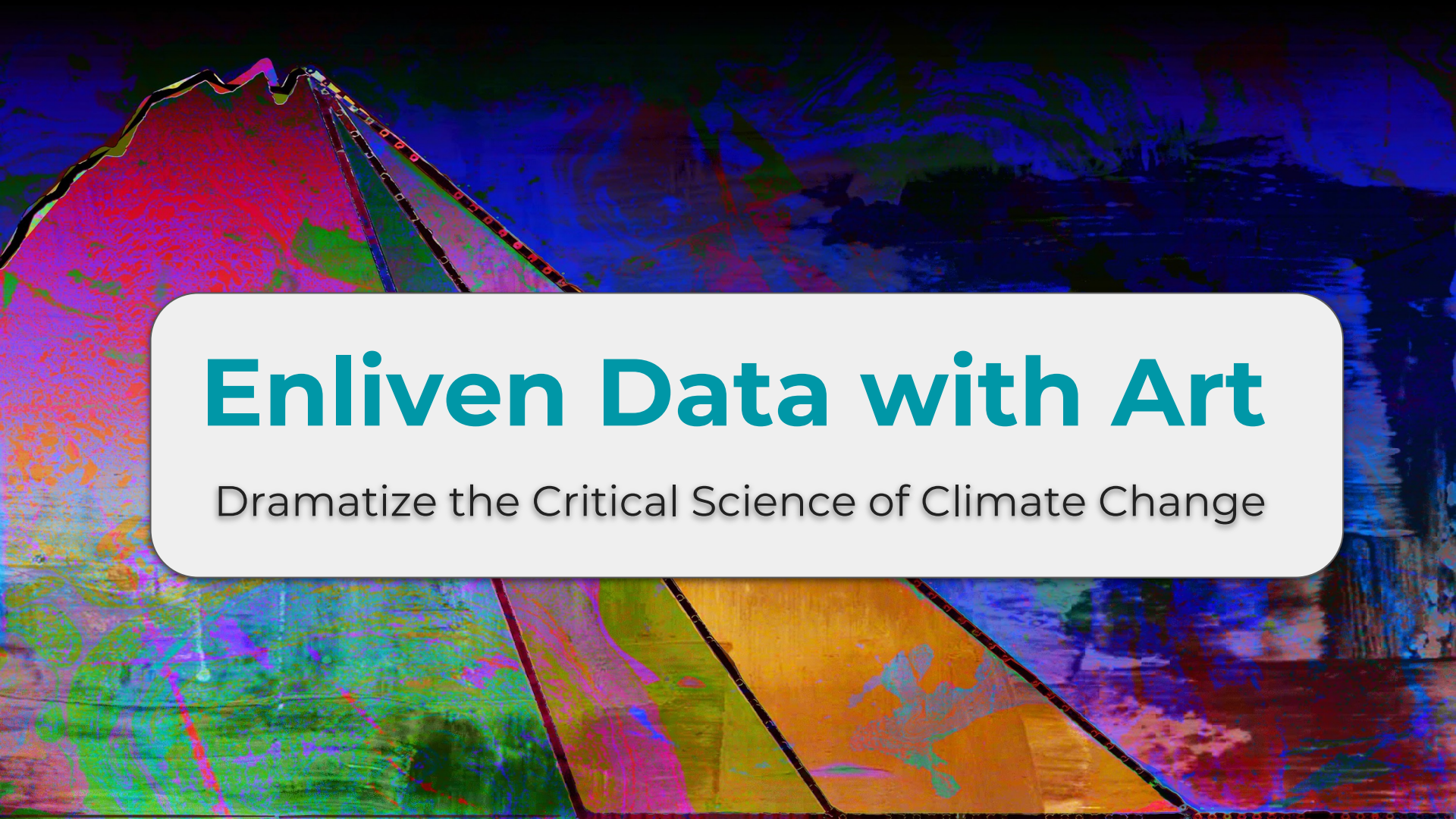

Enliven Data with Art
Dramatize the Critical Science of Climate Change

Environmental Graphiti® – The Power of Digital Storytelling
Toolkit Guide for Teachers created in collaboration with the UCI Science Project

Image 1. (cover slide)
Teacher Preview

Art can be an effective tool to communicate facts about climate change in a unique and powerful way.

Print 2 sets of the art images on pages 4-7 and the graph images on pages 31-34 prior to teaching the lesson. Consider having students work in groups of 4-5.

Useful links:

Environmental Graphiti website: https://www.environmentalgraphiti.org
UCI Science Project website: https://scienceproject.cfep.uci.edu

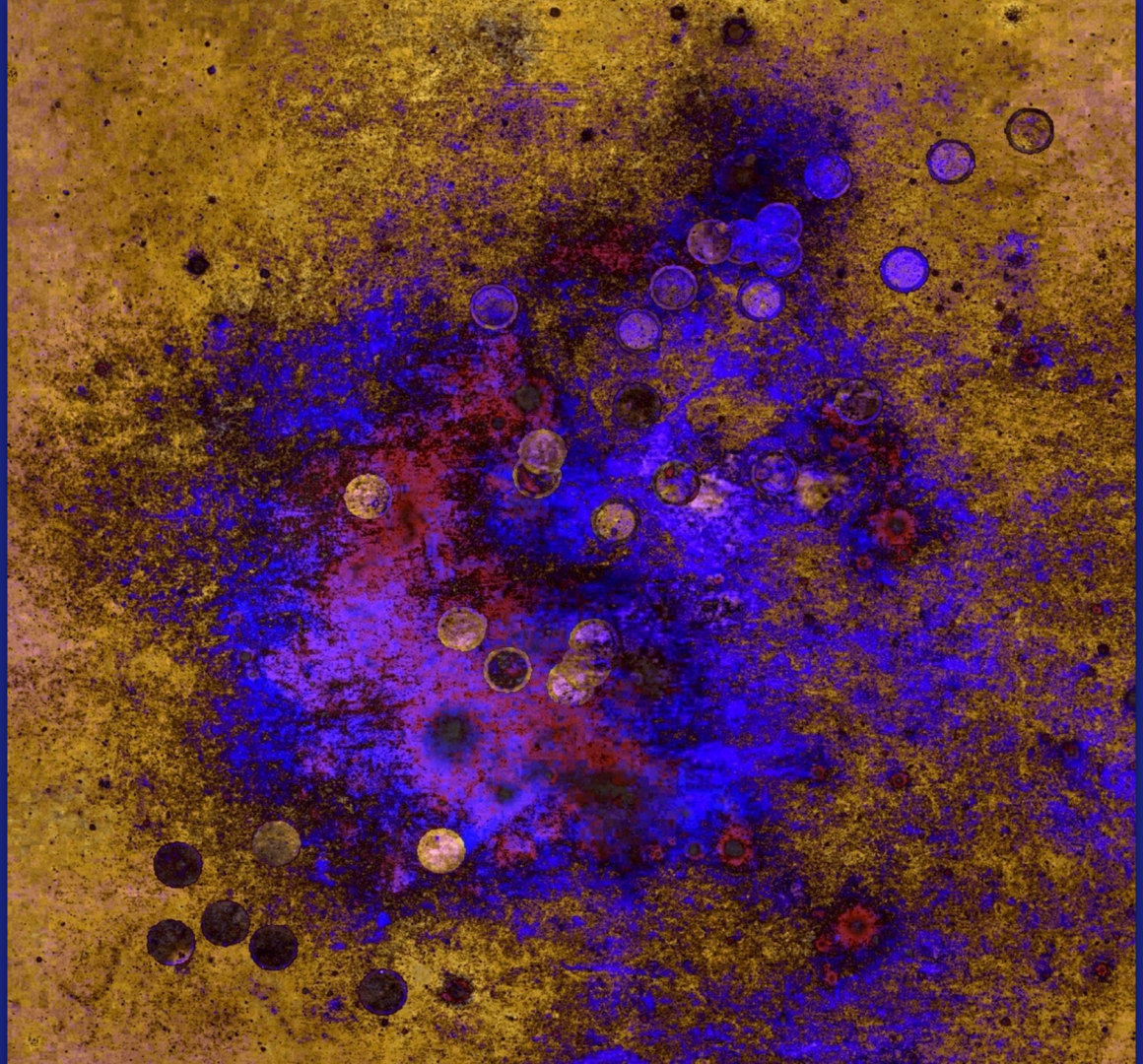
Images - Pages 4-7.
Teacher Guidance:

