Climate Change

GRADE LEVEL: 6-8

TEACHING TIME: 90 MINUTES

Experiment, investigate, and play games to gain a greater understanding of climate change. Explore the difference between weather and climate and use online modeling to simulate global climate change. Experiment with changing pH and calcium carbonate organisms. Model food web interactions in a changing environment, and develop your own environmental action project to help combat this phenomenon.

This lesson is part of the NESS Tacklebox. This document was created by the education staff at New England Science and Sailing Foundation (NESS) using supplemental resources from the National Oceanic and Atmospheric Administration (NOAA) and financial support from a NOAA B-WET grant. Designed for students within an alternative setting, these activities were tested by NESS B-WET Teacher Cohort, tasked with investigating best practices of teaching experiential learning in alternative schools. We encourage you to learn from and adapt these activities to best fit the needs of your students

STANDARDS ADDRESSED

NEXT GENERATION SCIENCE STANDARDS

- **MS-ESS3-5** Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

- **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

- **MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

OCEAN LITERACY PRINCIPLES

Principle #3: The ocean is a major influence on weather and climate

- **A.** The ocean moderates global weather and climate by absorbing most of the solar radiation reaching Earth.
- **A.10.** Short-term and seasonal changes in ocean temperature can affect rainfall and temperatures on land (i.e., weather). Long-term changes in ocean temperature can affect the climate.
- **A.11.** Land and ocean weather maps are used to display and identify weather patterns and to help predict future patterns.
- **A.12.** Long-term weather and oceanographic data sets contribute to climate predictions.

- **B.** Changes in the ocean and atmosphere system can result in changes to the climate.
- **B.1.** The global climate is influenced by the amount of carbon dioxide in the atmosphere. The more carbon dioxide in the atmosphere, the more the climate warms.
- **B.4.** Absorbing carbon dioxide can decrease the ocean's pH, making the water more acidic. This can have consequences for many organisms in the ocean.
- **B.6.** Humans are changing the climate by continuing to release large amounts of carbon dioxide and methane into the atmosphere.

Principle #6: The ocean and humans are inextricably interconnected

- **D.** Human activity contributes to changes in the ocean and atmosphere.
- **D.13.** Human activity can lead to the excess input of greenhouse gasses into the atmosphere, which can alter the temperature of Earth's atmosphere and affect the ocean.
- **D.14.** The excessive input of greenhouse gasses traps increased amounts of solar heat, which can raise the temperature of the ocean.
- **D.15.** Changes in ocean temperature can influence marine organisms by altering physical conditions (i.e., current patterns and temperature ranges) to which they are adapted.
- **D.16.** Excessive greenhouse gasses can lead to increased uptake of carbon dioxide by the ocean, which results in more acidic ocean water.
- **D.17.** Changes in pH of ocean water can dissolve the shells, tests, and skeletons of many marine organisms.

CASEL SOCIAL-EMOTIONAL LEARNING STANDARDS

Relationship Skills: The abilities to establish and maintain healthy and supportive relationships and to effectively navigate settings with diverse individuals and groups

- Communicating effectively
- Developing positive relationships
- Practicing teamwork and collaborative problem-solving
- Seeking or offering support and help when needed

Responsible Decision-Making: The abilities to make caring and constructive choices about personal behavior and social interactions across diverse situations.

- Demonstrating curiosity and open-mindedness
- Learning how to make a reasoned judgment after analyzing information, data, and facts

Self-management: The abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations

- Setting personal and collective goals
- Using planning and organizational skills

PROGRAM SUMMARY

ESSENTIAL QUESTION

A question is essential when it: *Questions that probe for deeper meaning and set the stage for further questioning, ones that foster the development of critical thinking skills and higher order capabilities such as problem-solving and understanding complex systems.*

How are humans connected to climate change? What variables drive ocean acidification, and how will this impact the biosphere?

ESSENTIAL LEARNING TARGETS

Educator Objectives
Students will be able to….

