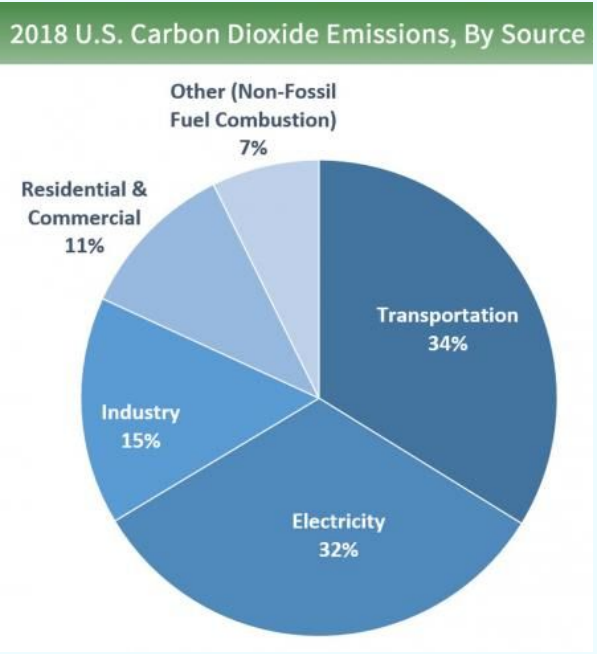
Ocean Acidification

The Problem's Origin

Excessive CO2 = GLOBAL WARMING



Let's Look at the Numbers!

Annual CO_2 emissions

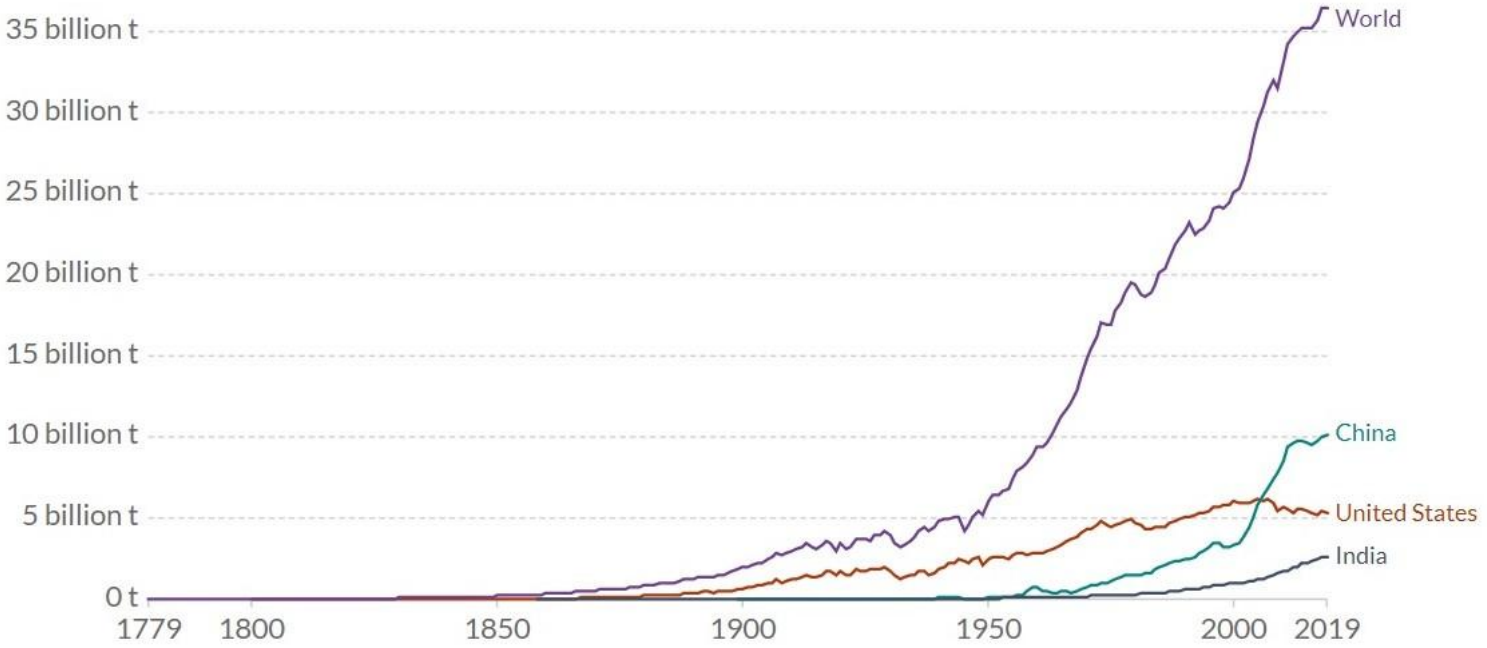
Carbon dioxide (CO_2) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.