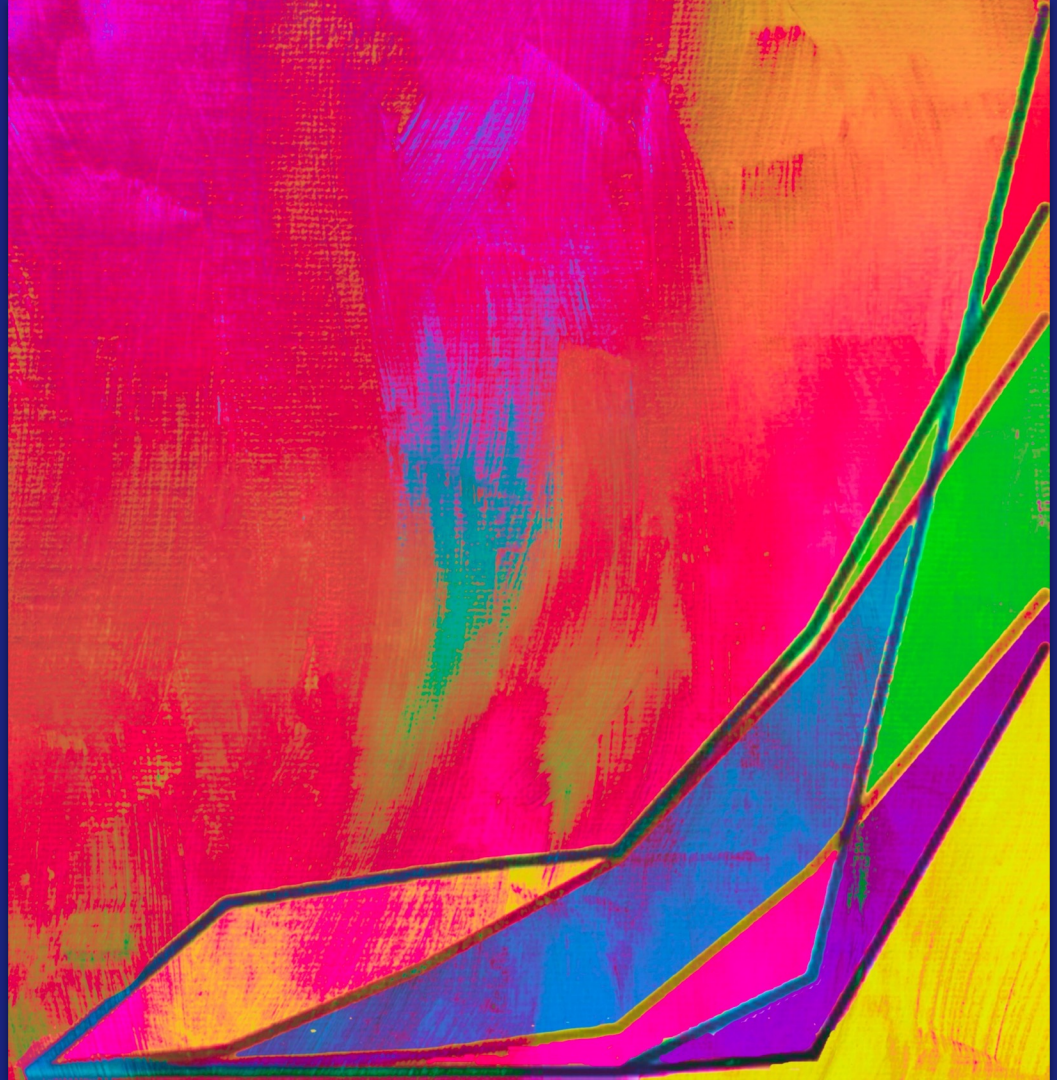
Display the slides of each of the 4 pieces of art from 4 different galleries found on the Environmental Graphiti website.
https://www.environmentalgraphiti.org

As a class, engage the students in whole group discourse at the end of the round robin activity, have students read all the comments from their peers next to the poster and select one speaker to share some major points or patterns from the reactions. Have each group's speaker share with the whole class before sitting down with their group.

Questions to Consider Posing:

- What questions do you have about what you're seeing?
- What story or message is the art trying to convey?
- What stands out to you most in each of these artworks?