- **Analyze** historical climate data to conclude a warming trend.
- **Experiment** and **collect data** on the changing pH of waterways.
- **Identify** and **develop** an environmental action project to minimize personal impacts on the ocean.
- **Model** climate change impacts on biodiversity and food webs.

Student Objectives
I can…

- **Observe** and **organize** graphics to **understand** how the earth has been warming over the past 50 + years.
- **Experiment with** the impacts carbon dioxide has on the pH of ocean water.
- **Investigate** and **collaborate** with peers in a local learning community.
- **Work together** to a **role-playing** game **modeling** plants and animals in ocean ecosystems.

BACKGROUND INFORMATION

KEY CONCEPTS

Greenhouse gasses (GHGs), such as water vapor, ozone, carbon dioxide, methane, and nitrous oxide, are all important for Earth as they protect from the sun's UV rays. GHGs allow sunlight to pass through the atmosphere, trap heat, and warm the earth to support life, creating the greenhouse effect.

As greenhouse gas emissions increase, they continue to trap the sun's heat. This will lead to global warming and climate change. The earth is now warming faster than at any point in recorded history. This poses a risk to humans and the natural world. (United Nations, Climate Action)

Generating power, manufacturing goods, cutting down forests, using transportation, producing food, powering buildings, and consuming too much are some of the main drivers of climate change.

Scientists around the world are identifying solutions to combat climate change, such as ending reliance on fossil fuels, increasing energy efficiency, developing renewable energy programs, creating sustainable transportation and buildings, creating better forestry management and sustainable agricultural systems, supporting conservation-based solutions, and designing sustainable industrial & technological solutions.

You can make a difference with your everyday choices! Be a leader to peers and teachers around you as you choose to minimize your single-use plastic waste and food waste, bike or walk when possible, mend old clothes, reuse items after their initial use, and advocate for your planet!

Carbon dioxide released into the air by humans can also affect the ocean. As the amount of CO2 in the air increases, more of it will be absorbed into the ocean. Then, through a chemical process that converts CO2 to carbonic acid, the water becomes more acidic. This is the driving force of **ocean acidification.**

Ocean acidification disrupts the ability of organisms with exoskeletons and shells to grow due to the change in availability of a building block crucial to shell and exoskeleton growth - **calcium carbonate**. This change in **pH** also affects the sensing ability of organisms, such as clownfish, with their **olfactory homing** and decreases the **rugosity** of coral reefs.

KEY WORDS

Climate Change: a change in global or regional climate patterns, in particular, a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Greenhouse effect: a natural process that warms the Earth's surface. When the sun's energy reaches the Earth's atmosphere some of it is reflected into space, while the rest is absorbed and re-radiated by greenhouse gasses.

KEY WORDS continued

Weather: measurement of variables such as wind, air temperature, cloud coverage, and precipitation in a short time.

Climate: long-term weather data and trends on average collected over 30 years.

Ocean Acidification: Ocean acidification is the ongoing decrease in the pH of the Earth's ocean, caused by the uptake of carbon dioxide from the atmosphere. Seawater is slightly basic, and ocean acidification involves a shift towards pH-neutral conditions rather than a transition to acidic conditions.

Carbon Dioxide: a chemical compound composed of one **carbon** and two oxygen atoms. It is often referred to by its formula CO2. It is present in the Earth's atmosphere at a low concentration and acts as a greenhouse gas.

Fossil fuels: natural fuels such as coal or gas formed in the geological past from the remains of living organisms.

Calcium carbonate: chemical compound with the formula $CaCO_3$. It is a common substance found in rocks as the minerals calcite and aragonite, and is the main component of pearls and the shells, exoskeletons, and eggs of marine organisms.

Olfactory homing: ability to use smelling senses to find the unique chemical signature of the waterway to return to a given place when displaced from it, often over great distances.

