Air Quality Curriculum

Tribal Environmental Protection Agency / Land Management

and

Hoopa Valley High School

Aligned to Next Generation Science Standards and
California State Content Standards

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Version 1

Engage: Lesson 1

Anchoring Phenomenon: The Salmon Complex Fire

Do Now:

Look at the following image.

Source: Inciweb (2020)

> 1. What do you notice?

2. What is this phenomenon called?
3. What are some causes of this event?
4. Do they happen all the time? Why or why not?
5. What are some impacts of this event?

Visit the incident report for the Salmon Complex fire: https://inciweb.nwcg.gov/incident/6891/

Answer the following questions:

6. What do you notice about the Salmon Complex fire?

7. What is the primary cause of this fire?	
8. How many acres did these fires consume?	
9. How many acres did the fires burn on the Hoopa Reservation?	

Air Quality Index (AQI)

Look at this infographic and respond to the questions below.

Provide an example of outdoor activities that you can engage in using the AQI scale above.

Good	10.
Moderate	11.

Unhealthy for sensitive groups	12.
Unhealthy	13.
Very unhealthy	14.
Hazardous	15.

Visit the Air Quality Outlook for the Salmon Complex fire:
https://inciweb.nwcg.gov/photos/CASHF/2020-07-28-1058-Salmon-Fire/related_files/pict20200917-112755-0.pdf

Answer the following questions:

16. What do you notice about the air quality?
17. Why was the air quality relatively "good" in Hoopa at the publication of this outlook?
18. Can you guesstimate where the wind was blowing relative to the Salmon Complex fires?

Next Generation Science

Select the ones you used for this lesson.

Which of the following science and engineering practices did you use today?
- ☐ Asking questions and defining problems
- ☐ Planning and carrying out investigations
- ☐ Mathematics and computational thinking
- ☐ Engaging in argument from evidence
- ☐ Developing and using models
- ☐ Analyzing and interpreting data
- ☐ Constructing explanations and designing solutions
- ☐ Obtaining, evaluating, and communicating information

Which of the following cross-cutting concepts did you engage with today?
- ☐ Patterns
- ☐ Cause and effect: mechanism and explanation
- ☐ Scale, proportion, and quantity
- ☐ Systems and system models
- ☐ Energy and matter: flows, cycles, and conservation
- ☐ Structure and function
- ☐ Stability and change

Wrap up:

21. What did you learn today that stood out to you?
22. What part of today's lesson was confusing?
23. What questions do you have? (in other words, write down your questions here)

Name:_____

Engage: Lesson 2

What causes good and hazardous air quality?

Do Now:

Respond to the following questions:

1. How long can you hold your breath for?
2. What would happen if you could not breathe?
3. What do you think about the air you breathe? Is it important that the air is clean? Why or why not?
4. When was the last time you felt that you could hardly breathe outside?
5. What did you notice about the air? You may draw a picture.

Is the air "good" or "unhealthy" to breathe?

Look at the following pictures and then respond to the questions below.

Salmon Complex Fire of 2020 Source: Inciweb	A photo showing smog over Los Angeles Source: Scijinks.gov	Haze in the Great Smoky Mountains, TN Source: Aviator31

6. In each picture above, what do you think is happening in the air? Why?

Salmon Complex Fire	
Los Angeles	
Great Smoky Mountains	

7. How would you find out whether the air is clean or unhealthy to breathe?

Visit the following webpages and then respond to the questions below:

- https://scijinks.gov/air-quality/
- https://www.airnow.gov/education/students/clean-and-dirty-air-part-one/

| |
|---|
| 8. How is air quality measured? |
| 9. What causes poor air quality? |
| 10. Where does the information about air quality come from? |
| 11. What is the Air Quality Index (AQI) and why is it important when taking actions? |

Take a look at the figure below and respond to the questions.

Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

(Not drawn to scale)
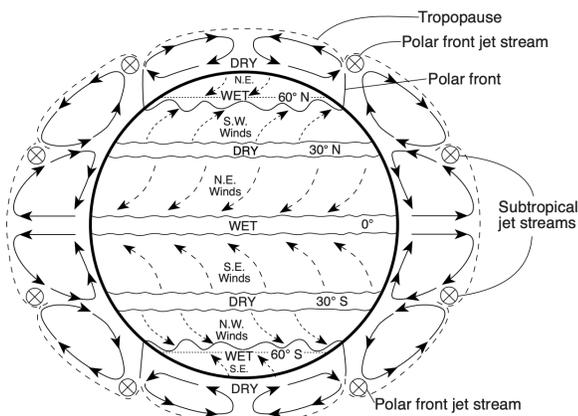
Source: New York State Department of Education

Coordinates of Hoopa, California: 41.0492° N, 123.6770° W

12. Where is Hoopa, California on the figure above? Where is the wind coming from and where is it going?
13. If a fire were to burn in Hoopa, California, would the smoke stay in the Hoopa Valley or move somewhere else? How do you know?
14. If a wildfire starts west of Hoopa, what actions would you take to mitigate your exposure to potential changes in air quality?
15. If a wildfire starts east of Hoopa, what actions would you take to mitigate your

exposure to potential changes in air quality?