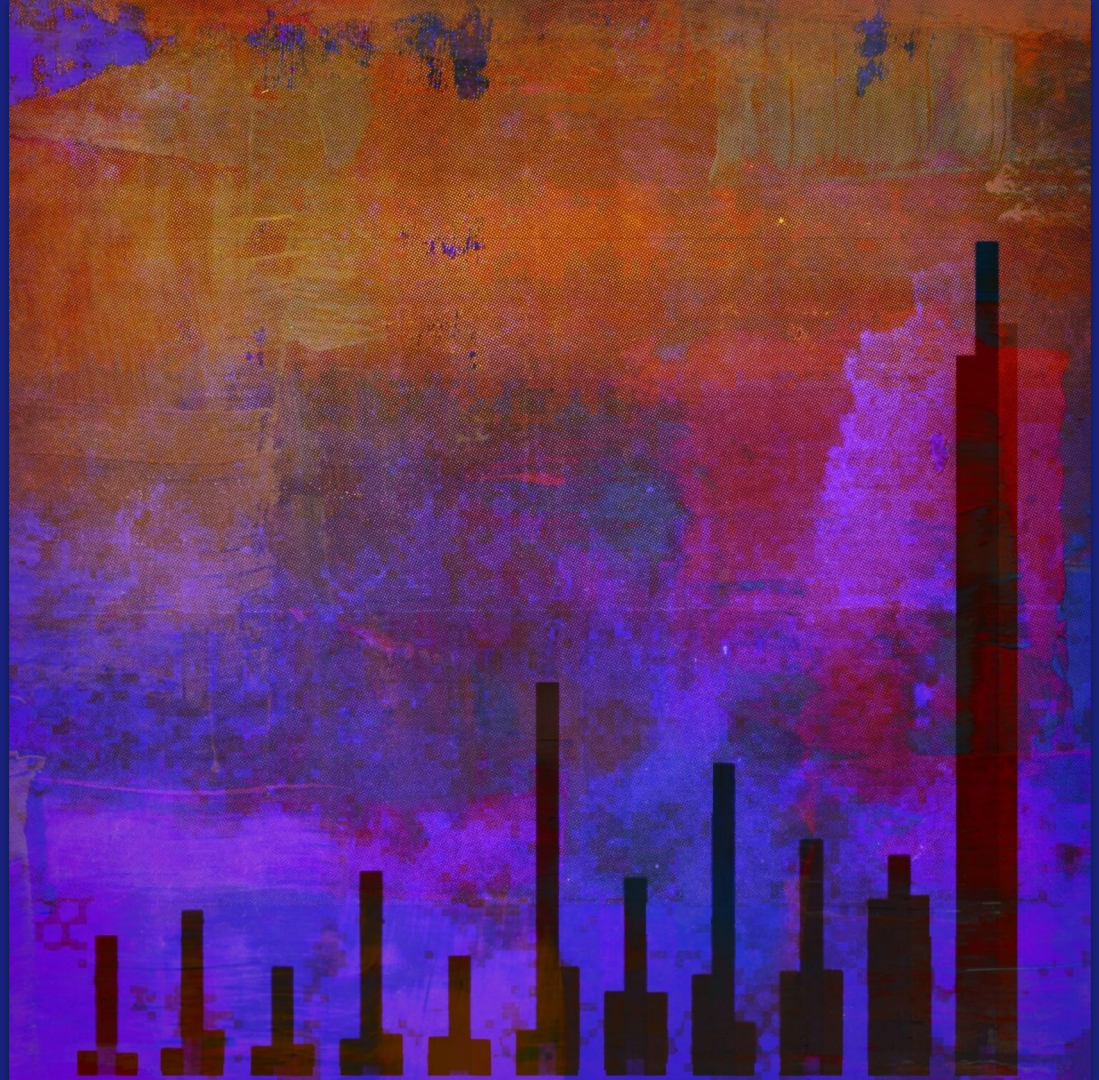
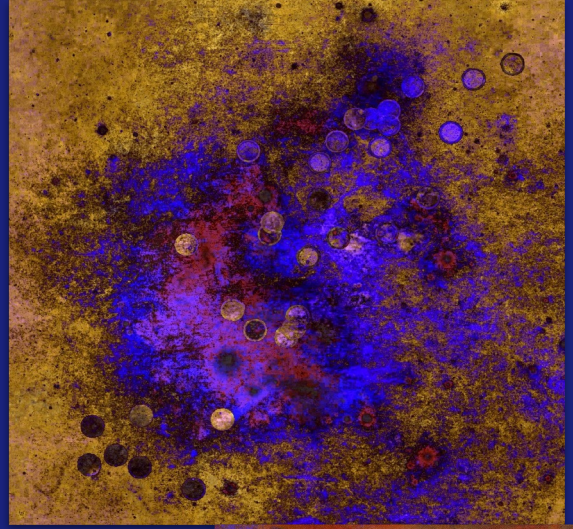


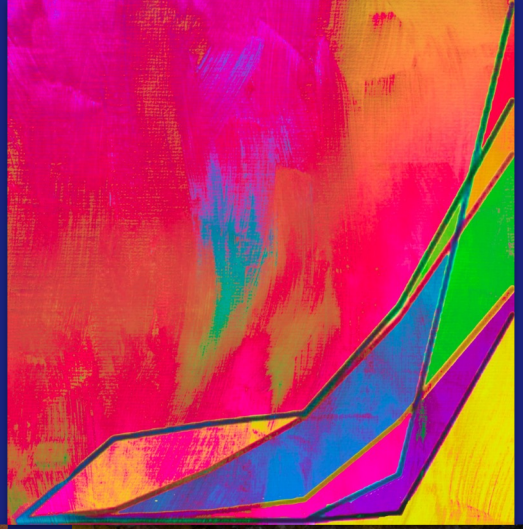
Image - Page 9.

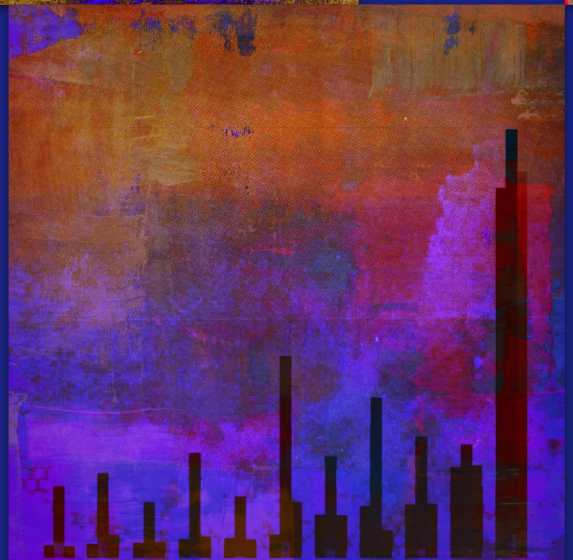
Teacher Guidance:

Combined Display of all 4 pieces of art used in this exercise. These pieces are selected from 4 different galleries found on the Environmental Graphiti Website:
https://www.environmentalgraphiti.org

Why is our climate changing?
How is climate change affecting our world?
Who is at risk?
What can we do to address climate change?







Video - Page 11.

Teacher Guidance:

Play the video for students to reveal how the ***Environmental Graphiti*** artist Alisa Singer creates art using science. Singer was attracted by the inherently aesthetic design elements of scientific charts and graphs and intrigued by the idea of using art to give them dramatic effect.

Where to Start with Science Art

Please note that when creating each piece, the artist tries to make the work stand independently from an aesthetic perspective, rather than trying to connect it to the subject matter of the underlying source graph. This creates an element of surprise which engages viewers' interest when they discover that the art is not abstract but, rather, based on climate science.


ENVIRONMENTAL GRAPHITI
Where to Start with Science Art
NSF

Image - Page 13.
Teacher Guidance:

Students will discuss their initial reactions to the art with their peers in small groups in five-minute rotations from one poster to the next. After speaking with their group, they will write down their thoughts for one of the following on a post-it note/easel pad paper/white board for the following groups to read:

- How did the artwork make you feel or what did it make you think about?
- What are your group's interpretations of the artwork?
- Does this artwork make you wonder about anything?

The teacher reminds the student to rotate every five minutes until they return back to their original poster. (There are 4 posters total.)

Visit Environmental Graphiti website https://www.environmentalgraphiti.org to select your own pieces of artwork from the various galleries:
"**Why** is our climate changing? **How** is our world affected? **Who** is at risk? **What** can we do to address climate change?"

Round Robin Activity

- How did the artwork make you feel?
- What did the artwork make you think about?
- What are your interpretations of the artwork?
- What does the artwork make you wonder about?

Image - Page 15.

Teacher Guidance

Hand out the graph (pages 31-34) that corresponds to each artwork. Have students discuss their interpretations of the data and rotate every five minutes from one poster to the next. After speaking with their group, they will write down their thoughts for one of the following questions on a post-it note/easel pad paper/white board for the following groups to read:

- How would you summarize the data on the graph?
- What is the figure trying to tell you?
- What data has been left out?
- What will you predict will occur?
- What questions do you have about the data?

