Climate Literacy

Grades 9-12

Lesson developed by the Center for Climate Protection for use in the ECO_2school Youth Leadership Program

Time: One class period 45-50 minutes

Summary:
Students are the people who will be most impacted by climate change. It is the number one issue facing students today. Our future rests upon all our citizens making a commitment to live in ways that are healthier and more sustainable for our planet. In 2015, Governor Edmund G. Brown Jr. established the nation's most ambitious California greenhouse gas reduction target, of 40 percent below 1990 levels by 2030.

He noted, "climate change poses an ever-growing threat to the well being, public health, natural resources, economy, and the environment of California, including loss of snowpack, drought, sea level rise, more frequent and intense wildfires, heat waves, more severe smog, and harm to natural and working lands, and these effects are already being felt in the state."

Developing and implementing solutions to these challenges requires a climate literate populace with the skills to understand, analyze, think critically about, and address the climate crisis. Climate Science Literacy is education about the interdependence of people and climate.

A climate literate person:

- Understands the essential principles of Earth's climate systems
- Knows how to assess scientifically credible information about climate
- Communicates about climate and climate change in a meaningful way
- Is able to make informed and responsible decisions with regard to action that may effect climate

Next Generation Science Standards:
ESS3C. HUMAN IMPACTS ON EARTH SYSTEMS When the source of an environmental problem is understood human activities can be regulated to mitigate global impacts.

ESS3D. GLOBAL CLIMATE CHANGE Science and engineering are essential to understanding the possible impacts of global climate change and to informing decisions about how to slow its progress and impacts.

Common Core Standards:
CCSS.ELA-LITERACY.CCRA.SL.2
Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
CCSS.ELA-LITERACY.CCRA.SL.3
Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.
CCSS.ELA-LITERACY.RST.9-10.2
Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

Materials:

- **Computer, projector and speakers to view the PowerPoint**
- **Copy of the Climate Literacy PowerPoint**
- **Laser pointer**
- **Pencils or other small prize**
- **Teacher activity packet**
  - **Literature Review**
  - **Current event articles**
  - **Climate Literacy Vocabulary**
  - **Calculate Your Commute Carbon Footprint**
  - **Essay: Students are Making a Difference**
  - **Presenter Evaluation**

Background for Facilitator and Assumed Prior Student Knowledge:
It will be helpful to have an understanding of basic climate science prior to giving this presentation. Review Climate Literacy, The Essential Principles of Climate Sciences A Guide for Individuals and Communities published by the National Oceanic and Atmospheric Association (NOAA) and the American Association for the Advancement of Science (AAAS)
The information in this unit can also be found in the notes of the PowerPoint. When using presentation mode on your computer the notes will be visible to you as a presenter. However, is it preferable to have a deep familiarity with the material so you are not reading off the slides.

Preparation:
Plan on arriving a half hour before your first presentation. Check in at the office and confirm school visitor procedures.
Set up and test all AV equipment in advance. If you are not using your own computer, check to see that it has the appropriate software to run a PowerPoint and embedded videos. There are two swear words in the first video. Check with the teacher prior to showing the video.
Be prepared to ask students questions to facilitate the understanding of key concepts.

Introduction and Overview *Slides 1-3*

Facilitators note: Introduce yourself to the students. What is your name? What organization are you with? Why are you here? What inspires you to do this work?

By the end of this presentation students should have an increased understanding of the different systems affecting our climate and be able to assess the difference between credible and unreliable information regarding climate.

Facilitators note: Vocabulary from the Climate Literacy Vocabulary List are bolded in the text.

Climate is the area's average weather conditions and extent those conditions vary over long time intervals. When you think about climate it has been relatively stable for the last 10,000 years. Climate is about the ways three systems - air, water and land - interact with each other over long periods of time.

Weather on the other hand is what you see when you look out the window. C*omment on the weather outside the window.* It is about relatively short periods of time and specific geographic areas. It can be about a day a week or a season and can refer to an area as small as *your town* or as large as the state of CA. Weather and climate are interconnect but different. Climate influences weather and weather is an indicator of what is happening with climate.

Facilitators note: When introducing the concepts of climate and weather this is a good opportunity to evaluate student levels of pre-knowledge. Ask the students the questions "what is climate" and "what is weather" and incorporate their knowledge and understanding into your definition.

