THE REDI

Jedi Master Program

Butte County Fire Safe Council

Nature journaling and place-based learning to enhance fire awareness

Program and illustrations created by Miriam Morrill @Pyrosketchology

Photos from the pilot Nature Journaling Fire Workshop at the Klamath Prescribed Fire Training Exchange event in 2019.

- **R: Recognize patterns, signals and signs in nature and how they relate to fire.**
- **E: Engage senses and elaborate on experiences and emotions that enhance fire awareness.**
- **D: Direct attention to field observation skills and creative journaling techniques.**
- **I: Illuminate fire readiness, response and resilience efforts with place-based knowledge.**

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INTRODUCTION TO THE GUIDE & REDI MASTER PROGRAM

The educator guide distills fire science and combines it with illustrations to enhance understanding of complex fire concepts and has a range of nature journaling exercises and examples to help youth and adults build their personal and place-based fire awareness and understanding.

This program can be used to create a deeper connection to more traditional fire education programs and fire readiness efforts. Traditional fire education programs focus on key concepts and terminology in a classroom or virtual setting, while nature journaling emphasizes place-based engagement with the environment. The REDI program integrates important and observable elements of fire, with full-bodied and full-brained nature journaling practices. You could consider the REDI program as an expansion of SEL. It builds social emotional learning but also:

S: Situational awareness of fire conditions, hazards, and risks
E: Environmental and systems thinking about fire
L: Learning through experienced placed-based practices (nature journaling)

Eight lessons in the guide contribute to the creation of a student story zine (11x 17 page size recommended but an 8.5 X 11 page can be used). Either size will have 8 sections/pages) as an additional education product. The zine template can be printed for students to use and copied after completion, and before assembly, submit for recognition or program certification, as appropriate to program scope.

The Butte County Redi Master program has a character that integrates with the current Fire Ready Racoon and youth education program. The Redi Master is a Great Aunt to Ready Racoon. She is looking for new apprentices in Butte County and other areas interested in deepening their fire awareness.

The Redi Master program focuses on the following abilities and actions:

R: Recognize patterns, signals and signs in nature and how they relate to fire.

E: Engage senses and elaborate on experiences and emotions that enhance fire awareness.

D: Direct attention to field observation skills and creative journaling techniques.

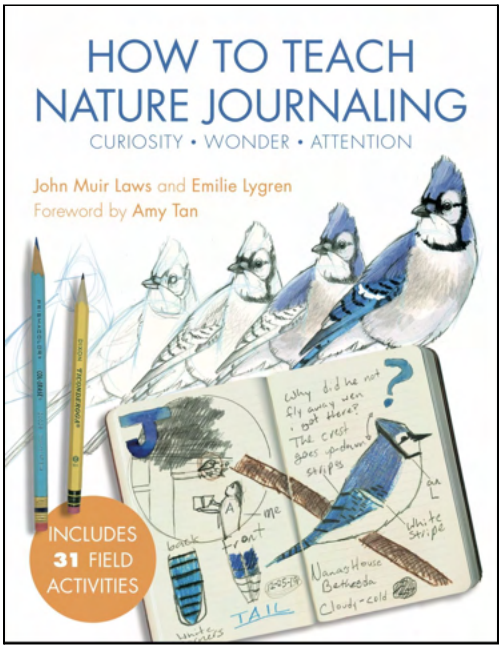
I: Illuminate fire readiness, response and resilience efforts with place-based knowledge.

What's important is that children have an opportunity to bond with the natural world, to learn to love it and feel comfortable in it, before being asked to heal its wounds... If we want children to flourish, to become truly empowered, let us allow them to love the earth before we ask them to save it. -- David Sobel, American education writer

How do you define a natural world? Is it one without human management or influence? I would say that our lives are intertwined. After a century of wildfire suppression and exclusion of Indigenous burning practices, nature has become starved of the fire functions necessary for long term survival of ecosystems, and many of us have developed fanciful and failed relationships with nature and fire. Indigenous peoples applied fire practices with mutual benefits as a form of reciprocity. How do others develop awareness and build balance and reciprocity with the local fire environment? I think it is important for children to have the opportunity to not only bond with the natural world, but to form real and resilient awareness and connections to the local fire environment. Few people will have access to active and adaptive fire management practices and observations, but the environmental elements that influence fire can be observed and our awareness enhanced through nature journaling practices. --Miriam Morrill, Pyrosketchology

EDUCATIONAL GOALS

The Redi guide uses the core nature journaling principles developed by John Muir Laws in his various nature journaling guides and workshops and it is highly recommended that teachers and programs looking to articulate educational standards and evaluation rubrics reference the How to Teach Nature Journaling guide that can be purchased or downloaded in a free pdf format. The Redi guide is not intended as a comprehensive nature journaling guide but offers insights, illustrations, and exercises that demonstrate how nature journaling can be used as a tool to enhance awareness and understanding of the fire environment. The guide is intended as an educational tool but does not include explicit educational standards and rubrics, which can be found in the Law's guide and easily expanded and applied to the different lessons in this guide.



The Redi guide integrates observable elements of fire science, applies various sensory engagement and sensory-motor exercises to engage the brain and build observations and journaling skills. For example, hands are used to estimate angle and slope of a hillside or student height to estimate and analyze ladder fuel arrangement. More formalized mathematical formulas and monitoring protocols could be integrated but the guide primarily focuses on the mind-body connection to nature and fire.

Lessons are intended to create deeper awareness and connections to the local fire environment and help build intentional curiosity and critical thinking skills. The goal is not for students to memorize fire concepts and terminology nor to create art, but to learn how to observe, ask questions, and record the internal and external experience. See the REDI Guide Content & Learning Integration Table below for more information about the various knowledge and experience approaches that have been integrated in the lessons.

The Butte County Fire Safe Council has a 6th-Grade fire education program called Wildfire in the Foothills which was updated in 2021 to support students who live in fire-prone areas and to build more fire-resilient communities in Butte County. The program consists of seven one-hour lessons with accompanying PowerPoint presentations for projection in the classroom. The program also offers a Jeopardy-style review game and a culmination activity in the form of a Firewise community meeting and discussion. The Redi guide and Wildfire in the Foothills programs integrate well and offer fire education lesson plans that outline standards and rubrics for traditional fire education approaches.

Fire and Journaling Content & Learning Integration Table

Learning Goals	Key Fire Environment Information	Relevant Field Observations	Key Learning Visuals/ Illustrations	Targeted Journaling Exercises
Lesson #1 Spatial sense of fire- fire size, shape and associated patterns across the landscape. Fire story setting (story zine cover page)	Patch and pattern definitions and types Patch dynamics Fire size, shape and patterns	How to observe different scales of landscape patches and patterns- need a high level viewpoint or AlertWildfire camera view of landscape. Differentiate terrain, forest and plant scale observations	Example landscape with mosaic vegetation Simplified landscape pattern types examples Example icons for symbolizing patch and pattern differences Example landscape sketch	Comparison tables Small landscape sketch with foreground, midground and background areas with different sketch/art types for differentiating space and distance.
Lesson #2 Sense of place and position in context of the fire environment- sense of direction, elevation and aspect. Fire story character context within the setting	Elevation and aspect differences in vegetation and fire patterns in Butte county, California and North America.	How to observe basic vegetation differences (forms) by aspect and elevation such as needle versus broad-leaves, smaller trees at higher elevations, etc.	3-D county landscape diagram illustration with key forest zones and elevation/aspect forest type illustration inserts.	Landscape map diagram Directional landscape and personal associations
Lesson #3 Temporal sense of fire- seasons and	Seasonal phenology and associations with fire and fuels	Compare simple plant changes such as amount and type of	Vegetation seasonal changes illustration (seasons).	Simple change observation table using different colors to associate

stages and the different time scale influences on the fire environment Observing changing levels of risk (changing energy)	Vegetation community succession and associations with fire and fuels Fire energy release component and fire seasons	vegetation over time and evaluate in context of the fire season.	Seasonal and successional stages as an integrated and changing system (vegetation community gear system) Examples of visuals to track and communicate a changing fire environment including a monthly fire weather wheel and comparison of a historic versus contemporary landscape with change elements.	labels for sense of changing conditions.
Lesson #4 Sense of terrain influences on fire - generalized/ threshold for steep slope and intense fire behavior and generalized sense of fire speed (rate of spread) over a landscape.	Slope analysis in relation to fire behavior- 10 degree angle and 20% slope important threshold for fire behavior. Basic heat transfer types General/typical fire rate of spread comparison compared with speed of example animals.	Looking out at a landscape scale (view of hills or mountains) to assess slope. Looking at vegetation elements arranged on slope.	Degree angle overlaid with slope and burning vegetation to see the difference of fire and heat influences. Hand/finger associations with degree angle. Heat transfer types illustration using a campfire Tortoise and sea turtle speed comparison with typical fire rate of spread range.	Use biometrics to gain sense of degree angle and percent slope (hands and fingers used to measure angle)- also to enhance learning with sensory-motor engagement Creating a simple small landscape sketch identifying slope. Comparison table for discussing radiation, convection and conduction heat transfer with landscape elements observed.
Lesson #5 Sense of weather and fire with emphasis on wind Fire situational awareness with changing	Light introduction to red flag concept Atmospheric instability (vertical instability) Wind observations (Beaufort wind scale) key to fire behavior (over 10	Sky observations for vertical atmospheric instability signs such as cloud build up, thermals, dust whirls, etc. Horizontal sky and wind observations such as clouds	Fire situational awareness elements illustration Past and present wind signs examples illustration Example vertical/horizontal wind journaling	Key sky observations targeted at vertical instability Modified and simplified Beaufort scale observations using sight and sound of wind in trees or across the

weather conditions	miles per hour). Fire situational awareness elements.	stretched and pulled, trees swaying, leaves rattling to gauge wind speed. Past and present wind signs to help gauge wind direction.	diagram	landscape. Observations of past and present wind influences on vegetation and animals (sculpted trees versus lee side shelter)
Lesson #6 Sense of moisture influences on vegetation and fire ignition/combustion Understanding of how the size and condition of vegetation influence fuel moisture and how relative humidity and vapor pressure deficit influences plants/fuels and fire ignition/combustion.	Introduction to the fire triangle with emphasis on fuels and fuel moisture (fuel size and moisture time lag) Descriptions of relative humidity and vapor pressure deficit and influences on fuel moisture and fire ignition potential	Looking at fuel size (fine fuels) and assessing surface area to volume ratio and potential influence of heat and oxygen. Looking at subtle differences in fuel moisture comparing live and dead fine fuels. Watching teacher/facilitator demo of different fine fuel ignitions.	Illustrations of the fire triangle associated with the fuel size and examples of size comparison (e.g. size of a quarter, etc.) Illustration visualizing relative humidity influences on dead fuel moisture. Illustrations visualizing vapor pressure deficit influences and live fuel moisture. Example nature journal page of a campfire and the fire combustion process.	Assessing fuel size and shape (surface area to volume) and varying fuel moisture Using multiple senses and creative descriptions to key in on subtel fuel moisture differences in live and dead vegetation. Using word art to associate sensory and observation differences.
Lesson #7 Sense of vegetation arrangement and its influences fire behavior.	Key fire types (ground, surface, crown) and fire behavior terms associated with fuels arrangement such as surface fuels, jackpots, and ladder fuels. Generalized flame-length calculation (4 foot flame for every 1 foot of vegetation height)	Observing horizontal and vertical vegetation/fuels continuity, concentrations and arrangement. Observing carrying fuels and ember materials.	Illustration of key fire types and fire behavior. Example nature journaling vegetation percent cover and cross section diagrams. Example fuel models and associated fuel measurements and flame lengths (timber understory, chaparral and short grass)	Using biometrics to gain a sense of vegetation height and ladder fuels. Creating a simplified personal character (star person) for inclusion in the nature journal and for biometric data labels. Creating a simple diagram for percent cover and basic vegetation elements (trees, shrubs and grass)

				Creating a cross-section diagram to capture and visualize important vegetation elements with estimated flame lengths and ember spread.
Lesson #8 Sense of plant and animal responses and adaptations to fire and heat. Idea of plant and animal signs integrated with personal sensory observations-shared experiences and awareness.	Describes different types of effects (direct, indirect, cumulative) and components for evaluating vulnerability to fire and heat (exposure, sensitivity, and adaptive capacity) Describes some differences of immediate response versus adaptations. Describes some plant and animal heat indicators (insect thermometer)	Looking at various local plant and animal signs, characteristics and conditions (structures and functions). For example, comparing bark thickness and thinking about exposure and sensitivity to potential fire or looking for signs of plant stress such as wilting or sap and considering responses to heat.	Illustration of positive indirect effect- smoke influences on water temperature and benefiting salmon. Image collage of plant elements that can be used for looking at responses and adaptations associated with fire and heat. Illustration of plant and animal heat responses and information for calculating temperature based on cricket calls.	Observing and documenting plant and animal signs, structures and functions and associating them with fire. Using words, pictures and numbers along with key nature journaling prompts such as I notice, I wonder, and It reminds me of, to make observations that can be linked to effects and vulnerability to fire and heat.
Lesson #9 Sense of information integration-using place-based knowledge Using nature journaling approaches and practices to enhance fire readiness and response (extra credit-family evacuation planning/journaling)	Information about key fire management programs and approaches: fire prevention, fire mitigation, fire readiness. Fire ready-set-go elements	Not required as a field exercise but reviewing and integrating past lessons and field exercises. The lesson can be outdoors for part or all of the time if that helps trigger ideas and considerations.	Example nature journal page with page design and symbols for reminders and tracking key field observations. Example nature journal pages used to evaluate evacuation routes and planning using nature informed observations.	Group, individual and family approaches and exercises to evaluate and brainstorm nature observations that can support ready-set-go planning and activities.

Intergenerational Approaches

Place-based and outdoor educational programs like the REDI guide are great opportunities to use intergenerational learning approaches. Although the lessons in this guide have some advanced concepts and terminology more appropriate for older middle school, high school, and college students, the nature journaling exercises are fairly simple and lessons can be modified to accommodate a broad age group. If the facilitator or instructor is comfortable adapting information and exercises in the guide, here are some tips for adapting to different age groups from Bethan Burton's nature journaling approach.

- Adults and teens should be able to complete the entire lessons as outlined or expand with more advanced math and monitoring protocols.

- Primary age children (5 to 12 years old) may prefer to do the active and interactive exercises and some time for more creative exploration of the sketching and art skills.

- Children under five, would be better encouraged to watch an adult or older children work through the exercises while discussing what they are working on and providing time for play with art materials or hands-on activities like gathering natural materials.

Trauma-Informed Exercises

The REDI guide introduces some warm-up or meditative exercises, intended to help relax and focus attention in a positive way when fire topics could have emotionally triggering influences, displacing the learning and experience goals. Some of these exercises will naturally integrate emotionally deep discussion and expression to create therapeutic opportunities, but most exercises aim to reduce potentially traumatic or triggering topics and observations in a way that benefits and balances learning goals.

There are many support resources and organizations that focus on reducing the effects of trauma and there is a list in the appendices. You may consider working with local partners or groups in fire affected areas that have experience with these sensitive topics to identify key messages that can be framed and used to guide trauma-resilience discussions. I believe nature focused observations can help reframe how we associate and relate to loss associated with fire. I have noticed that when making focused nature observations, my mind lets go of emotions and I can integrate emotions and memories in more controlled, creative and targeted ways. I also believe that learning and looking at nature outside of our personal concepts of experience, can help reframe the scope of environmental change. For instance, the time for a forest to recover from a wildfire may seem devastating to us, but from a 'nature' perspective of time, may be considered part of a natural cycle that builds resilience. The size or severity of fire may seem devastating to us, but may have a mosaic of impacts with many environmental benefits. Separating and adding context to environmental changes and losses can be a foundation for integrating nature journaling exercises and trauma-resilience curriculum.

EQUIPMENT AND SUPPLIES

There are many approaches and attitudes about the equipment and supplies for nature journaling. It can be fun to explore and experiment but most of the experienced nature journalers recommend starting simple and cheap. When you're in the field trying to journal observations it can be challenging to dig through lots of supplies. For nature journaling about the fire environment, most of what you'll be sketching is the sky, mountains, and vegetation, with a few fire related sketches. Most of these diagrams and sketches can be created with a graphite pencil, pen, or one to two colored pencils. An ideal starting point for supplies is to have a mechanical pencil, a waterproof ink pen, a small watercolor paint set, a regular sized water brush (a paint brush with water in a fat plastic handle functioning like an ink pen), a small set of colored pencils (3-5 colors), a mixed media sketch pad (small to medium sized) and an over-the-shoulder tote bag. Adding a cheap measuring tape, ruler and magnifying glass are helpful and eventually getting equipment like binoculars and a weather Kestrel or small weather kit. The John Muir Laws website has a page with lots of tips and recommendations for specific supplies and brands that can be ordered directly from his website.

FIELD SAFETY TIPS

Addressing field safety is important on many levels. Protecting students from injury is obvious but reducing stress and anxiety for students less familiar or experienced with being outdoors will provide a better learning environment. The following field safety tips come from the Back to Nature Network Intro to Nature- A Guide to Teaching in Nearby Nature. Safety is as essential to the outdoor learning experience as it is to teaching indoors, but there are several differences to consider:

a. Have a do's and don'ts discussion and a list of all things you want to cover and add subjects your students would like to discuss. The list could include:

- Things to avoid and the reasons, for example poison oak can cause itchy, spreadable, fluid-filled blisters on skin.
- How to interact with things found in nature using our senses: observing, smelling, and touching (but not eating) natural objects.
- Responsible handling of animals such as insects after confirming with the teacher that it is safe to do so.

b. Be weather-aware:

- Wearing appropriate clothes and footwear for the conditions.
- Weather limits for outdoor learning experiences, e.g. need for shade during excessive heat, class procedures in the case of extreme weather such as lightning and high winds.
- Symptoms of hypothermia and heat stroke.

c. Discuss how to react if a physical or mental injury occurs:

- Create a step-by-step procedure for all to follow if physical or mental injury occurs.

- Post the procedure for regular review and print off a reminder sheet for outdoor student kits.
- Consider inviting a First Aid teacher or social emotional emotional expert to visit the class prior to the start of a field program.

d. Let the office or a teaching partner know every time the class is going outside, and establish a method for communicating with the school at all times while outside (see next section for specific suggestions).

SITUATIONAL AWARENESS

A major goal in developing this guide was to gather information and develop exercises to enhance fire situational awareness (SA) skills along with building a deeper place-based sense of fire. Stated simply, SA is being aware of the potential hazards and risks in your surroundings. SA is discussed in work with potential safety hazards, and should be included in outdoor activities and when framing an educational subject that has changing levels of risk-- how we relate to and respond to something. This is important in teaching and learning in a way that helps build trauma-resilience and adaptive actions. The following outline was used in helping to frame the information and exercises in this guide and can be used as a field safety prompt to help enhance situational awareness skills.

PLAN for Enhancing (Fire) Situational Awareness

- **P**ause before proceeding into a field location or activity and consider what is most important for your time and safety. Identify the path and position of most value for observation and safety goals.
    - Ideally, you should do a hazard assessment prior to traveling to a location to better frame your time and activities.
- **L**ook and listen to what's happening around you before starting and throughout the field or nature journaling activity.
    - Develop prompts and practices that train you to observe potential hazards and changing conditions. For example, learning the cloud signs that can foretell incoming storms and how to use the Beaufort wind scale to observe wind shifts and increased risk of falling branches and trees.
- **A**ssess the immediate and potential threats (risks) to your nature journaling experience, especially working around an active fire and within a burned area.
    - Train your brain to recognize nature signs and patterns that can inform you of changing levels of risk. Consider building in baseline metadata like weather forecasts with scheduled local weather observations to compare and assess expected, normal, and elevated conditions.
- **N**arrow negative effects by implementing safety measures and alternatives and enhance responses and reactions to potential hazards and threats by preparing for field activities based on the place, people joining you, and your personal strengths, weaknesses, opportunities, and threats. Discuss/consider threats and responses prior, during, and after a field exercise.

LESSONS OUTLINE

Lessons by Fire Topic with Information, Examples & Exercises (Separate Documents)

1: Landscape Patterns, Patches, and Fire (Spatial Sense of Fire)

This lesson will focus on observing a landscape in the real-world or over an AlertWildfire Camera or Google Earth. Participants will learn how to describe and journal landforms and landscape patches and patterns. Understanding and observing patterns and patches across a landscape are relevant in recognizing scales of influence on the land. There are global, regional and local weather patterns that interact with terrain and vegetation communities and create various scales of patterns. We are primarily focusing on personal observations of patches and patterns at a landscape scale. A grounding exercise is used as a trauma-informed approach to seeing a landscape that may have been burned. The subject of fire will be discussed at the landscape scale and add context to fire's role in creating patches and patterns. Several illustrations and tiny fire history maps will be used to observe differences in fire size and shape. A landscape sketch will be added to a story zine that accompanies most of the lessons in this guide.

2: Nature-Informed Landscape Location (Positional Awareness of Fire)

This lesson will focus on observing, measuring and journaling spatial elements and position within the real-world and over Google Earth or a printed map. Where you are positioned has meaning for the fire regime and fire behavior you might expect. Positional awareness is foundational for fire awareness and readiness activities such as evacuation planning. Information and exercises will utilize the cardinal directions, points of reference and distance estimates, as well as natural elements that help identify location such as forest types and species associated with elevation and aspect. Several illustrations will be used to observe elevational gradients and landscape aspects with the associated forest zones, vegetation types and environmental conditions in Butte County. The lesson will end with a creative writing exercise that integrates the location data and observations with remembered experiences and senses associated with their position within the landscape.

3: Seasons, Stages, and Fire (Temporal Sense of Fire)

This lesson will focus on observing and journaling seasons, phenology, forest succession, fire regime, fire season and fire danger, within the real-world. Information and exercises will emphasize nature journaling techniques that can be used to track changes related to fire danger and environmental changes over

time. This section will include some climate change discussion as it relates to changing seasons, vegetation conditions and fire season. The lesson includes examples and exercises using visual language elements like words, images, color, texture and patterns to relate and represent changing natural elements.

4: Terrain, Heat Transfer, and Fire Rate of Spread (Foundational Fire)

Students learn how the steepness of terrain (slope) and heat transfer influences fire behavior. They will observe, measure and journal the relative steepness of the terrain by using angles estimated with hands, fingers, body position and movements.

5: Weather (Wind) and Fire Behavior (Foundational Fire)

Students observe and journal temperature, humidity and wind and learn how these observations relate to fire behavior. Students will use a diagram to journal vertical atmospheric gradients (temperature/moisture) and horizontal air movements (high and low winds) observed outdoors. Students will use nature journaling prompts to discuss mixed sensory observations associated with a relative wind speed scale. A sketch will be added to a story zine that captures key weather observations. No grounding exercise will be used in this lesson since the fire discussions and observations themselves are grounding. This lesson could be expanded or include homework that focuses on cloud identification and cloud painting and sketching techniques. Visit the UCAR Center for Science Education (UCAR SciEd) website for resources and lesson plans on clouds. A recorded workshop by Rosann Hanson on nature journaling clouds is available on the Field Arts website.

6: Plant Moisture and Fire Combustion (Foundational Fire)

Students review basics (observable aspects) of the fire triangle and how that relates to fuel moisture, humidity, and vapor pressure deficit and what that means for fire ignition and spread. Students will gather live and dead vegetation elements (grasses, leaves, etc) using a comparison table to study differences in plant moisture using hearing, sight, smell, and touch. The teacher uses plant materials for an ignition and burning experiment that students observe and journal. Students will choose one of their live/dead vegetation observations and sketch the shapes on their story zine, adding key descriptive words and phrases that differentiate between the live and dead plant elements. Students then add a few notes on thoughts relative to fire ignition and spread based on plant moisture.

7: Vegetation Arrangement and Fire Behavior (Foundational Fire)

Students review key fire and fuels terminology and what that means for fire behavior and spread over the landscape. Students will assess horizontal fuels and surface fire types like creeping, backing, advancing by creating a bird's-eye view diagram and vertical fuels and transitional fire types like torching and embers with a cross-section diagram. Students will learn how to use symbolized human figures (star people) in journaling practices and apply biometrics (body

measurements) and quick mathematical calculations to estimate fuel levels and potential flame lengths and fire types.

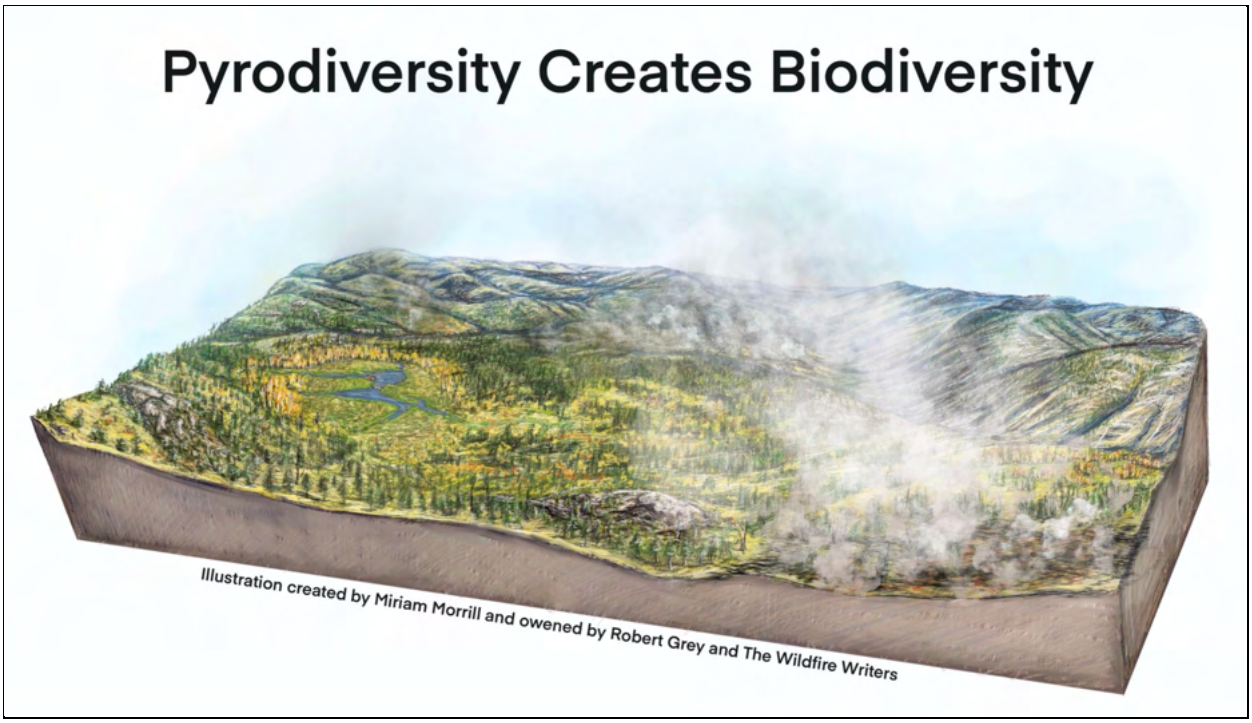
8: Plant and Animal Signs: Fire and Heat Indicators (Nature Interconnections)

Students review some climate and fire effects considerations (effects, vulnerabilities and adaptations associated with form and function) along with observable plant and animal signs of the fire environment (heat signs). Students will also learn a little about biophonies and geophonies and how to use those to help enhance fire environment observations.

9: Illuminating Fire Practices: Place-Based Knowledge (Knowledge Integrations)

This lesson gives an introduction to some fire readiness actions (Ready-Set-Go), risk perceptions, and trauma resilience and integrates elements learned in this guide. There is an optional homework evacuation planning exercise. The lesson would be best served in teams or group discussions and if able to integrate parents and fire partners would be greatly enhanced. Although, this can be done alone or as an individual.

1- LANDSCAPE PATCHES, PATTERNS & FIRE



INTRODUCTION

This lesson will focus on observing a landscape in the real-world or over an AlertWildfire Camera or Google Earth. Participants will learn how to describe and journal landforms and landscape patches and patterns. Understanding and observing patterns and patches across a landscape are relevant in recognizing scales of influence on the land. There are global, regional and local weather patterns that interact with terrain and vegetation communities and create various scales of patterns. We are primarily focusing on personal observations of patches and patterns at a landscape scale. A grounding exercise is used as a trauma-informed approach to seeing a landscape that may have been burned. The subject of fire will be discussed at the landscape scale and add context to fire's role in creating patches and patterns. Several illustrations and tiny fire history maps will be used to observe differences in fire size and shape. A landscape sketch will be added to a story zine that accompanies most of the lessons in this guide.

OVERVIEW AND ESTIMATED TIME (70 minutes)

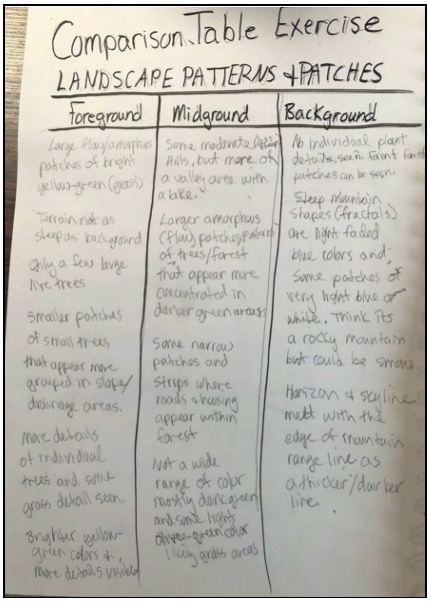
- Field safety discussion and lesson introduction (5 minutes)
- Grounding exercise (5 minutes)
- Exercise: Landscape patterns & patches comparison table exercise (20 minutes)
- Exercise: Landscape sketch on story zine (30 minutes)
- Exercise: Discussion and writing about landscape and fire patterns (10 minutes)

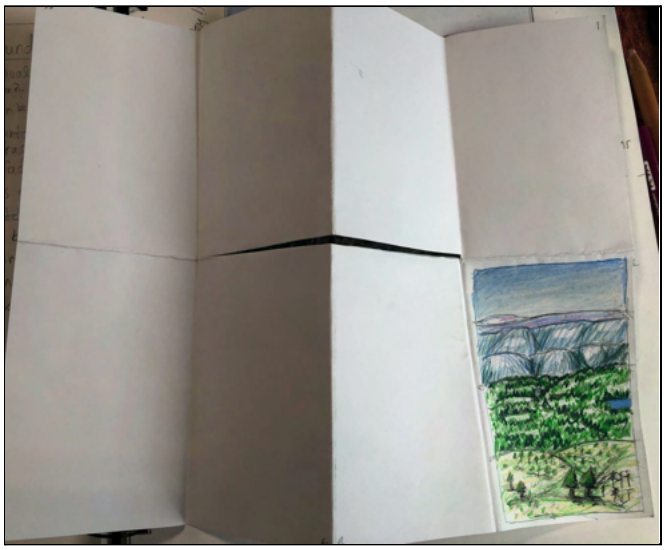
MATERIALS

- Journal or notebook
- Printed formatted story zine (11x17 page recommended or 8.5 x 11, if larger paper not available)
- Printed fire history map and illustrations
- Graphite pencils, erasers, crayons or colored pencils

LOCATION

Nature journaling practices are best done outside, in nature, but portions or all of each lesson plan can be done indoors. The first lesson is focused on seeing things at the landscape scale and should be done where you can see close vegetation as well as out to distant landforms and sky (20 to 40 mile view). The other option is to use the AlertWildfire live web cameras or Google Earth looking out over the local landscape. It does not have to be looking exactly at where the students are currently but a scene that captures the general local landforms, and demonstrates the shape of the land where they live.