Our World in Data

LINEAR | LOG

Add country

Relative change



Source: Global Carbon Project; Carbon Dioxide Information Analysis Centre (CDIAC)

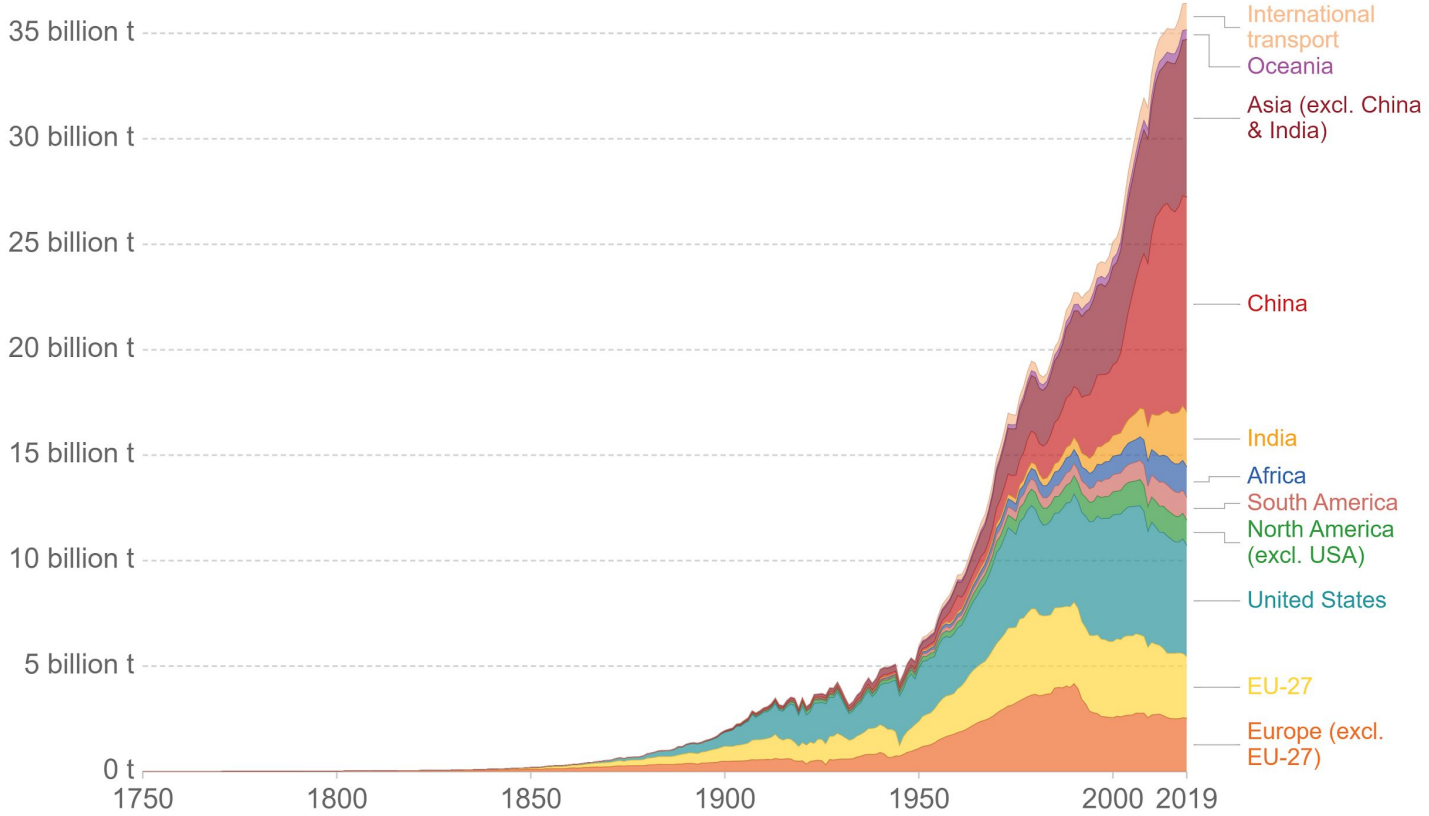
Note: CO_2 emissions are measured on a production basis, meaning they do not correct for emissions embedded in traded goods.

