The Future of Forests

Unit Summary

The Future of Forests: A story of wildfire and landscape change

Course/Subject Area	Life/Earth Science
Grade Level	Middle/High School
Unit time requirements	2.5 Weeks - Instructional Calendar
Big Idea(s)	• Drought-like conditions disrupt the way landscapes recover following a disturbance (e.g., wildfire)
NGSS Connections:	
Disciplinary Core Ideas	Middle School • LS2.C: Ecosystem Dynamics, Functioning, and Resilience • ESS3.C: Human Impacts on Earth Systems High School • LS2.C: Ecosystem Dynamics, Functioning, and Resilience
Science and Engineering Practices	• Developing and Using Models • Asking Questions and Defining Problems • Obtaining, Evaluating, and Communicating Information • Analyzing and Interpreting Data • Engaging in Argument from Evidence • Constructing Explanations (for Science) and Designing Solutions (for Engineering)
Crosscutting Concepts	• Stability and Change • Cause and Effect • Patterns

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Unit Overview
"The Future of Forests" is a middle/high school unit focused on wildfire and landscape change as it relates to ecosystem dynamics, functioning, and resilience. The unit is centered around an anchoring phenomenon of post-fire landscape recovery across the western United States. The unit focuses on the unit driving question, "How do landscapes recover after a wildfire?" and consists of ten unique lessons, each tied to middle school and high school NGSS Interdependent Relationships in Ecosystems standards. Each lesson provides students with evidence, kept track of in a **summary table**, they will use to explain the anchoring phenomenon in a **final descriptive model** and written explanation.

Unit Anchoring Phenomenon
Post-fire landscape recovery across the western United States

Unit Driving Question
How do landscapes recover after a wildfire?

Instructional Calendar

This 3-week curriculum is written such that concepts build from one lesson to the next and is best implemented all at once rather than in parts. Most materials are editable in Google Docs which can be used as-is or customized for the way you want to use them.

See Instructional Calendar here

Summary Table

The goal of a summary table is to keep track of what was learned from each lesson and how it relates to the unit driving question, "How do landscapes recover after a wildfire?" It is used after each lesson and provides an important public record at the end of the unit when students complete their final assessments, a descriptive model and written explanation for the unit driving question.

The statements written in the summary table are consensus statements developed in a whole class discussion. Prior to the class discussion, students work in small groups to reflect on their learning. Then, the teacher facilitates a discussion across groups and writes the consensus statements in the table.

See summary table example here

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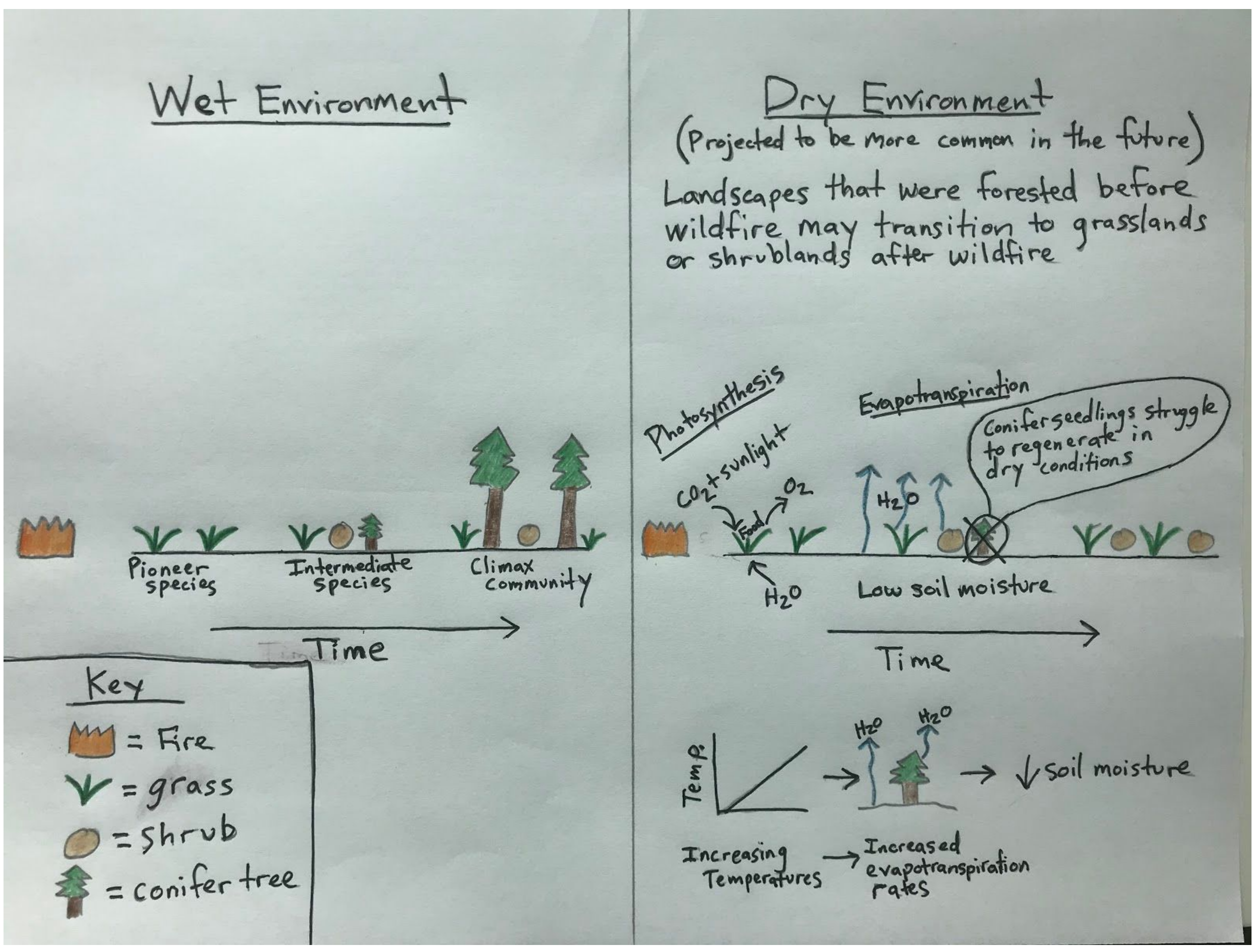
Final Assessments