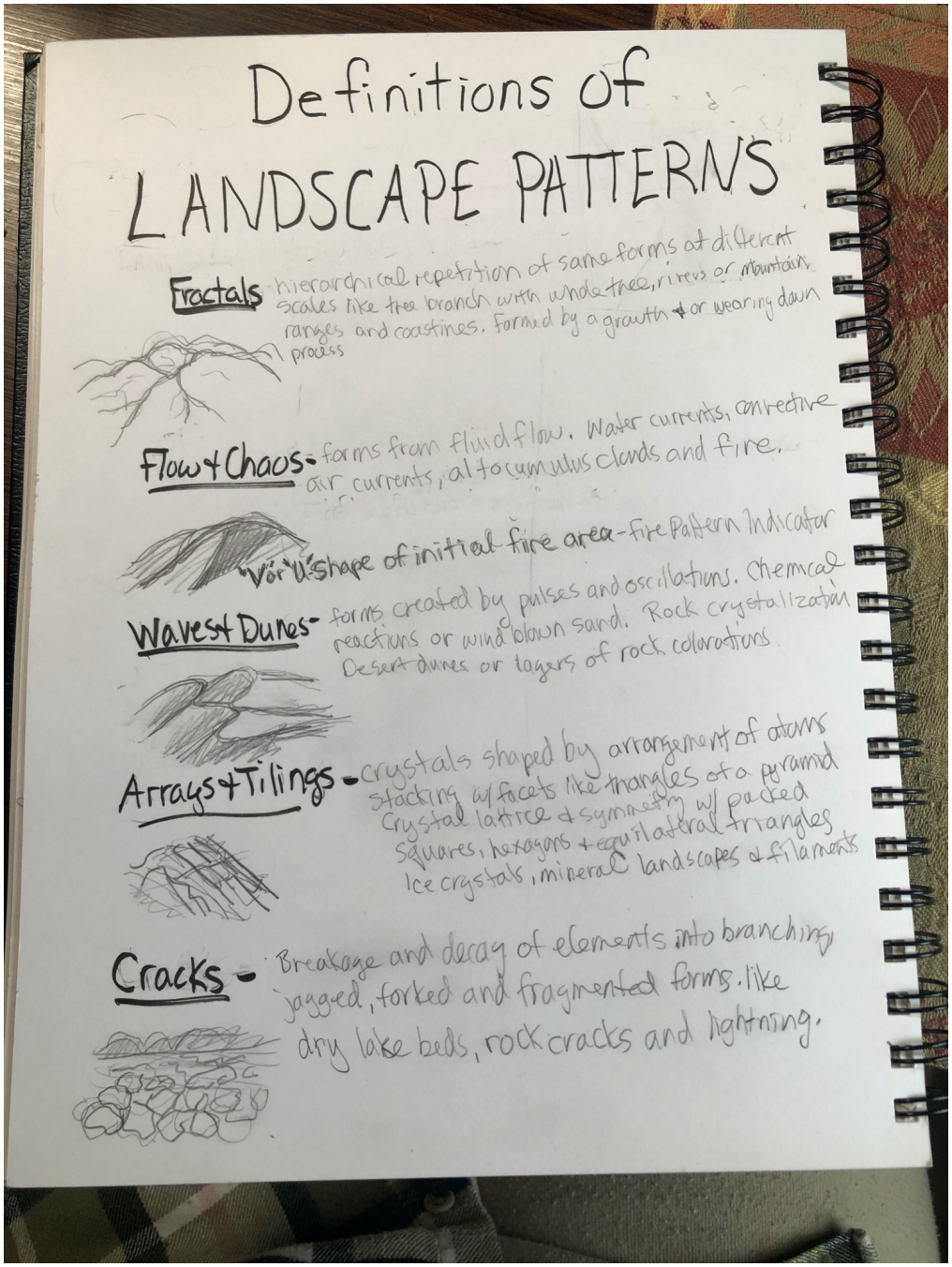
Example comparison table and landscape sketch for the story zine cover page.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

Fire is a natural phenomena and more than just a momentary event or chemical exothermic reaction. There are relationships between topography, vegetation and weather that influence how fire functions in the environment and over time. To gain a better sense of fire at the landscape scale, this lesson looks at the natural phenomena and how to observe patches and patterns in nature.

Patches can differ in size, gradient and arrangement and are created by processes external to an area (fire), processes between areas (plant competition) and processes

internal to an area (succession). Natural patterns are the recurring forms that result under different processes and can be modeled mathematically. Patterns that influence our fire environment include global, regional, and local weather patterns, weather-terrain interaction patterns, and terrain and vegetation interactions patterns. The ability to observe landscape patterns and build questions around cause and effect is important to building a sense of place.



A nice reference is the book with visuals is Patterns in Nature by Philip Ball. There are also human influences on patterns including urban development and landscape management such as cultural fire use, forestry and agriculture. See sketchnotes on key

landscape patterns by Miriam Morrill below. Fire patches and patterns are tied to various factors including differences in terrain, vegetation, weather and fire management actions. A landscape is the collection of patches and patterns with different histories.

Fires move across the landscape in varying patches and patterns and these can be seen within each individual fire and between different fires over place and time. It is a common misconception that the fire acres reported during a wildfire represent the acres burned. The fire acres represent the entire area (burned and unburned) within the fire perimeter and control line. The acres burned are more clearly observed in fire severity maps that show how much, where, and how severe landscape elements (vegetation and soil) burned. It is rare for every acre within a prescribed or wildfire fire area to burn.

SAFETY TALK & EXERCISE INTRODUCTION (5 minutes)

- Give safety talk appropriate to location and conditions. See guide introduction section with Safety Discussion overview.
- In this lesson, we are learning how to look out at broad landscapes and how to observe, journal and sketch landscape forms, patches and patterns. We will use an outdoor viewpoint or the AlertWildfire Camera or Google Earth to make our observations.
- We will learn about fire shapes, patches and patterns on the landscape using several illustrations and tiny fire history maps.

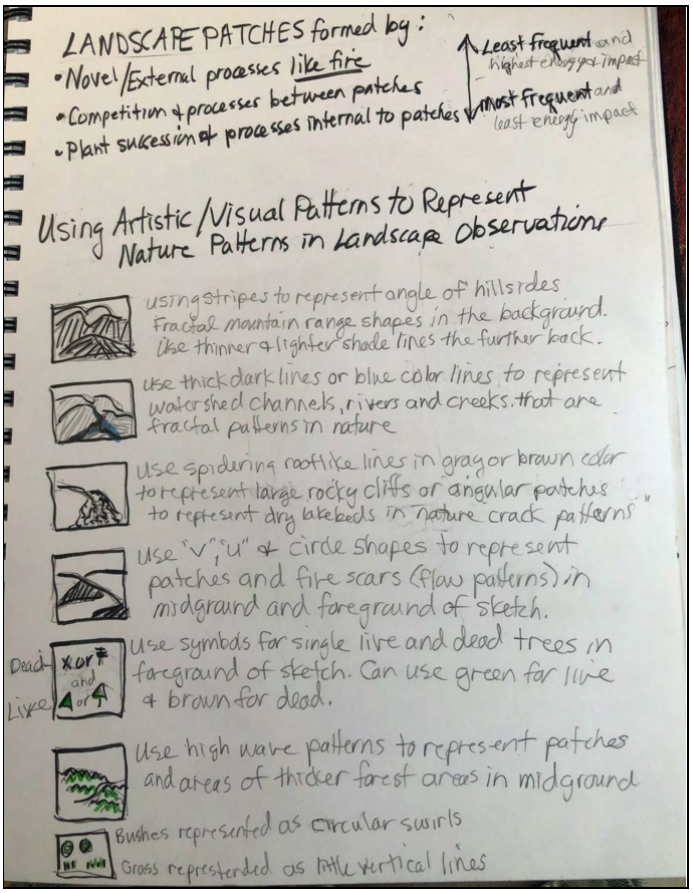
GROUNDING WARM-UP EXERCISE (5 minutes)

- Tell students to stand up straight. We will start the Redi journey with a grounding practice. A practice is something you do as a regular routine, like stretching before you run. This activity clears your mind of distractions and awakens your senses to everything around you. Feel your feet connect with the ground. Do you feel connected with stable footing? Spread your feet out a little further apart and sense your growing connection to the ground. Imagine yourself as a tree with your feet and toes holding you deep in the ground. Feel the strength in your body like the woody trunk of a tree. Stretch your arms out wide like tree branches to gather the light of the sun. Pause for a few minutes and feel yourself connected to the land.

- Tell students that once you are grounded, get your journal and materials ready to write and sketch information, ideas, and questions about this lesson, along with your observations and feelings. You can stand or sit for the next exercise but should show students how to hold the journal in a way they can write while holding the journal still.

- Don’t forget to add your name and the date on your journal page.

LANDSCAPE PATTERNS & PATCHES COMPARISON TABLE EXERCISE (20 minutes)



- **Exercise Introduction**: We are exploring a different way of seeing a landscape: we are looking at patches and patterns, which relate to fire on the landscape. We start by looking out at the landscape and putting observations into a comparison table. This will help us think about and describe things we are seeing at different scales.
- Before the teacher creates a demo comparison table, ask, “Who knows what we mean by a landscape?” Ask if students know what landscape patches and patterns are.

    - **Landscape** as a general term can be defined as all the things we see within an area of land. A landscape can be farmland, wilderness, urban and any other land area. Within a landscape there are landforms such as mountains, valleys and rivers. We can describe the landscape scene by the physical lines, shapes, size and how the eye moves over the scene and we describe and journal on paper.

      <u>Discussion:</u> Additionally, landscapes can be comprised of several diverse ecosystems or habitats, for example, in a mountainous area, the landscape might have alpine ridgelines, scree slopes, moist/cold forest, dry mixed forest, woodlands, riparian areas, shrub steppe or chaparral, and grassland. Within these ecosystems, there can be areas where the vegetation, rock, soils, and other topographical or landscape features are predominant.

    - **Patches** or mosaics are relatively small homogenous areas within the landscape that differ from the surrounding areas. In the mountain landscape, a patch could be a riparian area tucked into a canyon, or a forested area surrounded by chaparral. Patches in the landscape change over time – sometimes quickly, sometimes slowly – through what is called patch dynamics - meaning the ways that diverse vegetation, soils, topography, or other landscape components occur as a result of different influences and factors such as elevation, availability of water. Patches can be created and changed by (1) ecological disturbances such as fires, floods, disease, rockslides and avalanches, etc., (2) by influences from neighboring patches, like trees and shrubs competing for space or moisture, or (3) from things happening within a patch, like some plants growing faster than others.
    - **Patterns** are recurring/repeating forms that result from growth and movements of elements. These natural movements include weather, terrain and vegetation interactions at the global, regional and local scale. Some fascinating nature patterns include fractals and symmetries, but that is more advanced than this lesson. For this exercise, let's look at repeating elements such as dark and light shapes, straight and crooked lines/tree lines, steep and flat hillsides, etc.).

- **Establish Group View and Scene Framing**: Have everyone look out in the same general direction (best view for this lesson includes the sky touching the land and looking out at multiple landforms to a distance of 30-40 miles). If a field trip to a good view point is challenging, use the AlertWildfire cameras as described at the beginning of this lesson.
    - Show students how to use hands and fingers to frame a scene (portrait format/frame for this lesson) that includes a mix of land features from close up to far away. The view should include a portion of the sky so a title can be added later.
    - If you or they have trouble identifying patterns, try squinting and blurring your eyes so that the details don't distract from larger patterns on the land. You can also hold out a finger to focus your vision and use the blurred outer edges of your eyes to identify patterns.

- **Teacher Demo & Students Follow** (in a sketchbook carried around so everyone can see as you work): To help organize and describe the landscape, our comparison table will have three columns labeled Foreground, Midground and Background. In each of the columns we will use words, numbers and pictures to describe the patches and patterns seen on the landscape.

- **Start with the background** and move forward to keep from focusing on too many details. Describe and discuss any patterns you see within and between distance ranges. You can be creative in the words you use.

- Student goal is to make landscape scale observations of patches and patterns. Students can describe differences and similarities of patches and patterns at different distances. These descriptions will be captured in words, numbers and pictures in the comparison table.

- Look as far into the distance where the sky meets the land. We call the area in the far distance a **background** when describing a scene. The landscape features in the background should have faded unclear light-purple and light-blue colored features like mountains and or valleys. In this exercise, we are looking for patterns in the shape of the area. In this exercise we are looking for patterns and shapes in the landscape. We want to look at the slope and shape of the different landscape features (steep, rounded or flat, open areas or carved deep canyons, etc.).
    - Can you see differences in how steep, rounded, flat, smooth, or jagged the features are in the background? Are there differences between how those elements (hills, valleys, etc.) look? Are some hills or portions of the hill steep and others more rounded?
    - Describe background patches and patterns about the lean of the land with words, numbers and pictures in the background column of your comparison table.
  - **Midground** is the area closer than the background, but further than the foreground. You are looking for patches and patterns between vegetation communities and or forest openings.
    - Can you see patches or patterns in the midground? This is where you can see some forest or grassland shapes/areas but can't see individual plants. Are there differences between how crowded or open the forest, shrub or grassy areas look? Do you see different colors or textures between those areas?
    - Describe in words, numbers, and/or pictures the patches and patterns you see between vegetation groups and areas (forest area, grassland area, etc.) in the midground and note in your comparison table.
  - **Foreground** is what you can see and experience up close and nearby, like individual plants or trees. You are looking for patches and patterns between plants.
    - Can you see differences in how spread out or close together plants are in the foreground? Are there differences in the size of plants in

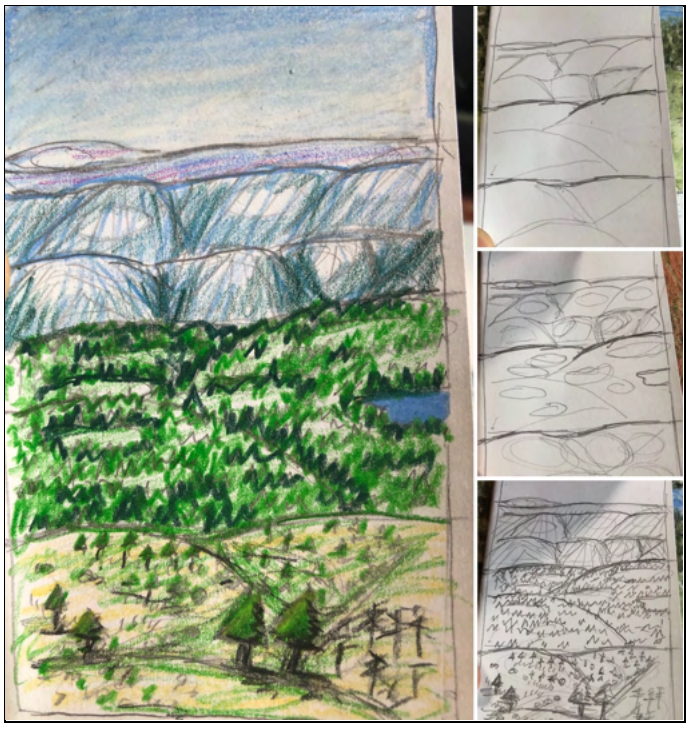
certain areas? Are there differences in colors of the patches of plants? Differences in sizes of plants in one area from sizes of some in another area?

- Describe in words, numbers and or pictures the patches and patterns you see in the types of plants, size, shape, color of plants and how those are located and grouped on the land in the foreground.

- As students work, keep track of time, circulate and troubleshoot, and engage in discussions. Students may discuss and model drawings from each other, as long as they are doing their own work.

- A few minutes before ending the exercise, Say: “Take about two minutes to wrap up and add any final details to your comparison table.”

LANDSCAPE SKETCH EXERCISE (STORY ZINE) (30 minutes)



- **Exercise Introduction**: Explain that in this exercise, we are creating a simple landscape sketch using symbols and designs on one of the spaces of a story zine (Space #1 on zine formatted 11x 17 or on 8.5 x 11 paper), using observations we made doing the comparison table and looking back out at the view we framed.
    - This sketch will be the cover of our story zine that is part of the Redi Master program and should capture basic landscape elements and an impression of the landscape patches and patterns observed. This exercise is not about creating a pretty picture and doesn’t have to look exactly like the landscape you see. We are sketching key information important in understanding the shape of the land. We will spend around ten minutes to complete this exercise together.
    - You can create your own symbols and designs for your landscape sketch or use the example.

- **Teacher Demo and Students Follow**- use the story zine paper- page/space #1, a graphite pencil and colored pencils and walk around to show students your work as you go. You can use your fingers and hands to frame the scene to fit the zine page (portrait format). Consider framing the view that offers an equal portion of sky, background, midground and foreground (see example).

  Overall Sketch Area

  - Start with creating some light graphite pencil lines for the separation between background, midground and foreground areas. Keep an area of sky at the top portion of the sketch, so there's space to add a story title later.
  - Use light graphite pencil lines to create the big terrain shapes in the background, midground and foreground and to lightly outline patch areas (where there are openings or concentrations of elements).

  Sky and Background Area of the Sketch

  - Leave the sky area blank without shading or elements
  - Hold your graphite pencil out in front of you so that the pencil is leaning on one area of the background. Look at the angle of the pencil and lay that pencil angle over that same area in the zine sketch to determine how much slope or angle to create. Move your pencil and create a series of lines along that landform area to indicate the lean of the land on that spot. Do the same for other landforms and or portions of the background until the background area of the sketch is filled with a mix of line patterns.
  - Go to next steps and when the graphite pencil details are finished come back and color in the sky and background with the light faded colors of blue and or purple to help indicate distance.

  Midground Area of Sketch

  - Use a variation of line pattern to indicate the shape and form of vegetation groupings. For example, use a v-shaped wavy line pattern to create a forest tree line or slightly bumping line for shrub areas and dotted or tiny vertical lines for grassy areas.
  - Start by creating those vegetation elements around the patch areas and then fill in elsewhere in the midground, as needed, to create simplistic and impressionistic vegetation patches and patterns in the midground.
  - Go to the next step and when the graphite details have been added come back and color in the midground areas. Use different colors to indicate patch areas and accentuate color/shading around the patch areas. Keep

colors somewhat muted with greens, browns and maybe a little yellow mixed into the greens and browns, if needed. This helps provide a sense of distance from the foreground.

Foreground Area of the Sketch

- Use graphite pencil to sketch simplified and or symbolic vegetation types into and around the patch areas. Don't spend time on details of individual plants to make them realistic, but on details that help show the different types of plants and different areas of plants.
  - Capture differences in vegetation type (tree, shrub and grass), general size and shapes of plants and colors and or shading differences.
- Use any and all color ranges you see and make them more vibrant in color than in the background and midground. If the vegetation appears similar in color to the midground, such as a green forest in the midground and a mix of forest and grass in the foreground, add a light layer of yellow color first and then overlay greens, browns, etc.
- Add a few highlights and shadows where needed to show some differences of key vegetation elements in the foreground. For instance, if there's a patch of live trees and a patch of dead trees, add some shadows below a few of the live trees to accentuate.

- When it comes time to color in the sketch, explain methods to shade lightly or with faded colors in the background (light touch, fewer lines, adding some white or erasing some of the lines to create a faded effect) and darker and or brighter colors in the foreground.
- Ask students if they have any questions about what they'll be doing, set boundaries, and set them to work.
- As students work, take time to keep track of time, circulate and troubleshoot and engage in discussions. It should be okay to discuss and copy each other as long as they are doing their own work.
- A few minutes before calling the students back, Say: "Take about two minutes to wrap up and add any final details to your journal entry.

FIRE PATTERNS EXERCISE (10 minutes)

- **Exercise Introduction**: Explain that in this exercise we are going to discuss and answer some questions on how fire relates to patches and patterns on the landscape using some illustrations and maps for reference.
    - Explain how scientists have studied deep layers of soil samples in California and found clear indications of repeated fires over the past 3,000 years. Native American ancestors used fire as a tool across much of California, which also created many patches and patterns on the landscape. Now, tribes, state and federal agencies and groups like the Butte County Fire Safe Council work to prevent unwanted human-caused wildfires and use prescribed fire and mechanical treatments to create healthy landscape patches and patterns.

- Use the Fire Ignition Area illustration as reference and describe how fires start burning in a small circular area (Fire Ignition Area Illustration) and then spread out in different directions and at different speeds based on the amount and type of vegetation, how steep or flat the land is and various weather conditions (how hot, dry and windy). This is called fire behavior and fire specialists use the fire behavior triangle (fuels/vegetation, topography/steepness and weather) to predict and assess fire behavior.

Screen captures in a collage of some Butte County wildfires between 1905 and 2020 from WIFIRE (firemap.sdsc.edu). This shows the different shapes and locations that wildfires can take. Each block is a five year period.

- Use the Fire Area Illustration and describe how fire interacts with landforms and landscape elements based on differences in the fire behavior triangle. Fire can move over the land at various speeds and in varying sizes and shapes to create different patches and patterns.
    - These fire shapes can look like a winding snake, a long triangular kite or a giant amorphous ameba. Can you see different sizes and shapes in different areas on the map? You might notice different fire burned areas having similar shapes based on where they are located in the terrain.
    - Patterns and patches can be seen within each individual fire and between different fires over space and time. It is rare for all of a fire area, within a prescribed or wildfire to burn. There are always patches of different burn severity (how hot the fire burns the landscape elements).
    - Explain how fire patterns and patches can be different on individual plants such as different portions of trees having been burned.
    - There are different phases of landscape and vegetation recovery after a fire where you can see different patterns within different patches of a fire. At a closer look you can see the different types of plant regrowth and different plant and animal species move in and out of the burned area over time. There may be obvious signs of fire in an area but sometimes it's hard to tell.
    - There are other things that create landscape patterns including elevation, floods, mudslides, and human development.

- **Teacher Facilitated Student Exercise**: Think about how to help students frame questions and discuss patterns they observed in the fire history maps. If they appear stressed by the topic, do another grounding exercise. Explain how we will take what we've learned about fire patterns and what we've seen in our landscape observations and answer a few questions.
    - If they are struggling to write questions, consider asking them to sketch a large question-mark to express that they don't know what their questions are. Putting question-marks all around a journal page to express what you don't know or where you want to know more is a part of the nature journaling process.

Pattern Questions:

- What are some patterns (repeated forms/shapes) you noticed in the shapes and sizes of fire in the fire history maps?

- What are some patterns you noticed from your observations listed in the comparison table that make you think about fire behavior? For example, do you see similar or repeated shapes and sizes of fires along roads, rivers or mountain tops?

Cause and Effect Questions:

- Look back at your comparison table and the fire history maps and consider any similarities in patches and what may have caused those patterns? Does it appear that different types of causes have happened over different periods of time?

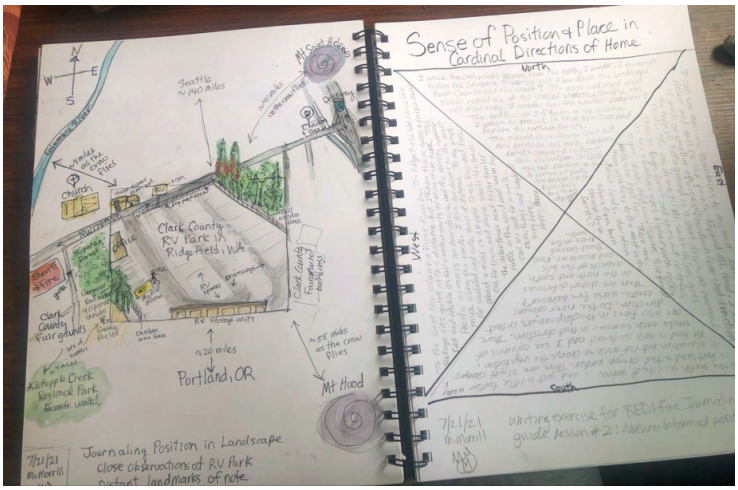
Structure and Function Questions:

- How were the structures in some patches (the forms, shapes, arrangement of elements in and around the patches) different from other patches and how do you think those patches function within the larger landscape? For instance, do you think rain water moves through the patches differently? Do you think animals use the patches differently from other areas?

2- NATURE-INFORMED LANDSCAPE LOCATION (POSITIONAL AWARENESS)

INTRODUCTION

This lesson will focus on observing, measuring and journaling spatial elements and position within the real-world and over Google Earth or a printed map. Where you are positioned has meaning for the fire regime and fire behavior you might expect. Positional awareness is foundational for fire awareness and readiness activities such as evacuation planning. Information and exercises will utilize the cardinal directions, points of reference and distance estimates, as well as natural elements that help identify location (eg.forest type and species associated with elevation and aspect). Several illustrations will be used to observe elevational gradients and landscape aspects with the associated forest zones, vegetation types, and environmental conditions in Butte County. The lesson will end with a creative writing exercise that integrates the location data and observations with remembered experiences and senses associated with their position within the landscape.



Not everyone has the same spatial perception capabilities but the exercises should be relative and general enough that most people can engage and explore the lesson. Spatial perception exercises can engage multiple parts of the brain and body, including the visual and the vestibular system. This lesson could be expanded to engage more of those neural systems, including adding mathematical information and exercises focused on the experienced sense of space and position.

OVERVIEW & TIME (60 minutes/ 70 with extra credit)

- Background information (review prior to implementing lesson)
- Field safety and lesson Introduction **(5 minutes)**
- Cardinal directions and points of reference exercise **(20 minutes)**
- Distance measures and landscape map features exercise **(15 minutes)**
- Position description and creative writing exercise (Nature-informed position and sense of place **(20 minutes)**
- **Extra Credit:** Distance estimates & the Rayleigh Effect exercise **(10 minutes)**

MATERIALS

- Journal or notebook
- Graphite pencil and eraser. Optional to add color with crayons/colored pencils and or watercolors.
- Ruler

- Printed area map (optional/alternative to Google Earth)
- Compass or compass app on mobile device
- Extra Credit/Optional but good to have as reference- AlertWildfire camera name and location from previous lesson and distance to view points in previous landscape sketch.
    - Sheet or piece of tracing paper

LOCATION

This exercise should be done outside at a school, business, camp or home location with the use of Google Earth or a map for visual information on additional spatial features around the area.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

Understanding and describing location and orientation are critical to relate elements in the environment and navigate through physical and mental space. They are also important for reasoning, remembering, and imagining things in your mind. Location - or as we are referencing in this lesson, position - tells us where something or someone is within a space and in relation to a frame of reference (i.e., a global origin and a set of coordinate system axes). The orientation of objects tells us if things are facing north, south, down, or up.

Mathematical/Cartesian orientation or Points of Interest are two primary ways to relate position to the environment. In mathematics, the Cartesian coordinate system is used to uniquely determine each point in the plane through two numbers, usually called the *x-coordinate* and the *y-coordinate* of the point. Vectors use a similar notation to Cartesian coordinates: distances along lines of reference but are representations of direction. A vector can be visually represented as a line with an arrow on one end. Direction can be either **relative** or **absolute**.

- **Relative** directions are in relationship to an object's current location and orientation. For example, if a person is facing north, west is to their left and east is to their right. Directions such as *left/right*, *forward/backward*, and *up/down* are relative to an object's current orientation.
- **Absolute** directions are relative to a fixed frame of reference and always point in the same direction, regardless of their location. Directions like *north/south* and *east/west* are examples of absolute direction.

Recognizing our personal perspective is also important in evaluating and conveying information. Whether you are viewing a scene from far away or close up can change how observations are perceived. For instance, foreshortening techniques are used in drawing to better convey the position of something based on perspective.

One natural phenomenon referenced in this lesson is the influence of the **Earth's magnetic fields** on a compass. Another phenomenon is **Phototropism**, which is a directional response that allows plants to grow towards (or in some cases away from) a source of sunlight. **Photoperiodism** regulates the physiology or development of plants in response to day length and can be applied to orientation in a landscape. **Elevational**

and altitudinal influences on tree growth and **slope aspect influences on plant communities** and growth are other phenomena integrated in this lesson. And lastly, the **Rayleigh effect** is a phenomenon where sunlight is scattered by atmospheric conditions over different distances, conditions (pollution) and times affecting which colors are seen and giving landscape features different appearances that can be used as reference in estimating distance.

This lesson introduces general location and orientation concepts but focuses more on the experienced sense of position using our seen and known points of reference and associated natural features and conditions related to location (elevation) and orientation (aspect) such as the Butte County forest zones associated with elevational gradients and different vegetation communities found on northern versus southern aspects.

SAFETY TALK & EXERCISE INTRODUCTION (5 minutes)

- Give safety talk appropriate to location and conditions. See guide introduction section with Safety Discussion overview.
- Explain to students that in this lesson, we are learning how to determine and describe our position in the landscape. We will be creating a simple map around the school/home with key elements to the north, south, east and west. This is what we call the four cardinal directions and is the primary way we navigate our space at ground level along with using points of reference. We will also be learning about elements in nature that can help determine our position in the landscape and how we can use creative writing to describe our position and travel through a landscape.
- Tell students that they will want to use their journal and a graphite pencil. Colored pencils or pens can be used to accentuate the map but are not required for the exercises.

CARDINAL DIRECTIONS & POINTS OF REFERENCE EXERCISE (20 minutes)

- Go out to the north side of the school, facility or vehicle and find an open place for the group to sit.

- Tell students that in this exercise we will be mapping points of reference around us.

- Ask students if they know how to describe and follow directions for their position and navigation around a landscape?

  Discussion: When you want to describe where you are located in the environment, you need to use points of reference around you and terminology and measurements for map-making (cartography). What key buildings, roads, landscape elements like mountains and canyons are around you? What direction is the sun now and which direction is it moving? For us to move from points of reference we need to know the orientation (direction facing) and navigation route (path of travel). When describing and following a path we most often use terms like right or left and up or down, but that changes when you move. So, it's important to learn and use the four main directions which include north (N), east (E), south (S), and west (W). The direction words are found on maps, street

signs, and in many other places. The cardinal directions help people travel from place to place. You can find north, east, south and west when you're outdoors by using a compass.

- Ask students to close their eyes. When they have closed their eyes, ask them to answer the following (or similar) questions and point their hands in the correct direction:

  Discussion: Where does the sun set? Which way is north? *Ask the students to keep their arms pointing north and open their eyes. When they see arms pointing in every direction, they quickly realize how disoriented they are as a whole.*

- Show students the compass or compass wheel and talk about the four cardinal directions.

  Discussion: What's really cool is that a compass works because of the magnet floating inside which moves based on the Earth's magnetic fields at the north and south poles. There are other tools that can help you find direction including Global Positioning Units (GPS) which many smart phones now have embedded. There are also things in nature that can help us determine which direction we are facing. Can you think of a really big thing that helps us tell which direction is East and West? Do you know which direction the sun rises and sets? If it's early or late in the day, you can get an idea of which direction is East or West. There are nature observations that can help us find north and south, but we'll talk about that a little later.

- Ask students to open their journals and get their pencils ready.

  Discussion: When nature journaling, the cardinal directions can be displayed on a page or map using a **compass rose** to indicate the direction on your page which should match the direction you are facing.

- Demonstrate how to draw the compass rose in a corner on the page and draw a large square filling the page and a smaller square in the middle of that circle - have students do the same.

  Discussion: The standard rule is that your map should have north facing at the top of the page. So when drawing your map, you'll want to orient your body facing north, then diagram, sketch and or write your observed elements within the appropriate orientation.

- Check the compass and have everyone move to face in the direction of North.

  Discussion: The compass rose uses the letters for each direction, N, E, S, W and you can also add those into different elements on your journal such as showing an "N" with squiggle lines to show wind coming from the northern direction. There are many different designs of compass roses, but all point to the north, east, south, and west.

- Ask students to point to where the sun rises and sets. Point to west and east and have students follow as you show them how to add a visual and note about where the sun rises and sets on their map in the journal.

- Ask students if they know what type of elements to add to a map?

  Discussion: There are many different types of maps based on the scale of the area and the types of elements you want to find and navigate to.

- Ask students if they can name some different types of maps (topographic map, city map, state road map, map of the mall, etc.)

  Discussion: For this exercise we want to get a sense of where we are and what is around us. If you were to describe where you were sitting to someone on the phone, what would you tell them? We don't want to have too much information that can be confusing and complicates the map, but we do want large, unique features that are easy to see and commonly known.

- Ask students to put a symbol or sketch of themselves in the center of the small square (their map) to indicate their location and show them how to create a legend for the symbols they use.

- Tell students that they have around ten minutes to put the key map features they see using words, numbers and pictures for each direction on their map, starting with the direction they are facing- north.

- Offer tips and support and add a few elements to your own map to help demonstrate different approaches such as a symbol that could be used to represent a building or tree, etc.

- Give students a two minutes warming when it's time to wrap up this exercise.

- When the exercise is wrapped up, ask if anyone had insights or questions they'd like to share about what they observed and added to the map.

DISTANCE MEASURES & LANDSCAPE MAP FEATURES EXERCISE (15 minutes)

- Gather students together somewhere open outside.

- We are now going to consider how we can map and describe distant landscape elements around us.

- Ask students if they can list some of the different types of metrics we use to measure distances.

Discussion: We know that distance is the space between two or more things but how do you describe and measure distance? Any guesses? What are some distance measurements used between small things (millimeters, inches, centimeters, etc.)? What about distances between people (feet, yards, etc.)? What about things far apart like mountains (miles, kilometers, etc.)? These measurements can also be used to describe the length and width of an object.

- Ask students if they can think of other ways to describe distance without using metrics.

  Discussion: We can use comparisons to help us describe distance too. For instance you could say that there are three car lengths between one car and another car or you can use travel time as an indication of distance like saying that I am located 20 minutes from the school. This form of measurement is not precise and can be misleading but is a quick and relative way to describe distance. We can also use our body to help us measure things. You can hold your hand and arm out to an object and see if it's smaller or larger than your arm or maybe it's an arm and a half in length. Objects, of the same size, that are farther away from you always appear smaller than the object closer. You can use this principle in sketching to give the sense of distance.

