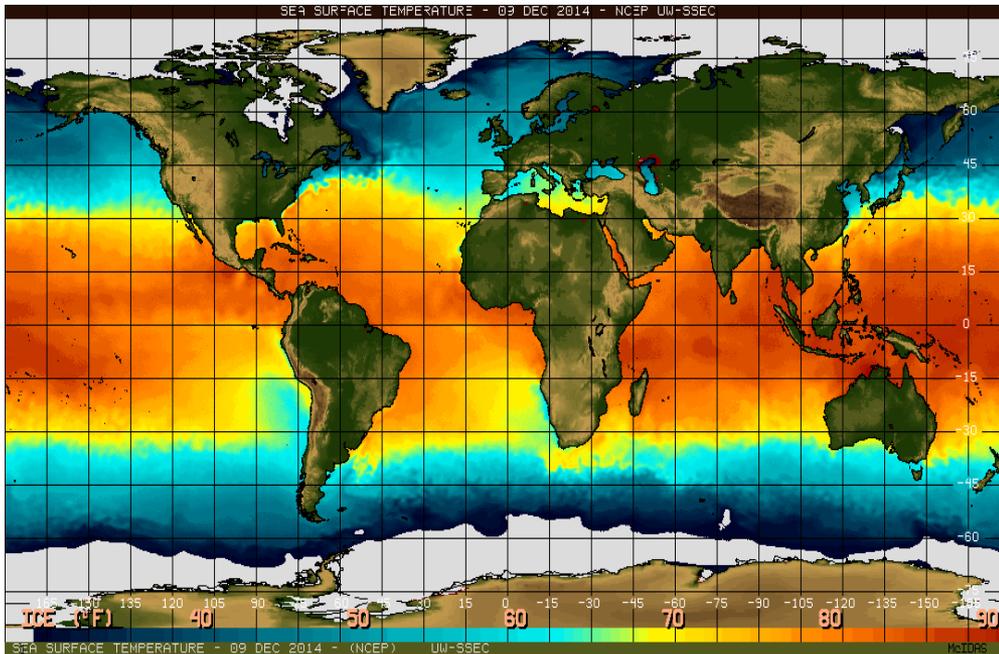
Oceans and Climate



Oceans have the ability to absorb, store and release heat and cold into the atmosphere which hugely affects our weather and climate.

El Nino & La Nina

El Nino and La Nina are climate events that are the results of temperature changes in the ocean.

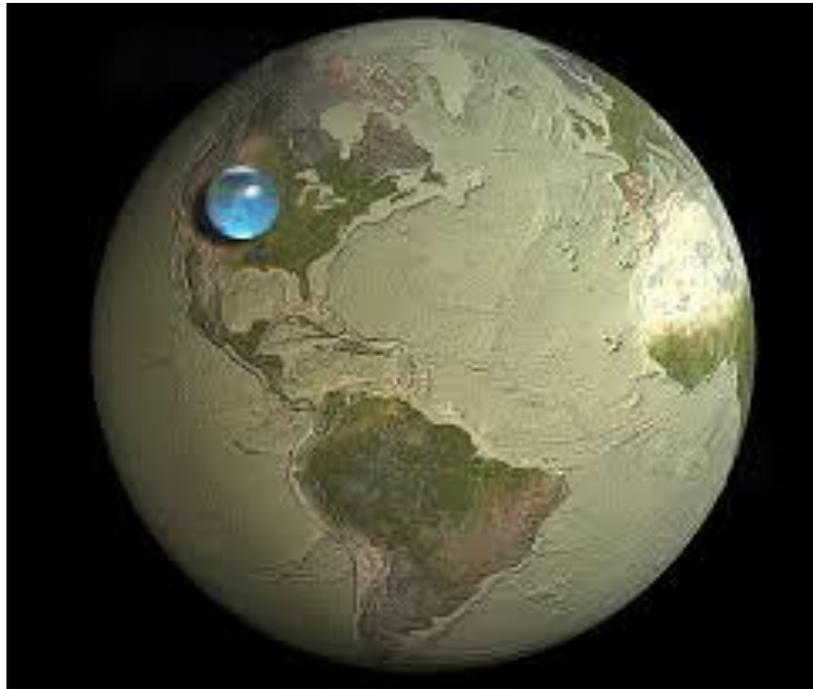


El Nino is characterized by unusually warm temperatures and La Nina is characterized by unusually cool temperatures



Ocean Basins

An ocean basin is a deep wide depression in the Earth's surface that contains water. Essentially, it is the ocean!



Where did these deep depressions come from?

Continental Drift

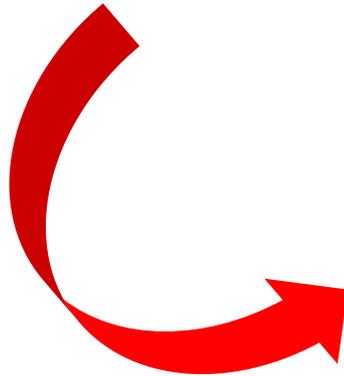
& Plate Tectonic Theory

In order to understand how ocean basins formed, we must understand continental drift.