Visit the following website: https://www.hoopatepa.org

16. What is the air quality now?

17. Based upon the current air quality information, what actions should you take?

18. What other causes besides wildfires contribute to poor air quality?

Next Generation Science

Select the ones you used for this lesson.

19. Which of the following science and engineering practices did you use today?
☐ Asking questions and defining problems
☐ Planning and carrying out investigations
☐ Mathematics and computational thinking
☐ Engaging in argument from evidence
☐ Developing and using models
☐ Analyzing and interpreting data
☐ Constructing explanations and designing solutions
☐ Obtaining, evaluating, and communicating information

20. Which of the following cross-cutting concepts did you engage with today?
- [ ] Patterns
- [ ] Cause and effect: mechanism and explanation
- [ ] Scale, proportion, and quantity
- [ ] Systems and system models
- [ ] Energy and matter: flows, cycles, and conservation
- [ ] Structure and function
- [ ] Stability and change

Wrap up:

21. What did you learn today that stood out to you?

22. What part of today's lesson was confusing? What questions do you have?

Explore: Lesson 3

Why is it important to measure air quality?

Do Now:

Look at the following Purple Air chart from Happy Camp and respond to the questions.

US EPA PM2.5 AQI
10 Minute Average

64.2

Average —— CARB_SMOKE_SCAPCD_HAPPY_CAMP_ELEMENTARY A —•— CARB_SMOKE_SCAPCD_HAPPY_CAMP_ELEMENTARY B

PurpleAir.com
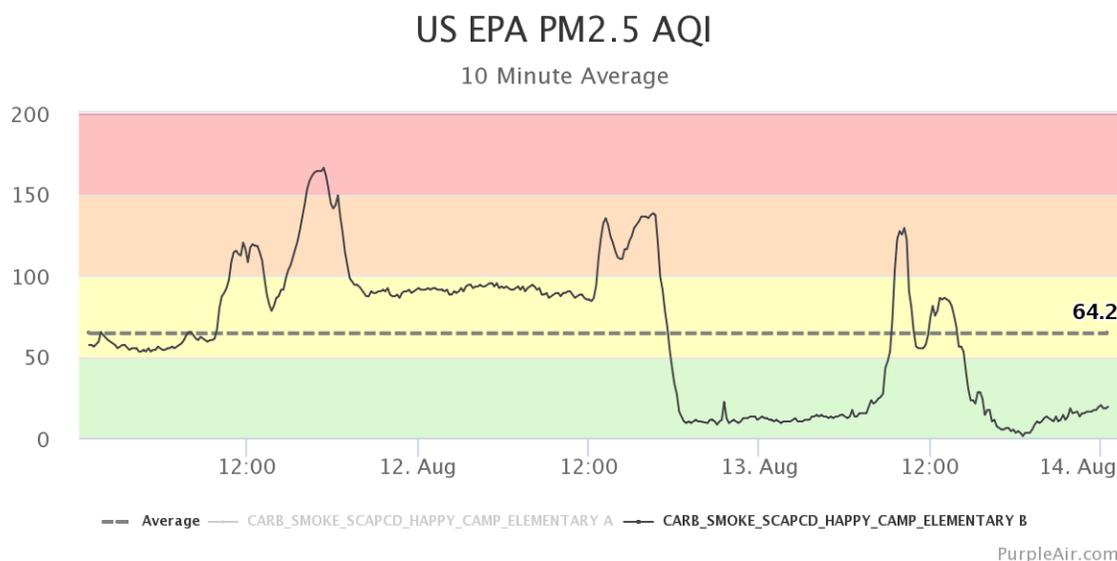
| |
|---|
| 1. What do the crests and troughs in the daily air quality fluctuations mean? |
| 2. During what part of the day is generally "good" to engage in physical activity outside? |
| 3. When is the worst part of the day to engage in extraneous physical activity? |