Graphs, charts, numbers, and words can be used to reflect key facts about how our world is changing, and can be transformed into stunning, vibrant digital paintings.

Image - Pages 17 and 18.

Teacher Guidance

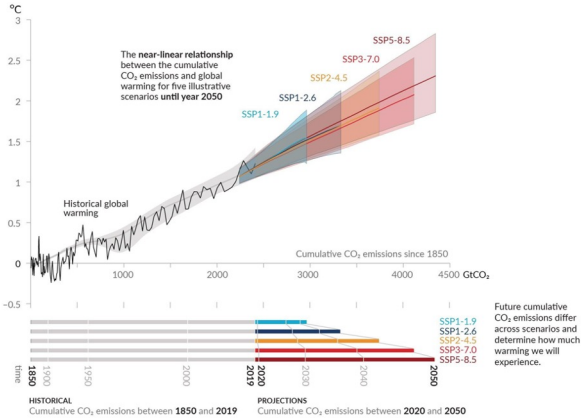
After students have determined which of the four graphs matches their piece of artwork, give students time to discuss the question: “What story is your piece of artwork trying to convey about climate change?”

There are many ways students can explain the graph. Ask students to provide justification for their responses.

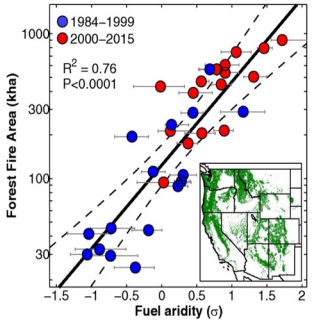
As each group presents their thoughts about what story is your piece of artwork trying to convey about the climate change, display slides 19 – 29 to engage in whole group discourse. (You may choose to eliminate some of the details on the graph descriptions.)

Every tonne of CO_2 emissions adds to global warming

Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)

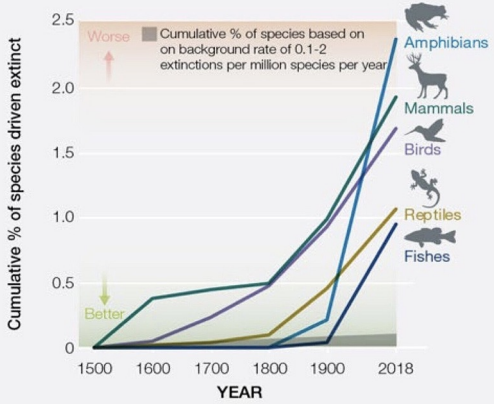


Wildfires



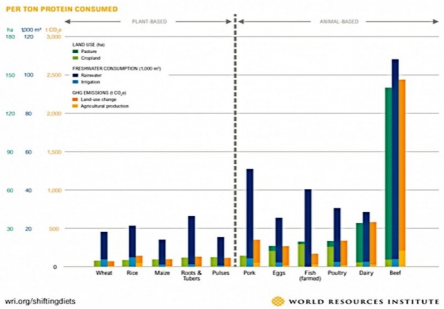
*Proceedings of the National Academy of Sciences, "Impact of anthropogenic climate change on wildfire across western US forests", Abatzoglou and Williams, PNA Oct 18, 2016. 113(42)11770-11775; https://doi/org/10.1073/pnas.1607171113

B Extinctions since 1500



Less Red Meat = Greener Planet

Animal-Based Foods Are More Resource-Intensive than Plant-Based Foods



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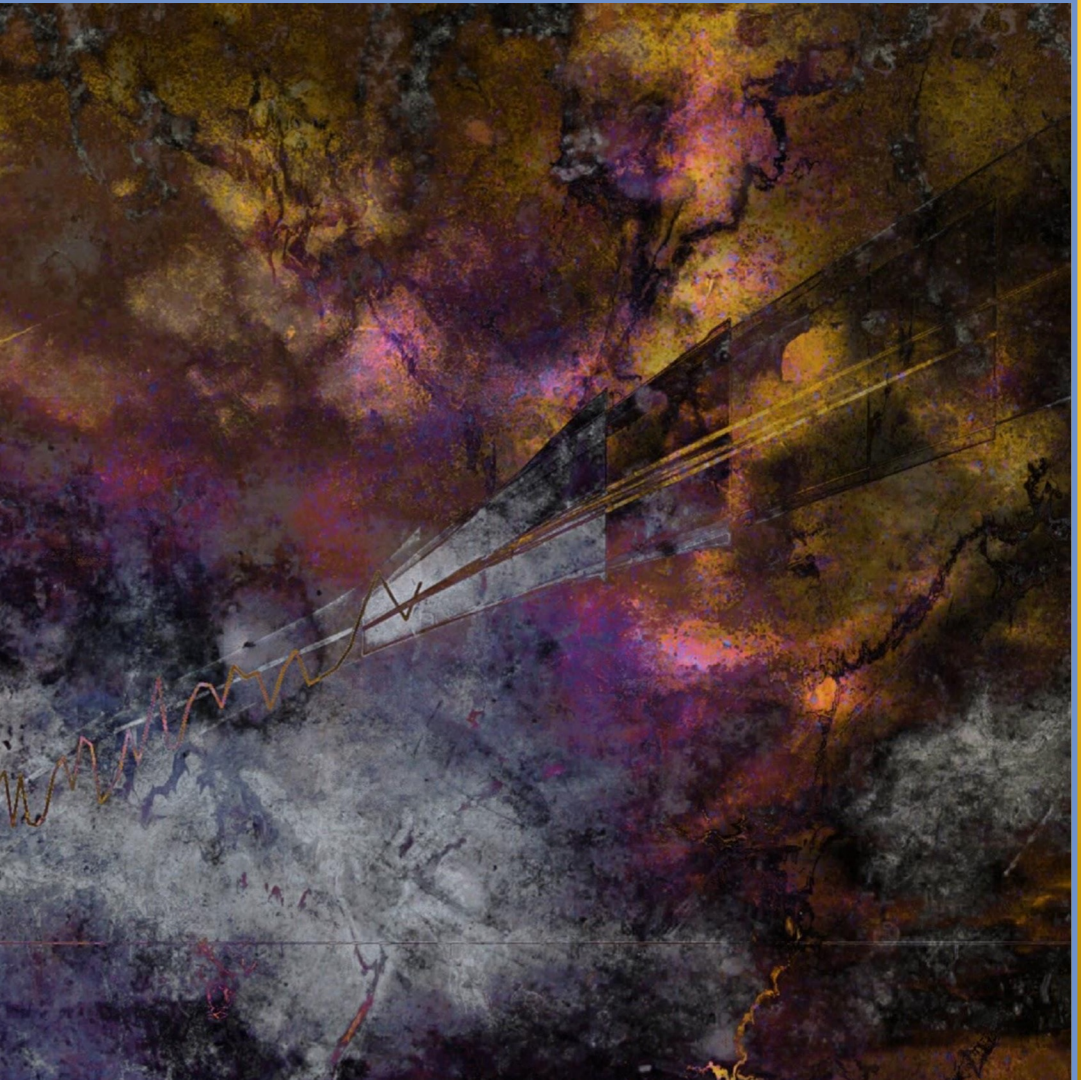
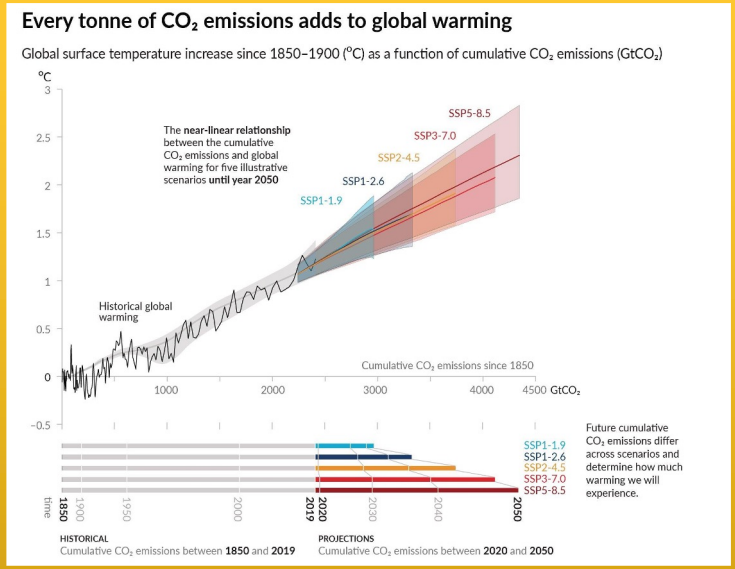
What story is your artwork trying to convey about climate change?