1750 2019

Annual total CO_2 emissions, by world region

This measures CO_2 emissions from fossil fuels and cement production only – land use change is not included.

Our World in Data

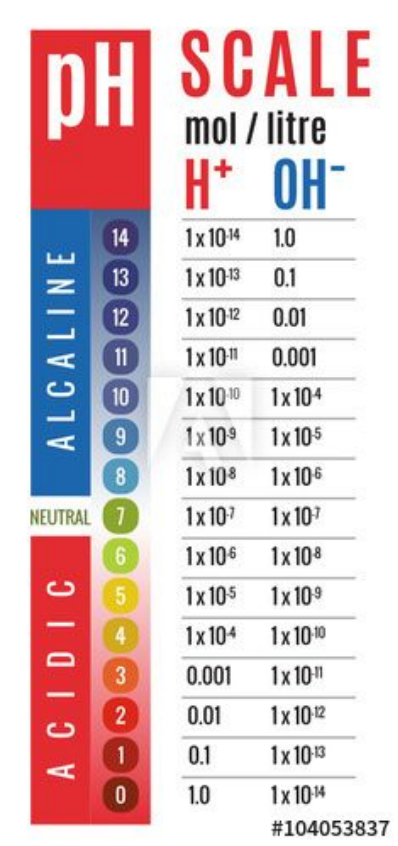


Source: Our World in Data based on the Global Carbon Project

OurWorldInData.org/co2-and-other-greenhouse-gas-emissions • CC BY

Note: 'Statitistical differences' included in the GCP dataset is not included here.