4. What do you think is causing the crests and troughs in the daily air quality fluctuations?

Look at the following map and respond to the following questions.
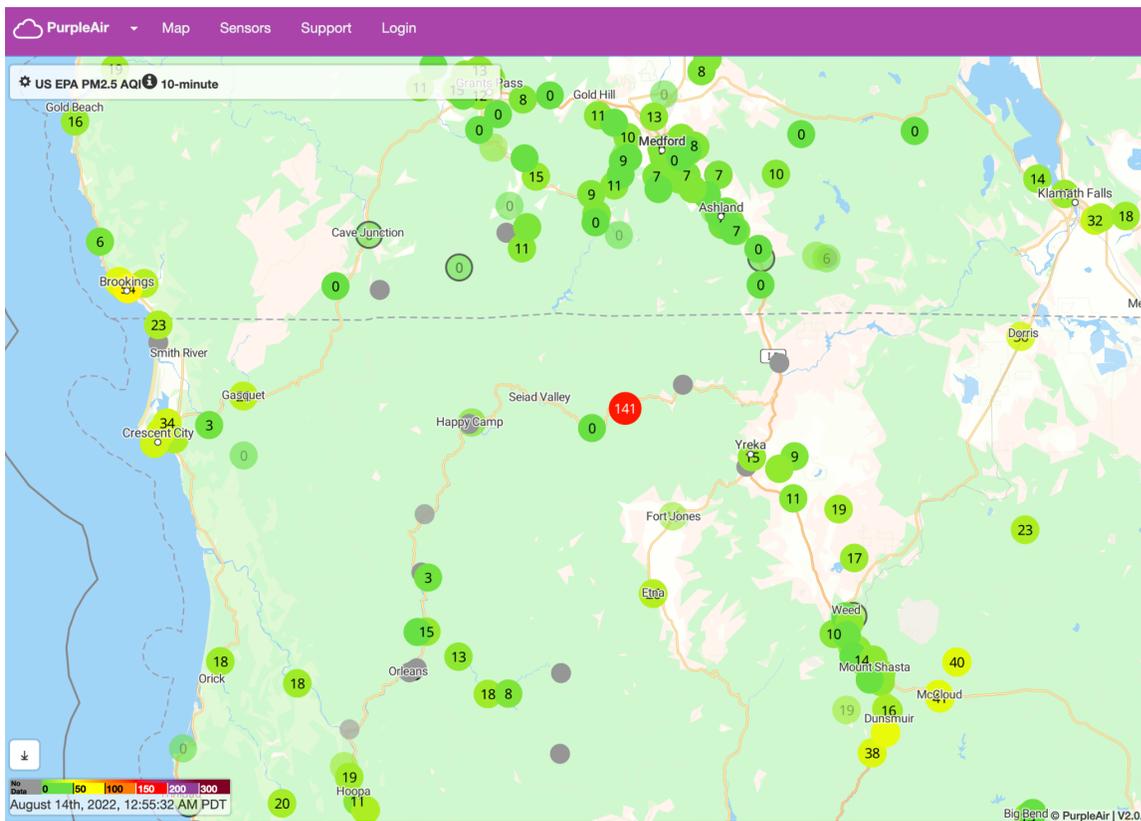
Source: Purple Air

Note: You may use the following guide to respond to the questions:
https://community.purpleair.com/t/map-start-up-guide/90

5. What do the green dots represent?
6. Where do you see a color other than green? What does that color mean?
7. Based upon what you know about the air quality index (AQI), what would you do to engage in physical activity where the red dot is located?
8. What do you think is causing the unhealthy "red" air quality there?

Look at the following map and respond to the questions.
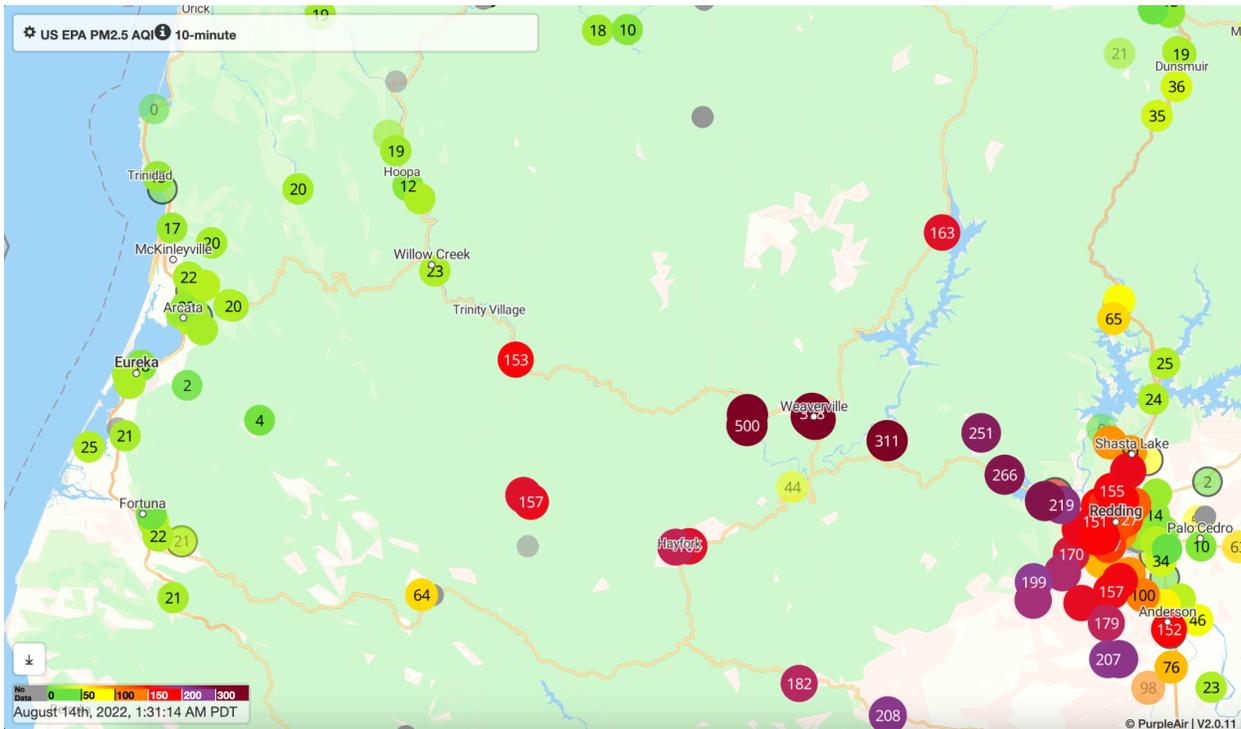
9. What do you notice about the map above?