The Climate Debate: Science vs, Popular Belief *Slides 4-7*

Now that we know what climate is, why is everyone making such a big deal about our climate? We see it in the news, social media, on TV shows, in politics, in classes. Everywhere we turn there seems to be another opinion about climate and more specifically about climate change. Amidst all of this information it is important to note is that there are two different arenas where this discussion is happening. First it is happening in the scientific community and among scientists there is almost complete agreement, 98%, that human caused climate change is happening. The second place is the realm of public opinion. Is this arena there is more confusion: only one in four people believe in human caused climate change. So why the disconnection between the scientific community and the public?

Science is the ongoing process of making observations and using evidence to test hypotheses. This is called the **Scientific Method.** As new ideas are developed and data is obtained our

Facilitators note: Most students are familiar with the process of scientific method or inquiry. The two terms are used interchangeable and teachers prefer one or the other term. It is a common practice in middle and high school science classes. Asking students to identify key components of scientific method is a good way to build engagement.

understanding develops. The scientific community uses a formal method of peer review to validate research results and understand their significance. Experiments, results and research are carefully reviewed for reliability, reproducibility and authenticity of results. Only concepts that have been well documented, researched and subject to scrutiny of experts are accepted as current science knowledge.
Popular opinion is not about scientific or any method. It is about power, persuasion and influence.

Facilitators note: Ask the question. "What do the five logos you see on the slide have in common?"

They are logos of the five biggest oil-producing companies in the United States. The entire oil and gas industry spent on average $400,000 each day lobbying senators and representatives to weaken public health safeguards and keep big oil tax breaks.

Facilitators note: Ask the question. "Why do you think these companies are willing to spend this much money?"

These five oil companies received $6.6 million in federal tax breaks every day. In 2011 these five biggest oil companies earned a combined profit of $375 million per day, or a record $137 billion profit for the year. That is a lot of money to keep people confused. The longer people are confused about the science the longer they can go on making these record breaking profits. The video clip is going to further articulate the difference between pop culture and science. *Play the video.*

Climate Science *Slides 8-20*

Once again, 98% of the scientific community believe in human caused climate change. For the remainder of this presentation we are not going to be talking about pop culture, we are going to be looking at climate science.

Facilitators note: Play the video.

In the past 2.6 million years the planet has gone through repeated cycles of warm periods and cool periods. It is kind of like a top. As it spins you can see that it does not spin in a perfect circle. Similarly, the earth is not a perfect circle. It too wobbles. A man named Milankovitch

discovered these wobbles about one hundred years ago. These wobbles cause variation in temperature over long periods of time. Remember when we talk about climate we are talking about big systems, the entire planet, over long periods of time, tens of thousands of years. This accounts for things like the ice age and temperature variation over long periods of time. This is called the Milankovitch cycle or more commonly **Ice Age Cycles**. With information from these studies scientists are able to predict that the next ice age is not scheduled to come for about 30,000 years. So we can all take a big sigh of relief.

Paleoclimatology is **t**he study of changes in climate taken on the scale of the entire history of Earth. Since it is not possible to go back in time and see what climate was like, paleo climatologists use natural records such as tree rings, ice cores and sedimentary layers. Historical observations, such as native knowledge and personal journals also document past climate change. Paleo climatologists take ice cores to look at what was happening millions of years ago and can estimate the average surface temperature of planet earth far into the past.

What these studies have shown us is that the climate is changing. According to the IPCC (Intergovernmental Panel on Climate Change) the period of 1995-2005 was the warmest decade in the Artic since at least the 17^{th} century with temperatures 2^{o} above the 1951-1990 average. Some regions within the Arctic have warmed even more rapidly with Alaska and western Canada's temperature rising by $3\text{-}4^{o}$. Temperatures in the region have not been as high as they currently are since at least 44,000 years and ago and perhaps as long as 120,000 years ago. Scientists, being genuinely curious people, have been documenting these changes.

Meteorology is the branch of science concerned with the process and study of the atmosphere, its effects on the environment, predictions of the weather, and investigations of climate trends. About sixty years ago a chemist named Charles Keeling figured out a way to measure carbon dioxide in our atmosphere. He measured CO_2 levels for years and discovered two important things:

- The amount of CO_2 in our atmosphere varies based on seasons and the carbon cycle
- The amount of CO_2 in our atmosphere is increasing over time.

We call this the Keeling Principal. It is also known as the Mauna Loa Curve.