Understanding the pH scale



Acidic

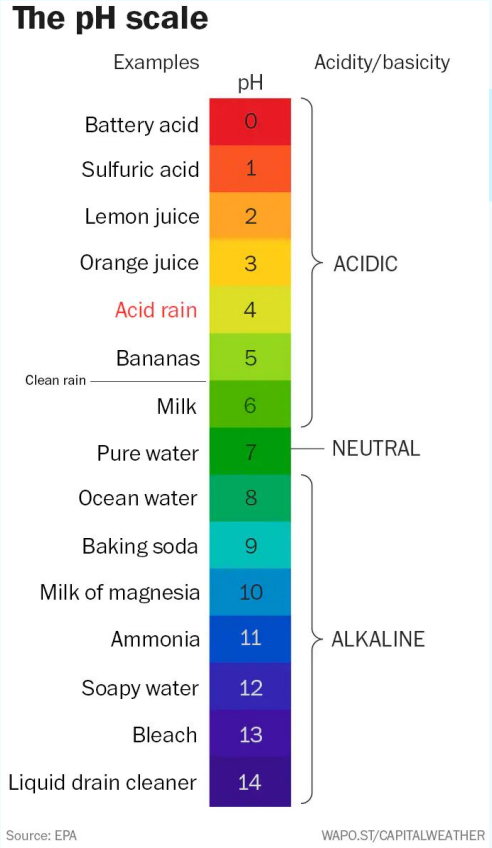
Excess of H^+ ions

Neutral

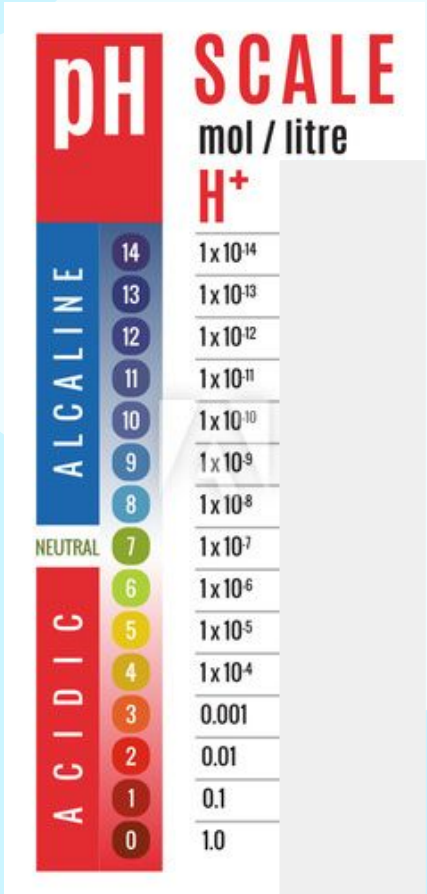
Equal amounts of H^+ and OH^-

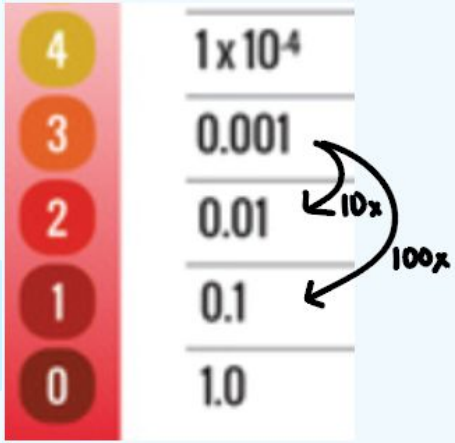
Basic

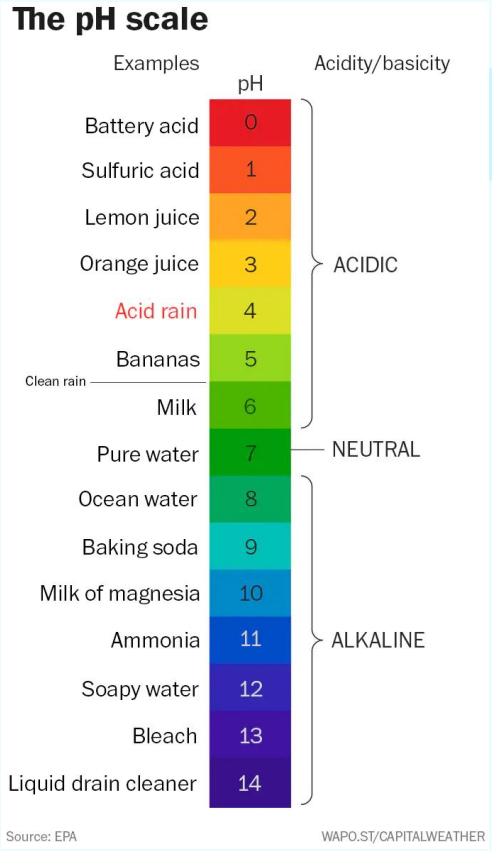
Deficiency of H^+ ions



Understanding the pH scale



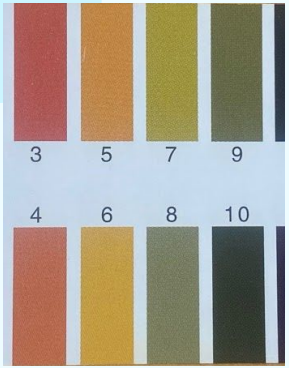




EXPERIMENT TIME :)

1. Fill the cup with water to the line as shown
2. Dip one of the pH strips in and observe the color change
3. Using the straw, blow bubbles into the water
4. Dip the other pH strip in and observe the color change