10. What is happening to the air quality towards Redding, California?

11. A place near Weaverville is showing AQI 500? Why is it so high there?

12. What may be the cause of the poor air quality in these areas?

13. Based on the map above, what can you estimate where the wind is coming from?

14. Look for Hoopa on the map above. What is happening there? What groups would be safe to perform outdoor activities?

Look at the following graph, then respond to the questions below.

US EPA PM2.5 AQI
10 Minute Average

Legend: Average — Hoopa HS A — Hoopa HS B

PurpleAir.com
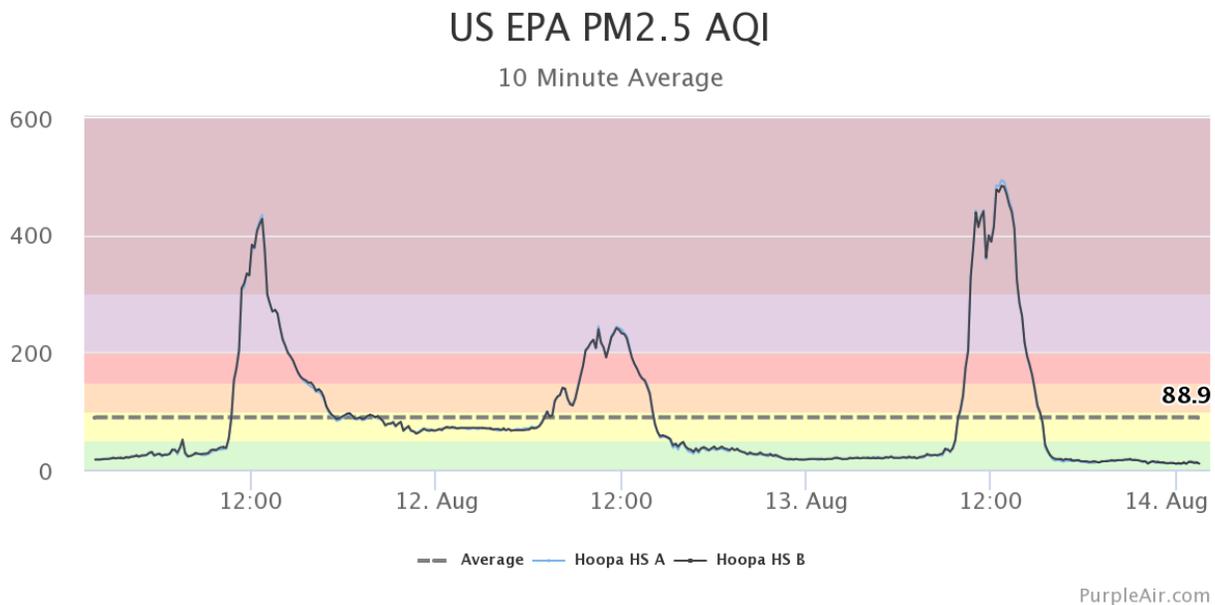
15. What do you notice about the air quality in Hoopa?
16. When would it be best to perform outdoor activities?
17. What may be a cause of the air quality fluctuations in Hoopa?
18. What are sensitive groups?

19. What time of day should sensitive groups avoid outdoor activities?

Group work

Names in your group: _____

In your group, select an incident from the Inciweb site:
https://inciweb.nwcg.gov/

20. Incident:	
21. Date of origin:	
22. Size (acres):	
23. Containment (%):	
24. Personnel:	

25. Cause:	
26. Fuels involved:	

27. What are "fuels"?

Use the resources on that website and select the appropriate Purple Air sensors: https://map.purpleair.com

Select a working Purple Air sensor (do not select a gray sensor).

28. Name of sensor: Measurement: Date: Time:
29. Time of day with the highest AQI: AQI:
30. Time of dat with the lowest AQI: AQI:
31. What time of day would you engage in outdoor activities? Or not, if it is not possible and describe your reasoning.

Next Generation Science

Select the ones you used for this lesson.

32. Which of the following science and engineering practices did you use today?
- ☐ Asking questions and defining problems
- ☐ Planning and carrying out investigations
- ☐ Mathematics and computational thinking
- ☐ Engaging in argument from evidence
- ☐ Developing and using models
- ☐ Analyzing and interpreting data
- ☐ Constructing explanations and designing solutions
- ☐ Obtaining, evaluating, and communicating information

33. Which of the following cross-cutting concepts did you engage with today?
- ☐ Patterns
- ☐ Cause and effect: mechanism and explanation
- ☐ Scale, proportion, and quantity
- ☐ Systems and system models
- ☐ Energy and matter: flows, cycles, and conservation
- ☐ Structure and function
- ☐ Stability and change

Wrap up:

34. What did you learn today that stood out to you?

35. What part of today's lesson was confusing? What questions do you have?

Explore: Lesson 4 (lab)

What is the school's air quality? What part(s) of the school have good air and what part(s) have poor air quality?

Do Now:

Visit the hoopatepa.org website and respond to the following:

1. What is the current air quality PM2.5 AQI at Hoopa High School?
2. What does PM2.5 mean?
3. What activities can you do outside?
4. What part of the school do you think has the best air quality? Why?   5. And, the worst air quality? Why?