- Ask students if they can see or remember any key landscape or community features further away (stores, restaurants, river roads, etc.)

- Reference a printed or Google map to see travel routes, big landscape or urban features out 50 to 100 miles in each cardinal direction and have students describe out loud how they perceive distance to those features.

  Discussion: For instance, if you are currently located in the foothills, which direction and how far away is the valley and other neighboring towns. What direction and distance is the biggest mountain you can see? What major roads run north to south?

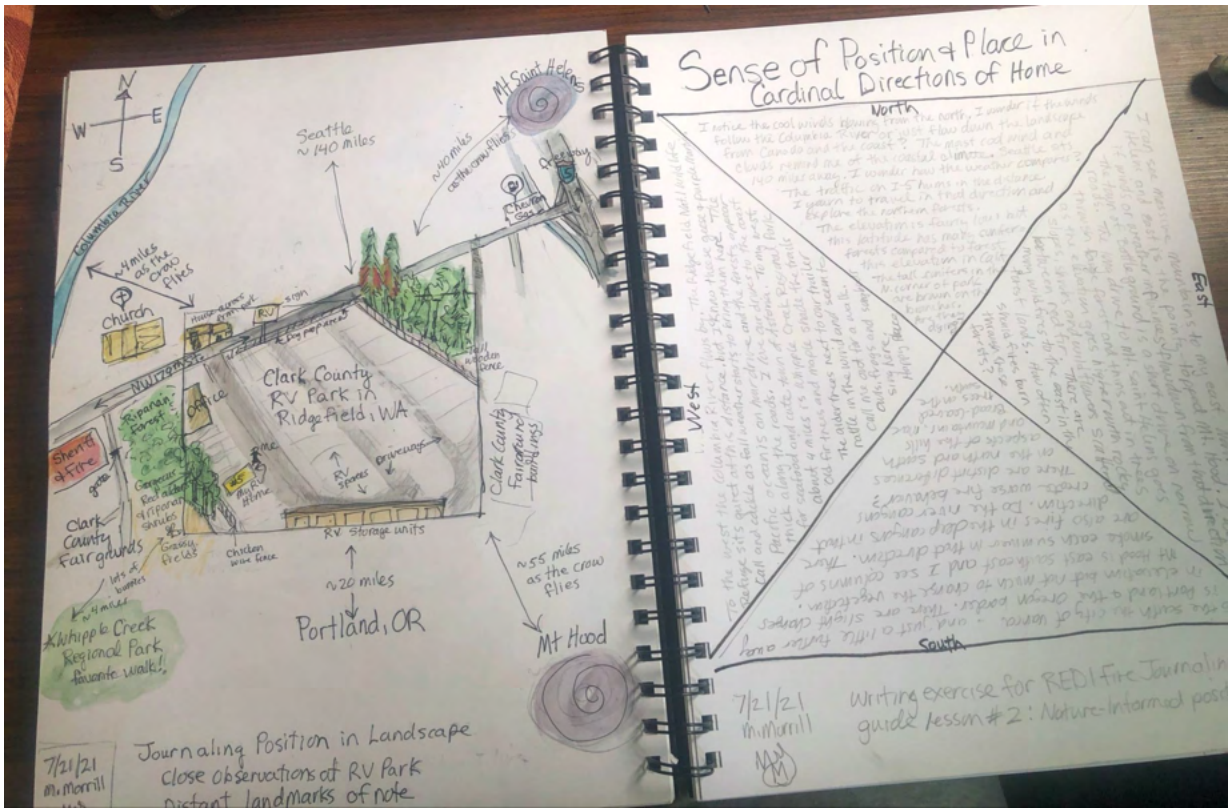
- Tell students they have ten minutes to add a few distant map features in the outer square on their page- what they can see, what they remember or ask for teacher input on map points. Ask students to use words, numbers or pictures in their journal to describe a few key features and the perceived, estimated and or known distances from them to those elements. Keep the second page in the journal spread open for the next exercise.

- As students work, walk around and demonstrate how to sketch or symbolize different map features and how to then add to their map legend. Remind students that this is not about creating art, as long as you can understand your map and that you have words, symbols, and sketches in the right area, you are doing it right.

- Give students a one to two minute warning when it's time to start wrapping up their journaling.

- When the exercise is wrapped up, ask if anyone had insights or questions they'd like to share about what they observed and added to the map.

POSITION DESCRIPTION & CREATIVE WRITING: NATURE-INFORMED LOCATION & SENSE OF PLACE (20 minutes)



- Have students gather together somewhere comfortable and inspiring. If comfortable and still in a group, have them stretch for a few minutes before jumping into this next exercise. Students can spread out after they have received instructions or stay in one location.

- Tell students that in this exercise we are going to learn about a few nature-informed ways to understand and define our position within the landscape. This information is also helpful for gaining a sense of fire on the landscape.

- Ask students if they can list some ways to describe our physical position in the landscape. Discussion: We talked about how we can use points of reference for our directions. We can also use those to better describe our location. For instance, we can say that we are high on the mountain, far down in the valley, next to the school and below the waterfall. We can also say that we are located next to or within a certain type of vegetation community like pine forest or open grassland. It is helpful to start by thinking about our position on the planet and work our way down to where we are specifically located.

- Ask students if they can name different ways we can describe where on the planet, in the state and in the county we are located?

  Discussion: When describing our position on the planet, we consider that the earth is a sphere and that we can split that in half. Those halves are called the northern and southern hemispheres; North America is in the northern hemisphere. We also use what is called longitude and latitude. A longitude is an angle from an imaginary north-south line that runs through Greenwich, England, measured to the east (longitudes to the west are negative). Latitudes measure an angle up from the equator (latitudes to the south are negative). In describing our position we also use the term elevation to describe how high up the land is from sea level and aspect to describe which side of a hill or mountain we are located. In different states and local locations we use other elements and points of reference to describe where we are located in relation to the coast, Central valley, foothills, and mountain ranges like the Cascades and the Sierra Nevadas. Below are some basic principles about the conditions of the environment that can help you determine where you are; nature-informed position.

- Highlight a few things in the Nature-Informed Location table and tell them they can reference this during the exercise.

- Ask students to look at the Butte County Forest Zone Illustration while we discuss some of the observations we can make to describe our position within the landscape and what that means for fire.
  Discussion: Each color zone on the landscape represents an elevational range and area within Butte County that has certain forest types that are more common or widespread in that area. Those zones also have a certain fire regime.
    - A fire regime is the pattern, frequency, and intensity of fires that prevail in an area over long periods of time. It is an integral part of fire ecology, and means renewal for certain types of ecosystems.

- Explain to students that in this exercise, they will use another page in their journal (next to their map) and write expressive and creative descriptions and or questions about their location in each direction.

- Demonstrate to students how to split up their journal page into quadrants with the cardinal directions and discuss how they will start at the outside of the quadrant and work their way inward on the page with a description, guess or question that includes discussion on:
    - global, regional and or state location,

    - within Butte County and the forest zones including elevation and fire regime and
    - within their map zones

- Explain how they should describe in words their position within the close and distant landscape (e.g. close to the school, 25, 50 and or 100 miles away to encompass key landmarks and elements). In this exercise they should be creative and can write as a poem or other expressive ways. Also point out that they don't have to put the answers, but can frame questions around the location and nature-informed observations. In nature journaling it is even more important to think about and question things rather than just label something.

- Explain how they should try to add something about that location with a memory or experience (e.g. where we went fishing, where my friend lives, where we saw a bear, where a fire burned).

- Give students a one to two minute warning when it's time to start wrapping up their journaling.

- When the exercise is wrapped up, ask if anyone had insights or questions they'd like to share about what they observed and added to the map.

Table 1: Nature-Informed Location Tips

LOCATION TERM	NATURE-INFORMED LOCATION DESCRIPTION
Hemisphere:	There's a natural phenomenon that can help inform you of which hemisphere you are located in. Phototropism is the orientation of a plant or other organism in response to light and in plants: differential cell elongation occurs to optimize photosynthesis. This causes the shape and form of some plants to grow differently based on which direction the sun has the strongest influence based on which hemisphere you're located. You will not likely see a sign of this effect on fir or pine trees, it's more observable in deciduous trees. In the northern hemisphere the southern side of a tree the branches typically grow closer to a horizontal position whereas the northern side of the tree has branches typically growing closer to the vertical. You cannot always tell if it is phototropism or something else, but if you can see this "checkmark" effect) asymmetrical form), as author and adventurer Trinstin Gooley calls it, you can make assumptions and see if that is the most likely cause.
Latitude:	In general, the further north in latitude you go, the colder the weather. These colder conditions change the types of plants and animals that you are likely to see. We will not go into latitude and longitude in this lesson but this is important to learn when considering map navigation.

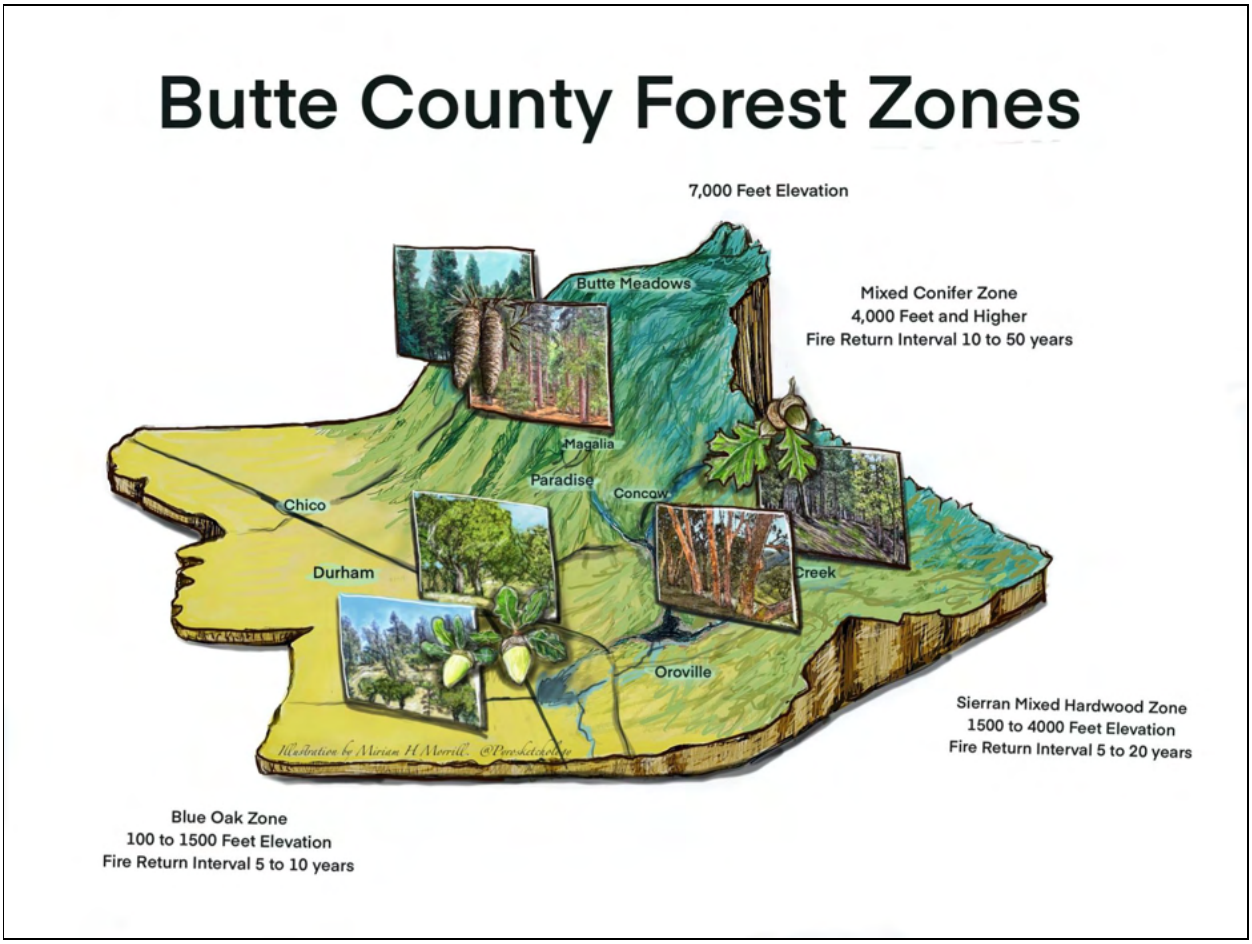
Landforms:	In California, you have the coastal mountain ranges, Cascade range and Sierra Nevada running from north to south along the state. The Central Valley covers much of the northern valley region of the state and within that is the Sacramento Valley where part of Butte County is located. You can describe where you are in relation to those mountain ranges and valleys. Are you north, south or east of the mountain range or within the valley?
Butte Landform	Butte County lies within north central California in the northern part of the Sacramento Valley, 70 miles north of Sacramento. About half of the county is valley grassland with river and riparian corridors. The Sacramento River and Butte Creek run along the western side and Honcut Creek along the southeast side of Butte County. The other part of the county is foothills and mountain ranges including the northern tip of the county which is located in the southern portion of the Cascade mountain range which includes part of the Lassen National Forest. Here, Humboldt Peak is the highest elevation point in Butte County at 7,044 feet. The mountains within the southern part of the county are in the northern part of the Sierra Nevada range and include part of the Plumas National Forest. The Feather River canyon runs in a northeast to southwest direction and Lake Oroville sits in the southern part of the valley in Butte County. In the Feather River Canyon, there are strong upcanyon winds in the morning and down canyon winds in the evening (diurnal- influenced by sunrise and sunset temperature influences on the landscape creating winds). In general most of the higher elevation rivers flow in an east (higher elevation) to west (lower elevation) toward the valley rivers which carry water south and westward to the ocean. The smaller canyons in Paradise foothills run north to south.
Elevation:	In general, the higher the elevation has cooler air temperatures. The higher the elevation, plant height and number of different types of tree species decreases the higher up in elevation and increases the number of understory plant species (herbs and ferns). The tree forms and shapes are often different as the elevation changes as well. In California the highest zone is called the alpine zone and the trees usually have needles and not the larger leaves you see on trees in the valley. These alpine trees look shorter than lower elevation trees but can be very old due to the slow growth rate. In California's upper mountain zone, below the alpine area, trees typically grow in an columnar form (apical dominance) like a Christmas tree (not multiple bases or widely branching). Apical dominance is when growth is concentrated at the tip of the plant shoot, where the terminal bud partially inhibits the axillary bud growth. This allows the trees to survive snow and resist decay. NOTE: With climate changes, we may see some changes in these plant forms and community distribution patterns but this may take a long time to occur for some species and is already occurring for some others. What we can expect is change.

Butte Mixed Conifer Zone Elevation	Elevational range between 4,000 and 7,000 feet elevation. Rainfall 60 inches and more. Wildfires naturally occur and the plant communities have adapted to fires returning within 10 to 50 years. A natural or “informed” fire regime (prescribed fire and cultural burning) in this zone will generally be of high complexity (patches and pattern of burned area after the fire) with varying? levels of fire severity. This would create many patches and patterns over the landscape with some patches completely burned and others with moderate burn impacts or none. In this zone you’ll see sugar pines, Douglas firs, incense-cedar and white fir (needle type trees). You can see these forest and vegetation communities in Cohasset, Forbestown and Maglia.
Butte Sierran Mixed Hardwood Zone Elevation	Elevational range between 1500 and 4000. Rainfall 32 to 65 inches a year. Wildfires naturally occur and the plant communities have adapted to fires returning within 5 to 20 year intervals. A natural or “informed” burning regime, using prescribed fire and indigenous practices, in this zone would generally be of moderate complexity (patches and pattern of burned area after the fire) and mixed severity (how hot and large) where you might see some patches and patterns but also areas with similar low level complexity burning. You’ll find black oak, madrone, tanoak, bay laurel, Douglas-fir, incense-cedar and dogwoods (mixed needle and leaf trees and shrubs). You can see these forest and vegetation communities in Forest Ranch and Paradise.
Butte Blue Oak Zone Elevation	Elevational range from the valley floor to 1500 feet in elevation. Rainfall 12 to 36 inches a year. Wildfires naturally occur and plant communities have adapted to fires returning within 5 to 10 year intervals. These types of fires are typically lower intensity and lower complexity, meaning that they have a fairly consistent impact across this landscape type (e.g., grasses, shrubs and small trees burned but larger trees only partially scorched). You’ll find blue oak trees in open grassy areas with some groupings of shrubs. Blue Oaks are also mixed with Gray Pines which is an important and enduring relationship for both species (mixed needle, leaf, shrub and grass). The Butte County Forest Health Guide Book discusses the traditional ecological knowledge about this relationship. Imagine Butte Valley, Big Chico Creek Ecological Reserve and Lime Saddle vegetation and you’ll have a mental picture of this zone. Blue oaks are very fire tolerant with low intensity fires and grasslands benefit from frequent fires. When the blue oaks become too crowded with branches touching other trees, fire impacts will be worse.

Aspect:	In the northern hemisphere the northern aspect of a mountain is typically cooler and has more moisture and thus usually has thicker forests and more vegetation while the southern aspect is typically warmer and drier with less concentrations of forest and vegetation. There are also differences in some of the plant forms and adaptations that you can observe. For instance, in warmer drier areas like the southern aspect, you may see smaller and thicker leaves than some areas with more moisture.
Butte Mixed Conifer Zone Aspects	You should see more of the fir and needle-type trees on the northern aspects. You should see more sugar pines, oaks, shrubs and openings on the southern aspects of this zone, with fire returning more frequently than on the northern aspects of the zone.
Butte Sierran Mixed Hardwood Zone Aspects	You'll see more fir and needle-type trees on the northern aspects along with some broader-leafed shrubs in the understory like dogwood. You should see more of the black oak, ponderosa pines, madrone, tan oaks, maple and bay laurel and other shrubs preferring drier sunnier conditions in the southern aspects. You should also see more open areas in the southern aspect areas and expect fire to return more frequently than on the northern aspects of this zone. The riparian corridors may cross into different aspects but have plant species more suited to the higher moisture such as dogwoods and willows.
Butte Blue Oak Zone Aspects	In the northern aspects you should see more blue oak trees and open grassy areas with some groupings of shrubs. Blue Oaks are also mixed with Gray Pines in certain areas, with the pines preferring the drier southern aspects along with chaparral like manzanita, red bud, and white thorn. Riparian corridors may have more cottonwoods than the higher elevation zones.

DISCUSSIONS & QUESTIONS

Feel free to use similar student discussion and question framing as the previous lessons to the end, if there's time.



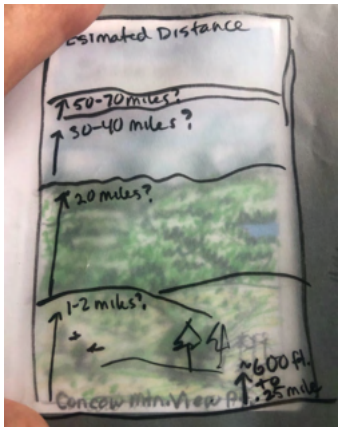
OPTIONAL EXTRA EXERCISE

RAYLEIGH EFFECT DISTANCE ESTIMATES EXERCISE (added to the zine sketch from lesson #1) (10 minutes)

The **Rayleigh effect** is an observed phenomenon describing how landscape features farther away appear to lighten in shade, shift to cooler colors, and lose details and focus. You may have noticed this effect while doing your sketch in the first lesson with the foreground, midground and background. The **Rayleigh effect** happens when sunlight is scattered by atmospheric conditions over different distances, conditions (pollution) and times affecting which colors are seen and giving landscape features different appearances that can be used as reference in estimating distance (faded blue mountains in the distance).
In this exercise we will go back to our zine sketch from lesson #1 and apply the estimated distances over a piece of tracing paper.

1. Teacher Note: If you'd like to add the actual miles or something close to the viewpoints in the previous lesson's sketching exercise use the AlertWildfire camera name and location in Google Earth and see if you can determine how far away your viewpoints are in the background. Otherwise, put the distance estimates as a question in this exercise.

2. Take a piece of tracing paper and lay over the landscape zine sketch in the first lesson.
3. Sketch a box on the tracing paper to frame the sketch underneath.



4. Look at the background area of the previous sketch. This should have been where the sky meets the land and the landscape features. If you were looking out to thirty miles or more away this distant landscape should be faded and light-purple or light-blue in color (e.g. purple mountains majesty). In good air quality conditions this may be **thirty miles or more away**.
    - In the tracing paper frame, add a simple outline for the top of the farthest feature in the background part of the previous sketch. Put down the estimated distance as a question based on the Rayleigh effect and, if desired, add the known miles on your tracing paper above the outline.

5. Look at the midground in your zine sketch. Depending on air quality conditions you may be seeing out **ten to twenty miles away**. You should still be able to see green, brown and blue colors and some shapes and patterns but should have trouble seeing the details of individual plants.
    - Follow the same process as above and put an outline over the top of the midground feature with the estimated distance as a question.
6. Look at the foreground in your story zine sketch. This is the area where you should be able to see with a full range of colors and the details that allow you to see individual plants and animals.
    - Follow the same instructions and add some estimates and or questions about distance within that range of the foreground.

3- SEASONS, STAGES & FIRE: TEMPORAL SENSE OF FIRE

INTRODUCTION

This lesson will focus on observing and journaling seasons, phenology, forest succession, fire regime, fire season and fire danger, within the real-world. Information and exercises will emphasize nature journaling techniques that can be used to track changes related to fire danger and environmental changes over time. This section will include some climate change discussion as it relates to changing seasons, vegetation conditions and fire season. The lesson includes examples and exercises using visual language elements like words, images, color, texture and patterns to relate and represent changing natural elements.

Slow and sometimes subtle changes in the landscape can be challenging to observe, relate to risk and respond to. Fire programs include programs like fire prevention and readiness that require a good understanding of the landscape and weather shifts and changes. One of the fire season and fire potential metrics used in the National Fire Danger Rating System is called the Energy Release Component (ERC). The ERC is tied closely to live and dead vegetation composition and moisture conditions and is a good metric for identifying the fire season. These are all observable elements that we can use to journal and relate to seasons and successional stages. Several illustrations will be used to support information and help convey concepts on fire season, fire regime, and fire danger.

OVERVIEW & TIME (60 MINUTES)

- Background information (review prior to implementing lesson)
- Field safety and lesson introduction (5 minutes)
- Phenology and succession overview and exercise (25 minutes)
- Seasons and energy flow overview and exercise (30 minutes)

MATERIALS

- Journal or notebook
- Printed copies of visuals in this lesson
- Printed formatted story zine
- Ruler (optional)
- Graphite pencils, erasers, crayons, colored pencils and or watercolors with paint brush

LOCATION

This exercise should be done outside where a mix of natural vegetation is viewable (trees, shrubs, grass, ground, etc.)

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

The fire environment we want to understand and journal changes over time. There are short time intervals such as heat waves and wind events that may affect vegetation and fire conditions and those are addressed within other sections of this guide. This section is focused on the longer time scales such as plant successional stages and seasonal changes. We will use techniques to observe changes that we often become acclimated and less responsive to. Increasing awareness of these slowly shifting changes in the environment are critical in becoming fire adapted and preparing for fire seasons. The following provides some background and definitions of the phenomena that are included in this section.

The **four seasons** and associated weather are caused by the tilt of the Earth's rotational axis away or toward the sun as it travels through its year-long path around the sun. In the northern hemisphere, winter starts in December, spring starts in March, summer starts in June and autumn starts in September although climate change is creating some shifts in the seasonal weather. How these seasons look and feel can be different to every ecosystem. For example Mediterranean ecosystems experience seasons of dormancy and growth differently than continental regions.

Phenology describes the timing of recurring biological events caused by biotic and abiotic forces (temperature, solar hours, etc.) and is strongly tied to the seasons. Plant phenology signs we can observe include things such as leaves turning yellow in the autumn or the dry season, flowers blooming in the spring and fruits ripening. Phenology is highly responsive to climate and many scientists and citizens study phenology to help track the impacts of climate change.

Climate is the long-term average of weather, typically calculated over 30 years. Regional climates are the result of processes that vary strongly with location and so respond differently to global scale climate changes.Temperature and precipitation are the primary weather elements tracked at the global scale and temperature is the easiest to calculate and project with more confidence compared to precipitation and wind. Plant and animal species have climate preferences and needs which can be modeled into a defined climate envelope.

A **climate envelope** describes a species' climate niche (envelope) using bioclimatic variables such as temperature and precipitation. Changes in the climate envelope can influence a species' vulnerability (exposure, sensitivity and adaptive capacity) and survival. The climate envelopes can be used to project locations where species can no longer survive and other areas where they may be able to adapt. Some of the tree species in California are on the edge and outside of their climate envelope and might have shifted in their distribution over previous decades if not for fire exclusion, urban development and forest management practices that have held these species within limited locations.

A **fire regime** is the general pattern in which fires naturally occur in a particular ecosystem over an extended period of time. Fire regimes have been identified as the dominant process in defining boundaries of certain forest types (e.g. mixed conifer). Fire regime is calculated by the frequency, intensity/severity (how hot the fire burns/how severe the effects to the ecosystem), seasonality (time of year when the fires burn), ignition sources (cultural, lightning and volcanism, etc.) and patchiness of the fire burned area. Current forest fire regimes are changing from historic patterns where the more frequent fires had less severe impacts. The fire-mosaic patchwork of historic landscapes and forests offered more openings and less vegetation continuity than contemporary landscapes that often carry and build-up fire into more severe fire scenarios.

> In Butte County, there are three primary forest management zones based on elevation and climate gradients. Starting from the highest elevation, the Mixed Conifer Zone has a fire regime and fire return interval of ten to fifty years, with variations between the aspect and other more localized conditions. The Sierra Mixed Hardwood Zone has a fire return interval of five to twenty years and the lowest elevation zone, the Blue Oak Zone, has a fire return interval of five to ten years.

Some forest types have a fire regime that burns all of the trees (stand replacing) and that is the natural process for that ecosystem. Other forest types have patches of trees burned down, alongside patches of unaffected trees, when functioning in their natural fire regime. When an area is cleared of the existing vegetation community, the forest or vegetation community goes through what is called **ecological succession stages** but it is important to note that vegetation communities are nearly always changing, especially when natural and cultural fire regimes are working. This successional process changes the species structure over a period of time. A forest may become more of an open area with colonizing plants, then more shrubs and resprouting trees or seedlings come in and eventually, over some period of time, decades or centuries later become a forested ecosystem. The long term shifting vegetation structure changes the potential fire danger depending on a mix of weather conditions and we'll understand more after learning about the Energy Release Component.

Fire season is the period(s) of time within a year when more destructive wildfires are likely to ignite, spread and affect resources to a level that warrants organized fire management activities. This is also the period that fire authorities apply restrictions to potential fire-causing activities such as debris burning and campfires. Fire season varies in timing and duration over different landscapes based on a range of weather and vegetation conditions. A study of 35 years of meteorological data confirms fire seasons have become longer. Wildfires can start and spread outside of the designated fire season but the environmental conditions are typically moderated to where firefighting resources can protect values at risk. The meteorological variables that affect the length of the fire season include: maximum temperatures, low humidity, rainless days and high winds. The fire season in California and Butte County are also affected by reduced snow levels, early snowmelt and the timing of spring rain.

The **Energy Release Component** (ERC) is a number related to the available energy (BTU) per unit area (square foot) within a potential fire's flaming front. This calculated

number changes over the year and daily due to changes in live vegetation curing (drying) and air moisture (relative humidity) influences on dead vegetation. This number also includes the amount of live and dead vegetation which relates to the successional stage of the vegetation community. The ERC is a close measure of an observable fire season. We do not need to use the formal ERC calculation process to observe, journal and track fire danger and the fire season. We will use seasonal phenology changes and successional vegetation as a proxy and approach to gain a general sense of the potential fire energy available (fire danger) in the environment as it changes over time.

SAFETY TALK & EXERCISE INTRODUCTION

- Give safety talk appropriate to location and conditions. See guide introduction section with a safety discussion overview.

- Explain to students that in this lesson, we are learning how to determine and describe fire danger and fire season based on environmental conditions like changing plant development and seasonal changes. We will be doing some simple sketches of things we see in the environment and creating color and pattern palettes to convey changing environmental conditions over the seasons.

PHENOLOGY & SUCCESSION OBSERVATIONS EXERCISE (25 minutes)

(Example journal page not included since this should be simple and intuitive)

- Go outside and find an open place for the group to sit and talk about the exercise.

- Tell students that in this lesson we want to understand and journal landscape changes over time that relate to fire danger. In this first exercise we want to see what we can observe and journal that represent plant phenology and ecological succession.

  Discussion: There are short time intervals such as heat waves and wind events that may affect vegetation and fire conditions and those are addressed within other sections of this guide. This lesson is focused on the longer time scales such as ecological succession that can take decades and centuries and seasonal changes that are observed over several months and throughout the year.

- Ask students if they know how to describe plant phenology and vegetation community or forest succession?

  Discussion: Phenology describes the timing of recurring biological events caused by biotic and abiotic forces (temperature, solar hours, etc.) and is strongly tied to the seasons. Plant phenology signs we can observe include things such as leaves turning yellow in the autumn or dry season, flowers blooming in the spring and fruits ripening in late-summer. Phenology is highly responsive to climate and many scientists and citizens study phenology to help track the impacts of climate change.

Discussion: When an area is cleared of the existing vegetation community, the forest or vegetation community goes through what is called **ecological succession**. This successional process changes the species structure over a period of time. A forest may become more of an open area with colonizing plants, then more shrubs and resprouting trees or seedlings come in and eventually, over some period of time, decades or centuries later become a forested ecosystem.

- Ask students to give some examples of what they may see outside that represents plant phenology and ecological succession. Some elements may be both a phenology and successional stage such as pine cones from a large tree. Ideally, they would have two different sketches, one of the pinecone and one of the tree. Let students know that they do not have to be certain about what they think might represent phenology and succession. Nature journaling is more about observing and asking questions.

- Tell students that they will be creating quick and simple sketches or diagrams of what they observe and think may represent these terms and next to the sketch they will write “I notice” adding words to describe what they sketched and observed. They will then write “I wonder” and add questions tied to phenology and succession. And lastly, they will write “It reminds me of” and write down what those items and elements they sketched and observed remind them of. Teacher or lesson guide, demonstrate by putting a light circle on the page for a space where a sketch will go and write- I notice, I wonder and It reminds me on the side of the page where those elements will be added once the sketch is done.

- Tell students they have ten minutes and can work in groups or as individuals to find at least one natural plant element that they think represents phenology and one for succession. They can add as many observations as they like, but should have those two as a minimum.

- As students work, ask if any help is needed and remind them that this part of the process is not about creating finished artwork but capturing information quickly in the field.

- At about eight minutes into the exercise, let them know they have two minutes to wrap things up and then come regroup to discuss and share observations.

- When students are back together, ask everyone to lay their journal pages down on the ground in a row. Let them know that they do not have to stand next to their own journal or tell people which one is theirs. We will spend a few minutes (10 minutes) looking over them and getting ideas of things we might want to add to our own journals. Offer some journal observations starting with the least artsy journal sketches. Frame the comments as “I notice..., I wonder... and It reminds me of...” focusing on positive and reinforcing comments on how the student captured observations and asked questions.

SEASONS & FIRE DANGER OVERVIEW & STORY ZINE EXERCISE (30 minutes)

- This exercise can be inside or outside. Students will need their printed story zine and should have their journals too. Consider a printed copy of the background information and illustrations as a visual reference. Pick a comfortable and least distracting location.

- Tell students that in this exercise we want to think more about journaling the landscape changes over time and how that relates to fire danger. They can add notes and information to their journal but the exercise will be added to their story zine. To understand more about the fire season and fire danger we first want to review some of the key concepts.

- Ask students if they can describe seasons. Ask if they have an idea of how and why we have different seasons. Ask students how they would define their local seasons. Would it be a different time range, different description or different name?

  Discussion: There are traditionally **four seasons** which are associated with weather and caused by the tilt of the Earth's rotational axis away or toward the sun as it travels through its year-long path around the sun. This is a traditional approach to defining seasons and may not apply to all areas or into the future. The traditional seasons are defined as the northern hemisphere having winter start in December, spring start in March, summer start in June and autumn start in September although climate change is creating some shifts in the seasonal weather.

- Ask students if they know what, and when, is a fire season.