Facilitators note: Ask the question "If these changes are seasonal what is the big thing that happens in the fall that would cause an increase in CO_2?" Answer: Leaves fall from the tress and decompose. Trees are releasing CO_2. Ask the question "What then happens in the spring that would cause CO_2 levels to drop?" Answer: Trees put out new growth and new leaves. Increasing their ability to store CO_2.

Knowing that Air, Water and Land are interconnected and being naturally curious people, meteorologists wondered if CO_2 is rising in our air, what is happening in the water?
They went to **Oceanographers** or scientists that study our oceans. What do you think they found?

Facilitators note: Check for understanding. Ask the students what they think the correct answer is before continuing.

They noticed a trend that the amount of CO_2 in our oceans is also increasing. Furthermore, they discovered that the increased CO_2 is causing something called **Ocean Acidification.** When carbon dioxide enters the ocean it combines with seawater to produce carbonic acid. This increases the acidity of the water and lowers its pH. Now scientists are really curious. They are seeing an increase in CO_2 in the air and an increase in CO2 in the water. Remember our three interconnected systems air, water and land? What do you think is happening to the CO_2 in the land?

Facilitators note: Check for understanding. Ask the students what they think is the correct answer. Ask for a show of hands as to how many people think that the amount of CO_2 in our land is also increasing? How many people think the amount of CO_2 in our land is decreasing? You can also ask students to do a thumbs up for increasing, a thumbs down for decreasing or a flat hand for unsure.

It turns out the amount of CO_2 in our land is decreasing. Humans are removing the CO_2 that has been sequestered deep in the earth in the form of coal, oil and natural gas at an alarming rate. And the CO_2 that is being released into the air and water is having a visible impact on those systems. We mentioned plants sequestering CO2 when we looked at the Keeling Curve.

Who knows what the carbon cycle is? Who can explain it to us?

Facilitators note: Ask 1-3 students, depending on the quality of their answers, what the Carbon Cycle is. Once you hear a good answer reiterate it for the class to make sure everyone has heard it.

The **carbon cycle** is the key to making Earth capable of sustaining life; it describes the movement of carbon as it is used and reused by plants and animals. Plants use CO_2 and release Oxygen. Animals (like us) use Oxygen and expire or breathe out CO_2. For most of history plants and animals have balanced each other out. At the turn of the century the Industrial Revolution created an increase in the use of electricity for power for factories and dependence on cars that burn fossil fuel (gas). This has increased the amount of CO_2 being released while massive deforestation has decreased the amount of CO_2 absorbed by the plants. The carbon cycle has been thrown out of balance. Where is all this extra CO2 going? It is going into our oceans and up into the atmosphere. What we are primarily looking at now is the excess CO_2 in our atmosphere.

Who knows what the Greenhouse effect is? Who can explain it to us?

Facilitators note: Ask 1-3 students, depending on the quality of their answers, what the Greenhouse effect is. Once you hear a good answer reiterate it for the class to make sure everyone has heard it.

The **Greenhouse effect** is an important part of earth's ability to sustain life. The earth gets its warmth from the sun. The **atmosphere** is the mixture of gases that surround the earth in layers. It both holds and protects us from the suns heat. **Solar radiation** or the energy we get from the sun passes through the atmosphere to warm the planet. Some of that heat escapes back into space and some of it stays on the surface. **Carbon Dioxide** and other atmospheric gases trap heat. If it weren't for these gases the earth would be a very cold and inhospitable place. CO_2 and Oxygen are both key elements of our atmosphere. When the amount of CO_2 rises, more solar energy becomes trapped., thus raising the temperature. It is like putting extra blankets on your bed. You might want one to keep you warm at night but if you add too many it gets too hot to be comfortable. The increase in CO2 is causing global temperature rises and it is getting too hot to be comfortable.

Climate change refers to the rapid rise in global temperature caused by human influenced imbalance in the carbon cycle and the subsequent greenhouse effect. During the 20^{th} century the Earth's global average surface temperature rose by about $1.08^{o.}$ Since 2000 an additional warming of 0.25^{o} has been measured. While this may seem small it is an extraordinarily rapid rise compared to the changes in the last 10,000 years. Over the 21^{st} century, climate scientists expect the Earth's temperature to continue to rise even more than it did in the 20^{th} century.