Rugosity: simple measurement of the surface roughness that has been used routinely by **coral reef** biologists. Areas of high **rugosity** allow corals to attach and grow on higher substrata not influenced by sand and sediment movement along the bottom.

Experimental group: the group that is changed during an experiment to see how something might affect it.

Control group: the group that is not changed during an experiment so that it can be compared to the experimental group, which is changed.

MATERIALS

Introduction: • NOAA Global Data Explorer • Monthly Air Temp Data Cards Annual Data Cards / Projection	**Activity 1:** • Greenhouse Datasheet • NOAA graphics • Sand • Water • *Heat lamps • Plastic wrap • Clear containers * Optional*	**Activity 2:** • NOAA Data Global Viewer • Purple Cabbage • Vinegar • pH strips • Antacid • Straws	**Activity 3:** • Coral Reef Maze • Game Identification Tags • Chairs • Tables

INTRODUCTION
Climate Change Investigation

EDUCATOR PREPARATION

Prepare the handouts for each group. **Provide** access to NOAA Global Data Explorer using personal devices or a projector.

TASK

EDUCATOR ACTIONS	STUDENT ACTIONS
Write "climate" on the board. **Ask** students what phrases or concepts come to mind with "climate". **Record** each student's response and create a word map. **Facilitate** student exploration and **demonstrate** how to use the NOAA Global Data Explorer . Using the menu on the left, select the plus (Add data) > ocean > temperature > at the surface. **Demonstrate** how to change results to show weekly, monthly, and yearly data. Once selected, reset the timeline on the bottom and press play to view from 1982 - 2023.	**Access prior knowledge** and **share** phrases and concepts associated with "climate". **Actively observe** instructions to change variables. **Investigate** changes in weather and changes in climate over different time periods.

After initial investigation**, regroup** students and **ask** which time frame best represents "climate" and which represents "weather". **Draw connections** to student responses and back to the word map as you clarify that yearly selection, viewed over 30 + years, represents climate. **Expand** and **define** climate as *long-term weather patterns collected over 30 + years.* **Ask** students, knowing this, to clarify the definition of weather, and identify which selection best represents weather. **Ask** students to provide examples of weather. **Draw connections** to responses and **define** weather as a *measurement of variables such as wind, air temperature, cloud coverage, and precipitation, in a short time; it changes from week to week.* **Circle back** discussion to the initial word bank. This time, **write** "change" after the word "climate" in a different color. **Ask** students to expand on their word map, and share any phrases or concepts that come to mind with "climate change". **Record** these responses in a different color. **Draw connections** to student responses and **provide context** that the day will be spent investigating, experimenting, and modeling climate change and some of its impacts. **Challenge** students to organize the handout without the time stamps. **Inform** students that Set A shows monthly data and Set B shows yearly, global data. **Ask** students to clarify which represents "weather" and which "climate".	**Draw connections** to yearly data represented over a long time as showing "climate" data. **Draw connections** that short term weather patterns were represented with weekly and monthly data. **Activate prior knowledge** and **draw connections** between "climate" and "climate change". **Understand** the context for investigating temperature and climate when exploring climate change impacts later in the lesson. **Demonstrate** that weather data is represented over a short time, and climate data is collected over a long time.

DIFFERENTIATION

If time allows, change variables on the data set to represent land or atmosphere temperatures and compare.

ACTIVITY 1
Greenhouse Modeling

EDUCATOR PREPARATION

Prepare safe spaces that are accessible and in-sight for the experiment. **Provide** access to the datasheet.