  Discussion:
  - A fire season is the period(s) of time within a year when more destructive wildfires are likely to ignite, spread and affect resources to a level that warrants organized fire management activities. This is also when fire authorities apply restrictions to potential fire-causing activities such as campfires.
  - Fire season varies in timing and duration over different landscapes based on a range of weather and vegetation conditions. Wildfires can start and spread outside of the designated fire season but the danger and conditions are typically moderated due to firefighting resources quickly and easily available to protect communities. In the designated fire season, more fires require more firefighting resources and that makes it harder to respond to and manage all fires.
  - The duration of a fire season is calculated by past and predicted weather conditions such as the maximum temperatures, low humidity, rainless days and high winds.
  - In our journaling, we may add thoughts and notes about fire season but our journaling observations will be based on environmental conditions we see over time and what that may mean for the fire danger. What is fire danger?

    - Fire danger is a measure of the relative seriousness of burning conditions and threats of fire.

- Ask students if they have ideas of what nature observations they could make to define and describe their fire season? Discussion:

  Discussion: Fire specialists use many different data sources and metrics to calculate fire danger periods,including how many historic fires have occurred at different periods. One of the data metrics used, that closely aligns what you might call a season, is the Energy Release Component (ERC). This is a number related to the available heat energy per square foot of vegetation within a potential fire's flaming front. This number changes over the year as live vegetation grows and cures and also based on the amount of vegetation, -which changes with succession. The ERC number also changes daily and over the fire season as temperature, wind and air moisture (relative humidity) influence how burnable dead vegetation is. Just because grass is dead, doesn't always mean that it will burn. If there was recent rain or fog, dead vegetation may absorb moisture and become too moist to easily burn. As moisture in the air changes over time, the fire danger changes as well. We'll learn more about relative humidity and dead fuel moisture in one of the following lessons.
  - We do not need to use the formal ERC calculation process to observe, journal and track fire danger and the fire season. We will use seasonal phenology changes and successional vegetation as a proxy and approach to gain a general sense of the potential fire energy available (fire danger) in the environment as it changes over time and how that increases and decreases in fire danger.

- Ask students if they've heard of what's called a fire regime. The fire season is used to help calculate the fire regime and is a much longer cycle of time.

  Discussion:
  - A fire regime is the recurring pattern in which fires would naturally occur (typically lightning caused) in a particular ecosystem over a long period of time. Fire regime is calculated by the frequency (how often), intensity (how hot the fire burns), seasonality (time of year when the fires burn) and patchiness of the fire burned area. The fire regime affects the timing of when you may see ecological succession stages.
  - In Butte County, there are three primary forest management zones. Starting from the highest elevation, the Mixed Conifer Zone has a fire regime and fire return interval of ten to fifty years, with variations between the aspect and other more localized conditions. The Sierra Mixed Hardwood Zone has a fire return interval of seven to twenty years and the lowest elevation zone, the Blue Oak Zone, has a fire return interval of five to ten years.
  - Some forest types have a natural fire regime that burns all of the trees (stand replacing) and that is the natural process for that ecosystem. Other forest types have patches of trees burned down, while other areas within the fire have little to no impact on the trees, when functioning in their natural fire regime.

- When an area is cleared of the existing forest or vegetation community it goes through the ecological succession process. The long term shifting of vegetation structure changes the potential fire danger and energy available for wildfire.
- We can think about the relative fire danger as the landscape/vegetation structure and condition creating scenario with potential fire energy available that changes with shifting weather, climate and ecosystem cycles over different time scales (seasonal, yearly, decadal or longer).
- The larger, more concentrated and overlapping layers of vegetation (structure) with more dead and cured vegetation (condition) creates higher fire energy (fire danger). The fire danger levels shift over time and with changes in the landscape, vegetation and weather conditions. See the Cycles and Gears Illustration below.

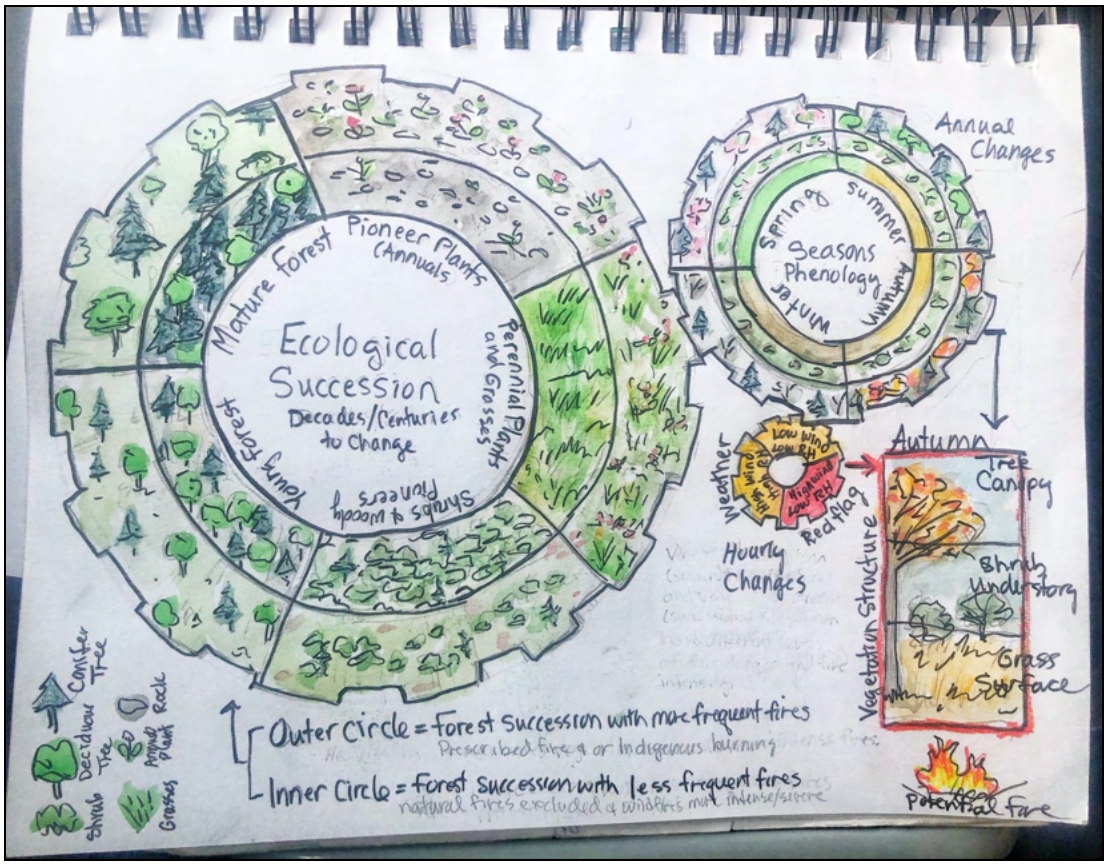
- Tell students that it's time to shift gears and to think visually. Ask students if they have ideas of how they would visualize and journal observations over time.

  Discussion: You can use a wide variety of methods to represent information over time. It's helpful to have one or two elements that you can observe over time with some approach to measuring the change in that element. For instance, showing how grasses cure over time and create fire season conditions could use colors of green changing to gold with words, height measurement and or other symbols. You also need to have a visual that captures the time element. The easiest method is a line with left to right changes. Other options include circles, like clocks or seasonal calendars (clockwise changes). You can also create storyboards or comic strips with scene elements framed and arrows to indicate the direction and movement of time. Most stories and timelines move from left to right but sometimes top to bottom or a mix.

- Ask students if they have ideas of how they would show increasing elements such as increasing vegetation height and or increasing fire danger. This is most often a bottom-to-top visual and can have arrows or use colors or color saturation to indicate the changes.

- Tell students that we are going to look at an example of how we can apply the successional and seasonal changes in vegetation and consider the changes in fire energy (fire danger) and fire season elements over a year.

- Ask students to describe elements in the sketch/graphics below and if and how they represent different time scales, and changing elements over time.



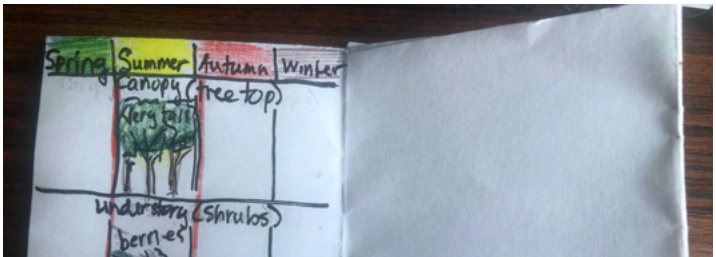
Sketch represents the interacting cycles, of different time duration, including ecological succession, seasonal phenology and weather. The sketch above includes symbolic representations of vegetation communities at different successional stages, colors to represent seasonal phenology changes such as cured grass and a red frame to represent a fire weather event (fire danger) associated with a season and successional stage scenario.

Journaling Exercise #2: Succession and Season Observations Zine Sketch

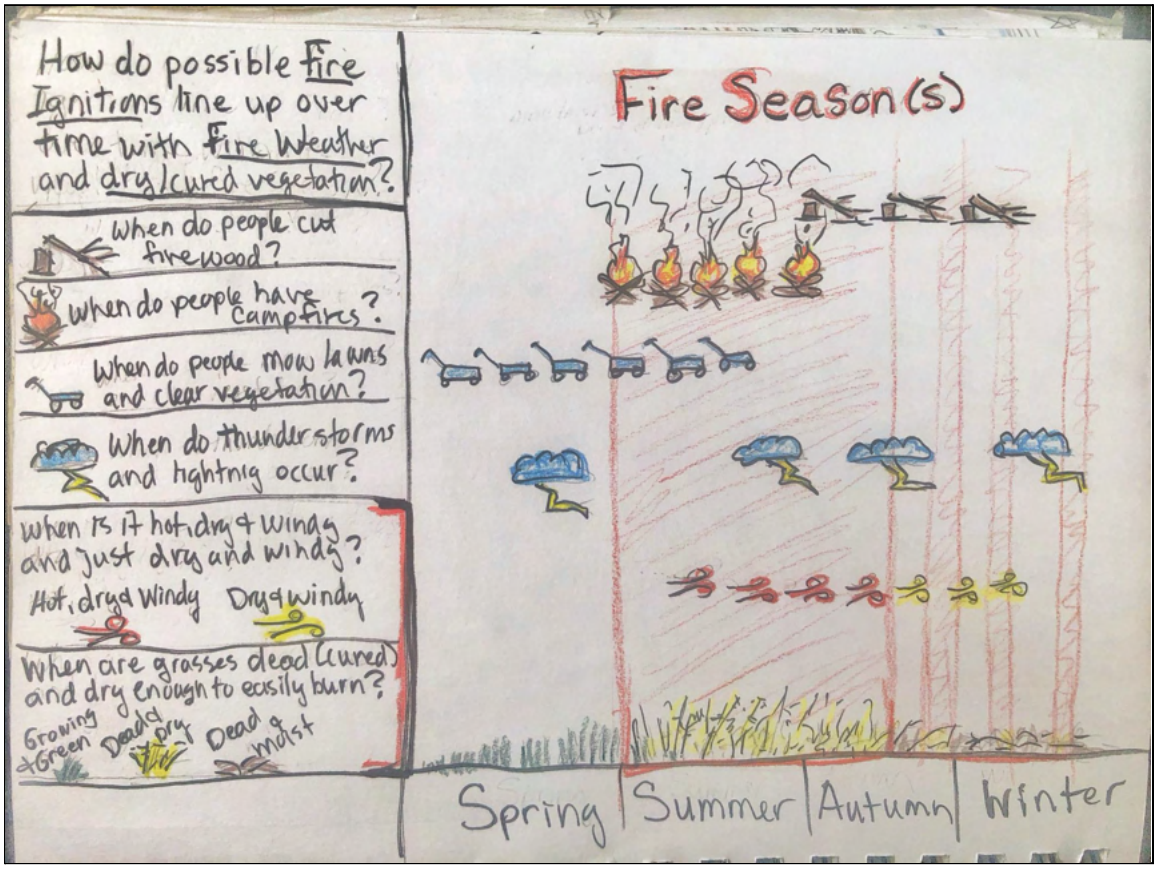
- Tell students that we are going to get out our story zine and go to page two. You will need a pencil and something to add colors. A ruler or something to help create the four-columned table would be helpful.

- Demonstrate how to create the four columned table on the story zine (see example below) with the seasonal labels to represent a change in time. If students want to create a different style table or other way to have different seasons- go for it!

- Tell students they will have three layers within the table that help represent the potential fire energy and the successional and seasonal elements they observe over four time periods. This exercise only



requires them to add the elements for the current season they are making the observations. They can come back to this zine page and exercise during the other seasons to build a complete graphic or for extra credit, they can add the expected changes they would observe for the other seasons.



This is a sketchy graphic of fire season (when fires ignite and grow) analysis considering when the ground vegetation is cured (dry/dead), fire weather events (hot, dry & windy) and potential ignitions. Demonstrating multiple time elements over a year that can be journaled with the use of data and observations.

Discussion: The top area represents the tree canopy level, the middle is the understory/shrub level and the bottom is the ground surface. This section of the sketch/table can be the entire tree, just the leaves or even a symbolic shape (triangle or circle for tree or leaf) and color swatches. This does not have to be the same place as where they observe the other levels. What is important is to try and find a deciduous tree(s), shrubs and ground vegetation that will change over the seasons. You don't want an evergreen tree that won't have the same observable changes. You also don't want a watered and mowed lawn to represent the ground level. Find a natural or weedy spot.

- Before students jump into their observations, ask them to think about what colors they see in the landscape now (ground, shrub and tree) and if that seems representative for the season. For instance, are there many fields of dry grass that look gold or yellow? Would yellow be a good color to represent that season?

Ask the group to discuss which colors would best represent the four seasons listed in the column and have students add that color over the column heading.

- Tell students that they have five minutes to add the three different levels of elements for the column that represents the current season they are making the observations.

  Discussion: This is a very small sketch and it does not need a lot of detail but should include colors that help identify the season. For instance, the tree leaves are green or are they turning gold or are they missing leaves. Don't worry if the colors are not exactly the same as what is seen in nature- this is more representational. The sketch should also include some phenology observations like sprouts, blossoms, seeds, cones or berries, if possible.

- When there is about two minutes remaining in the exercise, tell students they have a couple minutes left to finish and before they complete the sketch.

- When everyone is done, ask if there are comments and questions that students want to share.

- Ask students to raise their hand if they think they are in a fire season and have them keep their hands up as everyone looks around. If there is time left in the session, ask some of the students to discuss why they think it is fire season. Also ask if anyone has ideas on how they could journal their fire season.

EXAMPLES OF TRACKING & VISUALIZING FIRE OVER TIME

These examples are strictly for brainstorming visuals and the specific fire information is not relevant to the exercises in this lesson.

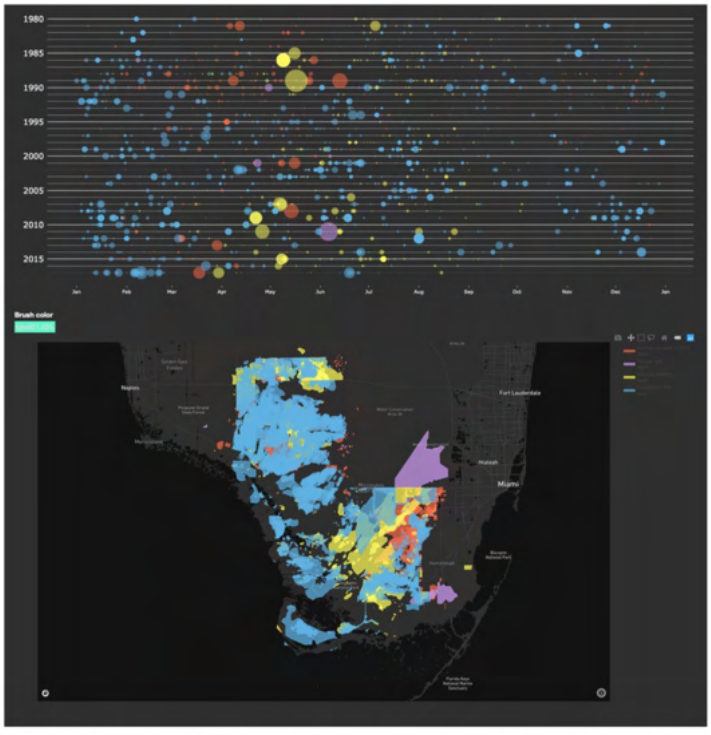
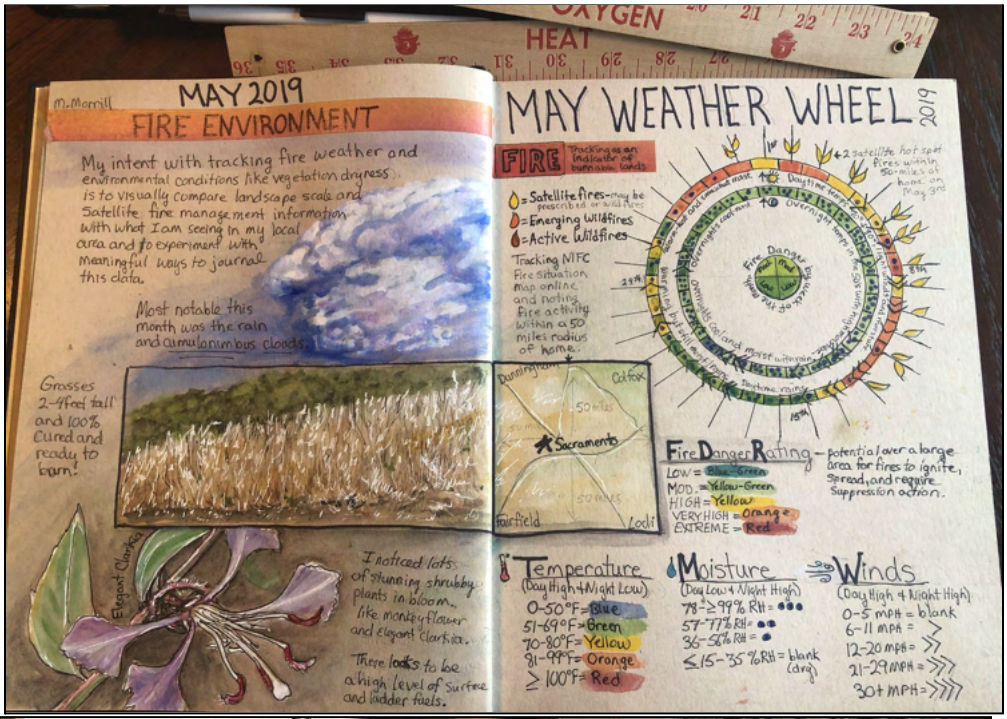
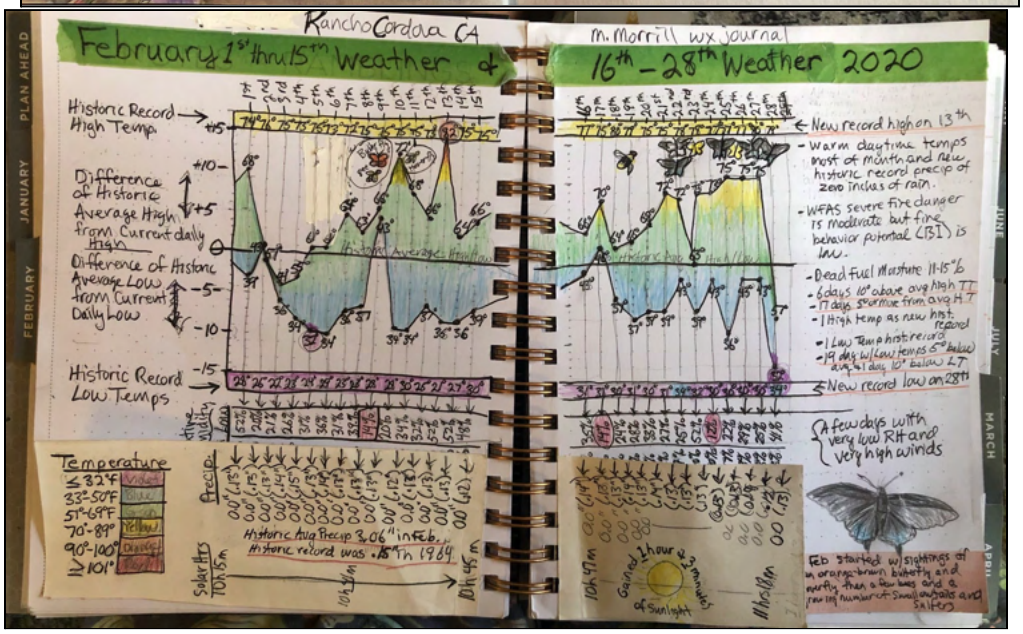


Figure 4. Everglades National Park and Big Cypress National Preserve fire history data, 1980-2017, depicting natural (yellow), human-caused (red), prescribed (blue), and mutual aid (purple) fires. The size of each point on the chart (top) corresponds to the fire's size. An interactive map (bottom)

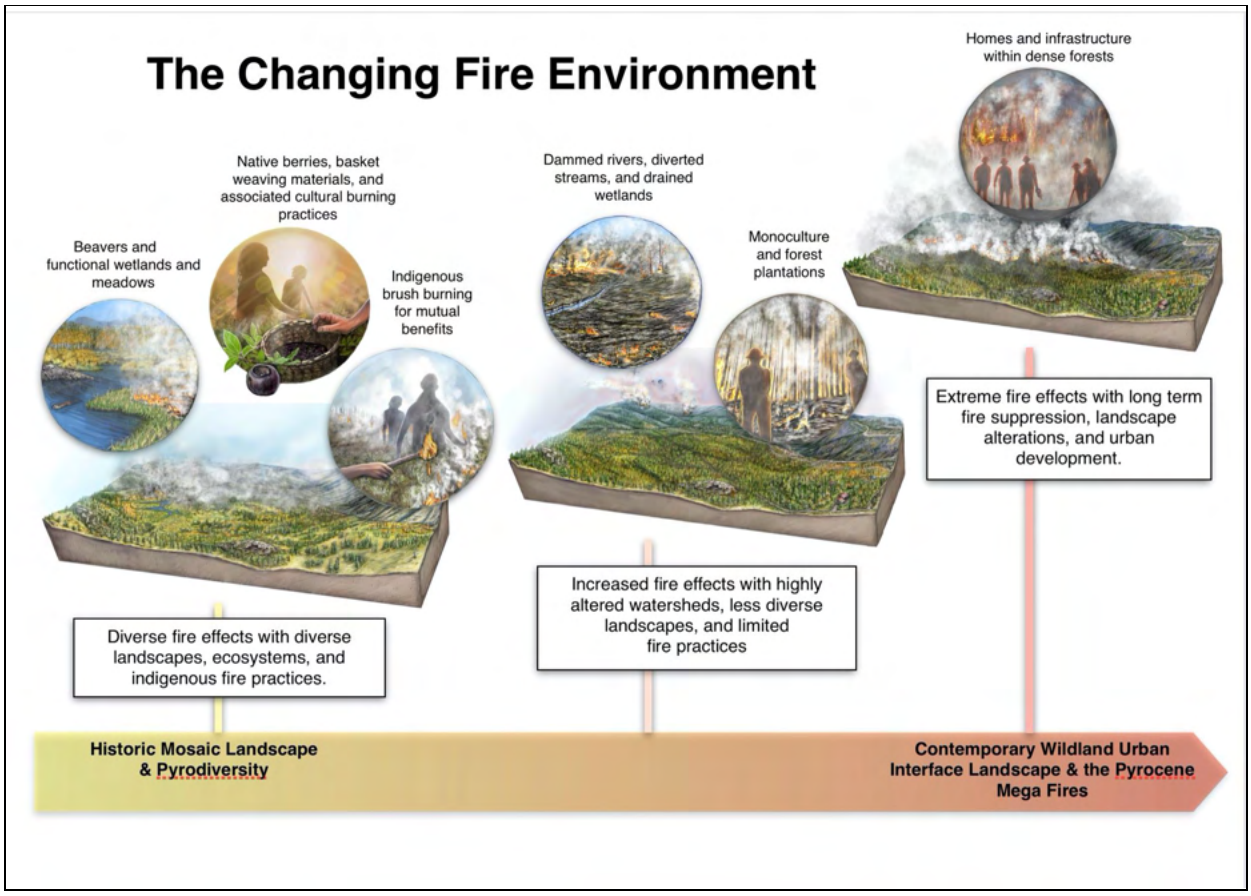
This visual from a research study created two graphics that show different fires, of different size, over time, in a graph and by season and then an accompanying map showing where on the ground those fires have occurred. Look at the combination of horizontal lines layered over time and the associated map to combine different ways to see the information. Do not get caught up in the specific data in this visual but consider if the observations you have about the season could be used in a visual like this.



This is a monthly fire weather summary journal page that includes fire weather tracked in compartments along a circle with color codes for the temperature and other symbols for wind and moisture. Sketches were added for significant observations during that month.

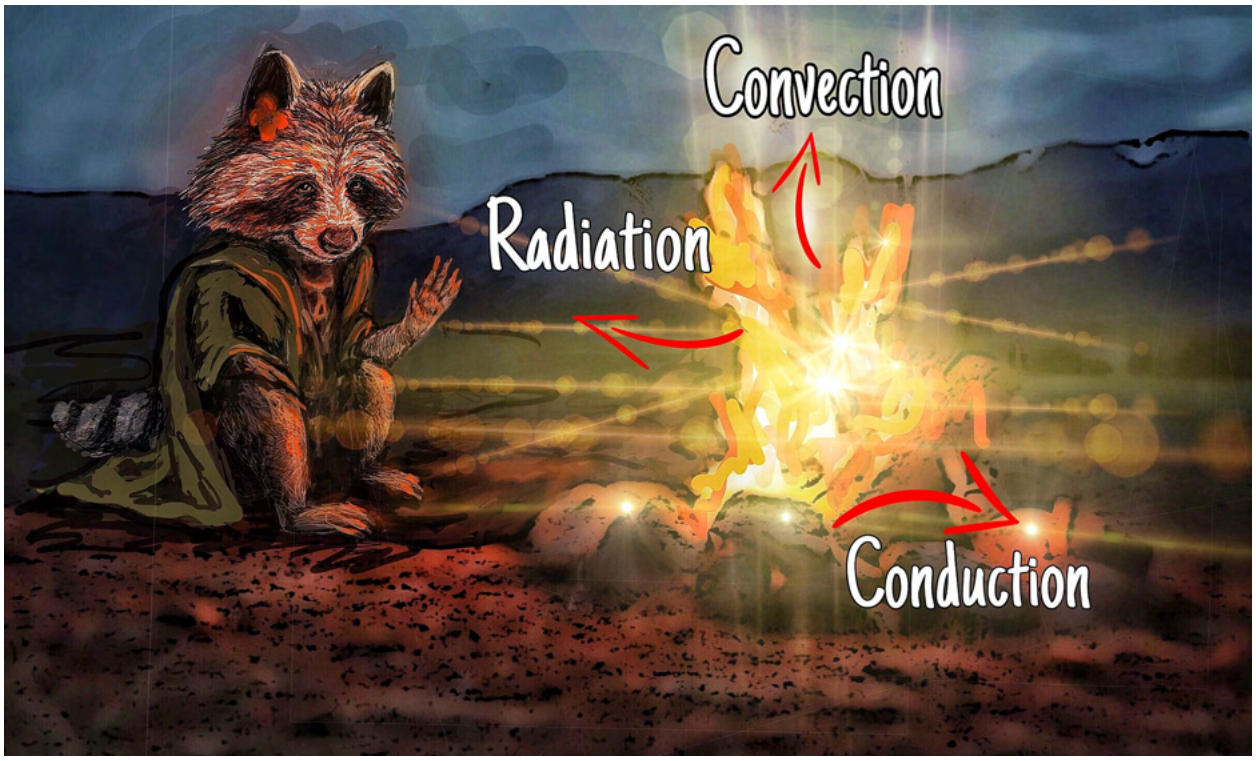


This monthly fire weather journal page is in a graph format with color used for the range of daily temperature but also includes how those daily temperatures relate to historic temperatures (average and extremes). Other observations such as bees and butterflies were overlaid.



This illustration uses a mix of illustrations and design features to demonstrate a change over time. The illustration on the left shows a historic landscape with a mosaic of vegetation caused by frequent fire. A mid-period landscape illustration in the center shows altered and overgrown vegetation conditions. The illustration on the right identifies the contemporary landscape with overgrown vegetation, urban development and catastrophic fire conditions. The baseline landscape block illustration, with changing vegetation conditions in several illustrations with different time associated activities and labels help demonstrate a change in time, as does the arrow along the bottom with time associated labels.

4- TERRAIN, HEAT TRANSFER & FIRE RATE OF SPREAD



INTRODUCTION

Students learn how the steepness of terrain (slope) and heat transfer influences fire behavior. They will observe, measure and journal the relative steepness of the terrain by using angles estimated with hands, fingers, body position and movements.

LESSON OVERVIEW & ESTIMATED TIME (60 MINUTES)

- Safety Discussion and Grounding Exercise on Slope (5 mins)
- Fire Behavior Triangle and Slope Angle Review (10 minutes)
- Hand Slope Measurement Exercise (5 minutes)
- Landscapetto Slope Measurement Exercise (10 minutes)
- Heat Transfer, Slope and Fire Behavior Review (10 minutes)
- Heat Transfer Comparison Table (5 minutes)
- Heat Transfer Slope Discussion (10 minutes)
- Fire Rate of Spread (3-5 minutes)

MATERIALS & RESOURCES

- Journal or notebook
- Graphite pencils, erasers, crayons or colored pencils

LOCATION

The exercise is ideally conducted in the real-world but not all locations are suitable for viewing terrain. It is recommended to use the same landscape-scale viewpoint as lesson #1or use the AlertWildfire live web cameras or Google Earth. The view does not have to be looking exactly at

where the students are currently but a scene that captures the general terrain of the local area - steepness.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

We are referring to terrain as the physical features of the landscape. In fire management the term topography is used to describe the physical features of land, but terrain is a more relatable term for the purposes of this guide. The terrain features are typically formed by natural processes but can also be altered and created by human activities such as mining, road creation and flood management features. In this lesson we are not identifying and naming terrain features but observing the steepness of a hill or mountain slope and relating that to fire behavior. Some terrain features like boulders and sand dunes can hinder fire movement while others like steep hills and canyons can increase fire spread.

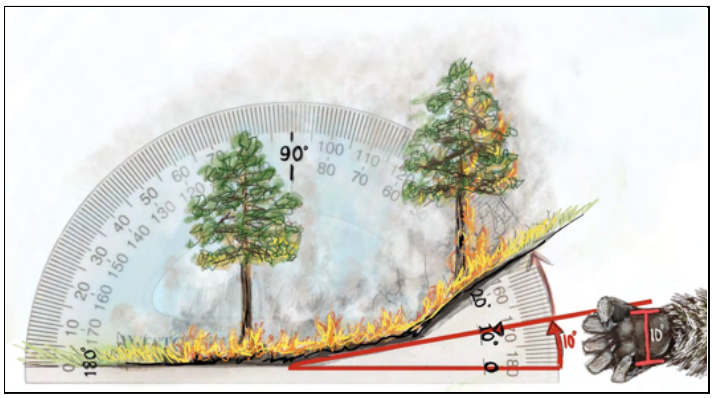
- Let's stand up again for a different grounding exercise. Feel your feet connect with the ground. Sense your body as a straight post/board in the ground.

- Look out at the landscape you've been journaling about and find a hill or mountain you like. Think about that hill or mountain as another creature and look at the shape of its body. How curved is the back? To communicate with them, you'll need to use your hands, arms and body to address it by its name. Its name is a hand, arms and or body gesture or movement that resembles the slope or steepness of its back.

- Reach out to your hill or mountain creature and address it with your gesture/movement. Say hello, and tell it something you see about it (e.g. you are a tall, steep mountain).

- Now let's get your journal and materials ready to write and sketch information, ideas, and questions about your observations and feelings.

FIRE BEHAVIOR TRIANGLE & TERRAIN OVERVIEW (10 minutes)



You learned that the fire behavior triangle influences how fire moves across the landscape and includes topography (landforms), fuels (vegetation) and weather in the first lesson. Terrain influences fire in a number of ways but one of the basic principles is that the steeper the incline or slope, the faster fire will burn over the landscape.

Fire scientists have determined that a slope of 20 percent or more can have major influences on fire behavior. We'll learn more about this in a minute.

- To estimate how steep a slope is, we can use mathematics, but let's save that for another class. We will consider tools like a protractor or measurements using your hands

to estimate the angle and slope.