Why is our climate changing?

Image – Page 21 (page one)

Subject of Piece

Historical increases in global surface temperatures correlate directly with increases in carbon emissions in the post-industrial age. This clear relationship allows us to predict future temperature increases depending on the different scenarios for future carbon emission levels.

As can be seen, projected future temperature increase varies significantly, depending on which emissions scenario is selected. In other words, the amount of global warming that will be experienced by the planet will depend on how much carbon humans choose to continue to emit into the atmosphere

Background Information on Graph
The graph depicts the relationship between emissions levels and temperature rise.

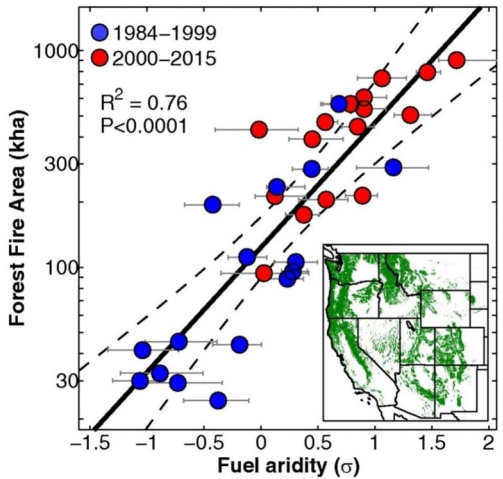
“Figure SPM.10 | Near-linear relationship between cumulative CO2 emissions and the increase in global surface temperature.

Top panel: Historical data (thin black line) shows observed global surface temperature increase in °C since 1850–1900 as a function of historical cumulative carbon dioxide (CO2) emissions in GtCO2 from 1850 to 2019. The grey range with its central line shows a corresponding estimate of the historical human-caused surface warming (see Figure SPM.2). Coloured areas show the assessed *very likely* range of global surface temperature projections, and thick coloured central lines show the median estimate as a function of cumulative CO2 emissions from 2020 until year 2050 for the set of illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5; see Figure SPM.4). Projections use the cumulative CO2 emissions of each respective scenario, and the projected global warming includes the contribution from all anthropogenic forcers. The relationship is illustrated over the domain of cumulative CO2 emissions for which there is *high confidence* that the transient climate response to cumulative CO2 emissions (TCRE) remains constant, and for the time period from 1850 to 2050 over which global CO2 emissions remain net positive under all illustrative scenarios, as there is *limited evidence* supporting the quantitative application of TCRE to estimate temperature evolution under net negative CO2 emissions.

Bottom panel: Historical and projected cumulative CO2 emissions in GtCO2 for the respective scenarios. {Section 5.5, Figure 5.31, Figure TS.18}”
Figure SPM.10 in IPCC, 2021: Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY,USA, pp. 3−32, doi: 10.1017/9781009157896.001 .]
Source - https://eg-v2.squarespace.com/all-series/emissions-levels-determine-temperature-rise

How is climate change affecting our world?

Wildfires



*Proceedings of the National Academy of Sciences, "Impact of anthropogenic climate change on wildfire across western US forests", Abatzoglou and Williams, PNA Oct 18, 2016. 113(42)11770-11775; https://doi/org/10.1073/pnas.1607171113

Image – Page 22 (page one)

Subject of Piece

Halfway through the Australian 2019/2020 wildfire season, 24 people had been killed, dozens more were still missing and 15 million acres had been burned - an area larger than Denmark. This followed Australia's driest and hottest year on record. There has also been a devastating toll on wildlife, mounting to the hundreds of millions by some estimates and bringing some local species to the brink of extinction. By the beginning of the California fire season in 2020 more than 3,000,00 acres had been burned and six of the 2 largest fires recorded had occurred. Oregon experienced double the scale of a typical season. Other parts of the world, including unlikely places such as the arctic and Siberia, have also experienced their worst fires in recorded history.

Global warming causes trees, plants and soil to become drier because warmer air draws more moisture, which increases fuel aridity. Drought, decreased rainfall and earlier melting of snow pack are also contributing factors. "Simply put, climate change results in longe fire seasons and larger and more intense fires."* According to a report by the National Academy of Sciences, during the period 1984-2015 human-caused climate change resulted in a near doubling of area impacted by forest fires in the western United States. According to NOAA, 2018 was the first year that wildfires exceeded the average cost of hurricanes in the U.S..**

"The most destructive, the deadliest and the largest wildfires in California history have all occurred in the past two years. …The 2018 National Climate Assessment — a major scientific report produced by 13 federal agencies — concluded that if greenhouse gas emissions from burning fossil fuels continue to increase at current rates, the frequency of severe fires in the west could triple." ***

"California has dealt with a series of devastating fire seasons in recent years, which scientists say is in large part due to climate change, as hotter temperatures dry out vegetation, making it more likely to burn. The 10 largest fires since California began keeping records in 1932 have all occurred since 2000."****

Image – Page 22 (continued)

Background Information on graph
The above graph from the report reflects the correlation between "fuel aridity" and forest fire area burned.

**Proceedings of the National Academy of Sciences of the United States of America, "Impact of anthropogenic climate change on wildfire across western US forests", John T. Abatzoglou and A. Park Williams, PNAS October 18, 2016. 113 (42) 11770-11775; published ahead of print October 10, 2016. https://doi.org/10.1073/pnas.1607171113*
***Philip B Duffy, executive director of the Woods Hole Research Center in Massachusetts, as quoted in The New York Times, August 18, 2018.*
****New York Times, Nov 3, 2019*
***** The Wall Street Journal, August 25, 2020*
Source - https://eg-v2.squarespace.com/all-series/wildfires

Who is at risk?