TASK

EDUCATOR ACTIONS	STUDENT ACTIONS
Explain to students that climate change is driven by the **greenhouse effect**. Most of the gasses in the Earth's atmosphere (nitrogen, oxygen, and argon), which comprise 99.5% of the gasses in the atmosphere, do not impact global warming. However, small concentrations of 'trace gasses', including water vapor, carbon dioxide, methane, and others contribute substantially to the warming of the Earth because they can absorb infrared radiation. These glasses are referred to as **greenhouse gasses,** or GHGs.	**Gain context** to background information. **Understand** real-world connections, and the driving factors of the greenhouse effect.
When sunlight heats the Earth, some solar radiation, or ultraviolet (UV) energy, is bounced back from the Earth's surface into the atmosphere. UV energy are high-frequency waves that can negatively impact human health. 20% of UV energy is absorbed by the atmosphere. As humans continue to emit carbon dioxide into the atmosphere, the effects of the greenhouse effect continue to grow. **Show** students NOAA graphics that demonstrate the flow of solar radiation and the greenhouse effect. **Inform** students that they are going to experiment with the greenhouse effect.	**Observe** graphics that represent the greenhouse effect.
Set up at a sunny spot outside, near a window, or safely under a strong light. **Facilitate** student set-up of experiment.	**Collaborate** in teams to set up experiments and **collect** data as a group. • Pour 1 inch of water into two small containers.

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Ask students to hypothesize the following:

Which containers will retain the most heat?
Which containers will be cooler?
Will water or soil be hotter?

Display the group datasheet, and facilitate times every 5 minutes to check on temperatures.
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Cover one of them with plastic wrap.
Place 1 inch of soil in two small containers.
Cover one of them with plastic wrap.
Set all containers aside in the designated sunny space.

Record temperatures of each container every 5 minutes.
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WRAP UP

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Demonstrate how to analyze the data collected. Equations are available at the bottom. Each section will compare temperature changes of:

Land vs water
Covered vs uncovered

Facilitate student discussion with the following prompts:

Was your hypothesis supported?
What data are you referencing?
Which heated up faster, the land or the water?
Which became hotter, the uncovered or covered bins?
How does this apply to the real world?

Review the NOAA Global Data Explorer with the group and change the variables using the path.
Add data > Climate > Simulations > Greenhouse Gas Emissions
Select low, moderate, high, or very high to investigate. Draw connections from the activity and background information and ask students to describe what they see depicted with the model. Review with students that they are observing ocean temperature (or match the variable you first selected in the introduction). Ask students how this forecasted model compares to the historical data they investigated.
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Listen actively and ask questions to review how to analyze data.
Discuss as a group using the prompts.
Identify that land heats up faster, but the water holds onto the heat longer. Identify that the covered bins model the greenhouse effect and become hotter in the experiment.
Draw connections to the first model and observe possible impacts of temperature in a forecasted model with different levels of GHG emissions.
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ACTIVTY 2
Ocean Acidification Modeling

EDUCATOR PREPARATION

Prepare the cabbage juice indicator. Students can help prepare the cabbage juice indicator in classes leading up to the activity.

1. Chop cabbage into small pieces and place into a pot.
2. Cover the cabbage with boiling water
3. Leave water until it is a deep purple
4. Remove leaves and strain out small pieces
5. Cool down!

TASK

EDUCATOR ACTIONS	STUDENT ACTIONS
Pass out printouts of Figure 1. **Ask** students to identify the ends, and the median point. **Challenge** students to guess which end is basic, and which end is acidic.	**Observe** the pH scale, and **brainstorm** which end is basic and acidic.
Inform students that the pH scale is used to measure solutions based on the acidity or basicity (alkalinity). Solutions above 7.0 are basic, and solutions below 7.0 are acidic. Solutions at 7.0 are neutral. **Explain** that the pH scale is logarithmic, meaning that one change in pH corresponds to a ten-fold change in the hydrogen ion (H+) concentration.	**Connect** that an increased concentration of H+ ions will create an acidic solution. **Connect** that a change of 1 pH on the scale corresponds to a ten-fold change in H+ ion concentration.
Explain that the cabbage juice indicator will serve as a scientific instrument to visibly see differences in pH. When the cabbage juice changes to a pink color, the solution is more acidic.	
Facilitate student investigation with the following steps: **Ask** students what they observed.	**Investigate** in groups with the following steps. 1. Pour ¼ cup of tap water into a glass

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• The solution turned blue.