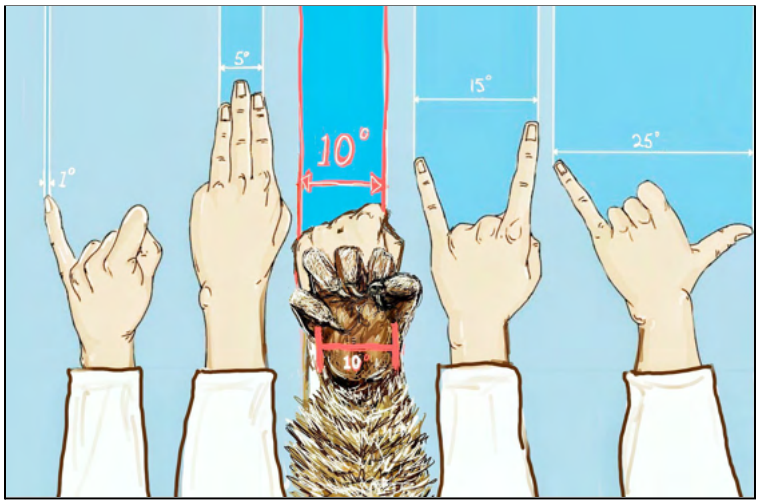
- NOTE: A 10°angle equals a 17.6% slope. For simplicity in the field exercises, let's just say that a 10°angle equals a 20% slope.

- Look at the protractor and landscape slope image above and how the angle degrees listed on the inside/bottom line on the protractor measure up to the landscape slope.

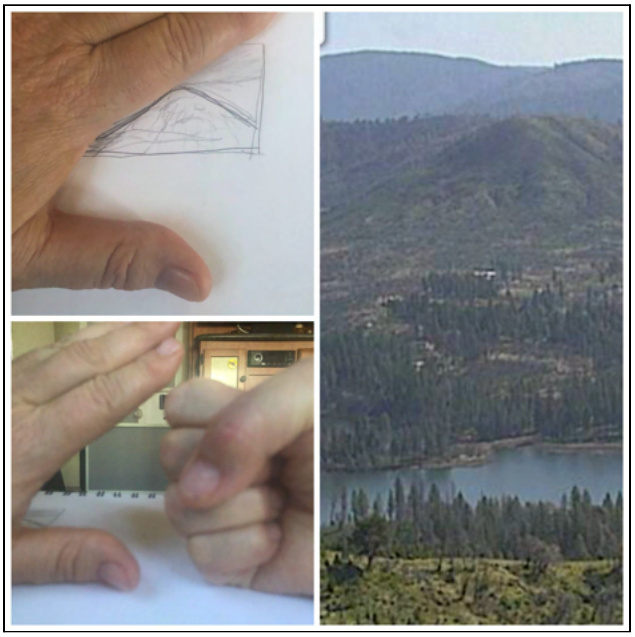
- In the image above, the REDI Jedi Raccoon is overlaying her fist to indicate the hand method for estimating the 10°angle (20% slope) that we want to remember and use in our landscape and fire observations. We can call it the "fit your fist" method in the gap between the slope angle and bottom (zero angle).

HAND SLOPE MEASURE EXERCISE (5 minutes):

- Teacher demonstrates the hand gesture measures for the different angles and has the students follow along. Emphasize the fist as the measure important for this exercise and for the slopes that can indicate more significant fire behavior.



LANDSCAPETTO SLOPE EXERCISE (10 minutes)



- Look out at your landscape view and pick a hill to estimate if it is less than or more than a 10°angle and 20% slope. Tell the students they will have five minutes to complete this exercise.

- Teacher demonstrates how to create another small landscapetto box of any shape (square or rectangle) on the journal page. Explain how to draw the shape/outline of the hill you are looking at, inside the box, with the bottom of the box as the zero line of the angle.

- Teacher demonstrates as students follow. Hold your left hand over the angle on the sketch you created with the thumb balanced at zero degrees and the fingers resting on the slope. Keep that angle on your left hand and bring your right hand fist to the same distance out and see how it fits in the gap of the angle. Is the gap bigger or smaller than the fist?

- Students write on their landscapetto hill and slope sketch or diagram whether the hill is less than or more than a 10°angle =20% slope. This is not the most accurate measure but can help give a sense of slope steepness and potential increased fire behavior.

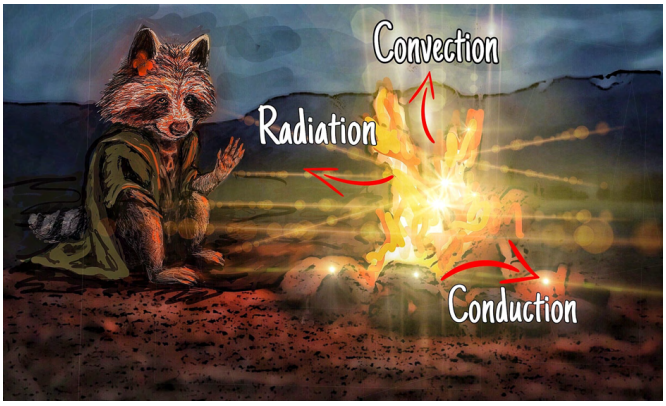
- Ask if there are questions about the assignment of if students need help sketching the box and hill, shaping their hands to the view and slope and or writing down the measurements on their landscapetto.

- Let students know when they have about a minute left to finish what they are working on.

- Ask students about what they came up with. Do they have other questions about slopes and fire? If so, have them write the questions.

- down on their journal near the this landscapetto sketch.

HEAT TRANSFER, SLOPE AND FIRE BEHAVIOR REVIEW (10 minutes)



- Now that we have an idea of how to estimate the angle and steepness of a slope, let's dig in a little deeper to why a sleeper slope increases how fast a fire will spread.
- A fire spreads by transferring heat energy in three ways: Radiation, Convection, and Conduction.

Radiation refers to the emission of energy in rays or waves. Heat moves through space as energy waves. It is the type of heat one feels when sitting in front of a campfire. It travels in straight lines at the speed of light. This is the reason that when facing the fire, only the front is warmed. The backside is not warmed until the person turns around.

Convection is the transfer of heat by the physical movement of hot masses of air and gases. As air is heated, it expands and becomes lighter than the surrounding air and it rises straight up, unless pushed to by the wind. (This is why the air near the ceiling of a heated room is warmer than that near the floor.). A convection column is formed above the fire which can be seen by the smoke that is carried aloft in it.
Conduction is the transfer of heat within the material itself, like the soil and rocks near the campfire. Wood and vegetation are poor heat conductors, so not an important factor in the spread of forest fires.

HEAT TRANSFER COMPARISON TABLE (5 minutes)

- Think about how to help students frame questions. If they appear stressed by the topic, do another grounding exercise.

- Ask students if they have any questions and tell them they have ten minutes to complete. It may take less time.

- Have students create another comparison table with three-columns and label them as Radiation, Convection and Conduction. Have them use words, pictures and or numbers to compare the differences.

HEAT TRANSFER AND SLOPE DISCUSSION (10 minutes)

- Tell students to look back at the protractor and landscape slope illustration and use those to help discuss the following questions and write in their journals?

- Students discuss as a group with the teacher or in small groups and discuss the questions below.

- Students can add other questions of their own or if they are struggling to write questions, consider asking them to sketch a large question-mark to express that they don't know what their questions are. Putting question-marks all around a journal page to express what you don't know or where you want to know more is a part of the nature journaling process.

- Tell students that fire scientists have determined that when the hillsides reach a 20 percent slope, flames will double in height and be four times as fast, without wind considerations, which can expand those numbers. Can you see how all three types of heat transfer overlap and combine on a higher slope or angle? That increases the amount of heat and how fire will behave and grow.

Patterns

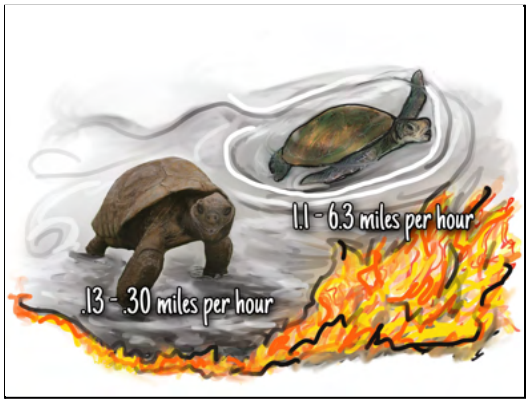
- What are some patterns you noticed in how the flames move on flat ground and steeper slopes?
- What are some slope patterns you noticed in the landscape scene you were viewing?

Cause and Effect

- What were some differences between some of the flames on flat ground and on steeper slopes? What are some possible causes for the differences?

FIRE RATE OF SPREAD (2 minutes)

A term used in fire management to estimate and measure the speed a fire travels is called the fire rate-of-spread (ROS). There are mathematical formulas and software programs that can estimate ROS based on the mix of topography (slope), fuels (vegetation) and weather variables. But for our nature journaling purposes, we'll consider a visualization for the average range of the ROS. On average, fires move at a ROS similar to that of a tortoise ambling across the desert and up to the speed of a sea turtle flying through the ocean.



A. Ask students if they can imagine a prescribed or cultural burn where fire is moving around the landscape at the speed of a tortoise to create healthy patches of wildlife habitat.

B. Imagine an average wildfire that is being pushed by the wind and fire is moving across the landscape like a sea turtle swiftly swimming on the ocean currents.

5- WEATHER (WIND) & FIRE BEHAVIOR

INTRODUCTION

Students observe and journal temperature, humidity and wind and learn how these observations relate to fire behavior. Students will use a diagram to journal vertical atmospheric gradients (temperature/moisture) and horizontal air movements (high and low winds) observed outdoors. Students will use nature journaling prompts to discuss mixed sensory observations associated with a relative wind speed scale. A sketch will be added to a story zine that captures key weather observations.

No grounding exercise will be used in this lesson since the fire discussions and observations themselves are grounding. This lesson could be expanded or include homework that focuses on cloud identification and cloud painting and sketching techniques. Visit the UCAR Center for Science Education (UCAR SciEd) website for resources and lesson plans on clouds. A recorded workshop by Rosann Hanson on nature journaling clouds is available on the Field Arts website.

LESSON OVERVIEW & ESTIMATED TIME (70 MINUTES)

- Teacher discusses field safety and session Intro **(5 minutes)**
- Teacher demos and facilitates vertical and horizontal weather observations using a diagram with words, numbers and pictures **(15 minutes)**
- Teacher demos and facilitates student journaling current winds using a relative scale and the multiple sense **(15 minutes)**
- Teacher discusses, demos and facilitates journaling key past and place-based wind observations in their journal **(25 minutes)**
- Teacher deemos and facilitates students putting highlights from the above exercises on to their story zine **(10 minutes)**

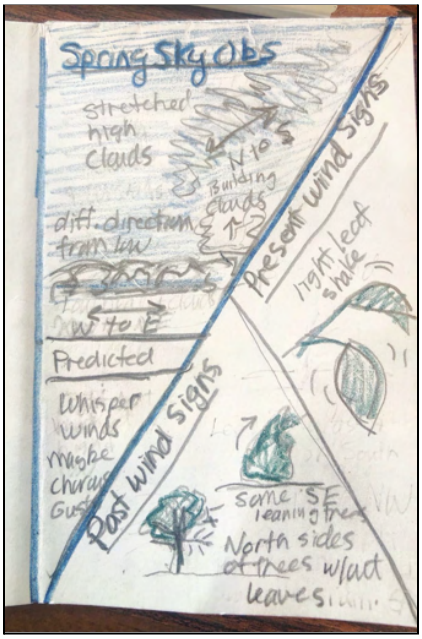
MATERIALS & RESOURCES

- Journal or notebook
- Printed formatted story zine and a piece of tracing paper
- Graphite pencils, erasers, crayons or colored pencils. Watercolors are best for sky and cloud sketches but don't need to buy anything special for this exercise.
- Printed weather cue table and illustration of Vertical and Horizontal Sky Observations
- Weather forecast for the period of observations
- Ruler optional to help with making vertical and horizontal lines for the diagram

LOCATION

This exercise can be anywhere outdoors but should be far enough away from buildings and large barriers to allow for better sense of wind and other weather conditions.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED



Weather phenomena are natural events and patterns that occur as a result of one or a combination of the water cycle, atmospheric pressure systems, and the Coriolis effect. The primary focus in this lesson is observing and sensing the phenomena of meteorological convection and the aggregate buoyant force or what is called static stability. In fire management, atmospheric instability is a primary situational awareness consideration along with increasing winds. This lesson emphasizes skills and observations intended to enhance the personal situational awareness of changing conditions that influence fire risk.

Other key weather elements influencing fire are temperature, humidity, wind and drought. These may be referenced but do not go into detailed explanation. Weather elements that may be referenced and observed in this lesson include:

- Wind (air and air pressure), Gusts and Gales
- Dust Whirls
- Clouds, Condensation Trails and Fog
- Thunderstorms and Lightning
- Thermals and Inversions
- Fire Weather (hot, dry, windy)

Our observed and experienced sense of weather and especially wind is strongly influenced by gravity and friction. Gravity is what holds the layers of atmosphere in place and friction opposes the direction of the wind and slows the speed.

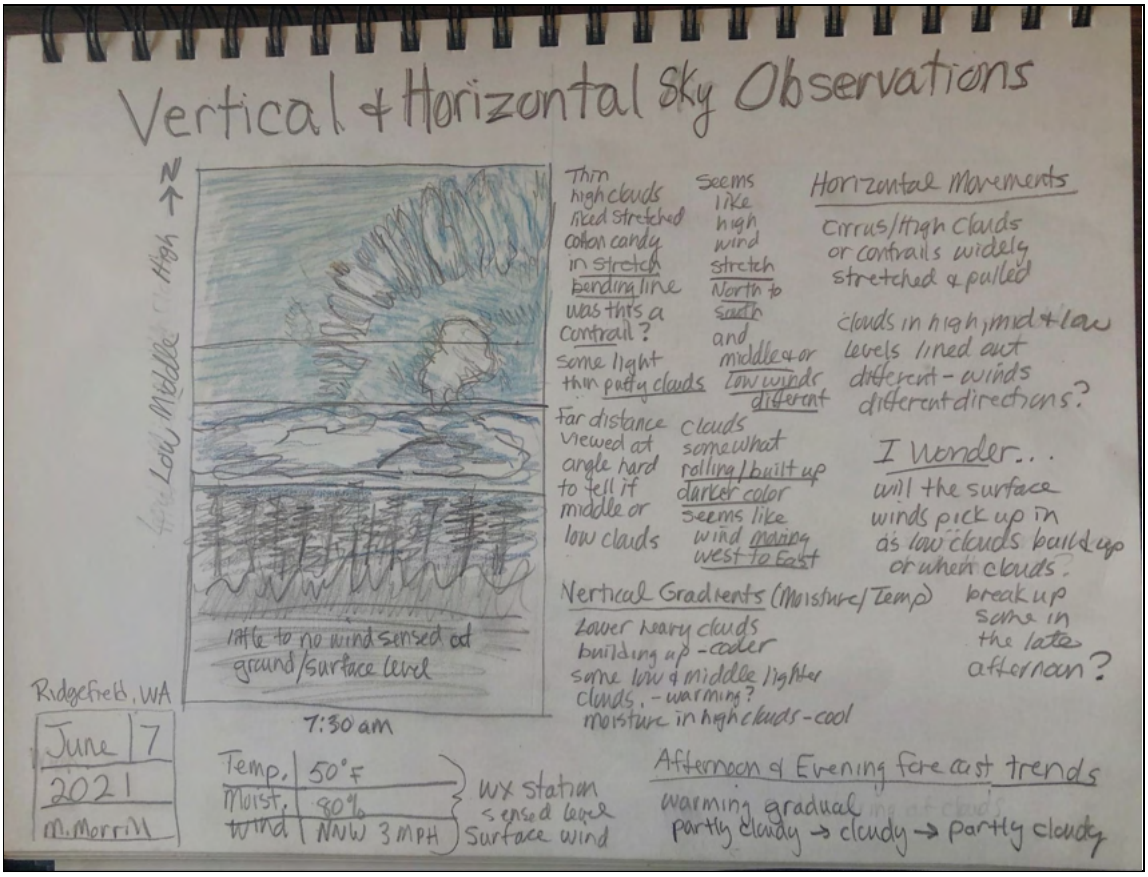
SAFETY TALK & INTRODUCTION (5 minutes)

- Give safety talk appropriate to location and conditions. See guide introduction section with Safety Discussion overview.
    - When it's windy enough to rattle and wave large tree branches and small trees, you should avoid being near dead trees or being under trees where branches can fall.

- In this lesson, we are learning about the weather that can influence fire behavior and techniques to help us observe and journal seen and unseen elements of weather.

- We will also learn how to build our sensory observation skills to better identify weather conditions.

VERTICAL & HORIZONTAL WEATHER OBSERVATIONS EXERCISE (15 minutes)



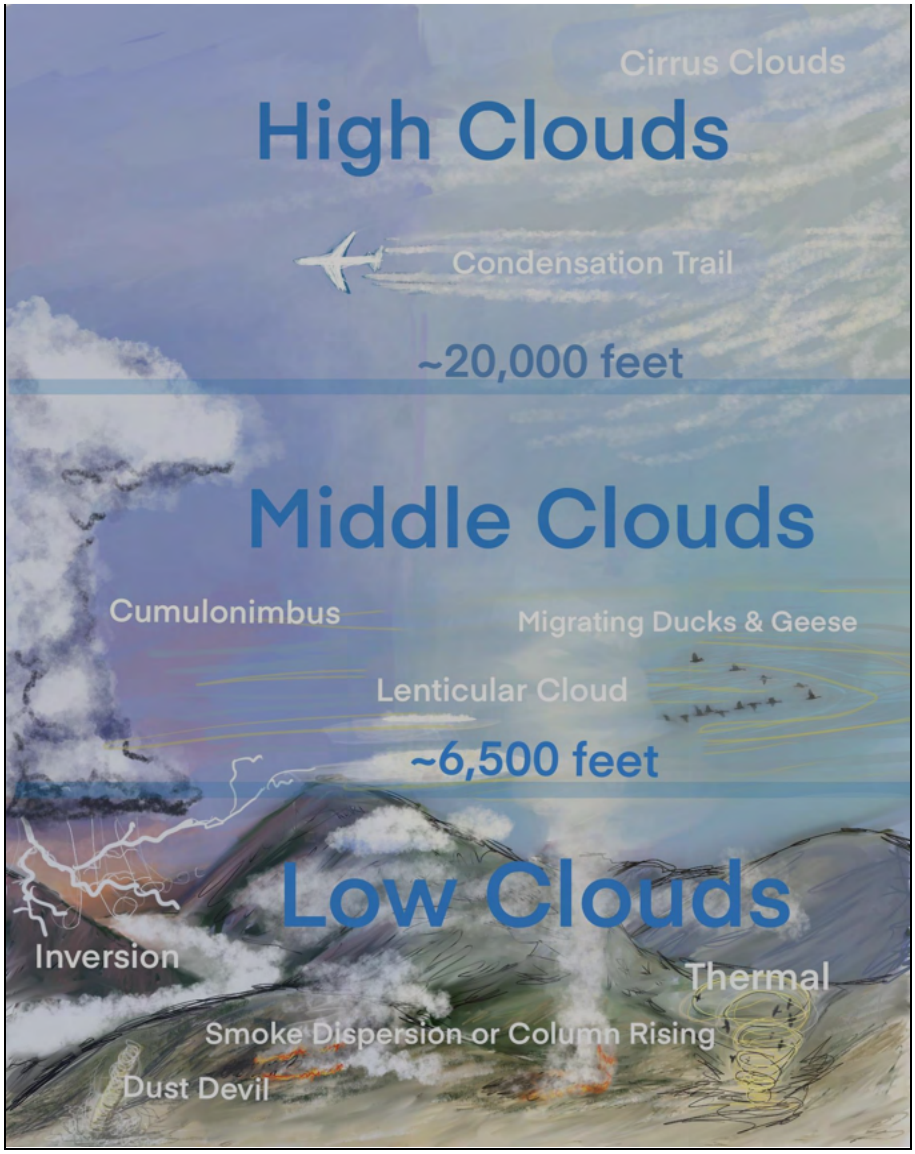
- **Exercise Introduction**: We are starting our observations by looking up into the sky high in the atmosphere and down to the ground (vertical and horizontal). Our primary goal in this first exercise is to look for vertical temperature and moisture gradients and horizontal winds. There are three main levels or zones in the sky we'll be looking at (High, Middle and Low Cloud Zones). From a fire behavior perspective we want to know and observe:

  Discussion: Is the atmosphere stable or unstable (static stability or aggregated buoyant force created by temperature gradients)? We can often observe whether the atmosphere is unstable when there are dark and bright blue skies. The lighter whiter and or smokier skies is considered more stable, like having a lid on a pot of water. This means that fire behavior is less intense when the skies are smokier and clear skies can create worse fire conditions.
    - Is the air moist or dry? Clouds are a good indication of moisture in the air and using weather data for relative humidity is very helpful. The smaller the humidity number the drier it is. A 15% RH number is often a red flag fire condition.

    - Is the air warm or cool?

    - Are there light or strong winds that you can see and feel? You cannot always feel the wind. Some winds are moving at higher levels of the atmosphere and are easiest observed when clouds are pushed, pulled and stretched.

- There is a table below with clues to help you determine vertical and horizontal weather.



- To highlight observations at different levels, we will use a tall vertical line for height and horizontal line along the bottom to indicate time and/or to spread out the different weather observations. You could instead, create a box to add the observations, with the same height principle.

- Before starting the teacher demo, ask students if they know what the atmosphere is or other questions about terminology used.

  Discussion: An atmosphere is a layer or set of layers of gases surrounding a planet and held in place by gravity. There are five layers of atmosphere around the earth based on different temperature zones. The earth's atmosphere is made up of oxygen, carbon dioxide, water vapor and several other gases.

- Let students know that any sketches in this lesson should be simple and quick. This is not about creating art but documenting observations which often need to happen quickly such as changing weather conditions.
  - Some quick drawing tips: Start with a light pencil sketch of the main shape of the element. Clouds can be challenging to draw, but the key for this exercise is to indicate whether the clouds are thin, flat, stretched, and broken or if they are fluffy and building upward. Are they an individual element or covering a broad area? You can use a simple outline for a cloud and light smeared pencil lines for a larger blanketed area. Use color sparingly and only to highlight key points. I used a sloppy blue colored pencil to help differentiate the sky from the clouds. The color of blue is not important.

  - Share with students the tips for differentiating high, middle and low cloud zones within the atmosphere along with the illustration.

    Discussion:
    High Cloud Zone- commercial airplanes and military jets cruise in the bottom portion of the high cloud zone. Clouds at the same level or higher than airplanes are likely in the high cloud zone.

    Middle Cloud Zone- migrating ducks and geese often fly at the low end of the middle cloud zone. Clouds below the airplane zone and equal to or above migrating geese are in the middle zone.

    Low Cloud Zone- Clouds below the other zones often appear closer, bigger and fluffier. Inversions are often in this zone based on the height of the mountains where it functions as a lid/cloud cover over a lower valley area.

- Draw the vertical and horizontal lines or a rectangle box in your journal and add lines with labels for high, middle and low cloud zones. Tell students they have 10 minutes for this exercise and have them follow along.

- Ask students what they see in the sky. Is the sky color bright blue or more white and grey? Can they see any clouds and can they differentiate how high. Demonstrate how to use words, numbers and pictures in the box in their journal describing what they observe. If they want to use an entire journal page, that is great too. Discussion: In most weather visualizations, the opacity (thickness) of white indicates how much water vapor is in the sky - places that look whiter in the visualization have high water vapor. You can use this technique when sketching

or painting your sky and clouds.

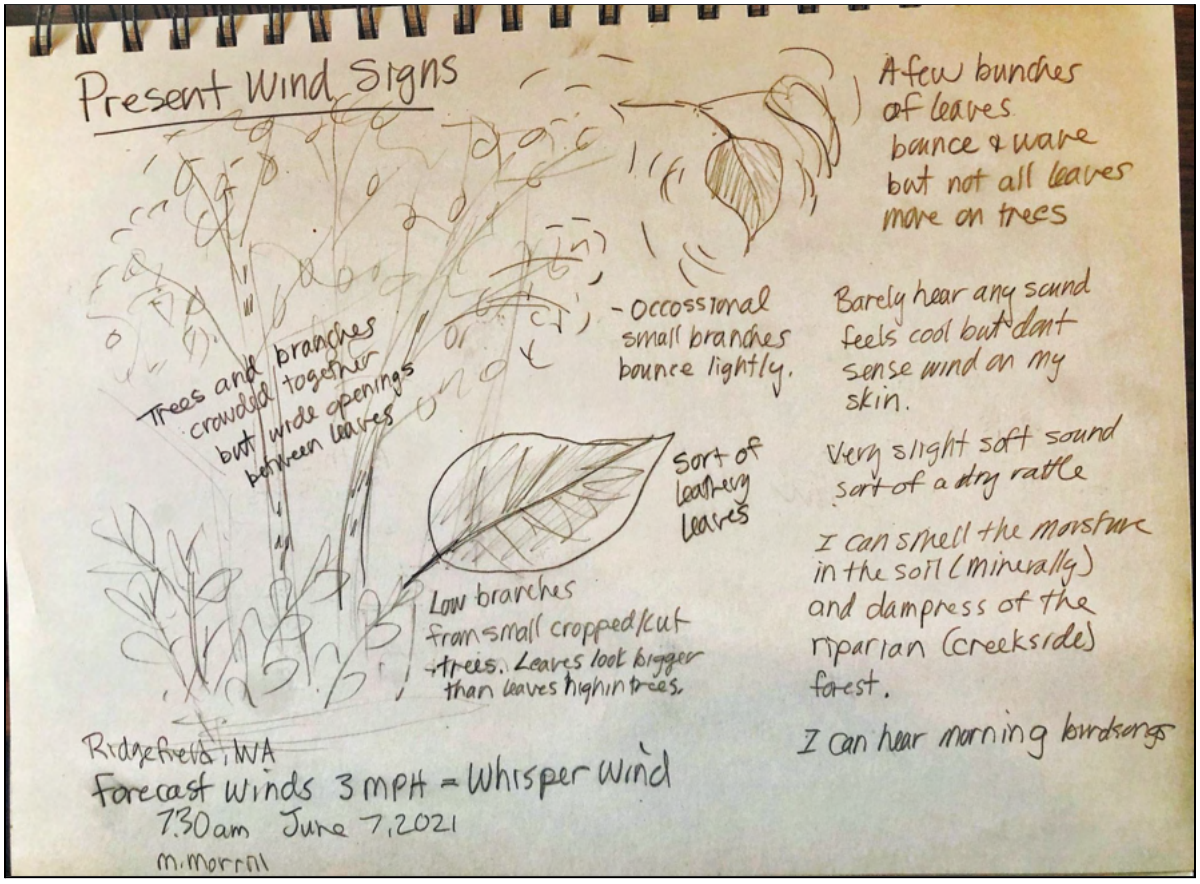
- As students work, take time to keep track of time, circulate and troubleshoot and engage in discussions. It should be okay to discuss and copy each other as long as they are doing their own work. Remind them that these are quick and simple sketches and for them to only use color if highlighting something important.

- A few minutes before ending the exercise, Say: “Take about two minutes to wrap up and add any final details to your comparison table.

Atmospheric Observations for Fire Behavior Situational Awareness		
Moisture & Temperature	**Winds**	**Transitions & Instability**
Moist and Cool: ● Cloud buildup (like biscuits rising in the oven) and cloud layers and fog ● Contrails observed and last longer in the sky ● Inversion development (looks like fog from higher in the mountains but like clouds from below in the valley.) ● Some people have headaches, allergies and joint pain when moist and cool. Dry and Warm: ● Absence of the above ● Relative humidity 15% or less ● Existing drought conditions ● Thermals (birds use to rise up in the air in a circular pattern)	● Cirrus (high level) and other clouds appear stretched and torn ● High, middle and low clouds moving in different directions. *NOTE*: Due to the influence of friction the high level winds have a 30 degree difference in direction from the felt wind at eye-level. ● Contrails pulled and stretched in direction of the wind ● Lenticular clouds (spaceship or disc shaped) and rolled and wave-like clouds over mountainous terrain features. ● Below the three cloud levels, at the ground, eye and or felt level, sustained winds of 10 MPH	● Low level cumulus clouds (cotton ball looking) build up throughout the day into large cumulonimbus thunder clouds which have a high risk of lightning and erratic and intense winds. ● Cold front passages which can bring Foehn winds (called North winds in northern California and come from NE in Butte County) ● Thermals and dust whirls indicating unstable air current from changes in temperature ● Morning inversions break up with warming and can cause erratic winds ● Smoke columns build and rise straight up into higher cloud levels instead of billowing out along a valley or hillside.

• Heat waves along flat surface like a road • Skin feels dry and lips chapped	or more and gusts of 25 MPH or more are typical fire weather or red flag conditions. ○ See the next exercise for a relative sensed wind scale.	• A 5 degree change in temperature.

PRESENT WIND OBSERVATIONS EXERCISE (15 minutes)



Exercise Introduction: In this exercise, we are going to use our senses to observe eye-level or sensed winds and try to describe differences in wind speed using a simple relative scale based on the concept of the Beaufort Wind Force Scale.

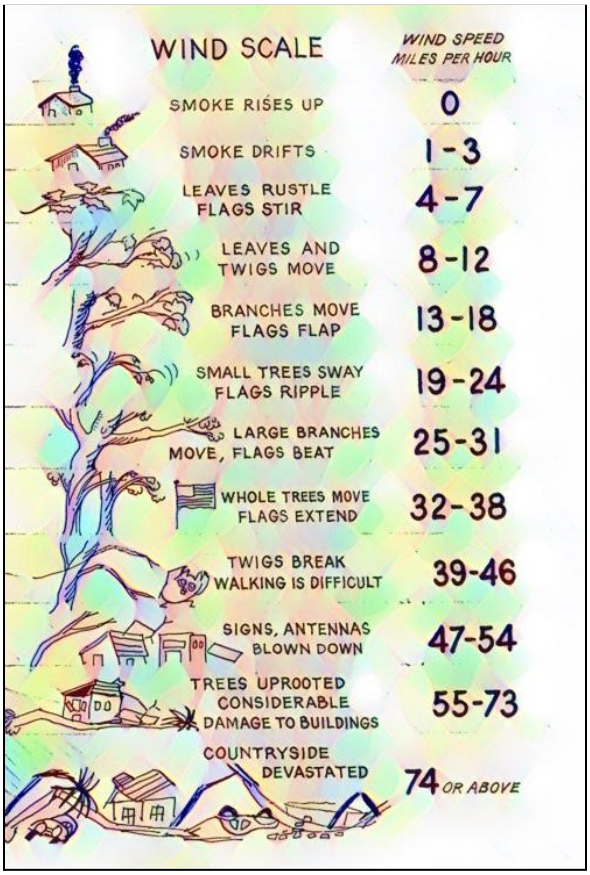
> Discussion: The Beaufort Wind Force Scale originated in 1805 by the British Royal Navy to help provide consistent interpretation and guidance on sailing. This scale has been modified and used widely for land wind observations

including use in fire management. Use of a more relative wind scale reduces time spent measuring and interpreting exact wind speeds but is also very subjective.

- For this exercise, we are not going to focus on learning or observing each of the Beaufort wind scales but differentiating at more intuitive levels that are key to fire behavior.

  Discussion: Depending on the specific location and terrain characteristics, like steep slopes, the critical wind levels can vary. In general, a 10 mile an hour wind is a threshold where fire behavior becomes more intense and often one of several red flag conditions. As the wind increases from that level the effect becomes more extreme. Students can rename the scale to something more meaningful but differentiate between less than and more than 10 miles per hour winds.