Group work

Names in your group: _____

In this activity, you will collaborate in groups.
You should have the following items:
- Wynd tracker
- Smartphone with the Wynd tracker app
- This worksheet
- pencil / pen

Data Collection using Wynd

| Location	Time (actual time)	AQI	PM2.5 (ug/m^3)
Classroom (inside)			
Classroom (outside)			
Cafeteria			
Gymnasium			
Warriors Stadium (next to the weather platform)			
Warriors Stadium (middle of the field)			
Warriors Stadium (next to the flagpole)			
Baseball diamond			
Library (inside)			
Library (outside)			
You pick:			
You pick:			

Analyze and Interpret Data

How would you visualize this data? What kind of graph would you use? Why?

Graph your data

You may use the graph below or you can use a computerized version such as Google Sheets, Microsoft Excel, or Apple Numbers. Label the graph with the following: Title, x-axis, y-axis, values.
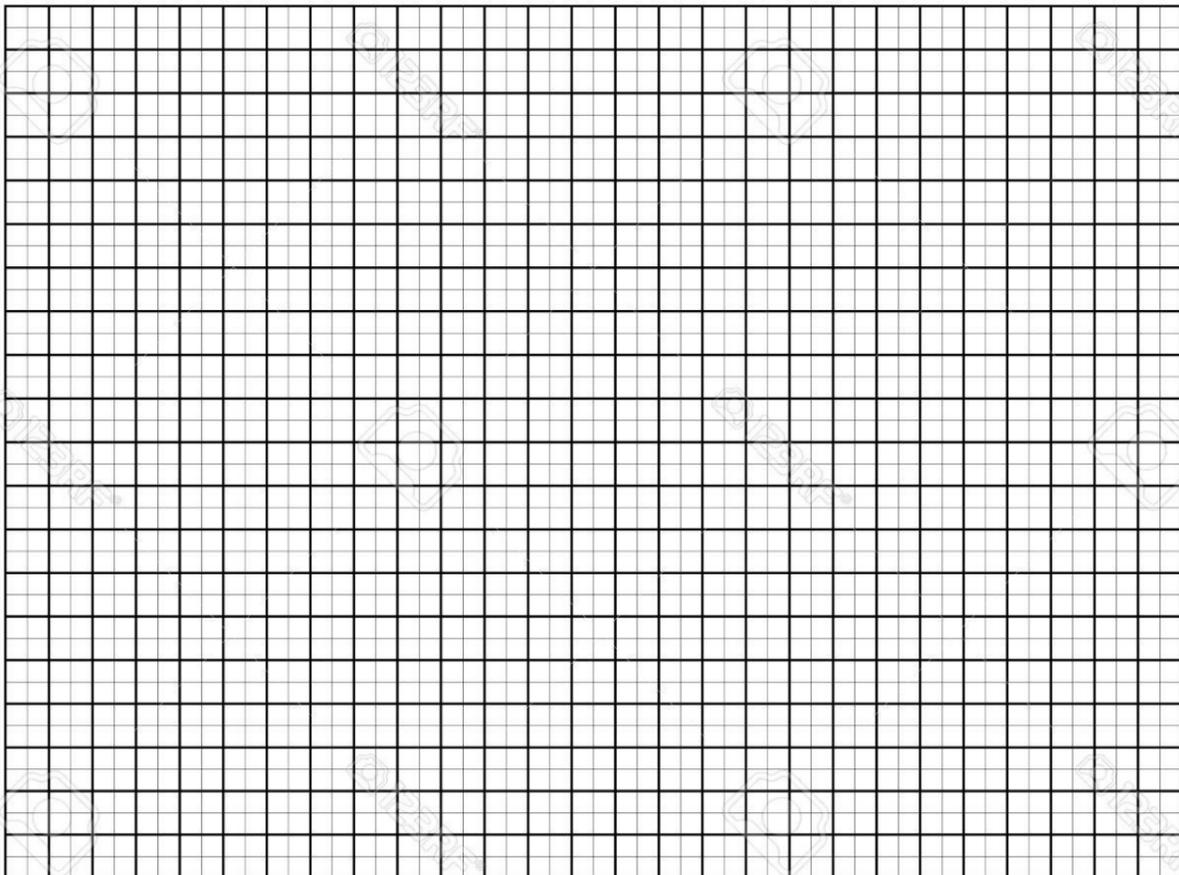
Discussion

According to your data, what part of the school has the cleanest air?
According to your data, what part of the school has the dirtiest air?
Do you think the air quality would be different during a different part of the day? Why?
What are one or two questions that you may have about the data?

Respond to the question in the table provided below.

What are advantages and disadvantages of using mobile air sensors compared to stationary air sensors?

Advantages	Disadvantages

How would you use the mobile Wynd air sensors besides what you have completed in this activity?

Next Generation Science

Select the ones you used for this lesson.

Which of the following science and engineering practices did you use today?
- ☐ Asking questions and defining problems
- ☐ Planning and carrying out investigations
- ☐ Mathematics and computational thinking
- ☐ Engaging in argument from evidence
- ☐ Developing and using models
- ☐ Analyzing and interpreting data
- ☐ Constructing explanations and designing solutions
- ☐ Obtaining, evaluating, and communicating information

Which of the following cross-cutting concepts did you engage with today?
- ☐ Patterns
- ☐ Cause and effect: mechanism and explanation
- ☐ Scale, proportion, and quantity
- ☐ Systems and system models
- ☐ Energy and matter: flows, cycles, and conservation
- ☐ Structure and function
- ☐ Stability and change

Wrap up:

What did you learn today that stood out to you?