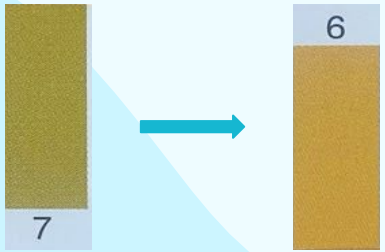
Ocean Carbon Sink



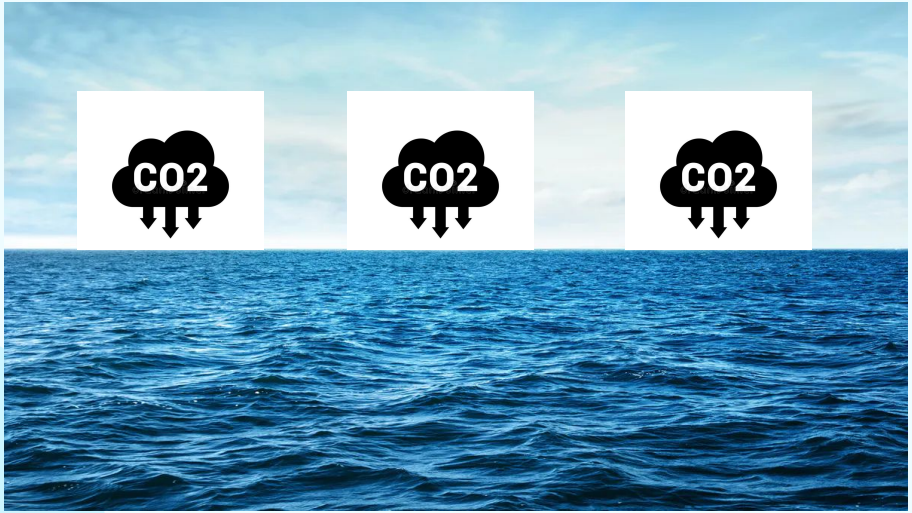
Water = Ocean

Exhales = Carbon dioxide emissions

Expected results:

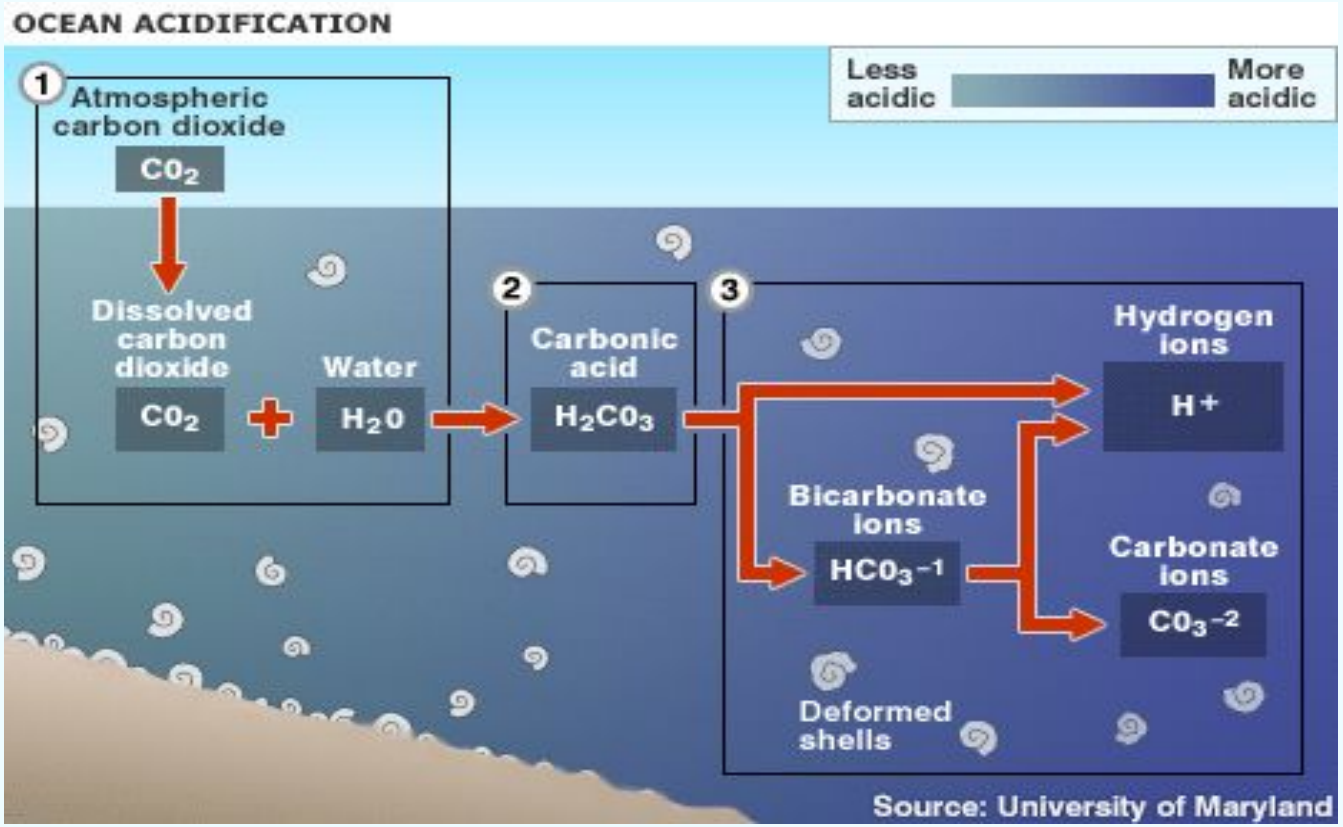


A change in pH is what we also see happening in our oceans today



SO, WHAT IS OCEAN ACIDIFICATION?