Beaufort Wind Force Scale Graphic Below (Not used in this exercise)



Relative Wind Scale:

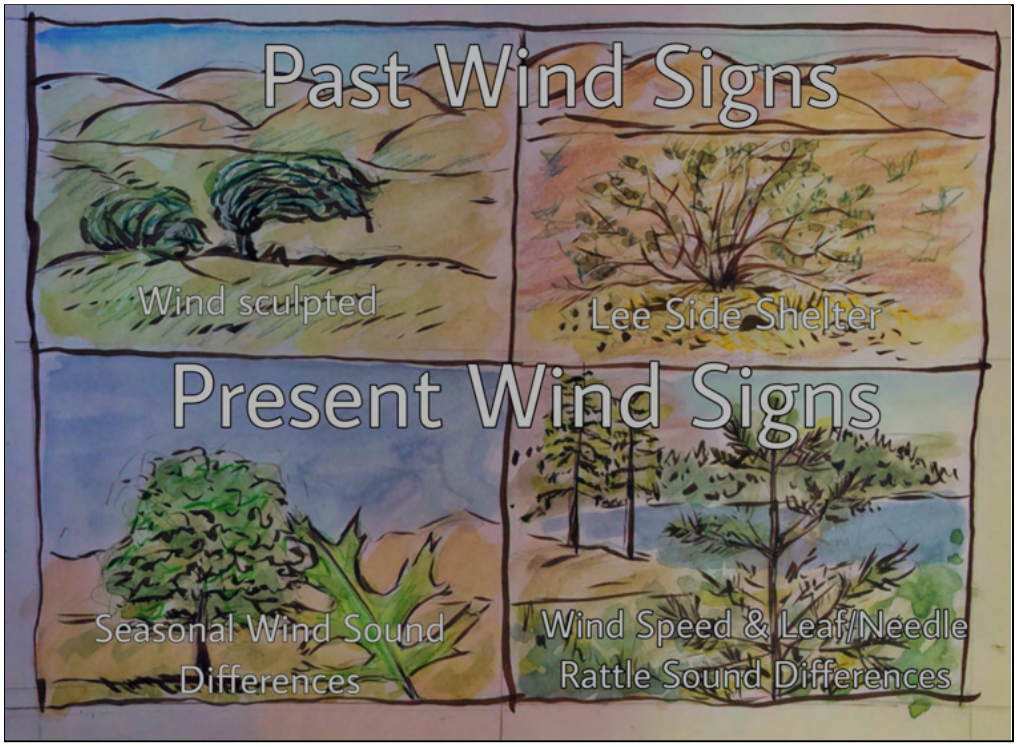
- **Whisper Wind (less than 10 MPH)**- barely sensed breeze on the skin and sounds like a whisper from the leaves when close to trees with medium to large leaves.

- **Conversation or Chorus Wind (10-30 MPH)**- Start of fire weather conditions. Winds felt strongly on the skin and in hair, with the leaves of close and more distant trees and shrubs making rustling, rattling, slapping, scraping and scratching sounds like a crowd talking or choral group singing. The wind alone should have a sound caused by friction.
  - Fire weather winds: Sustained 10 MPH winds or higher and wind gusts 25 MPH or more

- **Screaming Wind (30-72 MPH)**- Gale level winds makes it difficult to walk and whips large branches and trees back and forth, with some branches and trees breaking and crashing to the ground. Very loud sounds from the wind that can sound like a rock concert or train coming. Hurricane winds are the next and highest wind level.

- Describe the relative wind scale we are using in this exercise (above) and that

we are only focusing on the difference between the Whisper Wind and the Chorus Wind since we would not be nature journaling outside if the winds are at the Screaming Wind level.



- Ask students to look and listen quietly for a few minutes. Ask them if they can see or hear or see any wind. If they can see some leaves moving but not hear, have everyone move closer to the trees or vegetation observing.

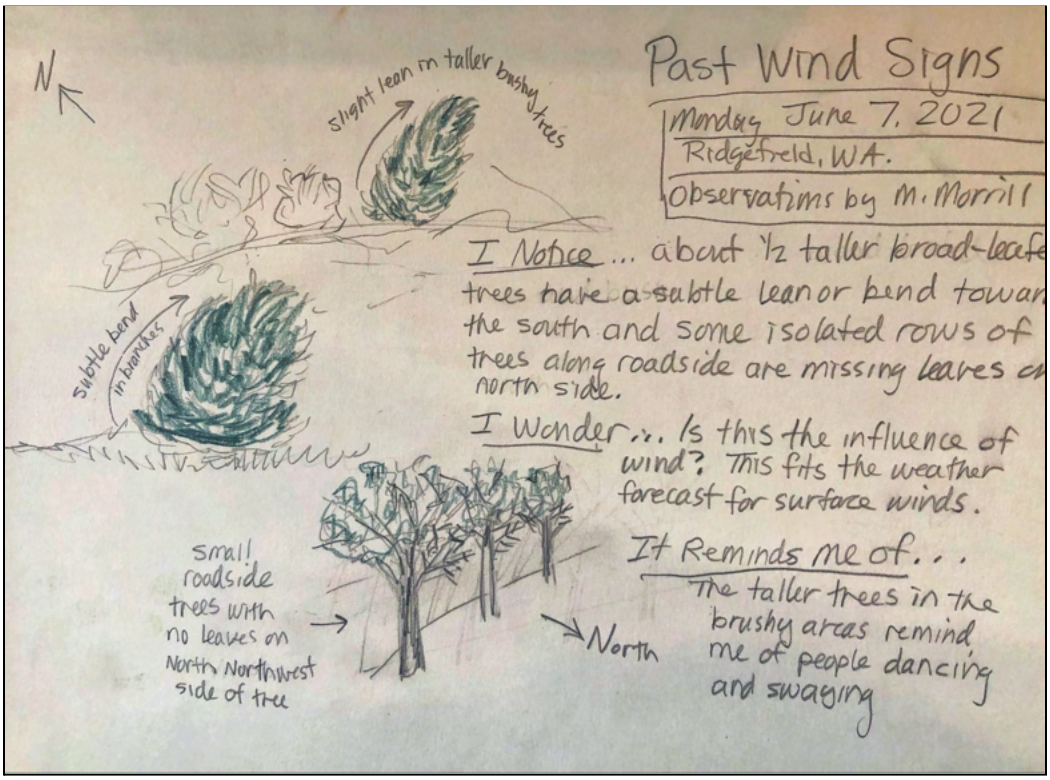
- Ask students to close their eyes and notice if they can smell, hear and feel the wind on their skin. Tell students they have around ten minutes to use words, numbers and pictures journaling observations about the felt or sensed wind and using the relative wind scale above.
    - If there is no wind, go to a low hanging branch or bush and rattle lightly to mimic a light Whisper Wind.

- After a few minutes, go to a low hanging branch or bush and rattle hard to mimic a more intense wind speed than currently experiencing. Have them describe their sensory observations again.

- After a few more minutes, ask students to write down the nature journaling prompts of ‘I wonder’ and ‘It reminds me of’ and then write questions and similarities of things they observed.

- A few minutes before ending the exercise, Say: “Take about two minutes to wrap up and add any final details to your comparison table.

PAST & PLACE-BASED WIND EXERCISE (25 minutes)



Exercise Introduction: In this exercise, we are going to look for signs of past wind and compare with current wind direction and speed. We are also going to use our Landscape Position Map from lesson #2, with tracing paper, and put arrows for potential terrain influenced winds. At the end of this exercise we will use all of our observations from today to make predictions of winds later today and put highlights on our story zine.

PAST WIND CLUES (15 minutes)

- Describe to students some of the past wind observations you might see. Discussion: For instance, you can sometimes see the tops and or sides of trees sculpted or leaning away from the direction of frequent past winds. You might also see the windy side of trees with less leaves. There are other reasons that trees may lean or have different leaf distribution, so it's important to look for these signs on numerous trees and important to just ask the question, is this a wind clue, rather than assume with certainty that it is from wind. You can also see wind signs on the leeward side of trees and bushes, where the wind has less impact. For instance, you might see more grasses, mosses, plant debris and animal signs like rabbit poop, small mammal burrow openings and bird nests. Again, there are many other reasons for why things look the way they do, so you want to look for these signs in numerous places.

- Demonstrate and have students write as different heading areas in their journals the nature journaling prompts of 'I notice', 'I wonder' and 'It reminds me of'. Tell

them they have about six minutes to first add their observations under the I notice heading using words, numbers and or pictures.

- Ask students to look around for trees and shrubs in the open or on the edge of a forest where they may have more clues of past wind influences. This can be done as a group, in teams or independently.

- After six to ten minutes, tell the students to stop their observations and use two minutes to now add questions about those observations under the I wonder heading. After the two minutes, tell them they have another two minutes to think about what these observations remind them of and put those comments under the It reminds me heading.

PLACE-BASED WINDS (10 minutes)

- Now that students have explored current and past wind observations, tell them we are now going to think about where those winds come from and move across the landscape.

  Discussion: It is critical to know which direction the wind is coming from and if it is being funneled through landscape elements. *The journaling example below was not done in Butte County so do not use that as a wind reference by visual sketch example.*

  - In northern California, the Foehn or North winds (winds pushed over mountains from a high pressure system) are typically warm and dry winds. In Butte County, we see these winds come from the northeast and funnel through areas like the Feather River Canyon. These are high fire risk winds and important to consider in fire awareness.

  - Winds are also created and influenced by terrain and sunlight interactions. For instance, in a canyon, late morning and evening periods when the sunlight is moving over a steep slope, the temperature gradients cause winds to move upslope as it warms in the morning and downslope winds as it cools in the evening.

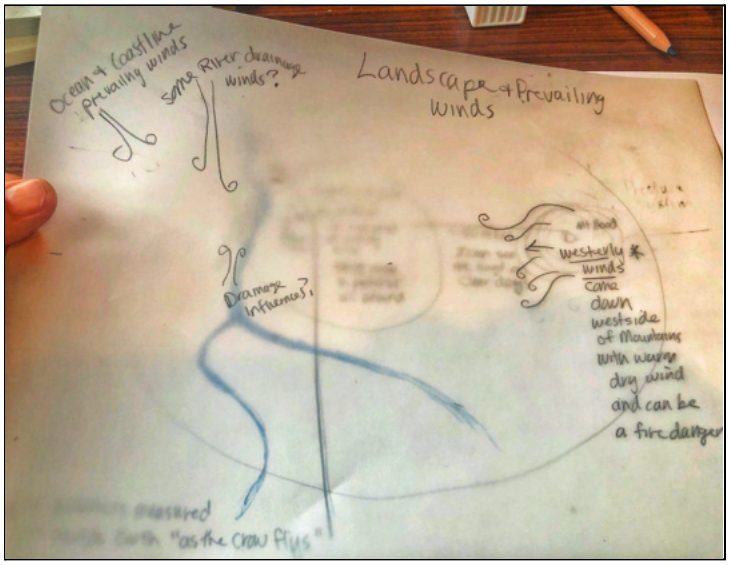
  - The most common winds are the prevailing winds which are large landscape scale winds and in Butte County, these are the winds funneled from the coast and up through the mountain gaps in the Bay Area and valley. These come from the southwest.

- Have students take a piece of tracing paper or parchment paper and overlay it on the Position Map created in Lesson #2. If doing these lessons out of order, you'll need to create a simple map with geographic elements laid out in the north, south, east and west directions before starting this exercise. This could be done quickly by printing Google Earth or Google Maps with key landscape features within 50-100 miles of the observation location.

- Demonstrate to the students how to overlay the tracing paper to the map and have them discuss the three types of wind referenced above and where they

might experience on the landscape and on their Position Map. Tell students they have around five minutes to show wind moving over their landscape on the tracing paper. If they have trouble visualizing, you can show the example or demonstrate with arrows, symbols or other visuals like color gradients. Have them use words, numbers and pictures.

- A few minutes before ending the exercise, Say: “Take about two minutes to wrap up and add any final details to your comparison table.



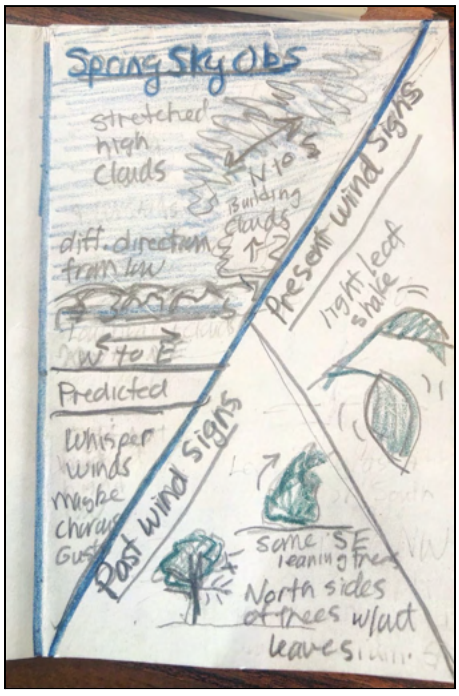
Example place-based winds exercise using tracing paper over the lesson #2 Landscape Position Map (example not in Butte County)

STORY ZINE OBSERVATION SUMMARY EXERCISE (10 minutes)

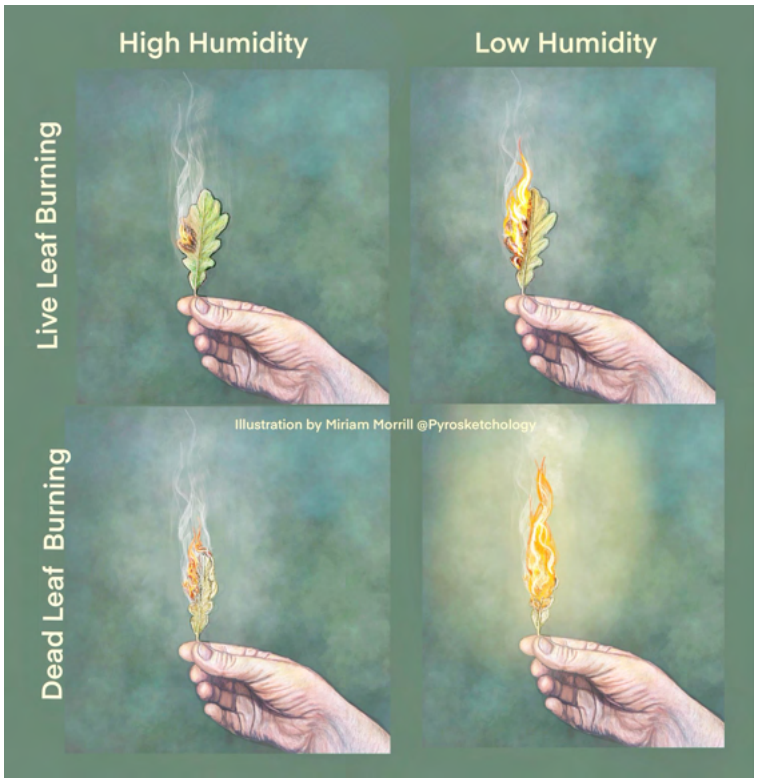
- **Exercise Introduction:** In this exercise we are going to take the weather observation highlights from the previous weather observations and add them to page #5 on our story zine.

- Demonstrate to students how they can compartmentalize their story zine page to put at least one thing they observed about the sky, felt wind, past wind and place-based wind observations. Tell them they have about eight minutes to complete. This does not need to be artistic but should have at least a picture and some words for each of the observation categories.

- A few minutes before ending the exercise, Say: “Take about two minutes to wrap up and add any final details to your comparison table.



6- PLANT MOISTURE & FIRE COMBUSTION (FIRE TRIANGLE)



INTRODUCTION

Students review basics (observable aspects) of the fire triangle and how that relates to fuel moisture, humidity, and vapor pressure deficit and what that means for fire ignition and spread. Students will gather live and dead vegetation elements (grasses, leaves, etc) using a comparison table to study differences in plant moisture using hearing, sight, smell, and touch. The teacher uses plant materials for an ignition and burning experiment that students observe and journal. Students will choose one of their live/dead vegetation observations and sketch the shapes on their story zine, adding key descriptive words and phrases that differentiate between the live and dead plant elements. Students then add a few notes on thoughts relative to fire ignition and spread based on plant moisture.

LESSON OVERVIEW & ESTIMATED TIME (60 MINUTES)

- Teacher introduction to lesson **(2 minutes)**
- Teacher discussion of the fire triangle, fuel size (surface area to volume) and dead fuel moisture lag time **(10 minutes)**
- Teacher discusses field safety **(3 minutes)**
- Teacher and or students gather live and dead vegetation materials (grasses, leaves, etc.) and come back as a group **(5 minutes)**
- Teacher provides weather metadata and demos and facilitates student creation of the comparison table facilitating discussion and journaling the sensory observations **(15 minutes)**
- Teacher overview of live fuel moisture considerations such as the vapor pressure deficit and what that means for fire ignition and spread **(5 minutes)**
- Teacher uses live and dead leaf materials to compare ignition and burning with different moisture levels **(10 minutes)**
- Teacher demo and students follow sketching and adding key words and or phrases from the comparison table onto the zine page **(10 minutes)**

MATERIALS & RESOURCES

- Journal or notebook
- Printed formatted story zine
- Graphite pencils, erasers, and optional colored pencils or water colors with paint brush
- Optional rulers or measure tapes
- Optional gloves and clippers or scissors, if needed to cut leaves or grasses
- Collected local leaves and grasses
- Plastic tube or large bucket with sand or water. Sand would allow dropping burning leaves and observing any additional burning,, but that is not crucial to the key part of the observation.
- Lighter and or large wooden matches. Matches are a nice approach to limit burning time and heat intensity in a visual way.
- Weather metadata for the day/time of plant collection and observations (temperature and humidity)

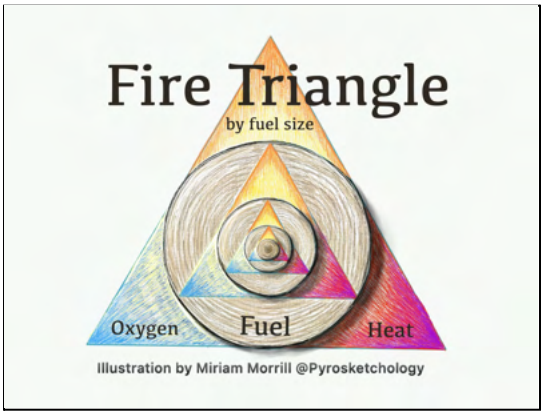
LOCATION

This exercise can be done indoors but is recommended to be outdoors for at least part of the session such as collecting plant materials. If no live and dead grass or leaves are accessible at the location, the teacher should collect materials prior to the session. The burning demonstration should be in an area free of vegetation and protected from winds. Most of this lesson will be completed as a group so a comfortable area for students to sit, observe and discuss is ideal.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

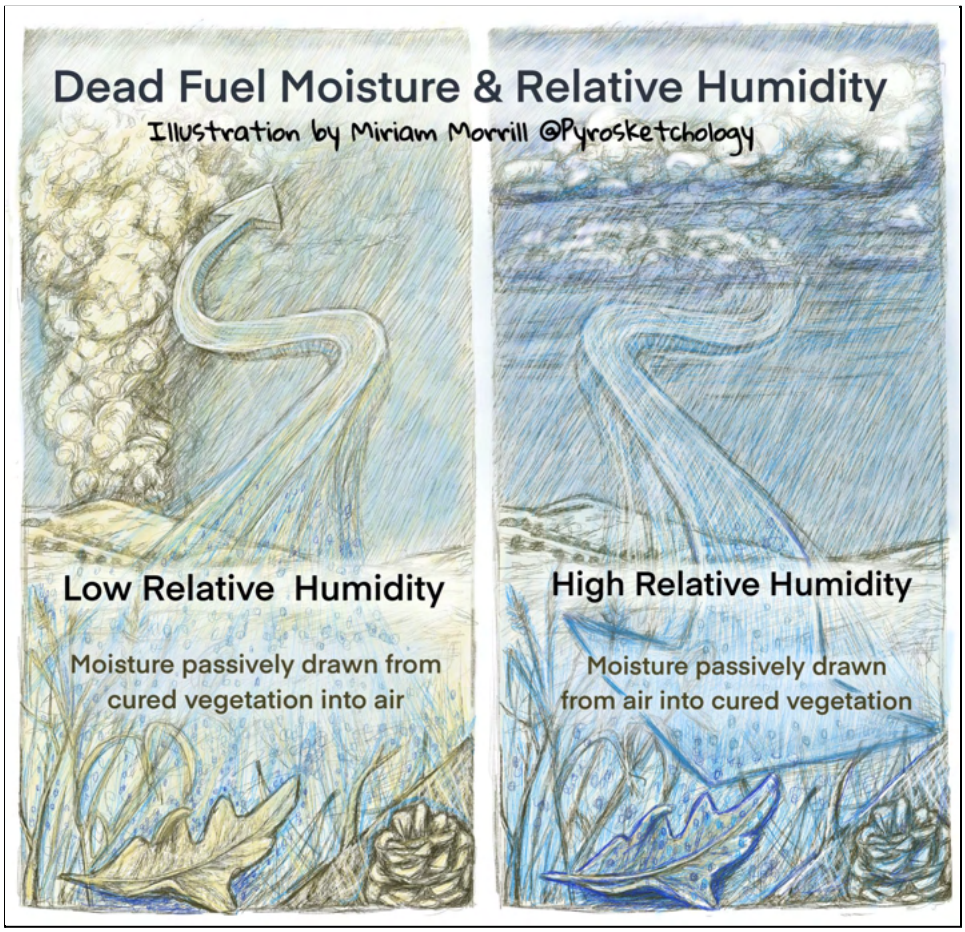
The influences of weather phenomena on vegetation is crucial to understanding fire ignition and spread. As learned in the weather and fire lesson, weather events and patterns occur as a result of one or a combination of the water cycle, atmospheric pressure systems, and the Coriolis effect. The photosynthesis process and phenological phases of plants are associated with the weather and influences the ignitability and spread of fire. The primary focus in this lesson is observing and sensing the moisture differences in live vegetation from vapor pressure deficit process and moisture in dead plant materials from the relative humidity in the atmosphere. This lesson emphasizes sensory engagement skills and observations intended to create a deeper sense and awareness of changing vegetation conditions and fire behavior.

LESSON INTRODUCTION FOR STUDENTS (2 Minutes)



In this lesson we will learn about how moisture in the air and in live and dead plants can influence fire ignition and spread. We'll start with a review of the fire triangle and how that relates to moisture influences on plants and fire. We'll be using our senses to make observations about plant materials and we will have a live fire demonstration with a few small plant materials to see if there are differences in how these materials ignite and burn.

REVIEW PLANT MOISTURE AND THE FIRE TRIANGLE (10 Minutes)



- Gather students into a group and explain how the fire triangle is framed around the three primary ingredients needed for fire to occur. Ask if anyone knows what those three elements are?

  Discussion: The fire triangle includes oxygen, fuel and heat and represents the combustion process. From an observation aspect, the fire triangle can be a little abstract, but if you also consider that the triangle symbol in math and chemistry represents a change in form or a chemical reaction it can be a little more representational. In Ancient Greek fire is represented as a triangle and symbolizes a desire to ascend, with the top pointing upward.

- Ask students if they have any idea of what the ascending aspect of fire might be referencing.

  Discussion: Fire (combustion process), on the landscape, is changing the form of solid carbon (vegetation) into a gas, which is propelled into the atmosphere or ascending into

the sky.. In the above concept illustration of the fire triangle, the triangle is used to represent the change in form but the three elements are not equal and opposing along the edges. Fuel (vegetation) is the central element that is being transformed when meeting with the elements of oxygen and heat. The tip of the triangle represents the flame coming from the reaction. There are smaller fire triangles embedded within the larger one, to represent that with a change in the size of fuel, the amount of oxygen and heat also changes. More on that with the next illustration.

- Ask students if they can think of a natural process that is the opposite of combustion. What process takes in carbon as a gas, using oxygen (air) and heat (sun) to create a solid carbon form?

  Discussion: Photosynthesis is nearly an opposite process to combustion. Combustion is a quick reaction whereas photosynthesis is a slower process occurring within a plant but photosynthesis breathes in carbon dioxide, using oxygen and the sun to help build plant tissue (solid carbon). Fire, in a way, breathes too. It inhales oxygen and exhales carbon dioxide. Plants inhale carbon dioxide and exhale oxygen. In many ways, plants are a product of the sky, and connected to the earth.

- Ask students if they know why moisture influences the fire triangle and combustion process.

  Discussion: Most people know that water cools and extinguishes a fire- reduces/removes oxygen to fire, but the amount of moisture in a plant changes how easily vegetation can ignite, burn. Both living and dead plants can have changing levels of moisture that are very important in understanding the fire environment and level of fire ignition and spread risk. In fire management, experts use different metrics to estimate live and dead vegetation (fuel) moisture.

- Ask students if they have ideas about how dead vegetation like fallen leaves, dry grass, pine cones and fallen branches can gain and lose moisture.

  Discussion: Rain is easy to relate to dead vegetation moisture and limited fire ignition, but there is something more important that fire specialists look at- something that changes throughout the day and the year. Air moisture or relative humidity levels have a strong influence on dead vegetation moisture and combustibility. **Humidity** is the concentration of water vapor (gas form of water) present in the air. The level of humidity depends on the temperature and atmospheric pressure. **Relative humidity** tells us how much water vapor is in the air, compared to how much it could hold at that temperature before it becomes saturated and produces rain. It is shown as a percent. Relative humidity is also used to measure moisture levels in dead vegetation to assess ignitability and potential fire spread. A low relative humidity means dry conditions and less water vapor in the air.

    - Explain to students that In fire management, dead fuel moisture is measured by several fuel size categories (volume) based on the time lag it will take for ⅔ of the

dead fuel to respond to the relative humidity. (10–hour, 100–hour, or 1,000–hour). A large leaf may have a big surface area but small volume. Consider how oxygen, moisture or heat needs to travel further through a larger volume and thus the longer lag time to equalize with the air moisture. For example, it takes 1 to 10 hours for the smallest vegetation materials to dry or moisten to the level of atmospheric moisture (relative humidity). Fire practitioners have wood rods measured and weighed for 1 to 1,000 hour fuel models. These fuel moisture sticks are placed outside at a weather station and used to estimate fire ignition potential, but anyone can observe some of the vegetation moisture conditions and make helpful estimates on fire ignition and spread.

- Review with students the Dead Vegetation Moisture & Ignitability illustration below discussing the size (volume) categories and time lag. Students will need to use this information for their field exercise.

SAFETY TALK (3 minutes)

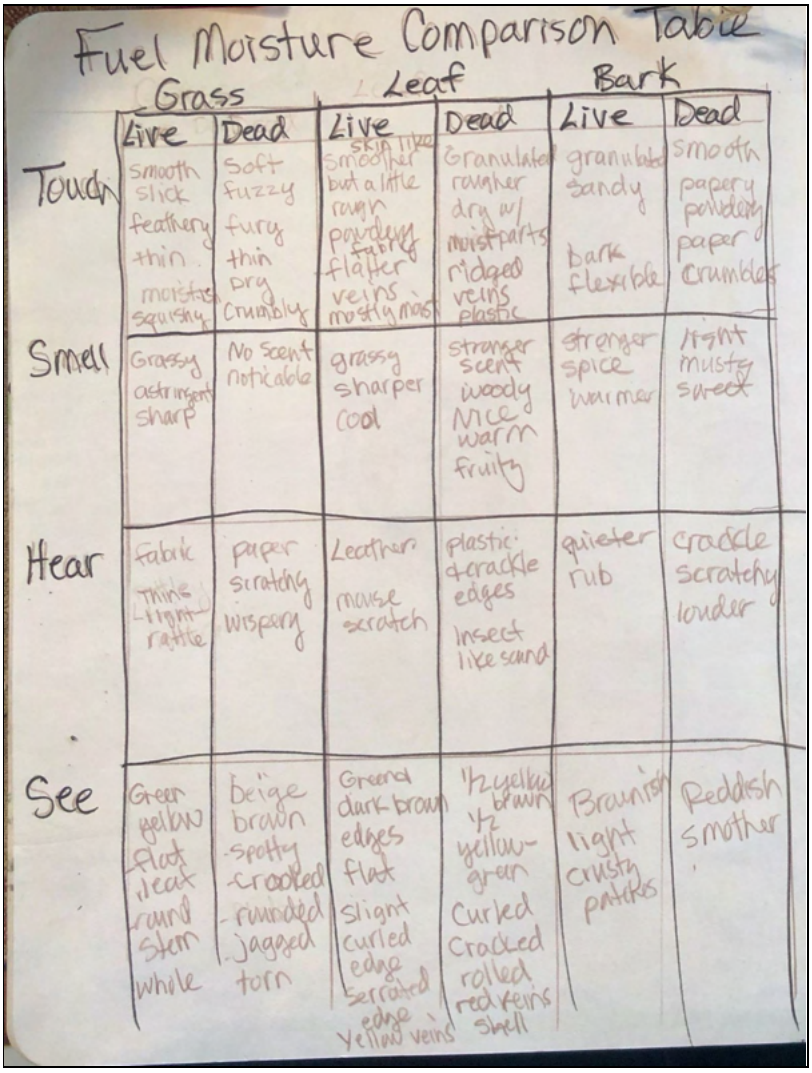
- Give safety talk appropriate to location and conditions. See guide introduction section with Safety Discussion overview.
    - Collecting plant materials that are safe to handle and avoiding potential skin irritation or cuts
- Fire safety when igniting and burning plant materials for demonstration. Be in an area more sheltered from the wind and away from dry vegetation. Have water available either in a bucket or a bottle of water over a sandbox to fully drown burning materials.
- Sensory observations of touching and smelling could have some potential allergy reactions so students with health risks may rely on the input of others from the group sensory discussions.

EXERCISE: GATHER LIVE AND DEAD FUELS (5 Minutes)

- In this exercise, the teacher and students will gather and journal sensory observations of live and dead fuels/vegetation and consider fuel size (surface area to volume), shape, and current moisture conditions. The teacher can guide students in gathering a mix of live and dead grasses, leaves and other small fallen vegetation materials (could include acorns, cones, bark strips, small branches) or direct students to gather with safety considerations. Ideally, the live and dead vegetation should be from the same or similar size and shaped plants to better compare moisture differences.

- The intent with this exercise is to build multi-sense observation skills around vegetation conditions that can inform you of fire conditions. This can form an environmental awareness and also be used as a fire practitioner when assessing best prescribed burning conditions.

EXERCISE: CREATE COMPARISON TABLE & COMPARE LIVE & DEAD FUELS (15 Minutes)

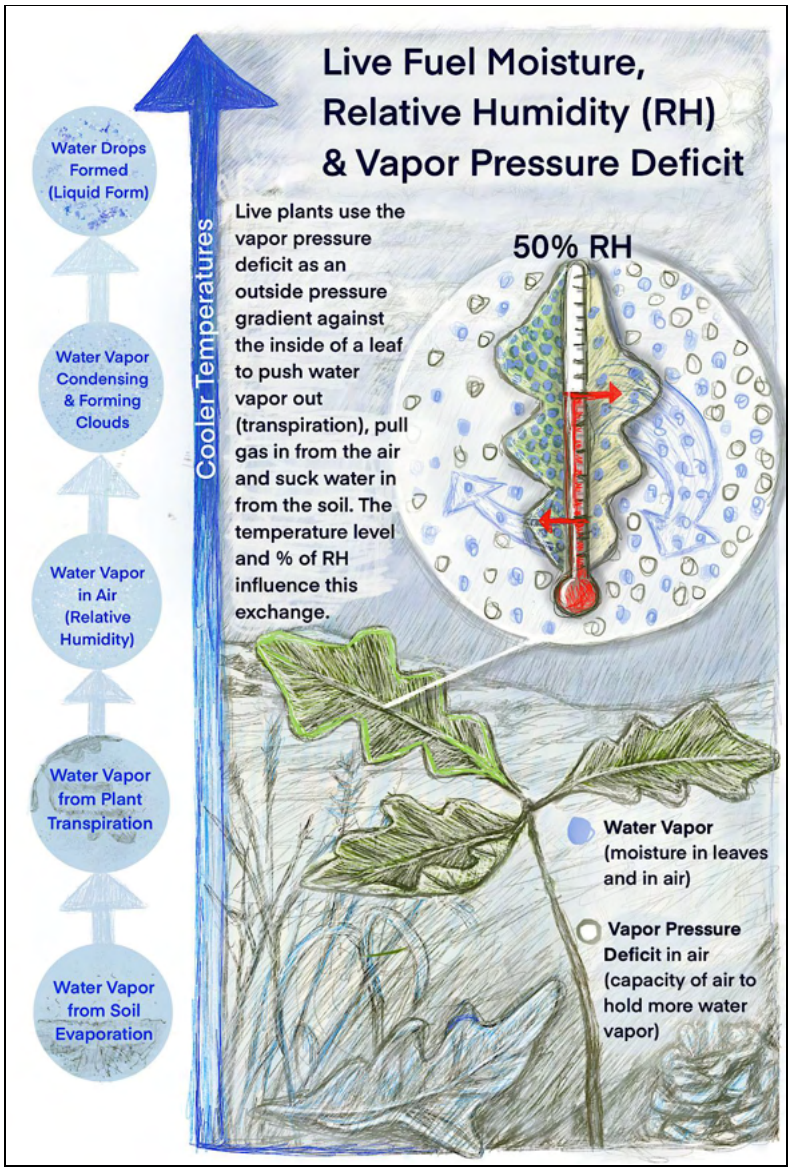


- In the nature journal/sketchbook, create a comparison table with two to three columns for the different fuel sizes or types (grasses, leaves, etc.). Split each fuel column into a live and dead plant column.
- Create a row for the sensory categories of Touch (texture, thickness, softness, etc.), Smell, Hear (while bending, curling or rolling in hand), and See (colors, patterns, shape, etc.).
- Make sensory comparisons for the live and dead fuels using words and phrases. This can be very creative with made-up words and comparisons to anything that relates to sensory observation...smells like a wet dog, etc.
- Discuss as a group the moisture observation differences and the current relative humidity
- Save a live and dead leaf for the zine exercise.