What part of today's lesson was confusing? What questions do you have?

Name:_____

Explain: Lesson 5

What are land management solutions in mitigating wildfires and poor air quality in Indigenous communities?

Do Now:

Read the following passage and respond to the question below.

	Notes
Air Pollution in Tribal Communities Air pollution is responsible for tens of thousands of deaths in the US each year. Pollutants such as ground-level ozone (smog), nitrogen oxides, sulfur oxides, and particulate matter cause harm to respiratory and cardiovascular systems and increase the risk of cognitive problems and mental health issues. Air pollution is also linked to diabetes and reproductive harm (preterm delivery, low birth weight, and infertility). *Air pollution is a major environmental health problem in Indigenous communities.* Generations of systemic abuses of Indigenous people have led, in many places, to chronic poverty, poor health care, substandard housing, and inadequate protection from sources of pollution. Indigenous adults and children have higher rates of many diseases linked to air pollution exposure, including asthma, diabetes, heart disease, and chronic obstructive pulmonary disorder (COPD). An emerging air quality threat for Indigenous people is climate change. Wildfires are an increasing concern to air quality. As the climate changes, hotter temperatures and drier conditions can trigger catastrophic wildfires on and near Tribal lands. Diesel pollution is a known human carcinogen and a pollutant of special concern for Indigenous people. Indigenous communities often rely on old or "legacy" fleets of diesel vehicles, generators,	

and other equipment that produce high levels of diesel emissions, contributing to poor air quality.

In addition to outdoor air pollution, indoor air pollution is also a major issue for many Indigenous people. Common indoor pollutants include allergens, radon, particulate matter, secondhand smoke, carbon monoxide, and excessive moisture. Some common sources of indoor air pollution include poor housing quality, lack of electricity, and inadequate ventilation.

NTAA estimates that 200 methane and/or coal power plants are within 50 miles of tribal lands. Living near power plants may expose people to higher levels of air pollution. In addition, Indigenous communities on Tribal lands may be disproportionately burdened by air pollution from the oil and gas industry. An analysis of population data and oil and gas facility information for three tribal groups on whose lands there is significant oil and gas production—Fort Berthold Indian Reservation in North Dakota, Navajo Nation (Utah and New Mexico only), and Uintah-Ouray (Northern Ute) in Utah—showed that Indigenous people are far more likely to live within a half-mile of oil and gas facilities compared to the total population in the encompassing state. This may increase Indigenous communities' exposure to volatile organic compounds and nitrogen oxides, which can combine to form ozone smog, and toxic air pollutants, such as benzene, formaldehyde, and acetaldehyde.

Source: Moms Clean Air Force (2022)

1. What do you think the passage above is about and how is it related to air quality?

Watch and/or read the following about a strategy on taking notes when reading or watching video:
- Video: Cornell Notes strategy to improve their note-taking skills

● Reading:
  https://medium.goodnotes.com/study-with-ease-the-best-way-to-take-notes-2749a3e829
  7b

Respond to this question after completing the activity above.
  2. What do you think about recording information using Cornell Notes? Is there a better way to take notes?

Group work

Names in your group: _____

  3. In this activity, you will collaborate in groups to either read or watch a video about wildfires, air quality, and/or health.

You will use the Cornell notes, as described above.

You may choose one of the following:

    Reading: Nature Conservancy, "Quiet Fire" by Page Buono (2020)
    Reading: Exposure to wildfires connected to lung and brain cancers
    Reading: Facilitating prescribed fire by Marks-Block and Tripp (2021)
    Video: Hupa Fire: Traditional and Cultural Fire Management (2022)

4. Write a summary about the reading or video you watched.

Read and/or watch the resources available in the following link and then respond to the questions below:

https://www.bia.gov/bia/ots/dfwfm/bwfm/fuels-management/traditional-ecological-knowledge

5. What is traditional ecological knowledge?

6. How can traditional ecological knowledge mitigate wildfires and improve air quality?

Next Generation Science

Select the ones you used for this lesson.

7. Which of the following science and engineering practices did you use today?
☐ Asking questions and defining problems
☐ Planning and carrying out investigations
☐ Mathematics and computational thinking
☐ Engaging in argument from evidence
☐ Developing and using models
☐ Analyzing and interpreting data
☐ Constructing explanations and designing solutions
☐ Obtaining, evaluating, and communicating information

8. Which of the following cross-cutting concepts did you engage with today?
☐ Patterns
☐ Cause and effect: mechanism and explanation
☐ Scale, proportion, and quantity
☐ Systems and system models
☐ Energy and matter: flows, cycles, and conservation
☐ Structure and function
☐ Stability and change

Wrap up:

9. What did you learn today that stood out to you?

10. What part of today's lesson was confusing? What questions do you have?

Explain: Lesson 6

What causes poor air quality and what are the impacts?

Do Now:

	Sentence framework
1. Write a **hypothesis** about air quality.	If _____, then _____ because _____.
In this lesson, you will develop a scientific explanation that consists of a claim, evidence, and reasoning.	