- pH of the ocean decreasing due to more carbon dioxide in the water
- Made worse due to increased carbon dioxide emissions into the atmosphere


OCEAN ACIDIFICATION
Less acidic
More acidic
1
Atmospheric carbon dioxide
CO_2
Dissolved carbon dioxide
CO_2
Water
H_2O
2
Carbonic acid
H_2CO_3
3
Hydrogen ions
H^+
Bicarbonate ions
HCO_3^{-1}
Carbonate ions
CO_3^{-2}
Deformed shells
Source: University of Maryland

BREAKDOWN OF REACTIONS:

$$CO_2 + H_2O \rightleftharpoons H_2CO_3$$

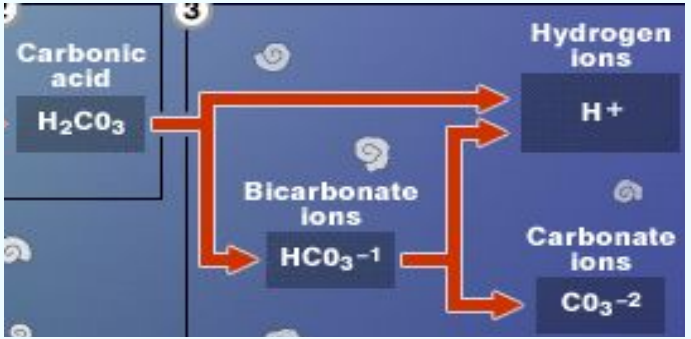
Carbonic Acid

$$H_2CO_3 \rightleftharpoons H^+ + HCO_3^{1-}$$

Bicarbonate ion

$$H^+ + CO_3^{2-} \rightleftharpoons HCO_3^{1-}$$

Carbonate ion



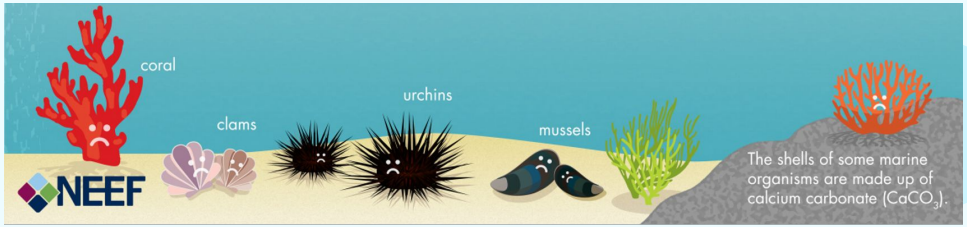
WHAT ARE THE EFFECTS?

1

Less Carbonate Ions Available

Ocean Life Dependency on Carbonate

- Marine organisms need carbonate ions to build their shells
- These organisms are becoming weaker, and their growth is slowed



$$H^+ + CO_3^{2-} \longrightarrow HCO_3^{1-}$$

2

Weakened Shells

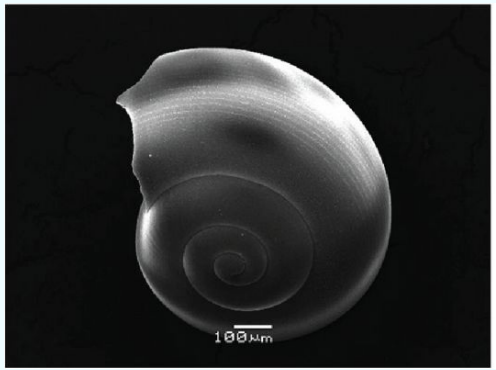
Acid Weakens Shells

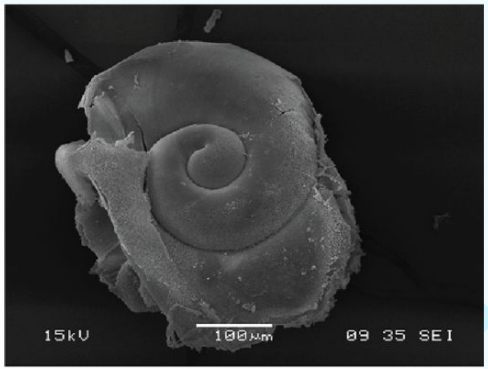
- Organisms take carbonate ions and use them in the form of calcium carbonate ($CaCO_3$) to build their shells and bones
  - Coral
  - Shellfish
  - Plankton
- Calcium carbonate is dissolved in acidic conditions
  - This produces even MORE carbon dioxide