REVIEW LIVE PLANT MOISTURE & THE VAPOR PRESSURE DEFICIT PROCESS (5 Minutes)

- <u>Discuss:</u> We learned a little about the dead fuel moisture influenced by the relative humidity. Live plants manage the amount of moisture within their cells through the process of transpiration.
- The transpiration process is driven by what scientists call the vapor pressure deficit (VPD). Water vapor content in the air or within a leaf can be measured as pressure (part of total air pressure). The VPD is how the plant feels specific to the location (exposure to sun) and weather conditions and is the major force moving water vapor out of the leaf based on the pressure difference between water vapor inside the leaf and water vapor outside the leaf. If there is adequate moisture in the soil and ground, plants can better maintain their temperature and manage the transpiration process when the VPD is high (higher temperatures).

- There is a complex process behind VPD and other key terms to learn but what is key for our purposes is to understand that higher air temperatures create a higher VDP and thirstier air. Even with the same amount of rain, warmer temperatures pull more water into the air (evaporative demand) and makes less available within the ground and for plants. If there is enough water in the soil and ground like in tropical areas, plants can manage their transpiration process. When the VPD is high and there is little to no water in the ground, plants shutdown their transpiration process and can starve to death. Higher temperatures, with limited moisture available.can also mean plants cannot cool themselves and can scorch leaves and even die. Understanding the connections between temperature, moisture and plants is crucial to fire awareness and climate change resilience.



- Another thing to note about relative humidity and VPD is that plants have different needs and functions during their development and phenology phases that are strongly influenced by different temperature and moisture conditions. See the Live Fuel Moisture, Relative Humidity and Vapor Pressure Deficit illustration and attached table below and discuss with students.

EXERCISE: BURNING LIVE & DEAD LEAF OBSERVATIONS (10 Minutes)

- Teacher assembles the fire safe tube or bucket with water and vegetation materials collected earlier with lighter or matches (wooden matches recommended).

- Students gathered around where they can observe the teacher demonstration.

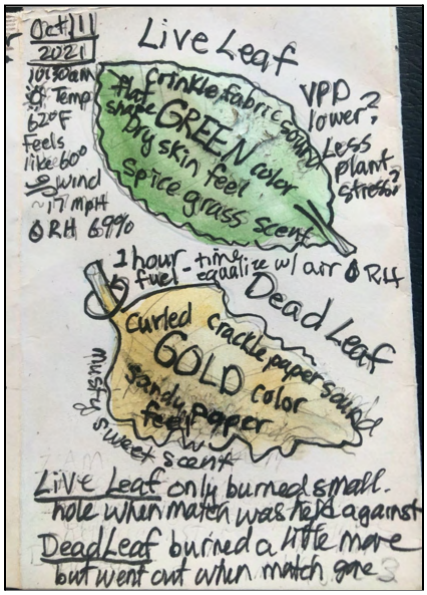
- Explain to students that they will need a pencil or pen and a page in their journal next to the comparison table, to add their observations during the demonstration.
- Teacher starts with the live grass or leaf and holds a lit match up to the lower edge of leaf/grass (room on leaf/grass to see if flame grows to tip) until the material lights or the

match burns out. Follow the same approach with the matching dead leaf/grass.

- Ask students what they observed with the live and dead leaf/grass burned.

- Ask students to discuss and write in their journal what moisture assumptions and or questions they have about the live and dead materials burned.
    - Observation review: Was there smoke? How much smoke and what color was it? White colored smoke often means more moisture (steam) and incomplete combustion. Was there a flame? How long was the flame? What color was the flame? If no flame occurred, was there any drying of the leaf by the heat source (the pyrolysis or prefire phase is a warming and drying but no flame or combustion)? A longer flame means better combustion and likely more oxygen in the vegetation (drier) and likely dryer air conditions. Was the leaf/grass fully burned or was there any material remaining? What color was the burned area and how much material was remaining? When the vegetation is completely consumed it is usually smaller in size and drier or the heat was held to the area longer (fire triangle). A black sooty area is a sign of incomplete combustion and can be a sign of higher moisture levels in vegetation and or air and also larger or more solid volume of the materials and or less combustible materials.

EXERCISE: LIVE & DEAD LEAF COMPARISON SUMMARY ON ZINE (10 Minutes)

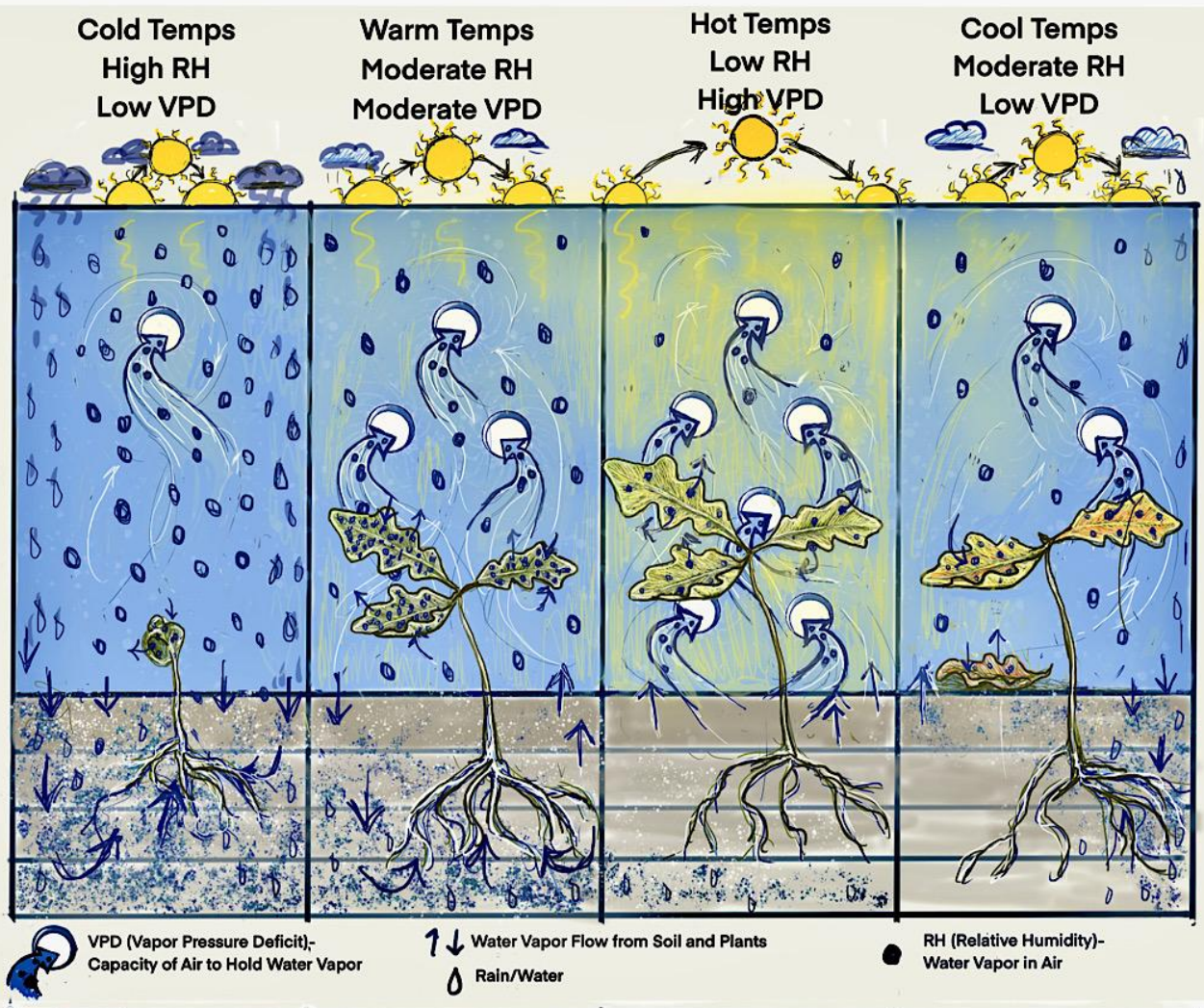


- Explain to students that they'll need to pull out their fire story zine and open to the next blank page. They will be sketching the outline of live and dead leaf (shape and primary veins only) saved from earlier, leaving some room on the page to add a few notes including the temperature and humidity (provided by teacher or looked up by student on weather site).
- Students can use a light color if desired, but the key is to add keywords and or phrases from their comparison table into the shape of their live and dead leaf that helps explain sensory and moisture differences between the live and dead leaves. Students should make larger words/text for the strongest observations. The text can be written in any pattern on and around the leaf shape and can be in color or just black and white.
- Students add the fuel size and lag time for the dead leaf and note about the lag time to reach equilibrium with the air moisture.
- Students add notes near the live leaf about the VPD feeling of the leaf based on the current temperature and relative humidity. Discuss and refer to the VPD illustration for seasonal and temperature and moisture scenarios (warm and wet= moderate VPD (temp based, but less stressed plant (water availability)

- Students add any notes or questions about the flammability of the live and dead leaves from the demonstration or in general.

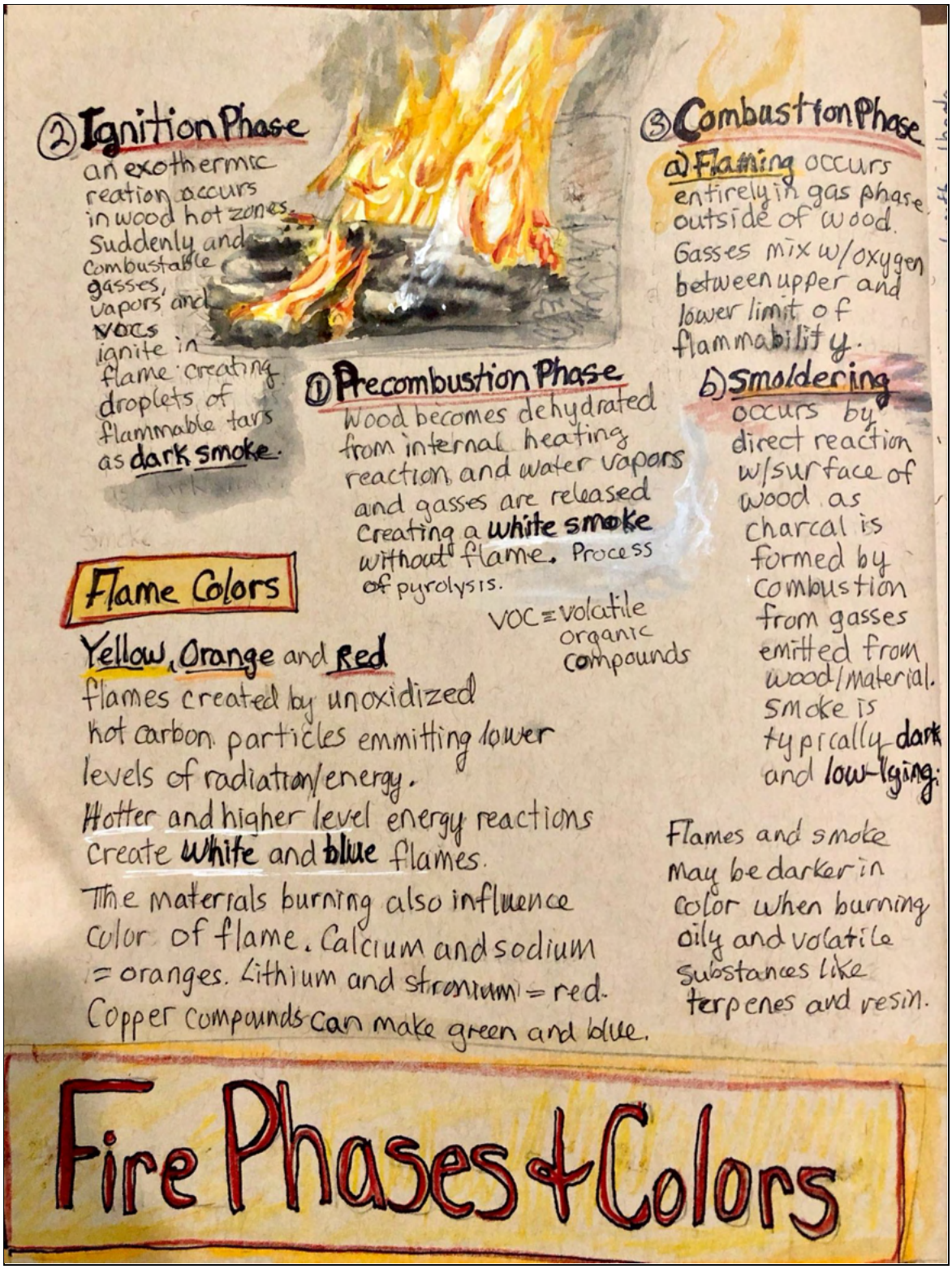
See large illustration on the following page.

Live Fuel Moisture, Relative Humidity & Vapor Pressure Deficit



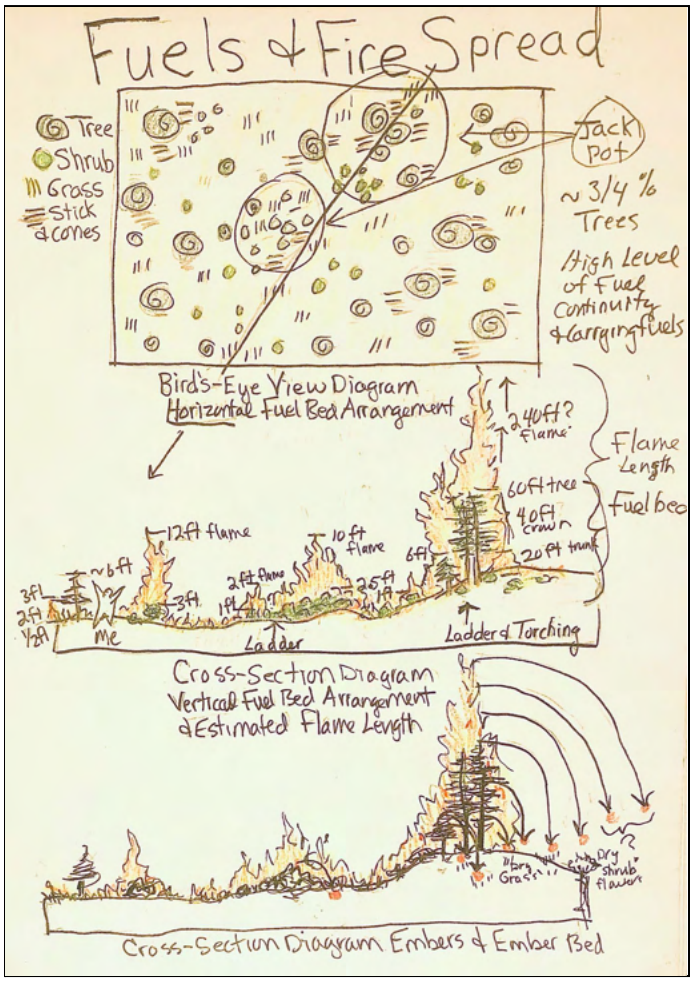
90-100% relative humidity good for plant germination with increasing sunlight and warming temperatures. 60-80% relative humidity good for tropical plants and warm temperatures. Dew point and 85% + relative humidity can cause fungal growth on plants with warm temperatures.	50-60% relative humidity ideal for the vegetative growth stage of most plants with enough sunlight and warm temperatures. 40-50% relative humidity ideal for the flowering and fruiting stage of most plants with good sunlight and warm temperatures.	20-30% relative humidity okay for cacti and succulents but many plants start to dry out. 15-30% a typical red flag fire condition. High temperatures cause plants to close pores (stomata) to avoid water loss reducing photosynthesis and cooling by the transpiration process. High temperatures also increase the vapor pressure deficit even with good relative humidity stressing plants.	Deciduous trees drop their leaves as sunlight hours decrease and temperatures cool. Less water is needed and plants can wait for soils to replenish with water. Warmer temperatures can reduce soil and ground water replenishment because more water vapor is held in the air. Less soil and ground water can stress and kills trees especially evergreens.

EXAMPLE FIRE COMBUSTION OBSERVATIONS THAT CAN BE REFERENCED



7- VEGETATION ARRANGEMENT & FIRE BEHAVIOR

INTRODUCTION



Students review key fire and fuels terminology and what that means for fire behavior and spread over the landscape. Students will assess horizontal fuels and surface fire types like creeping, backing, advancing by creating a bird's-eye view diagram and vertical fuels and transitional fire types like torching and embers with a cross-section diagram. Students will learn how to use symbolized human figures (star people) in journaling practices and apply biometrics (body measurements) and quick mathematical calculations to estimate fuel levels and potential flame lengths and fire types.

LESSON OVERVIEW & ESTIMATED TIME (60 MINUTES- Optional Extra Exercise 10 to 20 Minutes Added)

- Student lesson introduction and safety talk **(2 minutes)**
- Biometrics measurements and journaling people technique **(10 minutes)**
    - Optional extra exercise- pacing measurements exercise (10- 20 minutes)
- Overview of basic fuels terminology and horizontal fuels diagram exercise **(13 minutes)** which can be indoors or outdoors.
- Vertical fuels measurements and diagrams **(25 minutes)**
- Fuel and fire type data additions to diagrams **(10 minutes)**

MATERIALS & RESOURCES

- Journal or notebook

- Student story zine
- Cardstock or cardboard rectangle viewfinder (**can buy or create but necessary to create prior to the lesson**). Small rectangle opening with four marks along frame edges for halfway points and estimating percent area.
- Graphite pencil, eraser, and a few color supplies such as crayons colored pencils and or watercolors.
- Measuring tape (several, if possible)
- Optional ruler
- Printed Illustrations for lesson including fuel model journal page examples (end of lesson)

LOCATION

This lesson can be carried out anywhere with natural elements mixed in with human infrastructure (backyard, school field or local park) and or partially indoors. It is ideal to do the entire lesson outdoors in an area with mixed vegetation height elements such as trees, shrubs and grass.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

Most people have heard that our western forests are overcrowded and at risk to insect infestation and catastrophic wildfire, but the issue is far more complex to understand and relate to the local environment. One of the key aspects to understanding fire behavior on the landscape is fuels (vegetation and burnable materials). Fuel is one of three parts of the fire behavior triangle (topography, fuel, and weather). The term fuel feels very detached from the environment and relates fire as a machine or an engine using vegetation as the fuel to run. The fire environment is an interactive and living thing so in the content of nature journaling fire, it is recommended that the terms be learned to connect with traditional fire education and practitioner approaches but also how to connect the interactive and living environment. Fuels, plants and vegetation can be used interchangeably.

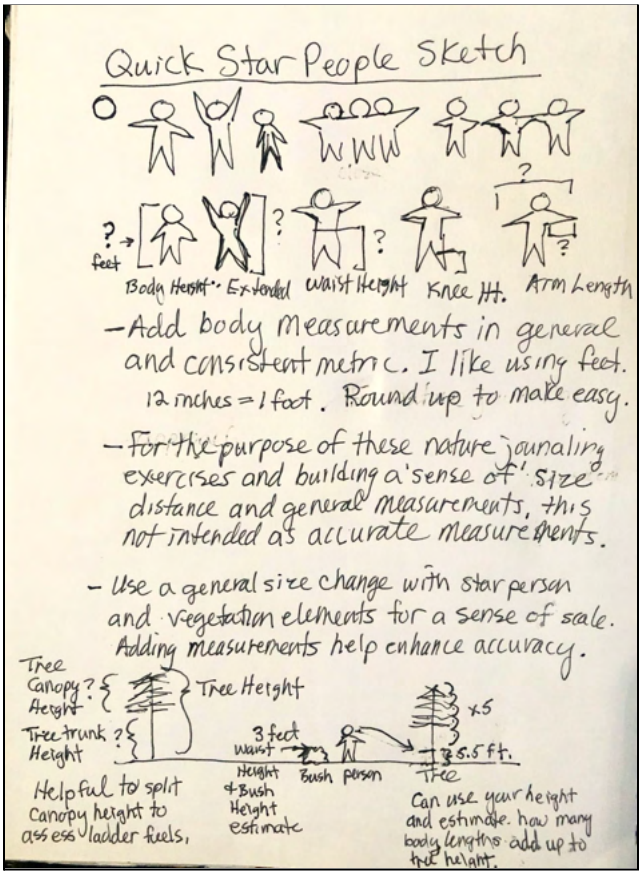
The previous lesson emphasized the relationship between plants (fuels) and moisture and how that influences fire ignition. Fire spread is closely tied to how vegetation is spread out and organized across the landscape. The primary focus in this lesson is understanding how vegetation arrangement influences fire behavior and how to observe and estimate those changing conditions on the landscape and estimate potential fire behavior. This information is key to understanding community and agency fire mitigation goals such as mechanical and prescribed fire treatments.

LESSON INTRODUCTION & SAFETY TALK FOR STUDENTS

This lesson is focused on assessing, estimating and diagraming vegetation conditions that influence fire behavior. This information is very important in understanding and supporting home defensible space and community fuel treatment projects. We may be walking in areas where you can trip or branches could fall from trees. Always have your eyes and ears open to these hazards.

BIOMETRICS JOURNALING (10 Minutes)

For the purposes of this guide, exact measurements are not strongly emphasized. They can be used if teachers and journalers want to integrate them, but the approaches provided are focused on building motor-sensory skills and a general sense of scale without added tools and equipment in the field.



- Let's start with a review, discussion and practice in creating star-people sketches in your journal. See the journal page insert example. It's surprising how our brains interpret very simple and sometimes sloppy shapes as people. These star people characters are used by professional sketchers and graphic facilitators to quickly integrate people into simple sketches. Once we indicate how tall our star people are in feet and inches, the star person can help us show the estimated height or width of vegetation and flames. We are using these measurements to estimate vegetation heights and estimate if flames can move from the surface of the ground into tree tops through what is known as ladder fuels.
    - A tip for using biometrics and comparison measurements in journaling is to sketch elements at a very generalized size scale and use measurement estimates to provide a bit more accuracy. For instance, you may measure a bush as waist height and sketch the star person next to a bush and on the same sketch have a much larger tree that is not proportionally

accurate in the sketch but the metrics help make the clarifications. See the example at the bottom of the sketch page inserted.

- Work with students and a measuring tape to add body measurements to their representative star people. Keep the same metric for all measurements and recommend using feet to relate better to tree height measurements.
    - foot to knee,
    - foot to waist
    - foot to head
    - foot to fingers with raised arms
    - Fingertip to fingertip with arms stretched outward from body at 90 degree angle

OPTIONAL EXTRA BIOMETRIC EXERCISE (10 to 20 minutes above 60 minutes lesson):

If the students are older or more advanced and an additional 10 to 20 minutes can be allocated to this lesson, consider integrating pace measurements to estimate distance between vegetation elements. This can be estimated, but is best when done in the field.

- A pace is equal to an adult's natural step which is about 30 inches long. The pace is determined by counting the number of steps it takes between two known measure points (everyone has different pace measurements). This is often counted as 100 meters. In western forestry practices, a pace is equal to two normal steps beginning with your dominant foot and is measured to 66 feet. Since most fire related metrics integrate forestry data, it's recommended to use the two-step pace to 66 feet.

- If this exercise is added, build the time into the first exercise for the horizontal fuels diagram.

HORIZONTAL FUELS DIAGRAM & FUELS ESTIMATES (13 Minutes)

This exercise can be done indoors using Google Earth and a projector with a bird's-eye view of the area where the follow up cross-section exercise will be conducted. This can be an easier way to visualize but learning to see and journal a landscape from an imagined bird's-eye view from ground level is a skill that takes development. You will need a nature journal and the story line. Use of a purchased or precut paper viewfinder is also recommended but time and supplies to create the viewfinder has not been integrated into the exercise. Create these before the lesson! Using fingers to frame the scene is also helpful if the viewfinder is not available.

- Gather students into a group (indoors or outdoors) and ask if they can define fuels.
  Discussion: Fuels are burnable materials and mostly focused on vegetation, although buildings and materials can also be included.

- Invite students to open their journals and write down their thoughts and comments from others on the discussion topics.

- Ask students how they would describe fuels to better relate to fire behavior.
  Discussion: Have they ever observed a fireplace or campfire and noticed what is important for starting a fire and what is important for a long-lasting and hotter fire. Small sized vegetation like dried grass, leaves, and twigs are needed for the fire to start, but larger woody materials are needed for fire to burn for longer periods. It's also important to think about the amount of fuels and how they are arranged and how that influences fire spread across a landscape.
    - A key term used in fuels and fire behavior is called "**carrying fuels**". This is the vegetation that most often spreads the fire across the surface of the land. Do you remember in the early lesson about terrain, how we used the speed of a tortoise and of a sea turtle to visualize the fire rate of spread?

    - There are topography, fuels, and weather scenarios that can intensify the fire rate of spread and cause the fire to move from the surface carrying fuels up into the treetops (**crown fire**) and where the crown fire can move with or differently from the main surface fire pattern. The carrying fuels are distributed along the surface of the ground and usually includes grasses, leaves, sticks and bushes but can also include fallen logs, fences and other materials touching the ground. Fire practitioners define these horizontal surfaces and carrying fuels as **light, heavy, uniform and patchy**.

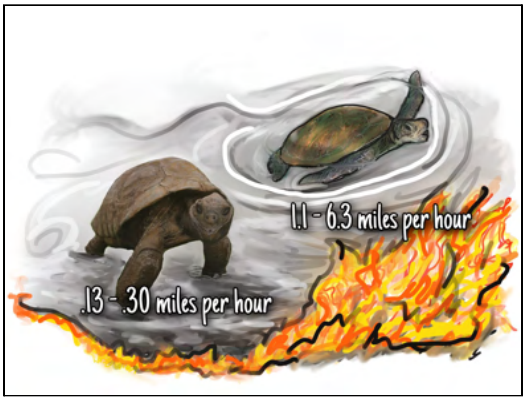


Figure 1—Light Fuels

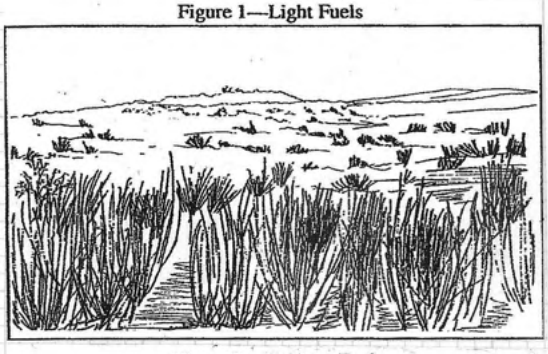


Figure 2—Heavy Fuels

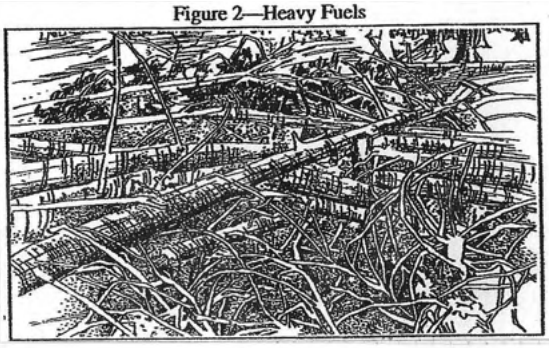


Figure 3—Uniform Fuels

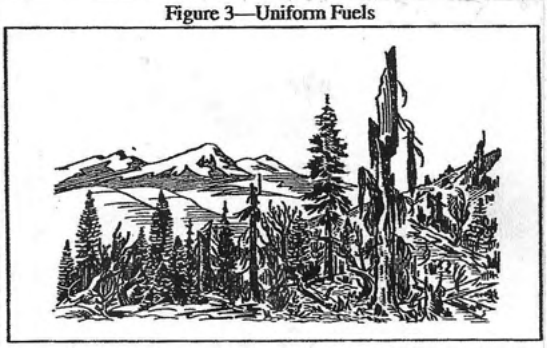
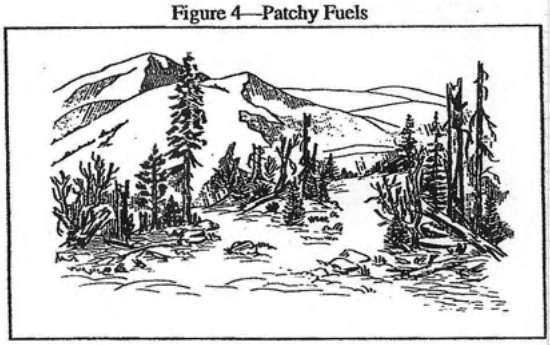


Figure 4—Patchy Fuels



- Discussion: Fire scientists and specialists have many ways to define fuels based on the different types of vegetation communities, concentrations and arrangements (fuel models) and how they will burn, but what is most important for basic nature journaling observations is to think about fuels within the basic vegetation types. There are several examples of fuel models at the end of the lesson:
    - **Agriculture**- different crops like corn, vineyards, etc.
    - **Grass** - mostly natural grass areas but could include lawns if defining whether it is watered or not. There may be occasional trees and shrubs but the area is dominated by grass.
    - **Shrubs/Chaparral**- small to large bushes covering dominating an area. There may be a few trees or grassy patches.
    - **Forest**- mostly trees of similar or different age groups. There can be grass and or shrubs in these areas but should be under trees or in smaller open areas.
- If not yet outdoors, head out to an area with the best mix of vegetation. Students can break out into different groups but it will be easier to demonstrate and discuss as a group.
- The journal visual will be created on the story zine but students are welcome to create an initial draft in their journal. It is a simple visual so should be easy to

create on the small story zine space.

- Put a small rectangle in the top 1/3 of the page/zine. To the left of the rectangle box on the page, discuss and create a legend with students using different symbols for the core vegetation types (grass, shrubs and trees) and other fuels as desired.

- Use the viewfinder or fingers to frame the scene to a reasonable size (can see all vegetation elements) that you will be estimating the vegetation types and arrangement within that space. Reassure students that this is just a general estimate so don't worry about capturing all vegetation or exactly where they are located.

- Quickly fill in the vegetation symbols within the box/diagram on the page that most closely estimates the location and arrangement of vegetation types.

- Ask students if they have questions and let them know how much time they have for the diagram (5 minutes).

- At about five minutes into the diagramming, discuss the area within the diagram where the most variety of vegetation elements are located and circle. Have them also label or put questions where they think concentrated pockets of vegetation are.

- Next, have students create a cross-section line across the diagram for the area with the most horizontal and vertical diversity, which will be used for the next exercise.

- Ask students to look at their diagram and discuss what percentage of the area is covered by trees, shrubs, and grass and to write, to the right of the diagram, what the primary fuels/vegetation type characterizes the area and what percent the dominant vegetation types sare. For instance, if trees cover 1/2 or more of the area, put 50% trees and forest dominant fuels.

VERTICAL FUELS & CROSS-SECTION DIAGRAM (25 Minutes)

In this exercise, students will use the cross-section line from the previous exercise to diagram in a new way and to walk along making a few key biometric measurements for a few different vegetation types along the line. The students are looking for areas with concentrated vegetation pockets (jackpots) and vertically connecting vegetation levels from the ground to the tree branches (ladder fuels). If splitting up the measurement

estimates between students, some can measure while shouting out the data for everyone to add to their diagram.

- In the middle and lower 1/3 of the journal or story zine page, put the same horizontal line that somewhat characterizes the shape of the land along the line. You will add the same vegetation elements on both lines but the middle line will be used for estimably ladder fuels, torching and crown fire spread, while the bottom will be used for adding ember materials and ember beds.
    - For the cross-section ground/surface line, if there is a small dip or a moderate hill, the line will estimate that shape. This can be discussed as a group and the teacher can demonstrate or students can all do on their own and then discuss how and why they shaped the line a certain way. It's not critical for the line to be accurate but a good practice to give a sense of space.

    - Emphasize adding vegetation elements along the line where you see potential ladder fuels and a fire might be carried from the surface into bushes and or trees (torching or crown fire) on both the middle and bottom cross-section lines.
        - Use different representational sketches for the vegetation elements than in the first horizontal fuels diagram. These vegetation sketches may be something like stick figure trees, blob bushes, and star people. A legend is not required for this diagram but can be added, if desired.

    - The teacher should demonstrate the first additions of vegetation elements added to the cross-section diagram and discuss how there should be some size differentiation between smaller and larger elements but that there is not enough space to create more accurate differences. The added measurement data will help clarify size differences.
        - For the first vegetation element sketch, add the start person somewhat proportional to the vegetation element. For instance a super tiny person near a tree or a larger star person next to a small bush at waist height.