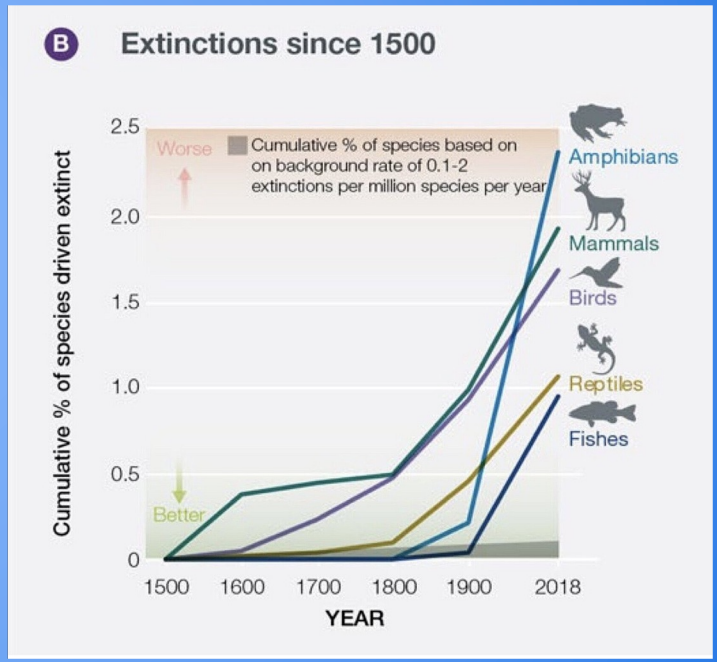


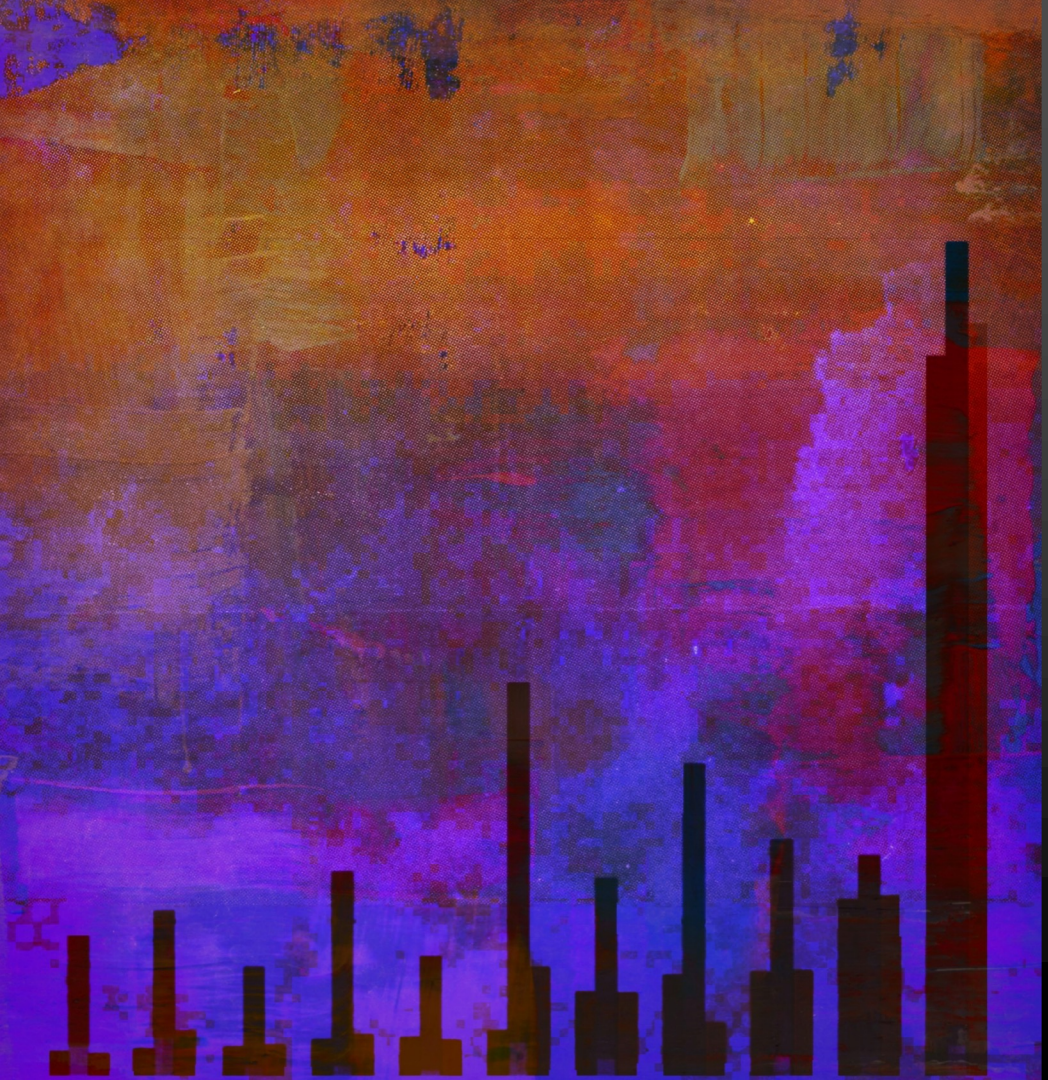
Image – Page 25
Subject of Piece

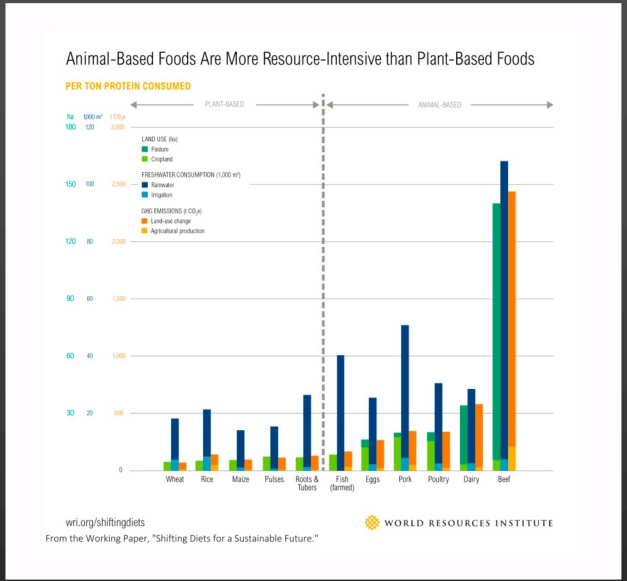
Trends in extinction - The 2019 Global Assessment Report* from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) finds that around 1 million species of plants and animals are at risk of extinction; in many cases this could happen within decades. Currently climate change is the third most significant driver of these threats, after changes in land and sea use (e.g., deforestation) and “direct exploitation of organisms” (e.g., overfishing). However, the report notes that, over the coming decades, climate change impacts are likely to surpass all other drivers of these threats.

“The overwhelming evidence of the IPBES Global Assessment, from a wide range of different fields of knowledge, presents an ominous picture. The health of ecosystems on which we and all other species depend is deteriorating more rapidly than ever. We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide.” *IPBES Chair, Sir Robert Watson*

*The report, which assesses changes over the last 50 years, is the most comprehensive ever on the subject, compiled by 145 experts from 50 countries with inputs from another 310 contributing authors and review of about 15,000 scientific and government sources.