Scientists study the past to understand what has happened and they use that information to help make predictions about what will happen. The past 100 years of observations, experiments and theory are used to construct and refine computer models that represent the climate system and make predictions about its future behavior. Results from these models lead to better understanding of the linkage between the earths systems and climate conditions. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change.

What are scientists saying? Tens of thousands of scientists all over the world working on their individual projects, coordinating efforts and sharing results and there is 98% agreement, a scientific consensus around human caused climate change. But don't just take my word for it. Let's hear what Michel Jarraud, one of the world's leading climatologists has to say. He is a representative of the IPCC, the International Panel on Climate Change, commissioned by the UN to study the issue.

Facilitators note: Play the video. Only the first 55 seconds. If you are working with a class or English Language Learners skip this video. It is difficult to understand Jarraud's accented English.

Human Caused Climate Change *Slides21-28*
To summarize, the earth is warming.

Humans are causing it. The **fossil fuels -** oil, coal and natural gas - we use to run our cars, supply our energy and run our factories emit CO_2 when burned. That CO_2 is going up into the atmosphere and causing **global warming** or an increase in the earth's average

temperature based on changes to our climate. Cutting down trees and clear cutting our forests that sequester CO_2 are also contributing to the problem.

Some of the results we are seeing today are increased frequency and intensity of heat waves, droughts and floods. Melting ice sheets and glaciers are causing a rise in global sea level and are putting entire island nations at risk and increasing the damage to homes, buildings and communities during storms.

Facilitators note: As you say " This is where Healdsburg and Cloverdale get their water." point or use the laser pointer to identify the photo of Lake Sonoma.

Here in California we are feeling the impact of a multi-year drought. The Sierra snow pack supplies water to 1.7 million people across the greater Bay Area. More precipitation is happening as rain instead of snow and spring run off is happening sooner. This means less water going into aquifers, and rivers.
This impacts us.

Facilitators note: Ask students to identify some of the impacts they have felt. Students will respond with comments like taking shorter showers, not watering the lawn or not washing their cars.

For eco-systems, the Eel River is drying up, salmon cannot get upstream to spawn or salmonids cannot get to the ocean and grow to maturity. Agriculturally, fruit trees that rely largely on ground water are dying or need to be irrigated.

The hotter weather is not bad for everything, ticks and mosquitos have a longer breeding season and are increasing in number. As a result, infectious diseases like malaria and Lyme Disease are expected to increase.

Facilitators note: Ask students, how many people know someone who has had Lyme Disease?

This is another impact we are feeling in our home community. Drought, the famine that results from it, disease and poor air quality are affecting human health and mortality rates all over the world. People in the developing world feel the greatest impacts.

Humans are not the only species impacted by climate change. The rate of extinction is happening 1,000 times faster. The International Union for Conservation now has more than 20,000 species of plants and animals on their list.

Incidents of extreme weather are projected to increase as a result of climate change, including heat waves and severe cold. Precipitation is expected to be less frequent but more intense and

droughts will be more frequent and more severe. Hurricanes Katrina and Sandy are both examples of this.

We don't know the upcoming costs of the impacts of climate change but we do know that the number is going up. In 2011 We spent $21.3 billion in disaster relief in the US, in 2012 it went up to $34.4 billion. The cost of super storm Sandy in 2013 was $75 billion. We pay off these debts over time, 20-30 years. That means you will be paying not just for these disasters but for increases into the future.

Solutions are Out There *Slides 29-36*
Reducing human vulnerability to the impacts of climate change depends not only on our ability to understand climate science but also upon our ability to integrate that knowledge into human society. The cost world wide to completely switch to **renewable energy** power sources like wind, solar and geothermal and whose impact does not adversely affect the climate is $40 trillion. That is a big number. However, it is only 1% of Global GDP for 50 years. Nor is it the first time we have had to do this. At the end of the 19th century the US and Europe had a problem. With industrialization and more people living in cities there was a huge issue with what to do with everyone's waste. It was a multi-continental, epidemic public health hazard. But home by home, community by community, city by city we put in what is now our modern sewage system. The cost of converting the US to indoor plumbing was roughly equivalent to 1% of the GDP. Not only that, but converting to renewable energy will save $115 trillion in fuel costs over the same time.

Facilitators note: Show the video

The video asks: how do we get to those solutions? Well a combination of strategies is needed to reduce greenhouse gas emissions.