Ask students what they think this indicates for the solution.

Connect student responses as you **explain** that ocean water is slightly basic. By adding in baking soda, it can model ocean water. This is indicated by the blue color.

Ask students to share their observations.

Remind students that by blowing bubbles, they were inputting carbon dioxide into the water.

Carbon dioxide, a gas that is also naturally in the atmosphere, can dissolve in seawater. When this happens, water and carbon dioxide combine to form carbonic acid (H_2CO_3), a weak acid that breaks into H^+ ions and bicarbonate ions (HCO_3^-).

Ask students what they think an increase in CO_2 in the real-world context might mean for our oceans.

Pass out materials for the next demonstration.

Ask students if vinegar is acidic or basic. **Inform** students that the antacid and eggshells are made out of calcium carbonate, the same substance that makes up shells in shellfish. **Explain** that the vinegar models the acidic ocean.

Ask students their hypothesis if the antacid and egg are covered in vinegar.

Facilitate student exploration with the following steps:
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2. Pour 1 teaspoon of indicator into the glass
3. Add a pinch of baking soda

Connect that ocean water is slightly basic. By placing baking soda into the tap water, it models ocean water, creating a slightly basic solution. This is **observed** with the blueish color of the solution once the indicator is mixed in.

4. Using a clean straw, blow bubbles into the solution for 1 minute.

Share their observations and **hypothesize why** the indicator changed from blue to pink.

Connect that an increase in carbon dioxide will increase the concentration of H^+ ions in the ocean. This will ultimately lead to a more acidic ocean environment, dropping seawater on the pH scale.

Identify vinegar on the pH scale.

Hypothesize what will happen when the antacid and eggshells are placed in vinegar.

1. Place antacid in one glass
2. Place an egg shell in another glass
3. Using the eyedroppers, add vinegar over each item, covering both slowly.
4. Observe changes

Observe changes in Ocean-Atmosphere CO_2 exchange from 1850 - forecasted 2100.
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Inform students that one-third of carbon dioxide emissions are absorbed by the ocean every year. **Ask** students what they think this means with an increase in carbon emissions. **Return** to the NOAA Data Global Viewer and use the following to navigate Add data > Climate > Simulation > Ocean Acidification > Ocean-Atmosphere CO2 Exchange. **Play** the video simulation and **ask** students to share their observations. **Facilitate** deeper thinking with some of the following prompts: • What do shells provide for shellfish? • How could this impact marine food webs? • How could this impact habitats? How can humans combat ocean acidification?	**Draw connections** between the activity and this forecasted model. **Collaborate** and **discuss** impacts of ocean acidification. **Brainstorm** human efforts to mitigate ocean acidification.

ACTIVITY 3
Coral Reef Tag

EDUCATOR PREPARATION

Identify a place of safe gameplay. This can be in the classroom or in an outdoor space. **Provide** materials (desks, chairs, cones, etc.) to safely maneuver around.

TASK

EDUCATOR ACTIONS	STUDENT ACTIONS
Connect to the previous activity, and **explain** to students that organisms, like oysters and corals, create their hard shells by combining calcium and carbonate from the seawater. When ocean acidification increases fewer carbonate ions are available for calcifying organisms. This means it is challenging for them to build and maintain their shells and skeletons. **Review** with students their discussion responses from before, how ocean acidification impacts food webs and habitats. **Inform** students that they will be modeling the impact of ocean acidification on food webs with a game! **Inform** students they are role-playing as clownfish. **Explain** that clownfish have an exceptional sense of smell as a	**Connect** increases in ocean acidification to challenges in building shells, and even dissolving shells of shellfish. **Review** discussion questions.

mechanism to help determine which direction to swim. This is called "olfactory homing", and they can use it to find their home anemone.