2. Identify your claim (or research question) from your hypothesis above.

Fact vs. Opinion

3. List 2 facts and 2 opinions about those facts

Facts	Opinions
Example fact: During a Six Rivers Lightning Complex fire, the highest air quality levels occurred during mid-day hours.	Example opinion: I think the poor air quality during the day was not significant enough to cause any harm to local communities because many people went to the beach where the air quality was good.
1)	
2)	

Facts as evidence
4. Where will you find evidence to support your claim (research question) ?

Reasoning
5. Where will you find the reasoning to support your claim (research question)?

Read the following article:

[Designing Science Inquiry: Claim + Evidence + Reasoning = Explanation](#)

[The Claim, Evidence, Reasoning framework is a scaffolded way to teach the scientific method.](#)

Scientific Explanation = Claim + Evidence + Reasoning (CER)

6. Claim:	7. Evidence:
8. Reasoning:	

9. Scientific Explanation:

Next Generation Science

Select the ones you used for this lesson.

> 1. Which of the following science and engineering practices did you use today?
> ☐ Asking questions and defining problems
> ☐ Planning and carrying out investigations
> ☐ Mathematics and computational thinking
> ☐ Engaging in argument from evidence
> ☐ Developing and using models
> ☐ Analyzing and interpreting data
> ☐ Constructing explanations and designing solutions

☐ Obtaining, evaluating, and communicating information

2. Which of the following cross-cutting concepts did you engage with today? ☐ Patterns ☐ Cause and effect: mechanism and explanation ☐ Scale, proportion, and quantity ☐ Systems and system models ☐ Energy and matter: flows, cycles, and conservation ☐ Structure and function ☐ Stability and change

Wrap up:

| 10. What did you learn today that stood out to you?

11. What part of today's lesson was confusing? What questions do you have? |
| --- |

Elaborate: Lesson 7

How do I communicate scientific information?

Framing question: What actions should be taken to improve the air quality of the Hoopa Valley?

Do Now:

	2020	2021	2022 (Jan – Aug)
Days Measured	356	360	220
# of days > 35 µg/m³	30	23	1
Maximum 24-hr concentration (µg/m³)	754	188	41
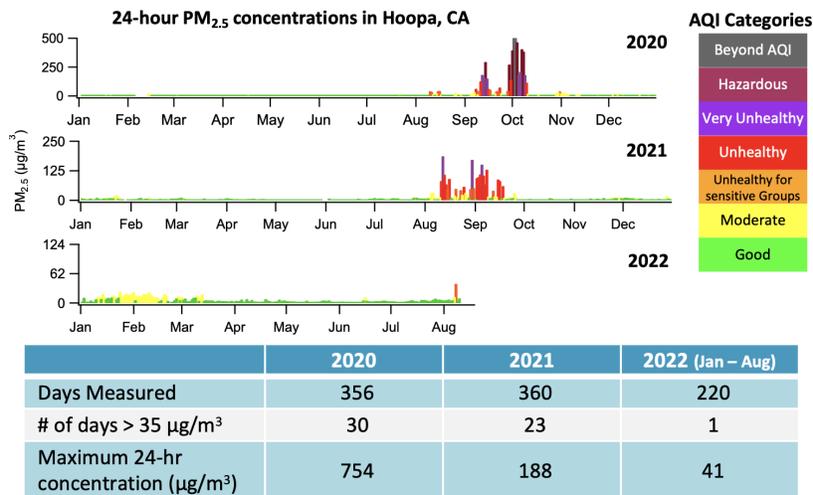
Source: ASPIRE study (2022)

1. When does the Hoopa Valley experience poor air quality? Why?
2. What actions will you take to address poor quality?

In this lesson, you will develop a mini-media project to communicate how to mitigate and adapt to poor air quality. You may incorporate prior knowledge and tribal ecological knowledge. The following are ideas about creating your mini-project:

- Write an op-ed article about air quality.
- Write a letter to the tribal council, U.S. representative about improving air quality.
- Create a poster, brochure, social media post on Canva.
- Create a presentation on Prezi or Google Slides.
- You may also use paper, pens, pencils, watercolors, etc. to generate your work

You can use the attached infographic as blueprint for your presentation.

Next Generation Science

Select the ones you used for this lesson.

Which of the following science and engineering practices did you use today?
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Which of the following cross-cutting concepts did you engage with today?
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Wrap up:

What did you learn today that stood out to you?

What part of today's lesson was confusing? What questions do you have?

Wildfire ASPIRE Study
Advancing Science Partnerships for Indoor Reductions of Smoke Exposures

August 2022 Update for Tribal Leaders
https://www.epa.gov/air-research/wf-aspire

Background

- Smoke from wildfires, prescribed fires, and residential wood burning continues to affect air quality in the Hoopa Valley.

- Since 2019, the Hoopa Valley Tribal EPA (TEPA) has collaborated with the U.S. Environmental Protection Agency (US EPA) to study how smoke impacts indoor air quality and how air cleaning and ventilation practices can improve indoor air quality during smoke events.

- The pollutant of most concern during a smoke event is fine particulate matter, or $PM_{2.5}$. These particles can penetrate deep into your lungs and cause health problems.