And that all started with this guy

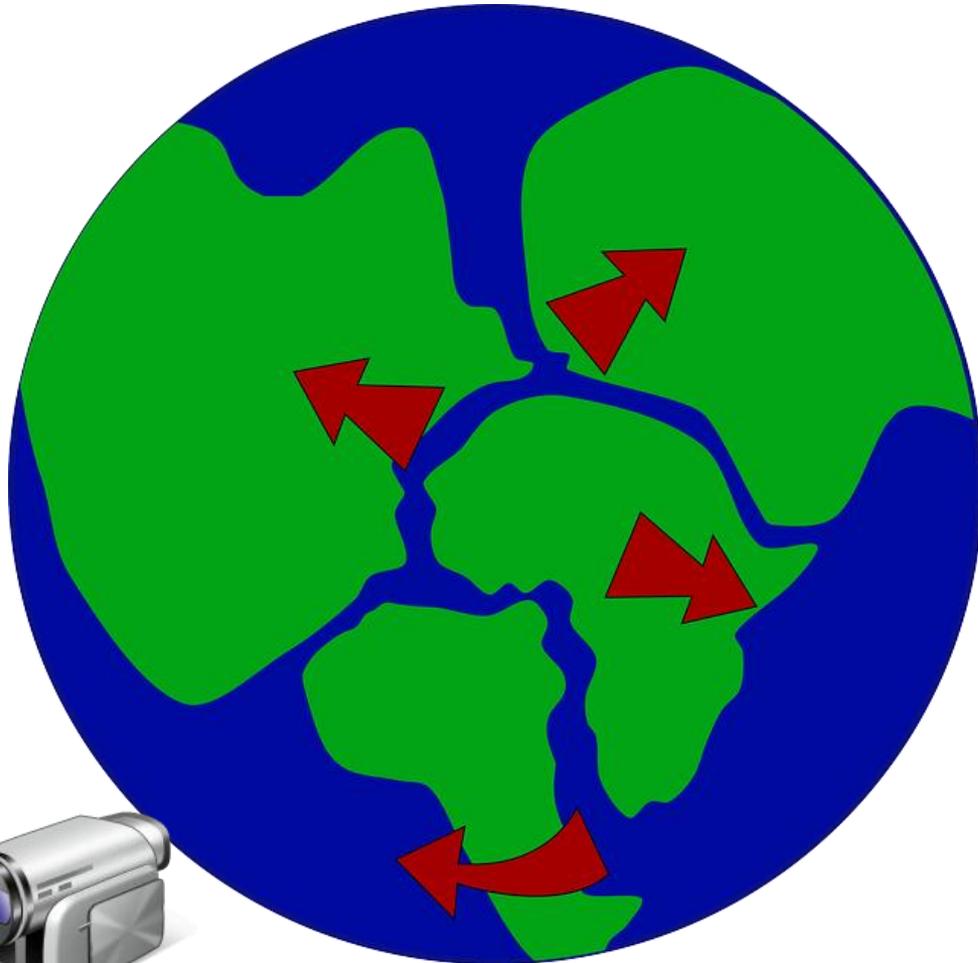


Alfred Wegener



Continental Drift

& Plate Tectonic Theory



As the continents “drift” apart, we have what is called sea floor spreading. This phenomenon leads to the creation of mountains, ridges and basins in the ocean!



Continental Drift

& Plate Tectonic Theory



The ocean has mountains too!
The longest mountain range in the world is under
the ocean.

It is over 40 000 miles long!
(64 375 kms)



Continental Drift

& Plate Tectonic Theory



The ocean has mountains too!
The longest mountain in the world is under the
ocean.

It is over 40 000 miles long!
(64 375 kms)



Glaciers



Glaciers are large sheets of ice that move.

They move very slowly and are very heavy!

Glaciers

Glaciers scrap away soil and rock as they move across the land.

When they retreat or melt, they leave piles of rock.