For the final assessments, students work in pairs to develop descriptive models and then individually to write an evidence-based explanation for the unit driving question, “How do landscapes recover after a wildfire?” Students should reflect on their learning, referencing classwork and the whole class summary table among other public records when completing their final assessments.

[See final descriptive model here]

[See final written explanation here]



Final model example representing the unit driving question, “how do landscapes recover after a wildfire?”

Model-based inquiry framework

Similar to NGSS Storylines, OpenSciEd, Inquiry Hub and other curriculum anchored by phenomenon, the model-based inquiry (MBI) framework is designed around the construction, revision, and testing of models by students as they gather evidence to explain natural phenomena. Student ideas and understandings about the science related to the phenomena are tracked throughout the unit via public records (e.g., summary table) and are collaboratively peer-reviewed. The unit culminates in students working in pairs to develop descriptive models and then individually to write an evidence-based explanation of the anchoring phenomenon.

The unit is broken down into 4 phases that have been adapted from the Ambitious Science Teaching group at the University of Washington and the Model-Based Inquiry group at Northern Arizona University, the University of Connecticut and the University of Texas at Austin.

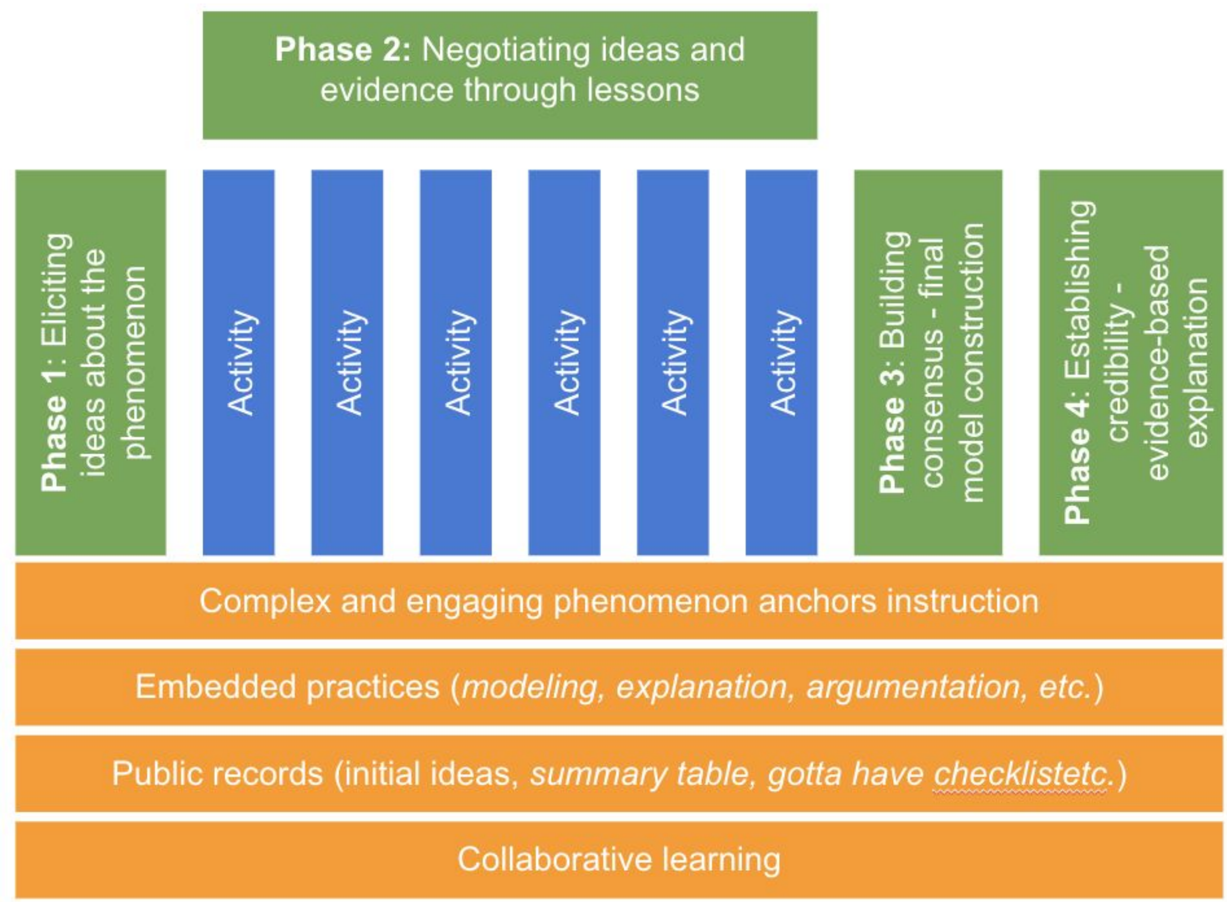


Figure adapted from Model-based inquiry

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Phases of MBI

Phase 1: Eliciting ideas about the phenomenon, (1-2 days, Lesson 1)

Students are introduced to the phenomenon on the first day and their initial ideas and explanations for the phenomenon are shared and represented in public records and initial descriptive models.

Phase 2: Negotiating ideas and evidence through lessons, (7-8 days, Lessons 2-7)