Explain that to model predator/prey interactions, students will play a version of tag. **Review** some rules to gameplay:

- When a lionfish tags a clownfish, the lionfish must count to 3 before resuming play; that clownfish is then out for the round.
- When "swimming", students will walk heel-to-toe to minimize running in the classroom
- Desks, chairs, cones, and other obstacles model reef structures. They cannot be moved from their location during the round.

Facilitate gameplay with the following guidelines. Be sure to find a space clear enough to provide safe gameplay. Using desks, chairs, and other obstacles, organize them around the room and **identify** them as coral reefs.

Roleplay as clownfish and lionfish (prey and predator) with a game.

1. **Identify** the home anemone (Figure 2.) on a whiteboard, cone in a field, etc.
2. **Identify** ⅔ of the class as clownfish and **place** the clownfish lanyard around your neck as identification (Figure 3).
3. The remaining ⅓ of the class will **role0play** as lionfish. **Place** the lionfish lanyard around your neck as identification (Figure 4).

ROUND ONE

4. Clownfish are challenged to get to the home anemone without being tagged (eaten) by the lionfish.
5. Lionfish are challenged to tag the clownfish.
6. The instructor **sets** a timer and **starts** gameplay.

Facilitate student review with discussion points:

- What were the predator-prey interactions
- What interactions happened with the coral?
- How many clownfish were tagged? **Record** this number on the board.

Using the time identified in round one, use this to set a time limit for round two.

Explain to students that as the pH of the ocean drops, there has been evidence that this impacts clownfish. Usually able to find the scent of an anemone in water currents, the olfactory homing ability of clownfish is severely disrupted by ocean acidification as it interferes with their neuron function. This can pose challenges for the clownfish when finding their home anemones. **Inform** students that they will model this challenge. Clownfish will spin around 5 times before starting the round.

Connect back to the discussion that as pH lowers in the ocean, coral reefs have a challenging time building their skeletons. **Model** this by removing ½ of the obstacles in the space.

Facilitate student review with discussion points:

- What were the predator-prey interactions
- What interactions happened with the coral?
- How many clownfish were tagged? **Record** this number on the board.

Facilitate Round 3 by

- Increasing the spins to 7 of the clownfish
- Removing all the obstacles

Review these changes with students and **ask** what they model.

Facilitate student review with discussion points:

- What is the change in the first to third round of clownfish tagged.
- What happened when we increased the disorientation (i.e. the olfactory homing was impaired).
- What happened when the reef was ½ removed and fully removed?

What does this mean for coral reef ecosystems? How can this be connected to the real world?

Review how the first round went, and what interactions happened. **Count** the number of clownfish tagged.

ROUND TWO

7. Repeat round one with facilitated changes from the instructor.
8. Round 2 will happen within the time limit identified by Round 1.

Review how the second round went, and what interactions happened. **Discuss** differences between the first and second rounds. **Count** the amount of clownfish tagged.

ROUND THREE

9. Repeat round one with facilitated changes from the instructor.
10. Round 3 will happen within the time limit identified by Round 1.

Count the number of clownfish tagged.

Review gameplay and **reflect** on how the changes in models.

Draw connections to the real-world impacts.

DIFFERENTIATION

If your learning space does not allow for gameplay, or you do not have enough students to simulate, you can use the Coral Reef Maze instead. Students will **role-play** as the clownfish, attempting to make it back to their anemone. Along the way they eat plankton, and avoid predators such as clownfish and octopus. Each level represents a higher pH level in the ocean, and its impacts on the clownfish's olfactory homing. Use the narrative above as students move from levels 1 to 5.