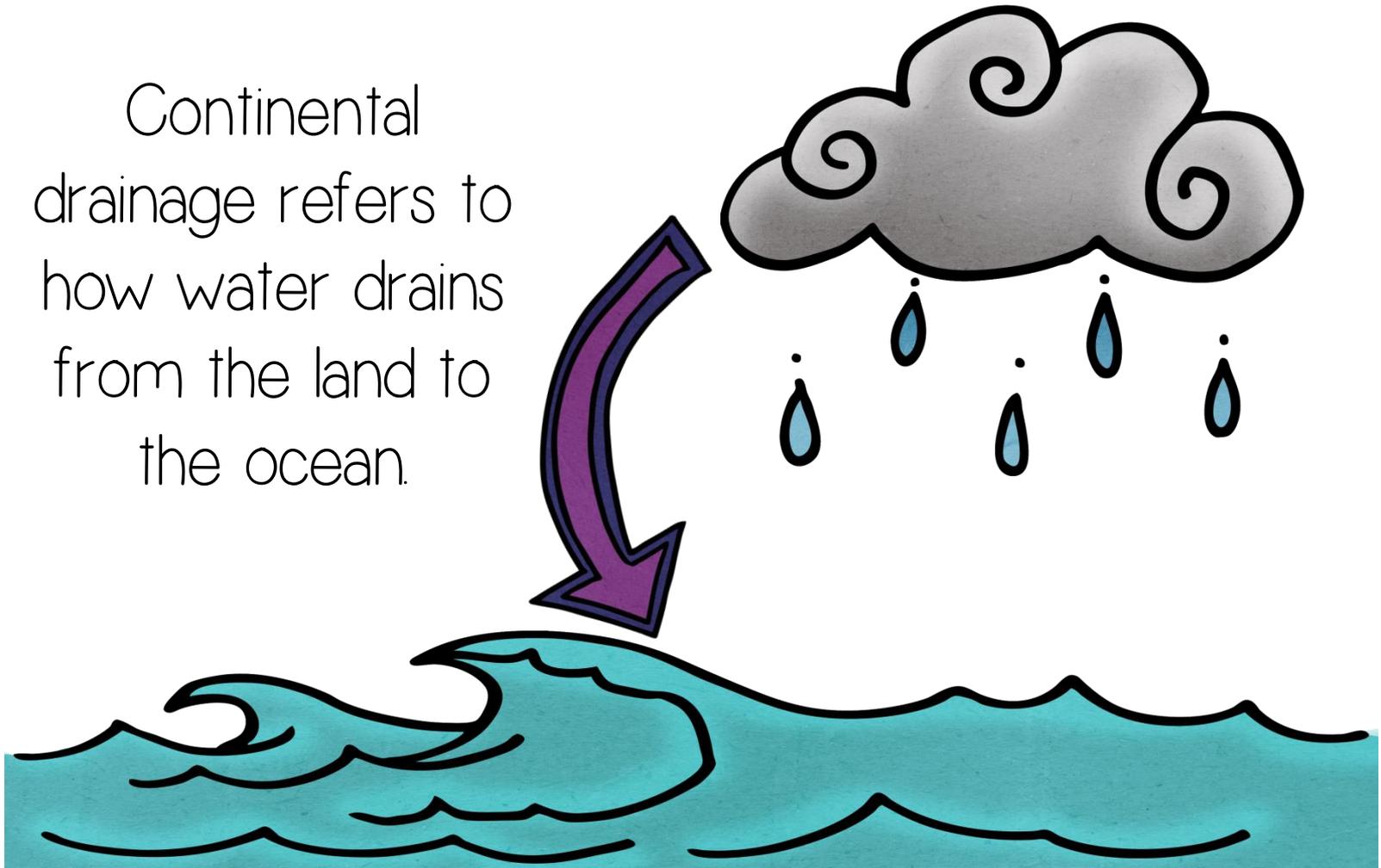
Forming Earth

So far, we have seen that continental drift, glaciers, erosion and volcanic action have helped for Earth as we know it.



Continental Drainage

Continental drainage refers to how water drains from the land to the ocean.



Continental Drainage



Exploring the Ocean

Humans have been interacting with and learning about the ocean since the dawn of time.

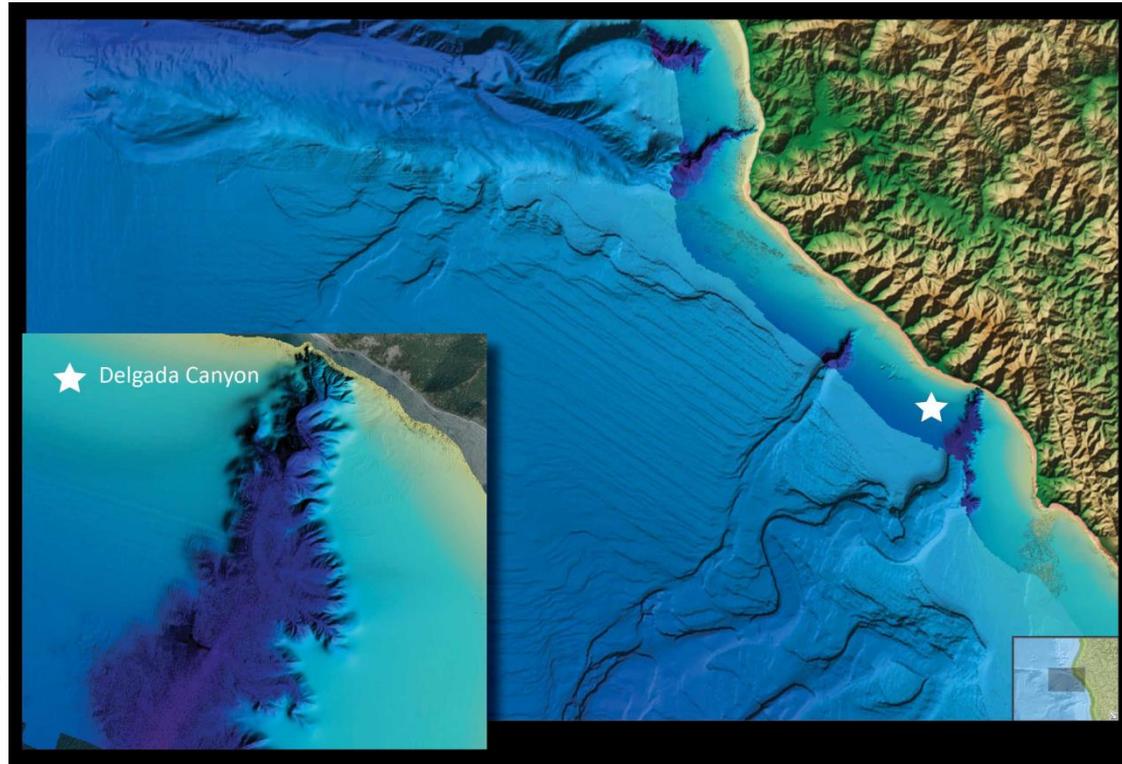
Even now, however, we know very little about them.



Investigation #3

Mapping the Ocean Floor

Mapping the Ocean



We now have new technology that allows scientists to explore parts of the ocean we have never been able to reach before!

Mariana's Trench

The deepest part of the ocean is now being explored!
Mariana's Trench is the deepest part of the ocean.

10,994 meters
(36,070 feet)

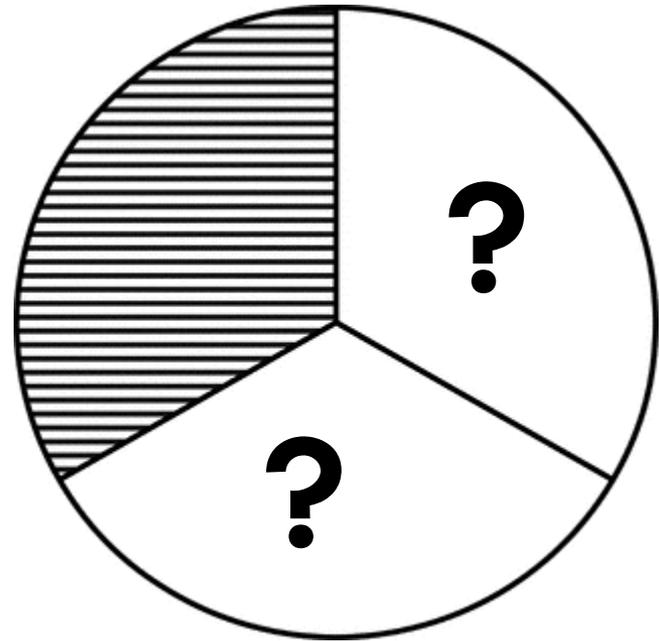


Map of the Oceans



Ocean Habitats

Oceans are vast and complex. Scientists estimate that between 50 and 80% of all life on Earth is found below the ocean surface! They also predict that we have only discovered about 1/3 of the species that currently exist in the ocean!