Air Quality in Hoopa

- Preliminary data analyses indicate many days when air quality was 'unhealthy for sensitive groups' or worse using the Air Quality Index (AQI).

Field Study of Public / Commercial Buildings

- Researchers monitored indoor and outdoor $PM_{2.5}$ concentrations in 13 buildings using PurpleAir sensors to understand real-world variation under typical conditions and when smoke events occur (Dec. 2019-Mar. 2022).

- Large differences in $PM_{2.5}$ reductions were observed across and within these buildings.

- Inspections of building characteristics and ventilation systems were conducted in 2021 to better understand factors affecting smoke infiltration and indoor air quality.

- Data analyses are underway, including summarizing specific findings and recommendations for building owners/managers.

24-hour $PM_{2.5}$ concentrations in Hoopa, CA

AQI Categories
- Beyond AQI
- Hazardous
- Very Unhealthy
- Unhealthy
- Unhealthy for sensitive Groups
- Moderate
- Good

	2020	2021	2022 (Jan – Aug)
Days Measured	356	360	220
# of days > 35 µg/m³	30	23	1
Maximum 24-hr concentration (µg/m³)	754	188	41
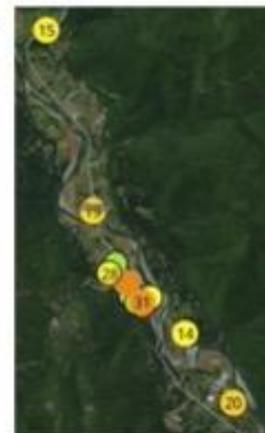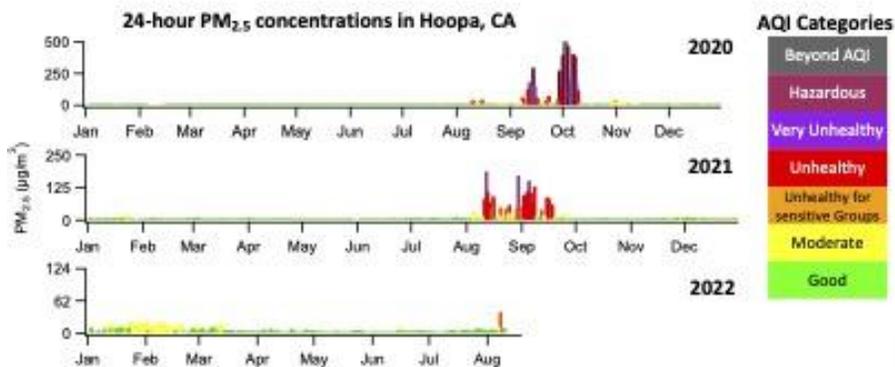
Map showing locations of Hoopa Valley Tribe study buildings

Background

- At the request of the Hoopa Valley TEPA, US EPA researchers added a new study component in 2021 – *ASPIRE- Health*.
- Pilot studies were conducted during Fall 2021 (wildfire season) and Winter 2022 (residential woodburning season).
- Researchers tested the effectiveness of two air cleaners (do-it-yourself (DIY) vs. commercial) in tribal households with no indoor smoking and assessed potential improvements in air quality and health.

Study Overview

Phase 1. PurpleAir sensor measurements only

Phase 2. Use DIY air cleaner

Phase 3. Use commercial air cleaner

Phase 4. Add sensor with visual display with air cleaner(s)

Preliminary Results

- Data collection for pilot studies was completed in March 2022 and data analyses are underway.
  - Fall 2021: 8 homes/10 study participants
  - Winter 2022: 11 homes/17 study participants
- Preliminary results indicate that both the DIY and commercial air cleaner usage were associated with lower indoor $PM_{2.5}$ concentrations in homes, but the loudness of the DIY air cleaner hindered its use.
- Frequent use of air cleaners was associated with small improvements in physical health.
- Home-specific summaries are being developed to share information with study participants.

> *A full report out to Tribal Leadership will be provided when data analyses for the ASPIRE-Health and field study of commercial/public buildings are complete.*

Questions? Please contact:
Hoopa Valley TEPA: Brian McCaughey – brian4epa@gmail.com or Ken Norton – kennorton@gmail.com
U.S. EPA: Beth Hassett-Sipple – hassett-sipple.beth@epa.gov

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Name:_____

Evaluate: Lesson 8

How do I tell the story of air quality in the Hoopa Valley?

Do Now:

1. Write a short poem that incorporates air quality in the Hoopa Valley and/or the Hupa Tribe.

2. Draw a picture that incorporates air quality in the Hoopa Valley and/or the Hupa Tribe.

In this lesson you can work on any of the following mini-projects:

- Create a DIY air cleaner and measure the air quality before, during, and after use. Use the data to analyze and interpret into a graph.
- Correlate between air quality and health
- Cause and effects of poor air quality
- Write a story (or graphic story) about how Indigenous cultural practices in the past and present have mitigated wildfires and/or air quality issues or water ecosystems.
  - You can also ask relatives to tell you stories about how their relatives have mitigated wildfires.
  - If you prefer, you have the option to submit a short video as an MP4, YouTube, or TikTok.

Next Generation Science

Select the ones you used for this lesson.

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Wrap up:

What did you learn today that stood out to you?

What part of today's lesson was confusing? What questions do you have?