$$H^+ + CO_3^{2-} \rightleftharpoons HCO_3^{1-}$$

$$CaCO_{3(s)} + 2\,H^+_{(aq)} \rightarrow Ca^{2+}_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$


zooplankton






phytoplankton

Demonstration

- Vinegar is acidic
- Bones are made of primarily calcium carbonate

EXPERIMENT #2: Chalk and Vinegar

1. Pour the vinegar from the baggie into the cup
2. Drop the chalk stick into the vinegar
3. Observe what happens

3 Coral Bleaching

What is Coral Bleaching?

When corals get stressed out, they expel the algae that live in them.

This doesn't kill the coral but it significantly weakens it

The algae corals produces is 90% of its energy so without it, the coral starves

*disclaimer: not directly tied to OA but is a result of climate change adding the the effect of OA

CORAL BLEACHING

Have you ever wondered how a coral becomes bleached?

HEALTHY CORAL

1 Coral and algae depend on each other to survive.

Corals have a symbiotic relationship with microscopic algae called zooxanthellae that live in their tissues. These algae are the coral's primary food source and give them their color.

STRESSED CORAL

2 If stressed, algae leaves the coral.

When the symbiotic relationship becomes stressed due to increased ocean temperature or pollution, the algae leave the coral's tissue.

BLEACHED CORAL

3 Coral is left bleached and vulnerable.

Without the algae, the coral loses its major source of food, turns white or very pale, and is more susceptible to disease.

WHAT CAUSES CORAL BLEACHING?

Change in ocean temperature
Increased ocean temperature caused by climate change is the leading cause of coral bleaching.

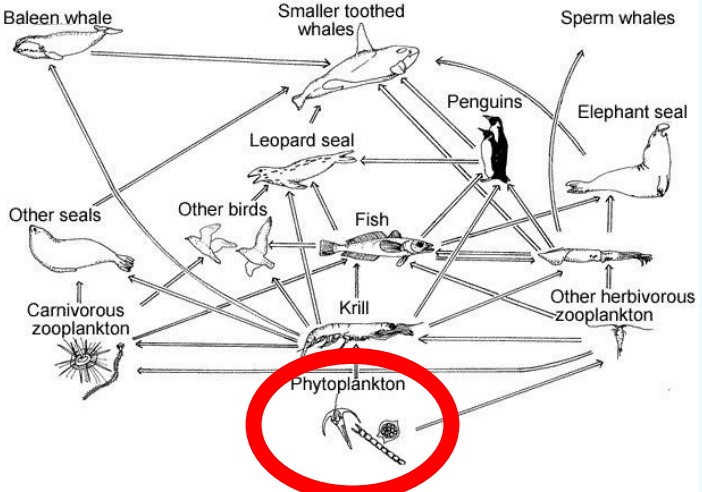
Runoff and pollution
Storm generated precipitation can rapidly dilute ocean water and runoff can carry pollutants — these can bleach near-shore corals.

Overexposure to sunlight
When temperatures are high, high solar irradiance contributes to bleaching in shallow-water corals.

Extreme low tides
Exposure to the air during extreme low tides can cause bleaching in shallow corals.

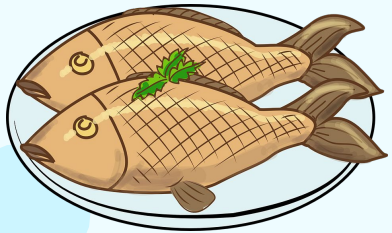
NOAA's Coral Reef Conservation Program
http://coralreef.noaa.gov/

Why should we care?