Ocean Habitats

Where do organisms live in the ocean?



Just like organisms living on land require certain habitats and have life requirements, ocean dwelling organisms do as well!

Ocean Habitats

Where do organisms live in the ocean?

Let's consider the Orca, or Killer Whale.

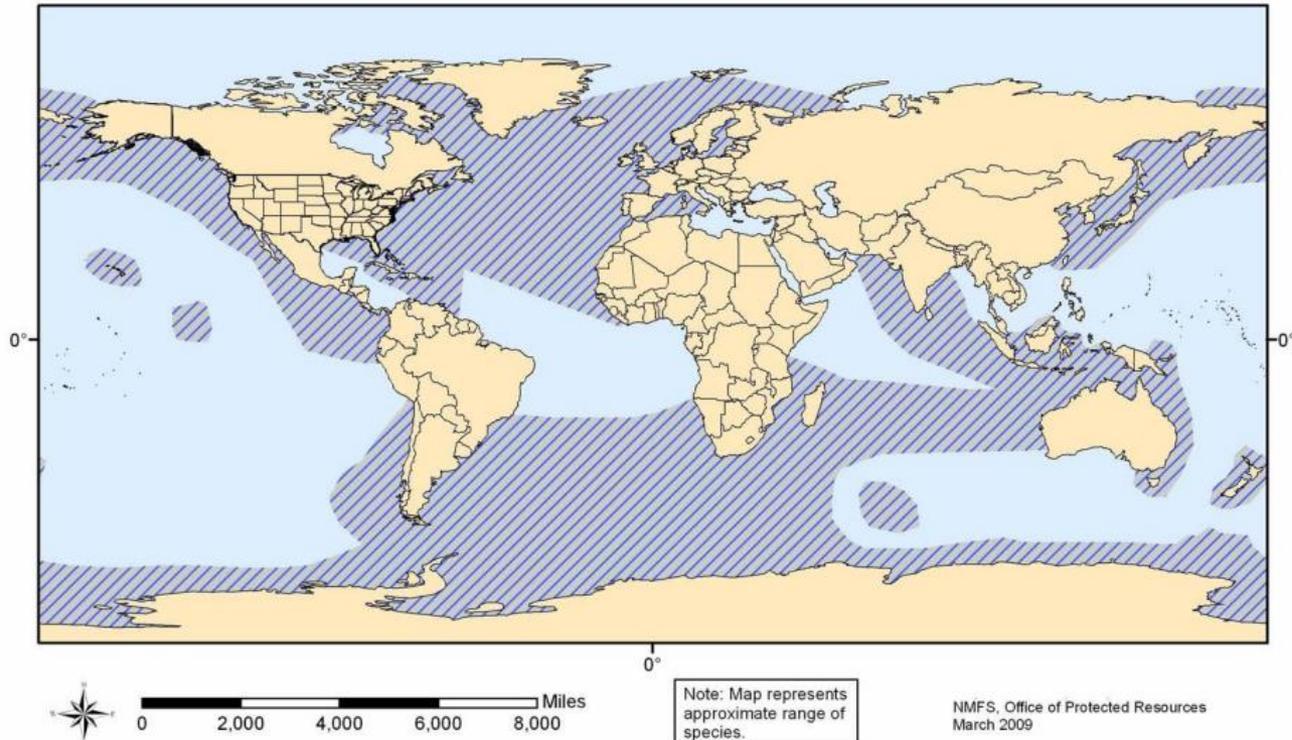
The Killer Whale is the largest dolphin in the world!

In what part of the ocean would you find an Orca?



Ocean Habitats

Killer Whale Range



Killer Whales can be found in almost all parts of the ocean but they prefer cooler water and coastal areas. Why do you think that they tend to stay in those areas?

Ocean Habitats

Why do Killer Whales (Orcas) prefer cooler water near the coast?

THINK ~ PAIR ~ SHARE

Ocean Habitats

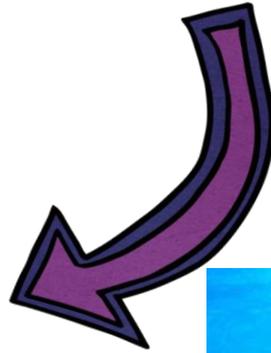
FOOD!



Let's consider the population of Orca's living along the West Coast of North America in the Pacific Ocean.

Ocean Habitats

Pacific North American Orca Populations



Ocean Habitats

North Pacific Orcas eat primarily Chinook Salmon, Harbour Seals, Dall's Porpoises and California Sea Lions.

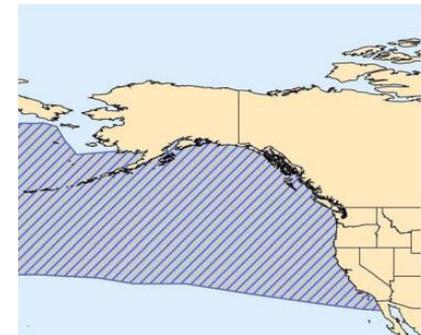
Here are their distribution maps:



Chinook Salmon



Harbour Seal's



Dall's Porpoise



California Sea Lion

What do you notice?

Ocean Habitats

Food supply is just one factor affecting where you find organisms living the ocean.

There are many other factors that affect where organisms live. There are ABIOTIC factors or non-living factors.