WRAP UP
Environmental Action Project

TASK

EDUCATOR ACTIONS	STUDENT ACTIONS
Reflect on student investigations and discussions, and **facilitate** student-led discussion with the following prompts: • What surprised you about the activities? • How does this impact our daily lives? • How does this make you feel?	**Reflect** on the activities completed throughout the lesson and **discuss** the prompts provided as a group.
Connect student responses and encourage them to investigate further.	**Understand** that while humans have impacted climate change and influenced ocean acidification, there are actions they can take to minimize carbon emissions!
Facilitate a time for students to calculate their Ecological Footprint. **Record** the "ecological footprint" (measured in Earths) or "carbon footprint" (measured in CO_2 emissions) on the board.	**Calculate** their ecological footprint /carbon footprint.
Facilitate a student discussion using the following prompts: • What is our average ecological footprint or carbon footprint as a class? • How did this survey make you feel? • What can you do as an individual to reduce your carbon emissions?	**Analyze** the average ecological footprint/carbon footprint of the group.

• What can we do as a group to reduce our carbon emissions? **Reflecting** on student discussions, provide encouragement and **facilitate** deeper thinking with the following prompts: • What action could be taken to address ocean acidification? • How would this action help address ocean acidification? • What resources do you need to make it happen?	**Collaborate** to identify ways to minimize carbon emissions as an individual: • Turning off lights • Walking/biking to work • Unplugging unused electronics • Wearing clothes more than once, etc. **Connect** increased carbon emissions to ocean acidification.
Connecting student responses, identify areas of growth and areas of support you can provide in your role.	**Brainstorm** possible projects they would like to develop as a team: • Green School challenges? • Classroom Advocacy posters? • School mini-announcements for "green tips" • Etc.
Coordinate student teams, and **brainstorm** how to create an environmental action project together.	
Provide a space for students to think creatively about how they can make a difference as a team, and **encourage** them to take the lead! **Provide** boundaries and support where needed based on your classroom and school environment, and let your students' creativity shine!	**Celebrate** successes along the way! • Creative thinking • Working together collaboratively • Encouraging teammates • Project milestones along the way

EXTENSION ACTIVITIES

For further support in facilitating Meaningful Watershed Education Experiences (MWEEs) with your students, use the [MWEE Educator Guide](). This will provide a detailed framework for you to create an engaging, multi-step Environmental Action Project (EAP) with your students throughout the year. Use NESS B-WET lessons to support EAP development in the investigation phase! Environmental Action Projects can include but are not limited to: restoration projects, community engagement projects, everyday choices, and other forms of civic engagement.

RESOURCES

United Nations, Climate Action
https://www.un.org/en/climatechange/science/causes-effects-climate-change
(last accessed 4/9/24)

Unicef Young climate activists demand action and inspire hope
https://www.unicef.org/stories/young-climate-activists-demand-action-inspire-hope
(last accessed 4/9/24)

NOAA Ocean Acidification
https://www.noaa.gov/education/resource-collections/ocean-coasts/ocean-acidification
(last accessed 4/9/24)

NOAA - National Centers for Environmental Information Climate at a Glance Global Time Series
https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/global/time-series
(last accessed 4/9/24)

NOAA - Climate.gov Data Snapshots Image Gallery
https://www.climate.gov/maps-data/data-snapshots/snapshot?id=8704
(last accessed 4/9/24)

NOAA Climate Data Mapper
https://www.nnvl.noaa.gov/view/globaldata.html
(last accessed 4/9/24)

NOAA Ocean Acidification Program
https://oceanacidification.noaa.gov/ocean-acidification-monitoring/
(last accessed 4/9/24)

NOAA National Centers for Environmental Information Quantifying the Ocean Carbon Sink
https://www.ncei.noaa.gov/news/quantifying-ocean-carbon-sink#:~:text=The%20ocean%20acts%20as%20a,and%20international%20partners%20in%20Science
(last accessed 4/9/24)

NOAA Carbon Toolkit
https://gml.noaa.gov/education/carbon_toolkit/
(last accessed 4/9/24)

pH Scale
https://openstax.org/books/biology/pages/2-2-water
(last accessed 4/9/24)

NOAA B-WET MWEE Educator Guide
https://www.noaa.gov/sites/default/files/2022-09/MWEE-Guide.pdf
(last accessed 4/9/24)