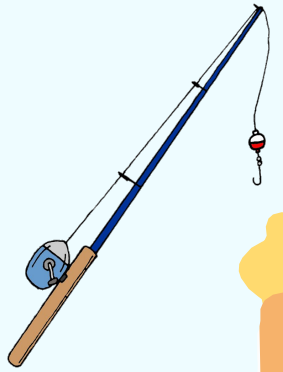
HOW DOES THIS IMPACT HUMANS?

Threatens Food Security



Tourism Revenue (Great Barrier Reef)

Threatens Fishing Industry



SO WHAT CAN WE DO TO COMBAT ACIDIFICATION?

Addressing Climate Change

- Dealing with the root of the problem
- Reduce the excess carbon dioxide entering the ocean by setting stricter limits to carbon emissions from factories
- Continue to try and reduce our own carbon footprints
- Advocate for increased regulation

Potential Career Paths

Research

Conducting experiments and finding new approaches to this problem

Legislation

Laws supporting carbon emissions restrictions will go such a long way

Advocation

One of the big challenges in combating OA is people not knowing what it is

Teaching

Being a professor at a university means constant awareness and research

Opportunities!

USC's Kelp Biofuel Project

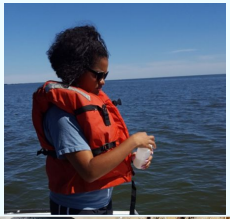
Overall cobats the issue of finding a clean energy source through kelp farms mitigating OA

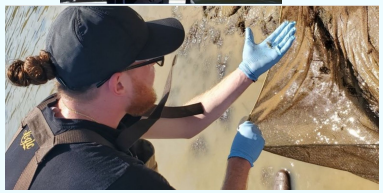
Ignite Earthwatch

Work alongside researchers and help collect data and work in labs for scientists trying to solve environmental issues.

Hutton Junior Fisheries Biology Program

"If you love science, are into Fisheries science and Marine biology or are passionate about protecting our natural resources...you're in the right place! "





GeoSciences Bridge Program

"The program introduces high school seniors to ocean sciences, atmospheric sciences, and geographic information systems (GIS)/Remote Sensing techniques."

Questions?

Contact us!

Athenna	atgonzalez@chapman.edu
Precious	phernandez@chapman.edu
Jessica	jromo@chapman.edu
Leah	zahn@chapman.edu

Take Post-Quiz on Canvas!

1. The average concentration of carbon dioxide (CO_2) in the atmosphere has _____in recent years.

a. increased

b. decreased

c. remained constant

2. When carbon dioxide dissolves in water, it forms a(n) _____.

a. base

b. acid

c. precipitate

d. metalloid

3. When carbon dioxide dissolves in water, the pH _____.

a. increases

b. decreases

c. stays the same

4. A slight change in the ocean's pH is...

a. something that will hardly affect the ocean and it's marine life

b. Stirring imbalance of chemical reactions in the ocean

c. Strong enough to affect marine life

d. b & c

5. What is coral bleaching?

a. Corals dying because of higher levels of CH_4 entering the ocean

b. Corals getting stressed due to high temperatures as a result of high CO_2 levels

c. A coral's season of turning ghostly white and store energy to prepare for the next season

d. A coral's way of self defense after being attacked by predators

6. Which of the following greenhouse gases is the most responsible for Ocean Acidification?

a. Methane

b. Nitrous Oxide

c. Carbon Dioxide

d. Chlorofluorocarbons

7. Which of the following compounds do most shelled creatures in the ocean depend on, and are beginning to lack?

a. Calcium Carbonate ($CaCO_3$)
b. Carbon Dioxide (CO_2)
c. Calcium (Ca)
d. Carbonic acid (H_2CO_3)

8. The pH scale ranges from 0 to 14 and is a measure of how acidic or basic a substance is. Pure water is _____with a pH of 7. Solutions with a pH less than 7 are _____ while solutions with a pH greater than 7 are _____.

a. neutral / basic / acidic
b. acidic / basic / neutral
c. basic / neutral / acidic
d. neutral / acidic / basic
e. acidic / neutral / basic

9. If the pH of a solution changes from 2 to 3, there is a _____change in acidity.

a. 1 x

b. 2 x

c. 10x

d. 20x

10. How could Ocean Acidification impact humans?

a. Threaten food security

b. Tourism Revenue would decrease

c. Fishing industry is affected

d. a & c only

e. All of the above