Temperature

Salinity

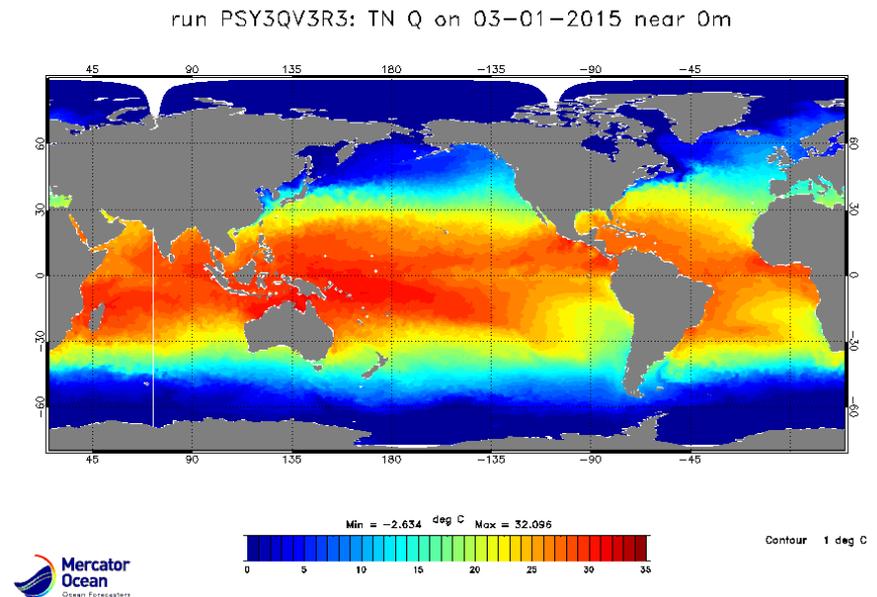
Currents

Upwelling

Ocean Habitats

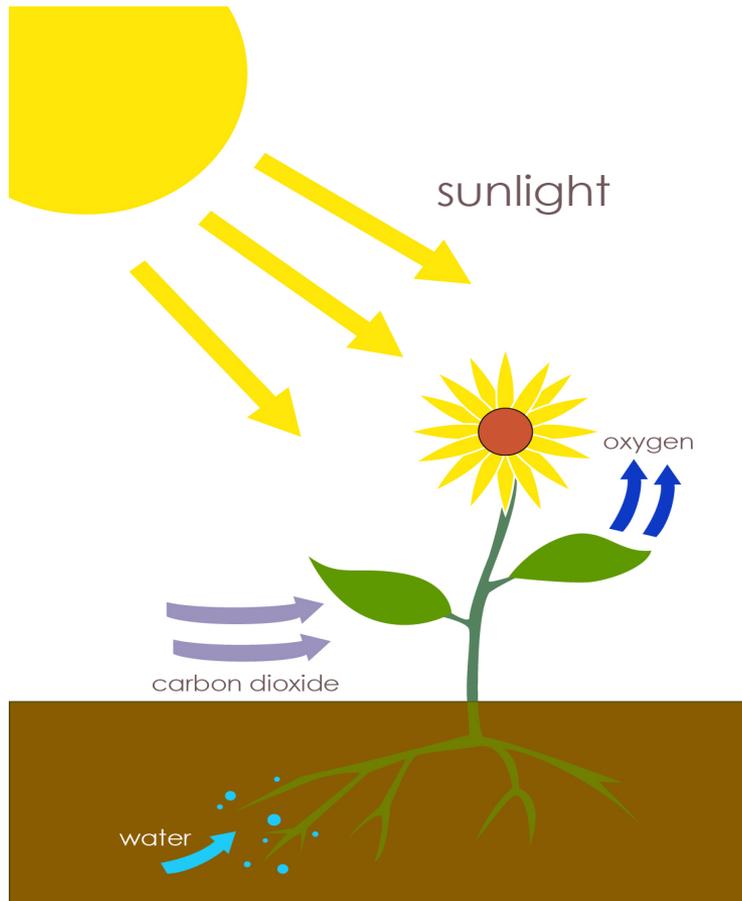
Temperature

Water temperature is one of the most important parameters to habitat. Water temperature not only physically affects the properties of the water but also alters the chemical properties of water!



Ocean Habitats

Temperature



Water temperature can effect the metabolism of organisms and affect photosynthesis production.

Ocean Habitats

Temperature

Water temperature can affect the amount of dissolved oxygen (and other gases) in the water.

Just like we need to breathe air, aquatic organisms need dissolved oxygen to respire (breathe).



Ocean Habitats

Temperature

Warm water contains LESS dissolved oxygen than cold water



Fish “breathe” the oxygen in water by running over their gills. There is less oxygen in the gills and so the oxygen moves into them by “diffusion”.

Ocean Habitats

Temperature

Water temperature also affects water density. We saw this with our investigation of water density experiment.

Hot water
Cold water
High salinity



Ocean Habitats

Temperature

Temperature can also affect the salinity of water.

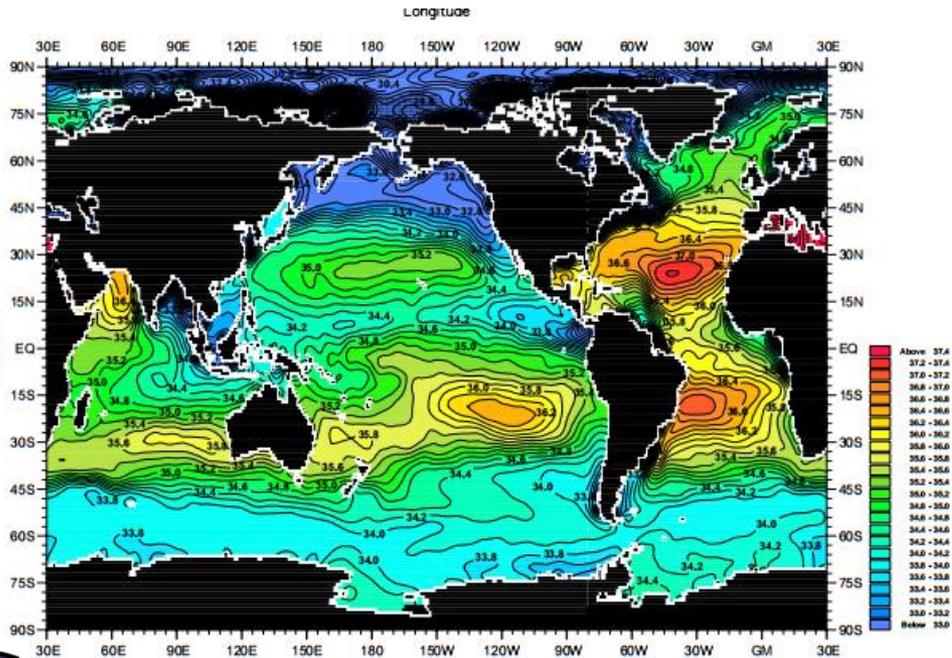
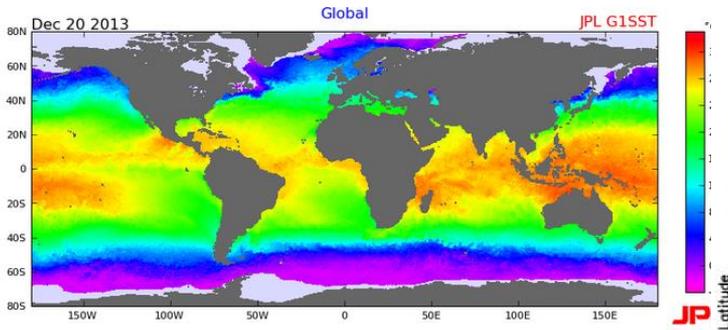