Lessons in phase 2 are designed to support the students on-going changes in thinking. Lessons provide students with learning experiences that relate back to the phenomena. At the conclusion of each lesson, science concepts and their connection phenomena are discussed and agreed upon as a class before being recorded in a **summary table**. Updating the summary table daily is vital as it helps students coordinate science ideas (connect the dots) to build a scientific explanation of the anchoring phenomena. This phase makes up the majority of the unit.

Phase 3: Building consensus - final model construction, (1 day, Lesson 8)

Students work in pairs to construct their final descriptive model representing the anchoring phenomenon. Students are encouraged to refer to evidence (e.g., datasets, summary table, etc.) when constructing their finals models. After the final models have been constructed and shared, the teacher facilitates the discussion and development of a "**gotta-have checklist**", a list of bulleted ideas, concepts, and evidence that the entire class agrees should be present in an accurate scientific explanation of the phenomenon.

See final model example

Phase 4: Establishing credibility - evidence-based explanation, (1-2 days, Lesson 9)

Students refer to evidence (e.g., gotta-have checklist, datasets, summary table, etc.) and work independently to write an **evidence-based explanation** of the phenomenon. An evidence-based explanation incorporates three parts, 1) the story of what happened, 2) important science concepts necessary to explain what happened, and 3) evidence of how we know each part of the explanation (citing specific activities from lessons).

See final evidence-based explanation

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Lesson Descriptions:

- Each lesson includes a teacher guide, student worksheets, answer key, Google Slides (speaker notes), among other resources.

Phase 1: Eliciting Ideas About The Phenomenon

Lesson 1: Landscapes on Fire

Summary:
In this 2-day lesson, students work in pairs to construct initial descriptive models and explanations for the unit driving question, “How do landscapes recover after a wildfire?”

Driving Question(s):
- Why should we care if landscapes recover after a wildfire?