Graph source: IPBES (2019): Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S. Díaz, J. Settele, E. S. Brondízio, H. T. Ngo, M. Guèze, J. Agard, A. Arneth, P. Balvanera, K. A. Brauman, S. H. M. Butchart, K. M. A. Chan, L. A. Garibaldi, K. Ichii, J. Liu, S. M. Subramanian, G. F. Midgley, P. Miloslavich, Z. Molnár, D. Obura, A. Pfaff, S. Polasky, A. Purvis, J. Razzaque, B. Reyers, R. Roy Chowdhury, Y. J. Shin, I. J. Visseren-Hamakers, K. J. Willis, and C. N. Zayas (eds.). IPBES secretariat, Bonn, Germany. Figure SPM 3. 56 pages. https://doi.org/10.5281/zenodo.3553579





What can we do to address climate change?

Image – Page 27

Subject of Piece

Decreasing the amount of meat we eat, especially red meat, could cut in half the per capita greenhouse gas emissions relating to agriculture. According to a 2019 report by the World Economic Forum, switching from beef to other sources of protein could cause global greenhouse gas emissions to fall by 25% and reduce diet-related deaths by 5%. It would also help avoid further deforestation and reduce the amount of water used for agricultural purposes. This could have a significant effect - 80% of the water used in the U.S. is for agricultural purposes and the amount required for meat production is significantly more than that used for plant production.

Graph Source: World Resource Institute

Image – Page 30

Teacher Guidance:

Now that students have analyzed each art side-by-side with the data that inspired the art, consider asking students, “how have your thoughts changed now?”
Consider patterns, colors, images, or how the art makes you feel now.

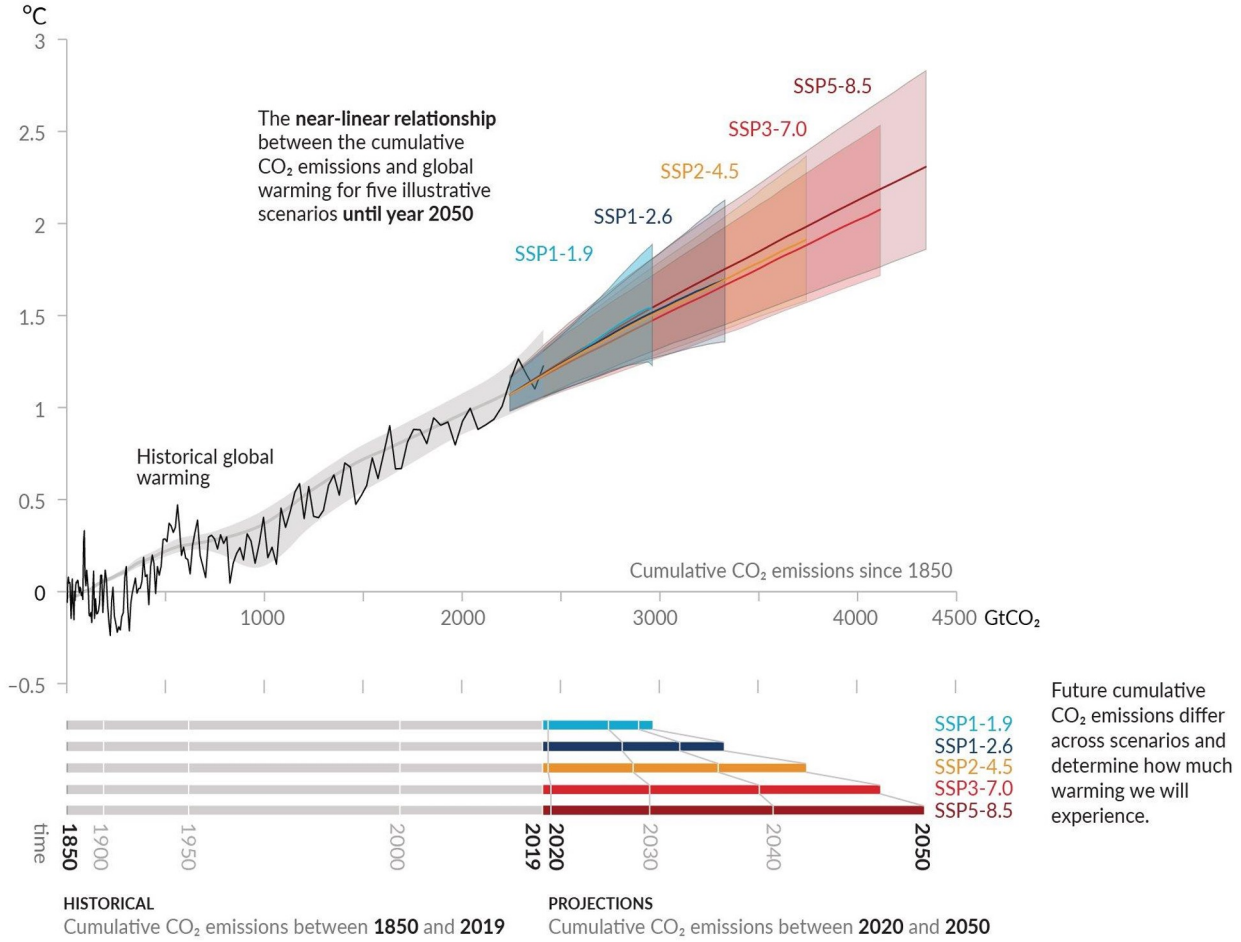
Given this activity, have students engage in whole group discourse with one or a few of the following questions:

- What are you curious about now?
- What are the major takeaways that you have about climate change?
- In what ways does art inspire you to take action against climate change?


What will you do with art to communicate your message?

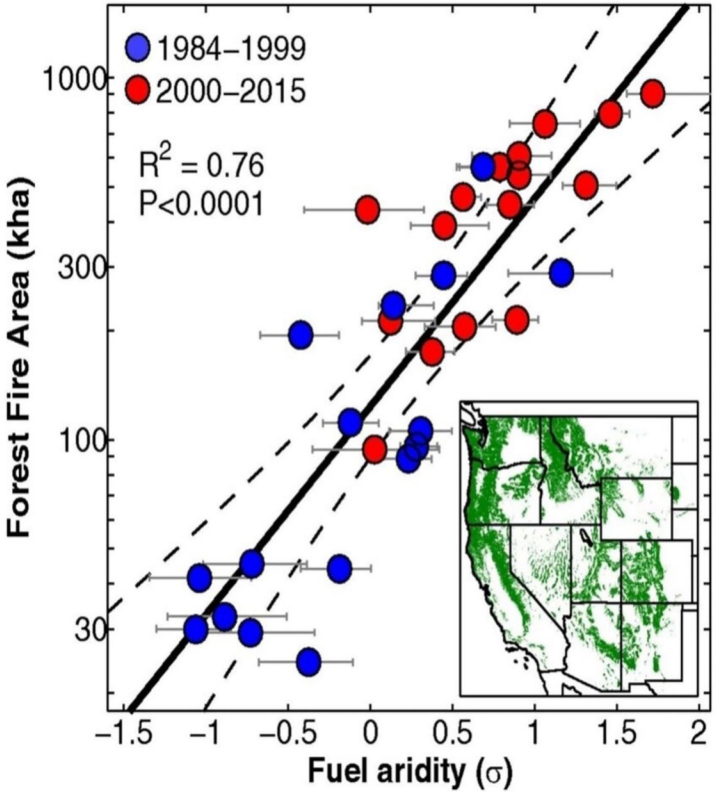
Every tonne of CO_2 emissions adds to global warming

Global surface temperature increase since 1850–1900 (°C) as a function of cumulative CO_2 emissions ($GtCO_2$)



Future cumulative CO_2 emissions differ across scenarios and determine how much warming we will experience.