Fig. A2-1. Annual mean salinity (PSS) at the surface.

Minimum Value= 2.37

Maximum Value= 40.37

Contour Interval: 0.20

World Ocean Atlas 2001
Ocean Climate Laboratory/NOEC

Ocean temperatures

Ocean salinity

Ocean Habitats

Salinity

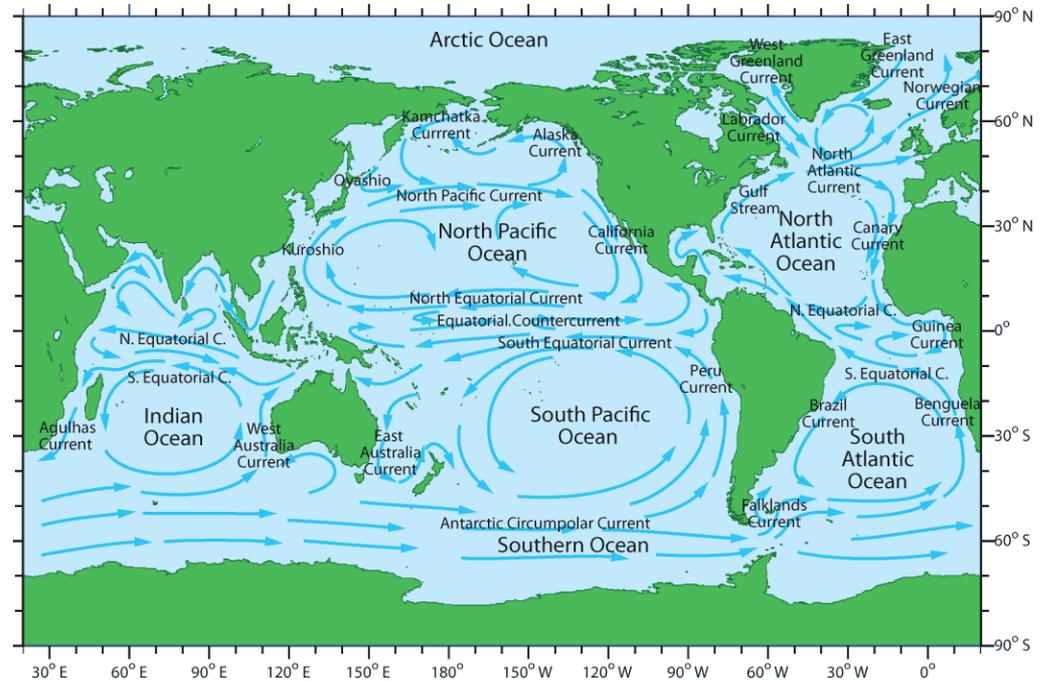
Salinity (saltiness) affects ocean organisms in a variety of ways. First, many marine organisms are highly affected by salinity as it affects their ability to move water in and out of their cells. This means that they can dehydrate if there is too much and bloat if there is too little. Both of these can be fatal.



Ocean Habitats

Salinity

Another way that salinity affects marine species is by affecting ocean currents and thus climate as we seen in previous lessons.



Ocean Habitats

Currents

Ocean currents are very powerful and move heat and water around the globe.

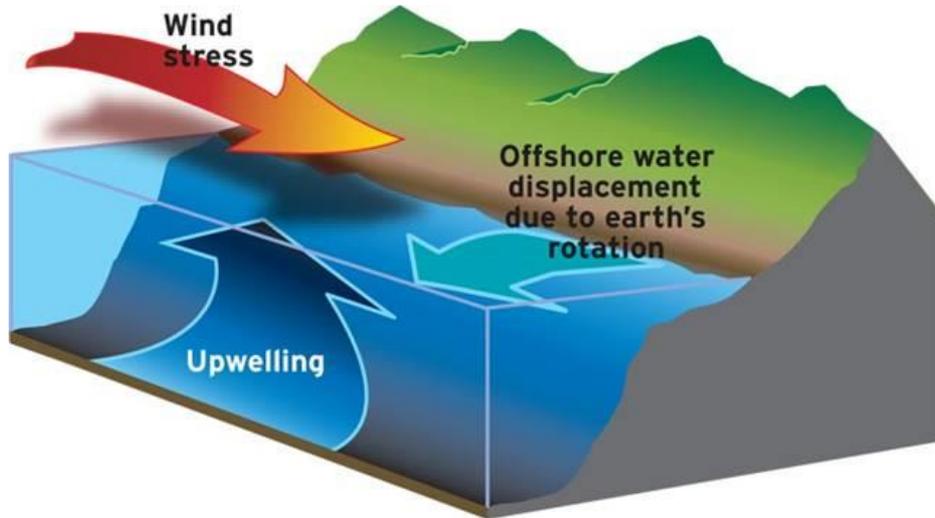
They can even be a method of transport for some species.