1. First, we need everyone changing habits and patterns of behavior to live in ways that are healthier for us and our planet.
2. Second, we need people like you to engage in community to help build **infrastructure** like bike lanes, farmers markets and Sonoma Clean Power that make it not just possible but easy to change our personal habits.
3. And finally we need the next generation of creative thinkers and problem solvers coming up with solutions we have not yet thought of.

Sonoma County has long been a leader in sustainability and building an economy and community that is less based in individual consumption and more in a shared economy. We have Sonoma Clean Power that gives people and businesses the option to choose electricity from renewable energy sources like solar wind and geothermal energy from the geysers. We also have farmers markets and farm stands that allow us to eat food grown locally. We have an increasing number of bike paths and lanes. We are building the Smart Train that will further decrease our dependence on single occupancy vehicles.

The number one thing that young people can do to reduce their carbon footprint and have a positive impact is to change your travel habits! Here in Sonoma County transportation accounts

for 65% of our carbon footprint. It is by far our greatest source of greenhouse gases. By walking or riding your bike, carpooling and using public transit you are doing something that is good for your personal health and the health of the planet. Over 70% of students live 3 miles or less from school. By walking or riding your bike just one day a week you can save an average of 100 Lbs. of CO_2 from being emitted a year.

That does not sound like a lot but look at what happens when everybody does it. If all the student in one school made that same commitment to walking or biking, they could save 60 tons of CO_2. As the number of people grows the power of our actions grow and so does the CO_2 savings. That is the power of **collective action**, by working together we can achieve a common objective. This is what we are all about.

These are students like you who are working to mitigate the impacts of climate change. Here are a few of your Youth Advisory Board members who have been working here in Sonoma County and the greater Bay Area to have a positive impact.
Jasmine Jolly won the Breathe CA award as a Freshman at Windsor for her work with Spare the Air Youth organizing the Youth for Environment and Sustainability Conference.
Patrick Schiller worked with Supervisor Shirlee Zane on a Gold Resolution and addressed the County Board of Supervisors when he was a junior at Maria Carrillo.
Shivani Shumar came with us to the NAAEE conference and helped facilitate a discussion about youth leadership and engagement with people from all over the United States. We invite you to join us.

Facilitators note: Use the laser pointer to identify students as you talk about them.

I am going to give you three things you can start to do.

1. Make a pledge to change your behavior and stick with it
2. Join your green club work with ECO_2school staff at finding solutions in your school community.

Facilitators note: 3. Name an upcoming event that students can participate in.

Jeopardy Game: Checking for Understanding *Slides 37-49*
The four Jeopardy categories are: climate debate, climate science, climate impacts and climate action.

Facilitators note: Jeopardy is a fun way to end the presentation. It is a good way to check for understanding and students like it. The text for these slides is on the slide itself. Read the text on the slide as students read along. Have students raise their hand to answer questions. It is helpful to have a pencil or some other small prize for correct answers. It builds enthusiasm and increases engagement. If you know the tune to Jeopardy you can hum or whistle it while waiting for students to think about the correct answers. This is a good time to practice your dramatic flair. If you can sound like a game show host, do. The more you play your role the more engaged students will be. Most students will not be familiar with the Jeopardy style of answering questions as a question ie: "what is…" That is ok. If the student gives the right answer in the incorrect form repeat the answer in the correct form.

Let students know that since there is not a lot of time we are going right to the answers worth 500 points each. Each correct answer is worth a prize.

Climate Debate for 500: The percentage of climate scientists who believe in human influenced climate change.
What is 98%.

Climate Science for 500: Carbon Dioxide and other gases in the atmosphere that trap heat and keep the earth warm.
What is the Greenhouse Effect.

Climate Impacts for 500: Some signs of this climate change impact are: taking shorter showers, salmon species are threatened and fruit trees are dying.
What is the California drought.

Climate Action for 500: The simple action you can take to save 100 pounds of CO_2 a year.
This is DOUBLE JEOPARDY
What is walking or riding your bike to school one day a week.

Facilitators note: This is a grand prize. If you have a different or special prize for the last answer you can use it.

Facilitators note: Supplemental activities can be downloaded on the eco2school website at www.eco2school.org/climate-literacy.html

Facilitators note: Thank the teacher and the students for having you in their class today. Ask if there are any last questions or comments. When you have answered the last questions turn the class back over to the teacher for their next set of instructions.