Wildfires



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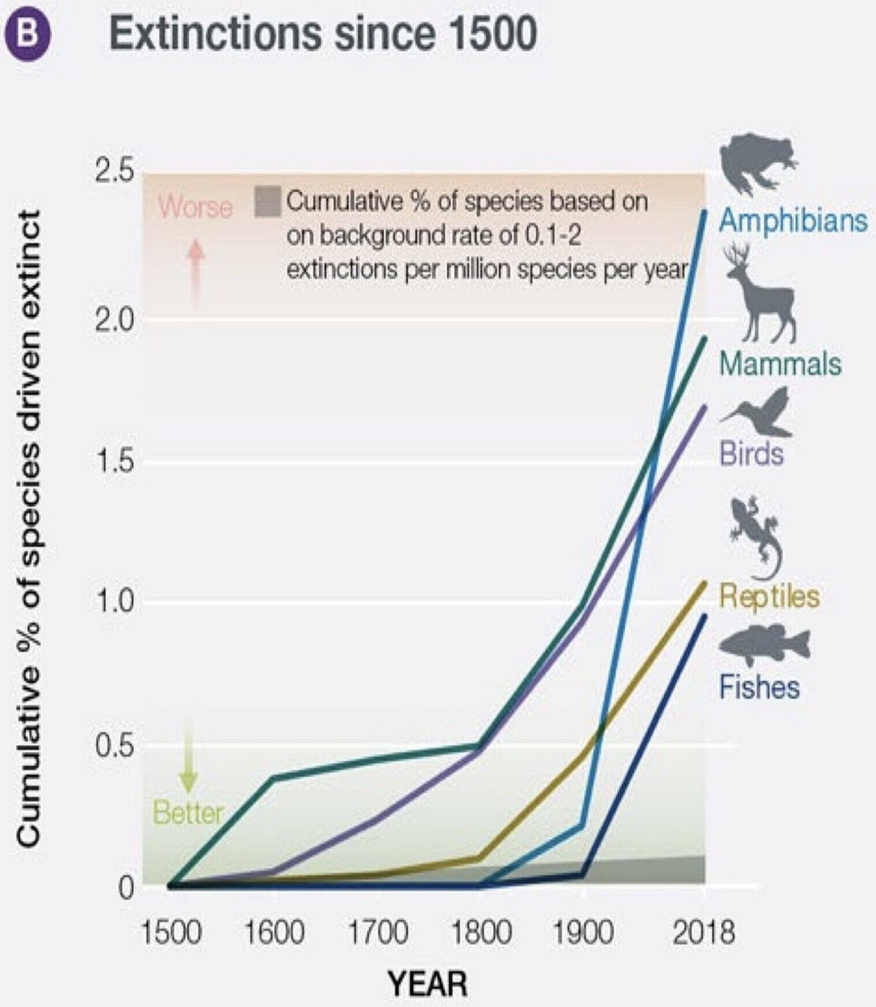
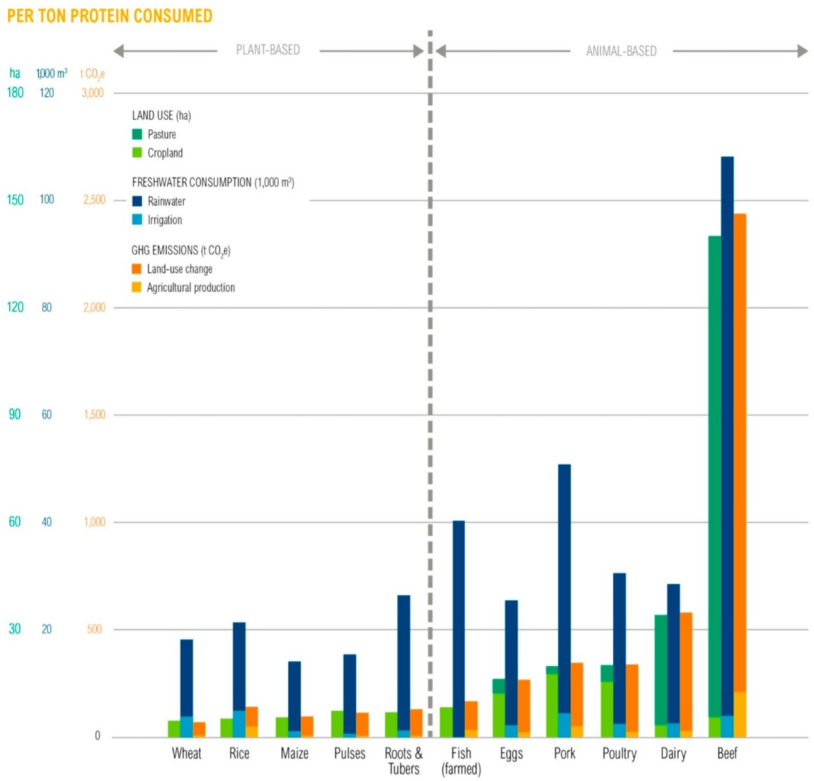

B
Extinctions since 1500
Cumulative % of species driven extinct
2.5
2.0
1.5
1.0
0.5
0
Worse
Better
Cumulative % of species based on on background rate of 0.1-2 extinctions per million species per year
Amphibians
Mammals
Birds
Reptiles
Fishes
1500
1600
1700
1800
1900
2018
YEAR

Animal-Based Foods Are More Resource-Intensive than Plant-Based Foods



wri.org/shiftingdiets

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From the Working Paper, "Shifting Diets for a Sustainable Future."

Acknowledgements and Credits

This Toolkit was created through a collaboration between **Environmental Graphiti** and the the team at the **UCI (University of California-Irvine) Science Project**.

Environmental Graphiti® is a collection of contemporary digital paintings that use art as a vehicle to enhance the public's understanding of the science of climate change. Each of the more than 100 paintings in the series is derived from a graph, chart, map, word or number representing key facts or data about climate change.

The art has been extensively exhibited in the US and other parts of the world and was commissioned for the covers of three recent major UN (IPCC) climate change reports. It is owned by dozens of universities, including sizable collections held by University of California - Irvine, Loyola University - Chicago, Michigan Tech University and most recently, Georgetown University and Smith College. The art can also be found at the Ontario Science Centre (Toronto) and the Peggy Notebaert Museum (Chicago).

https://www.environmentalgraphiti.org

The UCI Science Project "…specializes in working students, PK-12, teachers, and educational leaders to tackle 21st century issues using research-based approaches in science education…The UCI Science Project is grounded in research-based educational practices and understands the paradigm shifts needed for the Next Generation Science Standards. Our goal is to support educators as transformative leaders who build capacity in their schools through empowering learning experiences…"

https://scienceproject.cfep.uci.edu