Loggerhead turtles “ride” the EAC (East Australian Current) from Peru to Australia.



Ocean Habitats

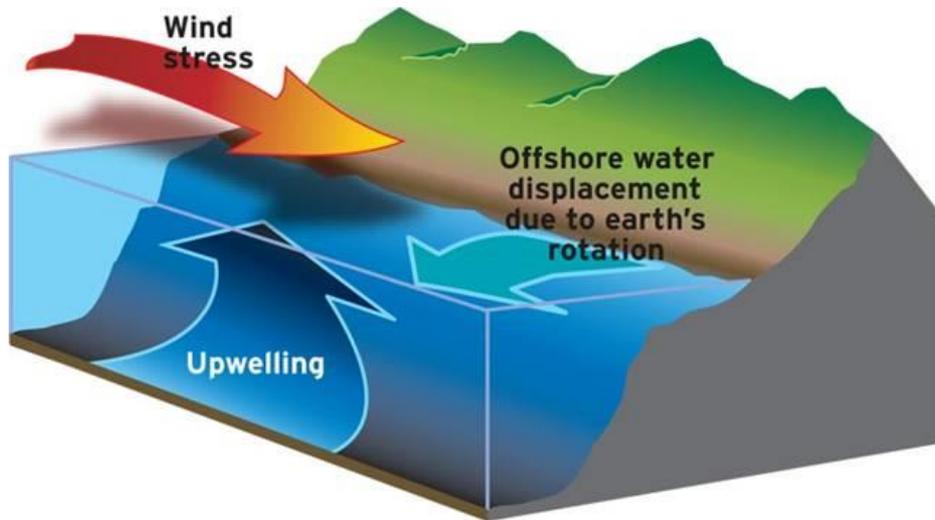
Upwelling / Down welling



Upwelling and down welling are two types of current motion. They strongly influence the distribution and abundance of marine life in the ocean.

Ocean Habitats

Upwelling / Down welling

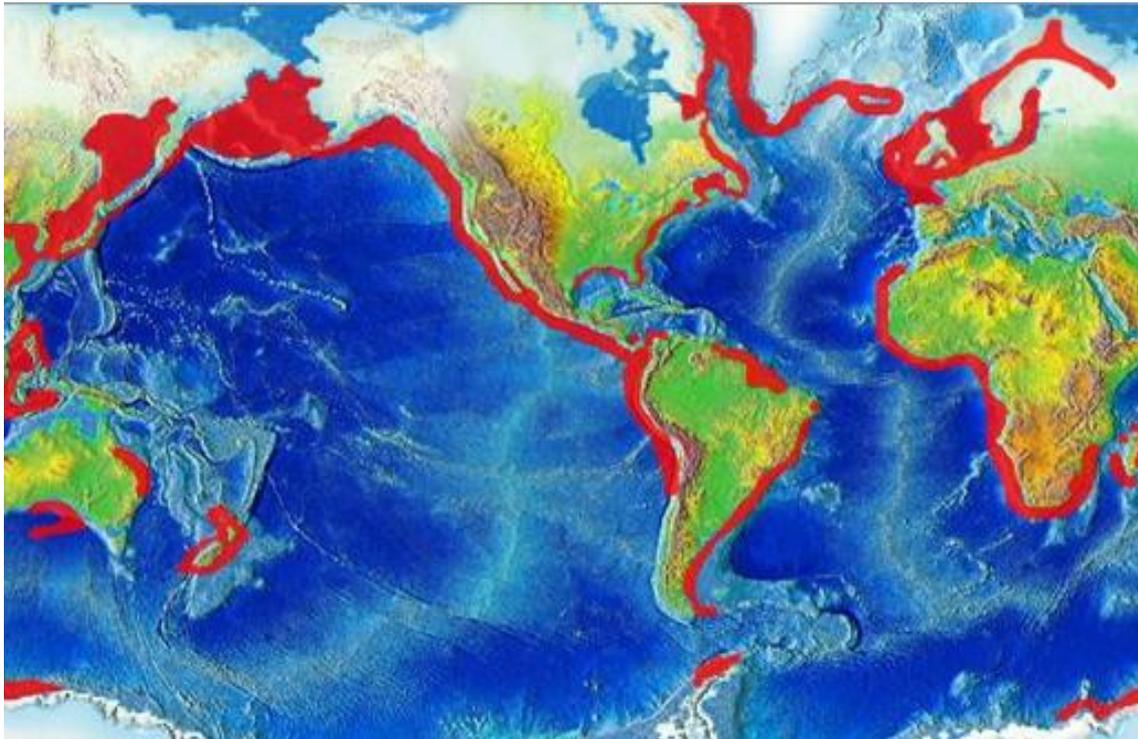


Upwelling is when currents flow upwards bringing nutrients to the surface from the bottom of the ocean.

Down welling is when currents flow downwards bringing nutrients from the surface from the bottom of the ocean.