What Students Will Do:
- Develop a model to explain how how landscapes recover/change after a disruption (e.g., wildfire)
- Ask questions that arise from observations of fire-affected landscapes to seek additional information about factors (causes) that might affect the landscape recovery process after a fire.

Phase 2: Negotiating ideas and evidence through lessons

Lesson 2: From Fire Comes Life

Summary:
In this lesson, students create a storyboard and play a modified game of Rock-Paper-Scissors to communicate the process of secondary succession.

Driving Question(s):
- How do wildfires affect landscapes?

What Students Will Do:
- Communicate the process by which landscapes change (secondary succession) after a disturbance.

Lesson 3: Succession Survey

Summary:
In this lesson, students will engage with the Landscape Change Monitoring System (LCMS) data explorer tool developed by the USDA Forest Service to evaluate the recovery of fire-affect landscapes.

Driving Question(s):

- Do all landscapes recover the same way after a fire?

What Students Will Do:

- Evaluate the recovery of fire-affected landscapes using the Landscape Change Monitoring System data explorer developed by the National Forest Service.

Lesson 4: Measuring Soil Moisture From Space

Summary:

In this lesson, students will analyze soil moisture data gathered from NASA satellites to evaluate conditions in their communities.

Driving Question(s):

- Why do plants need water?
- How do scientists measure soil moisture conditions over time?

What Students Will Do:

- Analyze and interpret soil moisture data collected by NASA satellites to evaluate the dynamic soil moisture conditions locally and globally.

Lesson 5: Temperature and Transpiration

Summary:

In this lesson, students explore the relationship between temperature and transpiration by analyzing and interpreting a transpiration rate dataset collected by a potometer and engaging with temperature and evapotranspiration data from the western United States.

Driving Question(s):

- How does water enter and exit soil?

What Students Will Do:

- Evaluate the relationship between changing temperatures (cause) and transpiration rates (effect) by analyzing and interpreting a transpiration rate dataset collected by a potometer.
- Evaluate the relationship between changing temperatures (cause) and evapotranspiration rates (effect) by analyzing and interpreting temperature and evapotranspiration data from the western United States (1979-2020).

Lesson 6: Landscape Recovery Case Study

Summary:

In this lesson, students analyze and interpret post-fire tree regeneration data from 1485 sites across 52 fire affected regions of the US Rocky Mountains.

Driving Question(s):

- How has a changing climate impacted post-fire tree regeneration?

What Students Will Do:

- Analyze and interpret post-fire landscape recovery datasets to identify tree regeneration patterns.

Lesson 7 - Putting Pieces Together

Summary:

In this lesson, students will work in pairs to construct a written argument supported by citing empirical evidence and scientific reasoning (obtained from previous lessons) that drought has prevented some fire-affected landscapes from recovering to their pre-fire conditions.

Driving Question(s):

- In a future where drought-like conditions are expected to persist, which vegetation types (conifer trees, grasses, shrubs) are most likely to regenerate after a wildfire?

What Students Will Do:

- Construct and present a written and oral argument supported by citing empirical evidence and scientific reasoning that human-caused drought has prevented some fire-affected landscapes from recovering to their pre-fire conditions.

Phase 3: Building consensus - final model construction

Lesson 8: Final Model Construction

Summary:

In this lesson, students draw on concepts and evidence acquired during the unit to construct final models for the unit driving question, “How do landscapes recover after a wildfire?”

Driving Question(s):

- Why do scientists continue to gather evidence and revise models of phenomena?

What Students Will Do:

- Develop a model to explain how how landscapes recover/change after a disruption (e.g., wildfire)

Phase 4: Establishing credibility - final explanation

Lesson 9: Final Explanation

Summary:

In this lesson, students work independently to incorporate concepts and evidence acquired during the unit into a written final explanation for the unit driving question, “How do landscapes recover after a wildfire?”

Driving Question(s):

- Why is science communication important in encouraging evidence-based decision-making?

What Students Will Do:

- Construct an explanation based on qualitative and quantitative evidence for how landscapes recover after a fire.

Lesson 10: Citizen Science with GLOBE

Summary:

In this lesson, students use NASA's GLOBE Observer app to engage in citizen science by making land cover observations that are important helping scientists monitor landscape changes.

Driving Question(s):

- How can we (the public) help scientists conduct their research?

What Students Will Do:

- Evaluate and monitor changing landscape conditions by engaging in citizen science with NASA's GLOBE Land Cover app.