Ocean Habitats

Upwelling / Down welling

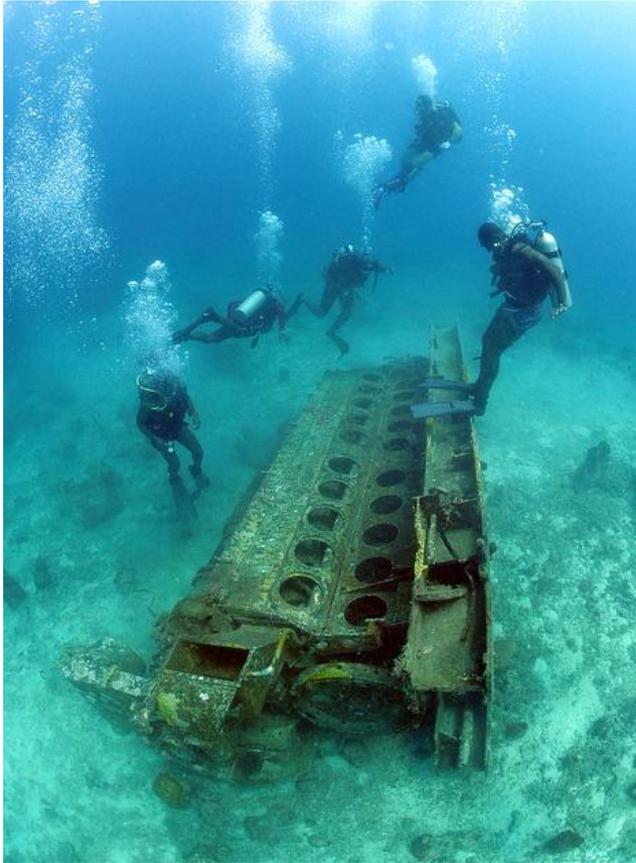


Major upwelling and down welling sites around the globe.

Where would you expect to find the most organisms?

Ocean Habitats

Human Effects



Many human activities and technologies impact the ocean.

Can you think of any way that humans impact the oceans?

Ocean Habitats

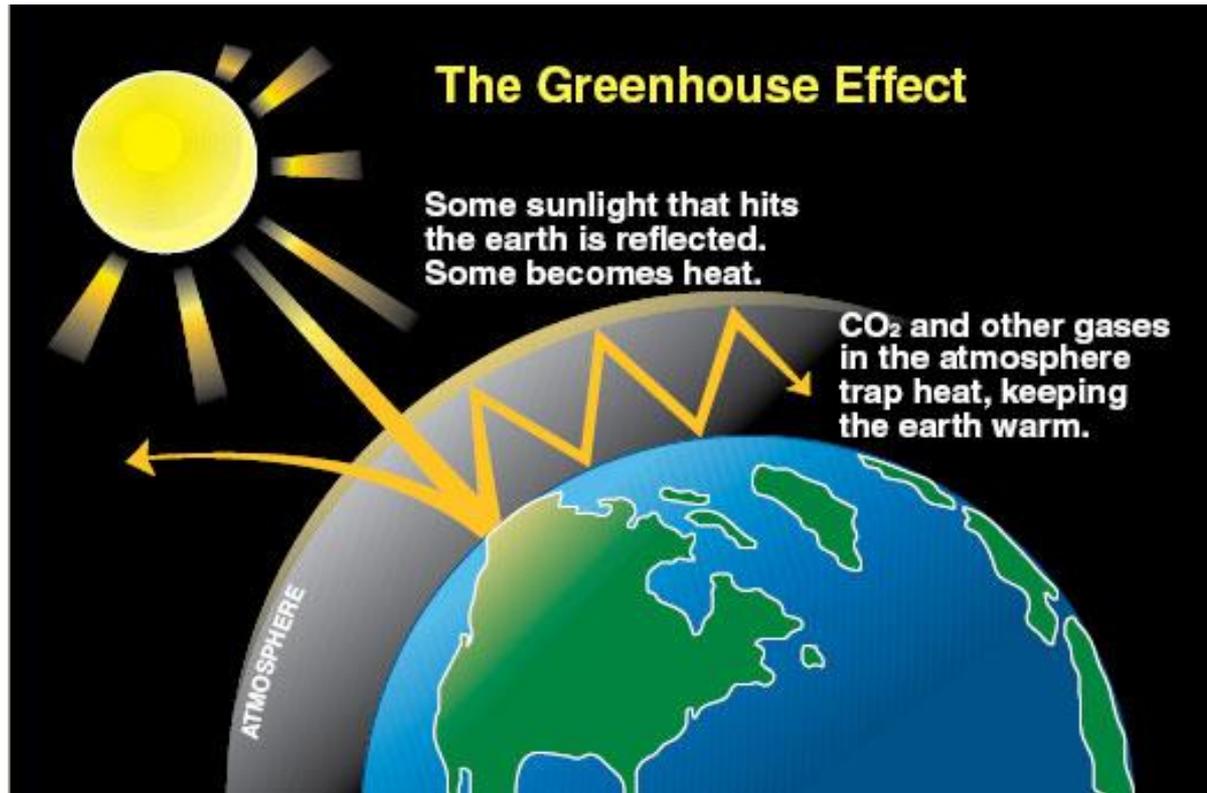
Debate

Global Warming

What do you know about global warming? .



Greenhouse Gases



Some gases that are released into the atmosphere, such as carbon dioxide, trap and hold heat.

Global Warming



As greenhouse gases accumulate in the atmosphere and the heat continues to get trapped, the overall temperature of the planet increases.

Global Warming

Some greenhouse gases are naturally released into the atmosphere, however, some human activities/technologies increase the amount of these gases.



Glaciers



Glaciers are bodies of ice that are made up of fallen snow that compresses into thick ice masses. Glaciers have the ability to move and flow very slowly like a river.

Some are as small as football fields, while other can be hundreds of miles/kilometers long.

Calving

As Earth's temperature rises due to greenhouse gases accumulating in the atmosphere, some of these glaciers begin to melt.



The melting glaciers begin to break apart and drop into the ocean. This process is called

calving

Investigation 4

Melting Sea Ice

Thermal Expansion



Just like air, as water is heated, it expands.



Why is this a problem?

Another reason is that if all of the sea ice (polar ice caps, glaciers, ice bergs, etc...) melted, the ocean level would rise 216 feet (65 metres)!

Click here to
explore the
where the
“new”
coastlines
would be.



Why is this a problem?

The ice at the poles influences the climate in that region. As the ice melts, the temperature can change which influences all of the climates on Earth!



Why is this a problem?

If Earth's sea ice melted and the oceans rose to the predicted levels and regional climates changed, what consequences might there be for our planet?

Consider what you know about climate and the ocean.



Film: Revolution