- When the students come to the first potential ladder fuels, measure the height from the top of the lower vegetation (usefully a bush or small tree) to the bottom of the larger tree branches (bottom of the tree crown). These areas do not need to be touched because flame-lengths can be up to four times higher than the vegetation height so add the vegetation elements measurements and then the following exercise will add possible flame-lengths.
    - In the areas with ladder fuels, stop and look for vegetation elements that can become fire embers or fire brands and ember beds. On the bottom

diagram, add a dot in the bush or tree where there are some potential ember materials and create an arch to the ground to see if an ember bed is there. If there is an ember bed, create a circle at that place on the diagram.

- Fire embers/brands are usually small woody materials blown and carried on the wind like acorns, pine cones, thick leaves, small branches, etc.

- Ember beds are areas with small dry vegetation materials that can quickly ignite. These may be patches of dry grass, dry flowers on a bush, or the crooks and crannies of a tree or building. Depending on the height of the flames, smoke column and speed of winds, embers can be carried a 1/2 mile or more, but more frequently they will drop down directly below the tree or be blown a shorter arched distance. This shorter distance is what we are looking at in this exercise.

- When students come to the tallest tree, work as a group to estimate the height. This will be used to measure the area's overall fuel bed.

- Once the core of vertical vegetation elements have been added along the cross-section diagram with key measurements, stop and go to a comfortable area to work on the diagram and additional journaling exercise

FUEL BED, FIRE TYPES, FLAME LENGTH & EMBER CARRY (10 Minutes)

In this exercise, students will be adding fire elements to their diagrams. To reduce potential traumatic memories and emotions, move away from the actual landscape view of the area and assess responses to the exercise, which can be dropped if needed. Ideally, the simplified sketchy diagrams with simplified fire visualizations and information will be less traumatic. There is a full-sized illustration with key fuel and fire type visuals below.

- In the new and comfortable location for follow up journaling (could be indoors), pull out a few additional color marking materials like colored pencils and go back to the two vertical diagrams on the page to add more information.

- Review the Fuels and Fire Types Illustration below and definitions with students and consider how all of the fire types and behavior are influenced by vegetation conditions.
  Discussion: Fire specialists have defined several different 'fire types' that

differentiate the location and mode of fire movement and associated fire intensities. The primary fire types are:

- **Ground fire**- fire type that is located under the surface fuels and or soil. Ground fire is often in the pyrolysis phase of fire before flame combustion due to lack or limited oxygen.

- **Smoldering**- is a fire behavior that occurs when the fire is not moving and growing and is typically at the start and end phase of a fire/flame combustion, which can vary around the overall fire area based on various conditions like moisture and wind.

- **Creeping**- fire behavior that occurs on the ground and surface fuels that is expanding very slowly with light fire effects and typically less combustion (less of fuels burned).

- **Surface fire-** fire located along the top of the ground and exposed to the elements and can be influenced by weather, topography/terrain, and changing fuel conditions (moisture, arrangement, etc.).

- **Backing-** a surface fire behavior that is moving against the direction of the wind and without strong influences of weather and topography. This fire behavior is slower moving and has lighter fire intensity and effects. At the very start of a fire ignition, the fire often moves in a circular backing pattern until the influence of weather, topography and change in fuel occurs.

- **Advancing/Running**- a surface fire behavior that is moving in the direction of the wind and influenced strongly by weather and topography. This is a faster growing and faster paced fire behavior and can have more intense flames, but usually results in mixed severity effects.

- **Spot fire**- this is not necessarily a fire type but a new ignition from the main fire movement pattern which is caused by embers/fire brands. A spot fire can start to move under the various fire types or behaviors and move or merge into the main fire or move in a different direction and pattern.

- **Torching**- is still considered a surface fire behavior that is typically influenced by ladder fuels that carry the surface fire into a tree crown. It is part of the surface fire behavior because it is still moving within the primary surface fire.

- **Jackpot-** is a fuels scenario or condition where a concentration of vegetation materials burns at an increased fire intensity. The jackpot can

be a heavy load of fallen branches and logs, a thick bushy area or a concentrated pocket of trees. The increased fire intensity of a jackpot can cause a surface fire to move into the crown with torching or crown fire.

- **Crown fire**- is a fire that occurs in the tree crowns and can move independently of the surface fire. This fire type has more fire intensity, severity and adverse fire effects.

- **Smoke Column**- is not a fire type but the result of more severe fire combustion and an organized large concentration of smoke which can carry fire embers higher and farther away. Smoke columns can also be blown by winds and lean up steep slopes igniting an entire hillside.

- Ask if there are any questions related to the fire types and behavior.

- Create a mark at the right or left side of the middle diagram at the height of the tallest tree/vegetation and pull down to the ground and label it as the fuel bed. The fuel bed is the entire vegetation height in the area.

- Go back to the potential ladder fuel areas on the middle diagram and calculate what the flame length could be for the lowest vegetation first. A very generalized formula for determining flame length is that for every 1-foot of vegetation height, there will be a 4-foot flame-length. Does the flame length reach the lower branches of the taller bush or tree? If yes, create the outline shape of a flame behind the lower vegetation and the taller vegetation (tree) and add the potential flame lengths of those vegetation elements since there is a possibility the surface fire could be carried into the tree.

- Underneath the horizontal vegetation diagram line near the ladder fuels, add the label ladder fuel.

- Look at the ladder fuels and see if there is a single tree that could catch fire. If so, label that as torching. Do the ladder fuels connect to multiple trees that are close to each other and where fire could move from tree top to tree top? If yes, label that as crown fire.

- Look back at the top diagram for horizontal fuels and consider if there are continuous surface fuels? Add labels or notes to relate that observation.

- If desired, go back to the flame areas and embers and color in.

Fuels & Fire Types

Vegetation

Loading

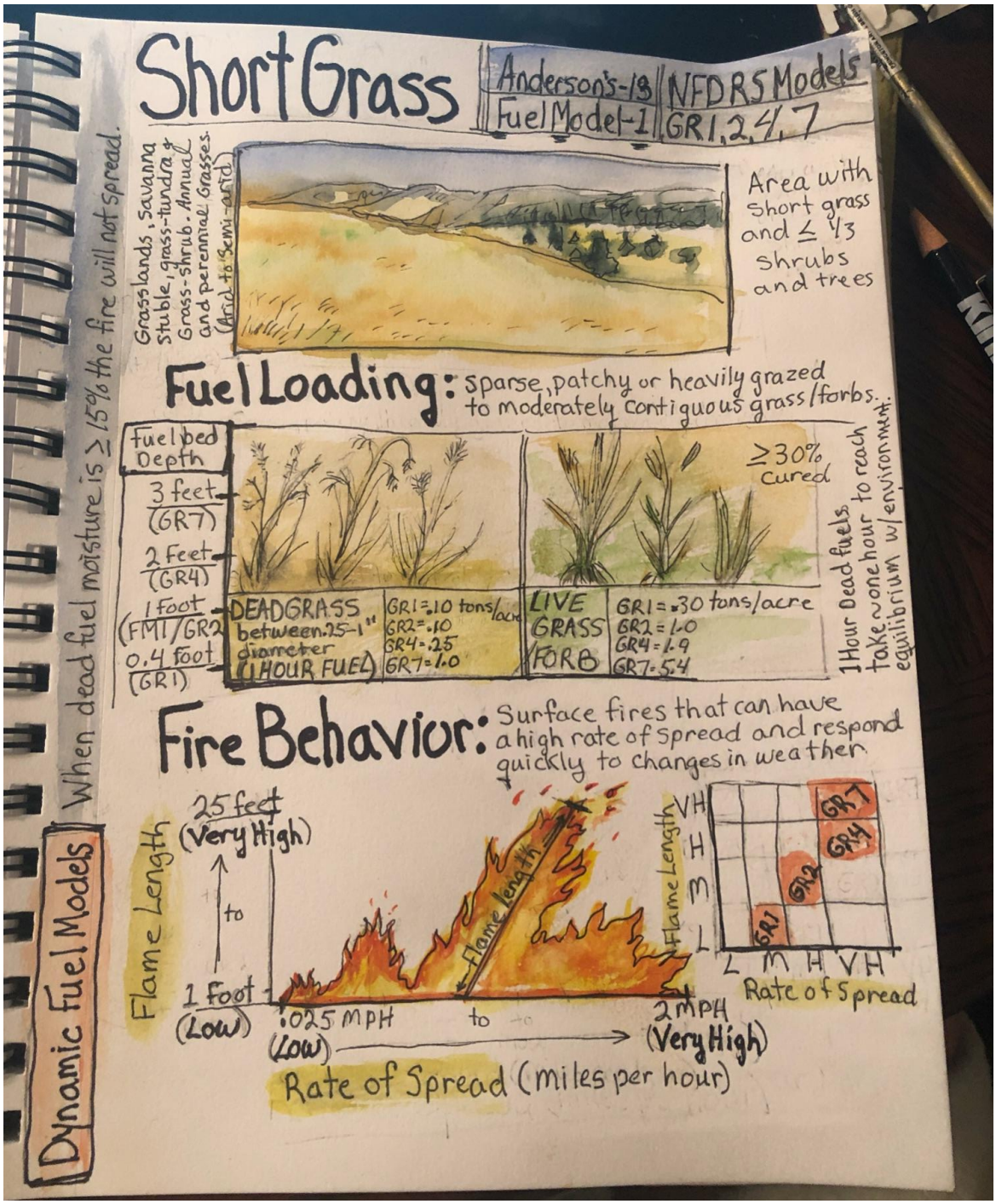
Location

Composition

Arrangement

Illustrations by Miriam Morrill @Pyrosketchology

OTHER FUELS AND FIRE SPREAD VISUAL REFERENCES- Not required for

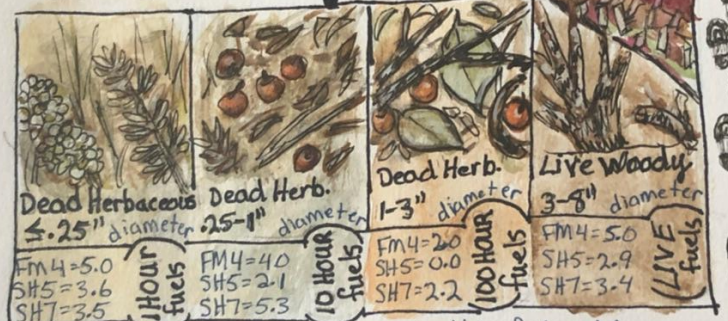


lesson

Chaparral | Anderson's-13 Fuel Model-4 | Rothermel's SH5 & SH7

Fuel Loading:

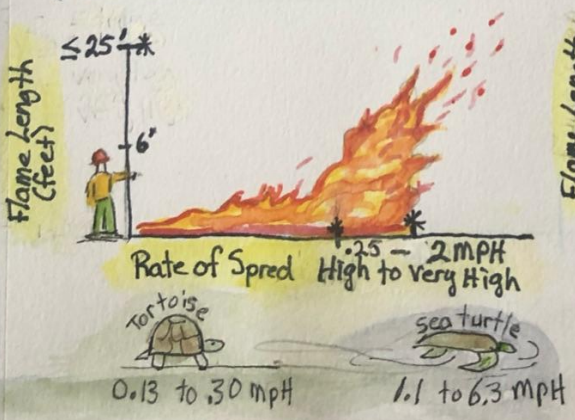
Primary carrier of fire is live and dead woody shrubs- foliage and litter. Heavy fuel loads in mature stands with shrubs six feet or taller.

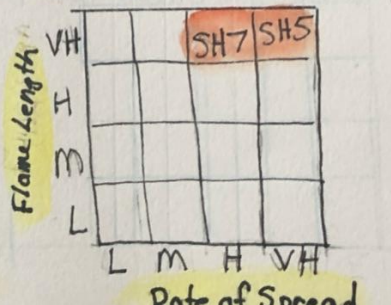


Herbaceous = mostly shrub leaves in this fuel model

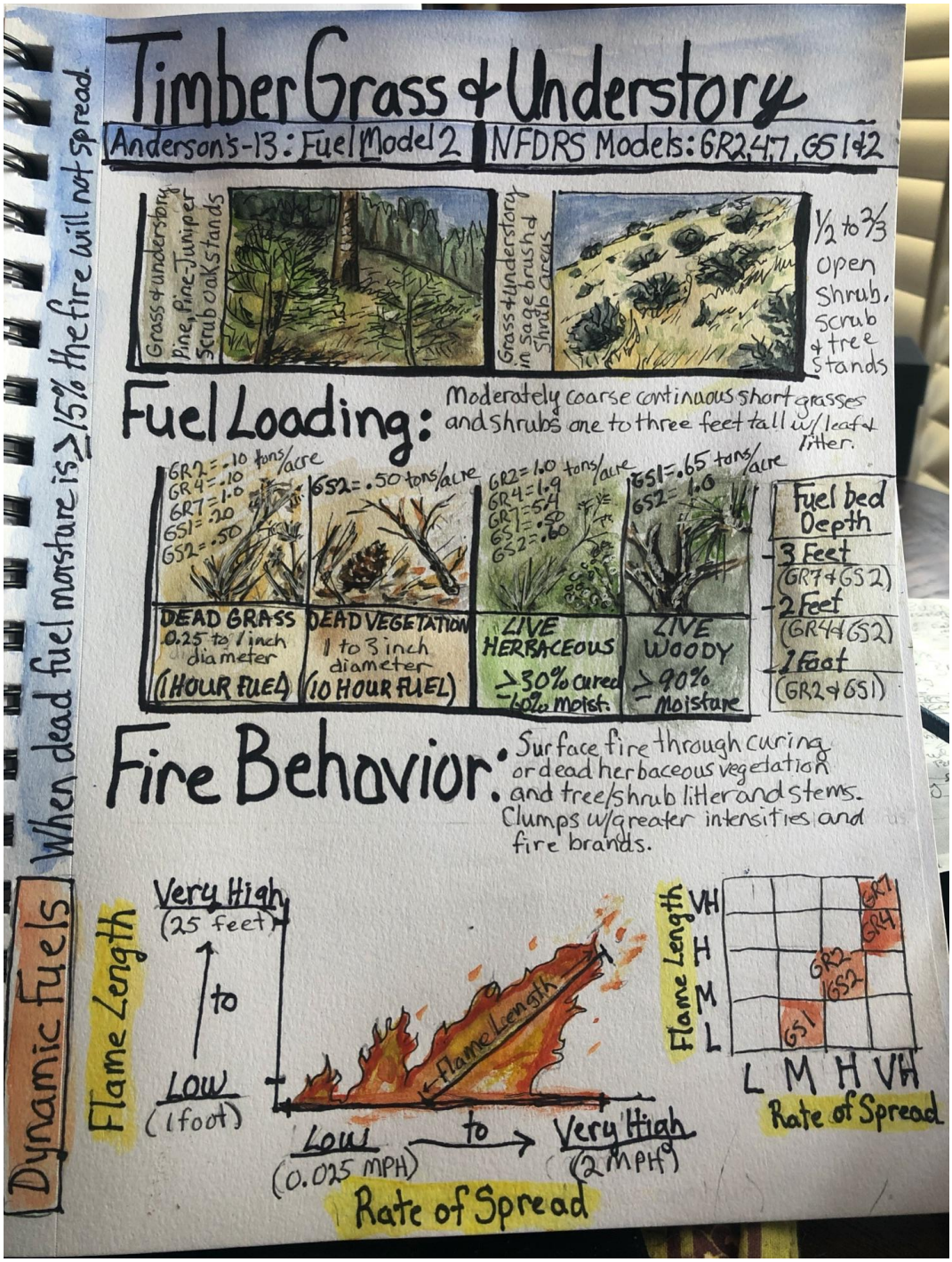
Fire Behavior:

fires intense and fast moving.
Deep litter may hamper suppression efforts.
Dry shrub flowers may increase ember ignition.





When the dead fuel moisture is @ 15% (SH5 + SH7) to 20% (FM4) the fire will not spread


Timber Grass & Understory
Anderson's-13: Fuel Model 2
NFDRS Models: GR2, 4, 7, GS1 & 2
Grass & understory Pine, Pine-Juniper Scrub oak stands
Grass & understory in sagebrush & Shrub areas
1/2 to 3/3 open Shrub, scrub & tree stands
Fuel Loading:
Moderately coarse continuous short grasses and shrubs one to three feet tall w/ leaf & litter.
GR2 = .10 tons/acre
GR4 = .10
GR7 = 1.0
GS1 = .20
GS2 = .50
GS2 = .50 tons/acre
GR2 = 1.0 tons/acre
GR4 = 1.9
GR7 = 5.4
GS1 = .50
GS2 = .60
GS1 = .65 tons/acre
GS2 = 1.0
DEAD GRASS 0.25 to 1 inch diameter (1 HOUR FUEL)
DEAD VEGETATION 1 to 3 inch diameter (10 HOUR FUEL)
LIVE HERBACEOUS >30% cured =60% Moist.
LIVE WOODY >90% Moisture
Fuel bed Depth
3 Feet (GR7 + GS2)
2 Feet (GR4 + GS2)
1 Foot (GR2 + GS1)
Fire Behavior:
Surface fire through curing or dead herbaceous vegetation and tree/shrub litter and stems. Clumps w/ greater intensities and fire brands.
Dynamic Fuels
When dead fuel moisture is ≥15% the fire will not spread.
Flame Length
Very High (25 feet)
to
Low (1 foot)
Flame Length
Low (0.025 MPH)
to
Very High (2 MPH)
Rate of Spread
Flame Length
VH
H
M
L
GR7
GR4
GR2
GS2
GS1
L M H VH
Rate of Spread

8- PLANT & ANIMAL SIGNS: FIRE & HEAT INDICATORS

INTRODUCTION

Students review some climate and fire effects considerations (effects, vulnerabilities and adaptations associated with form and function) along with observable plant and animal signs of the fire environment (heat signs). Students will also learn a little about biophonies and geophonies and how to use those to help enhance fire environment observations.

LESSON OVERVIEW & ESTIMATED TIME (60 MINUTES)

- Student lesson introduction and safety talk (2 minutes)
- Overview and Exercise 1: Cylinder Sound Map (13 minutes)
- Overview and Exercise 2: Effects, Vulnerability & Adaptation (25 minutes)
- Overview and Exercise 3: Climate, Fire & Heat Signs (20 minutes)

MATERIALS & RESOURCES

- Journal or notebook
- Student story zine
- Graphite pencil, eraser, and optional color supplies such as crayons colored pencils and or watercolors.
- Printed illustrations and tables from the lesson.

LOCATION

This lesson can be carried out anywhere with natural plant elements and potential animal observations and signs. The animal observations emphasize insects and birds so most yards, parks, and open areas should work. The more diverse the landscape the better.

BACKGROUND & NATURAL PHENOMENA INVESTIGATED

Using plant and animal observations can be fun but also helpful in showing interconnectedness and deeper ways of knowing the fire environment. The fire environment is strongly influenced by climate and those same climate trends influence plants and animals and can be observed as short-term reactions (heat responses), behavioral changes and shifts distribution. Plant and animal adaptations to the fire environment can also inform us of potential fire effects. Some climate terminology is used to frame observation categories such sensitivity, exposure and adaptive capacity (vulnerability) and build an understanding around effects analysis.

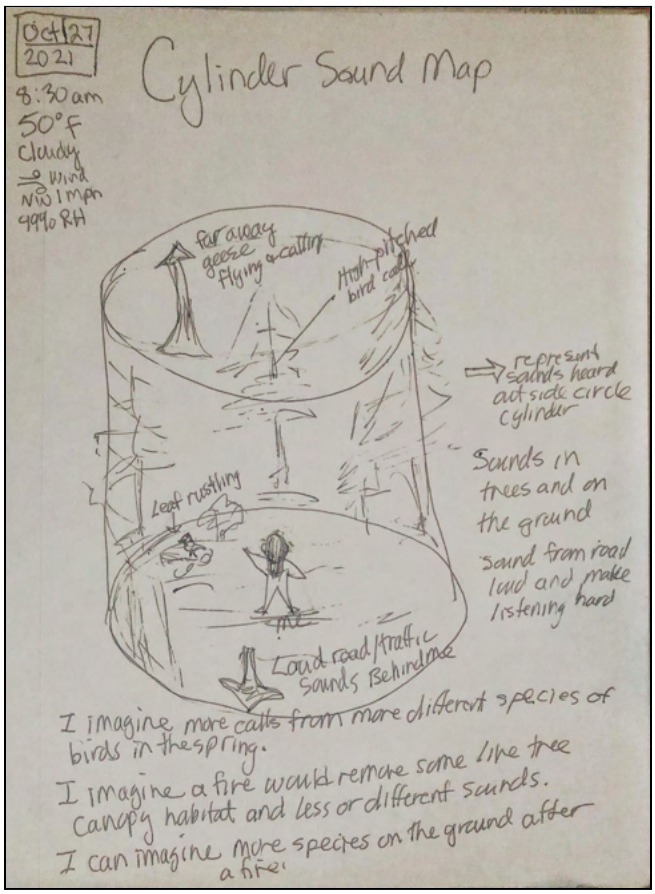
LESSON INTRODUCTION & SAFETY TALK FOR STUDENTS (2 Minutes)

Throughout this guide, you've learned different techniques for making fire environment observations using your senses. In this lesson we are going to use observations of plants and animals and how they respond to the fire environment to inform us. As you've seen, the fire environment is complex and something you can look at close up or

zoomed out, in the moment and over time. In this lesson you'll learn some key information about understanding and analyzing the plant and animal experience within the fire environment and approaches for journaling these observations.

As we go into nature, be aware of your environment and safety considerations. If you are standing under or near a tree, look and listen for wind influences and whether you should move. Be careful where you walk and how you step and point out things you are concerned with.

EXERCISE- CYLINDER SOUND MAP (13 Minutes)



Oftentimes, we narrow our observations to one topic or element like listening to the wind in the leaves. In this exercise, we want to take in all of the things we hear within the area around us. This is helpful for gaining more insight about changing and interactive elements of the fire environment. There is a specialized field in ecology called soundscape ecology, where you study the collective biophony and geophony of sounds in a particular place and time. We know that fire has a strong influence on the structure and function of the environment and thus the soundscape before, during, and after a fire will be different. The soundscape for each ecosystem will be different and each ecosystem will be different in each season and time of day.

- **Biophony**- the collective sound of vocal non-human animals in a given environment and time.

- **Geophony**- collective earth-related sounds in an area like the sounds of a creek flowing, rain and wind.

It's good to start your field observations with listening observations because as you move and interact in an area, many animals will go quiet or leave.

- Quietly gather students into a group near the edge of the natural area you want to observe as a soundscape. Have students pull out their journals and supplies.

- Demonstrate how to create a cylinder on the page by creating a large circle close to the bottom of the page and the same sized circle near the top of the page with lines connecting both circles along the outside. Keep some space along the top, bottom and edges for possible added elements such as underground or high up. This should resemble a 3-D cylinder and is a modified sound map, which is often a single flat circle. We want to know where in the vertical and horizontal landscape these sounds are occurring since this ties to fuels and fire behavior.

- After creating the sound map cylinder, demonstrate how to add a few habitat elements to give a sense of space and structure. Don't try to fit everything in and do this in a very light pencil mark so sound observations can be overlaid. We just want some vertical and horizontal elements.

- Tell students that they can use words, symbols or sketches within the cylinder to note what they are hearing. It will be quicker to work in pencil or pen and color in after they are done. If they choose to use symbols, they will want to create a legend along the side of the sound map. This can be done after the observations are made or as they go.

- Tell students they have five minutes to silently listen and journal what they hear.

- 1 minute before time is up, tell students they need to wrap things up.

- Over the next five minutes, invite students to share what they heard and how they journaled those observations.

- Ask students what changes in the soundscape they would expect to hear in different habitat types, at different times of year, and over different times of day. Have them write their comments and insights on their journal.

EXERCISE: EFFECTS, VULNERABILITY & ADAPTATION (25 Minutes)

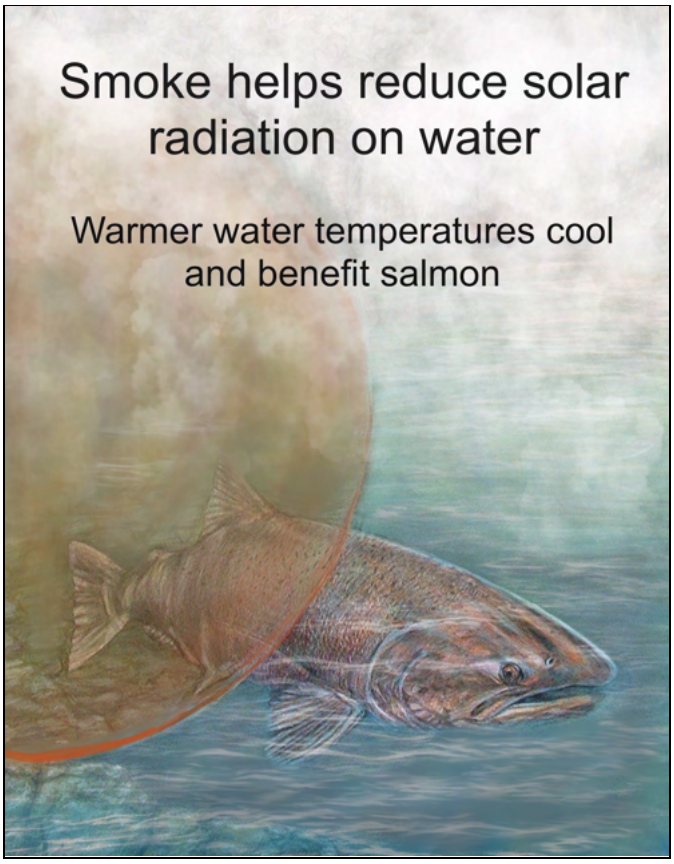
Spend about 10 minutes discussing the following terms and concepts with students and 10 minutes journaling on the story zine.

To connect plant and animal observations to the fire environment, it's important to have some understanding of how fire, weather, and climate can impact them (**effects**). How strongly plants and animals experience effects can be framed around their **vulnerability**. One way to assess vulnerability to the fire, weather, and climate is to look at the level of **exposure** they have, how **sensitive** the plant or animal is, and what abilities they have to **adapt** in response to those effects.

- Gather students together in an area with a variety of natural elements around them. This exercise will start with a discussion and then follow with interactive journaling.

- Ask if they can name or describe what an effect is and what different types or levels of effects that can be experienced. The teacher can point or use natural prompts to help facilitate the discussion.

- Discussion: An effect is a change which is a result or consequence of an action or other cause. There are three types of effects used for environmental analysis: direct, indirect and cumulative.



Direct effects occur in immediate exposure and response such as injury or death from flames.

Indirect effects occur after or as a secondary effect to the plant or animal as a result of the fire. This includes things like impacts to habitat values.

Discussion (Illustration): For example, smoke can have indirect beneficial effects on salmon. In the June 23, 2021 Bay Nature Magazine article, Don Hankins discusses how indigenous burning techniques can be used to create localized smoke with lower intensity burning in mountainous areas to help shade and cool waters for salmon, who require cold water to over summer in streams..

Cumulative effects are those that happen over time and are combined with other disturbances to create a different level of effect. This could include something like drought combined with fire effects having a more significant impact on plants and animals.

Effects can be negative, neutral or beneficial to plants and animals. For example, some hawks, cranes and other carnivorous birds take advantage of fire chasing small animals out of hiding places and hunt around the fire edge. Some Native American tribes used fire near salmon streams to create smoke and help cool water temperatures during hot periods of time. Many insects, birds and mammals are attracted to recently burned areas for easy feeding and hunting. Lizards, birds and deer have been seen rolling in the ash of recently burned areas to help remove parasites from their skin, feathers and fur.

- Ask students if they can describe what makes something more or less vulnerable to different effects. Use natural elements and facilitate discussion around effects and vulnerability to flames and smoke to help describe the terms.

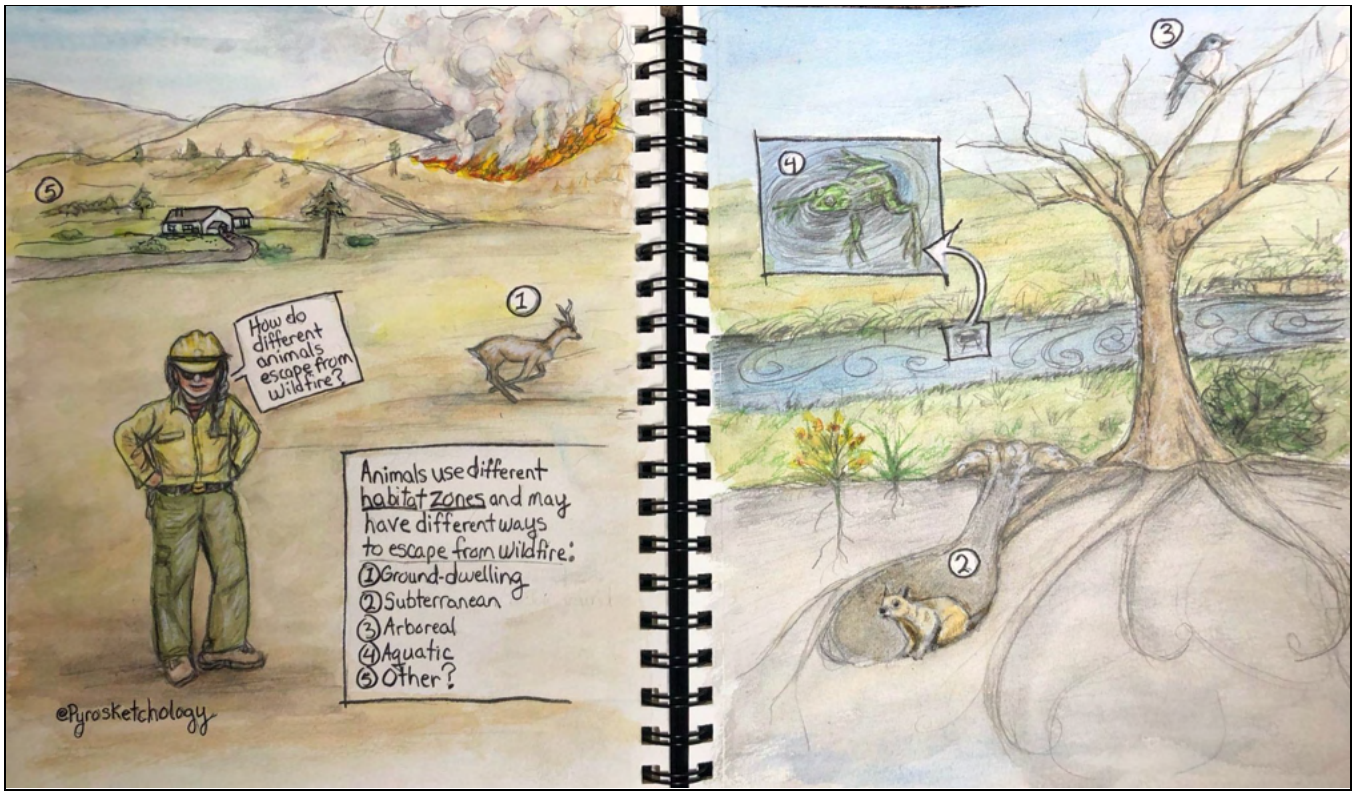
  Discussion: In climate science, vulnerability is commonly framed and analyzed around what level of exposure they have to the effects of… how sensitive they

are to effects of... and what adaptation abilities they have in response to the effects of… Note that this lesson will not emphasize memorizing these terms but use them as prompts to observe things in different ways and to ask deeper questions around this subject.

Exposure- It is helpful to frame exposure to fire (when there are not active flames or burned areas to observe) around the fuels conditions as learned in the previous exercises. Thus, lots of continuous dry grass around an individual plant under observation would likely mean more exposure to fire than a small plant in the middle of a large boulder or rocky area. Lots of dry grass leading into ladder fuels around a tree would create more potential exposure for a bird or bird's nest.

Sensitivity- It's helpful to frame sensitivity around form and function and thus a plant may be sensitive to fire or smoke when it is small, thin, and dry and during its growing and reproductive cycle. An animal may be sensitive if it has small and delicate features such as a frog versus a turtle. Additionally, if it is a form that limits movement away from flames and weather. A tortoise would have a form more limiting than a bird to move away from a fire and weather. The more vulnerable functions for an animal can relate to stages of reproduction such as disturbance to breeding, nesting and rearing of young. Birds are more sensitive to fire during nesting season than later in the year when the young have flown away (fledged). Butterflies would be more sensitive when they are in a caterpillar form.

Adaptive Capacity- For this exercise frame adaptive capacity around how well the plant or animal can respond and recover from the effects of fire and smoke. This may be challenging as an observation if fire has not occurred more recently in an area, but there may still be signs and the questions can be asked by looking at the form and thinking about the function.



- Start as a group, ask students to look around and say out loud what they see and to discuss the effects and vulnerability of those things for 2 minutes.

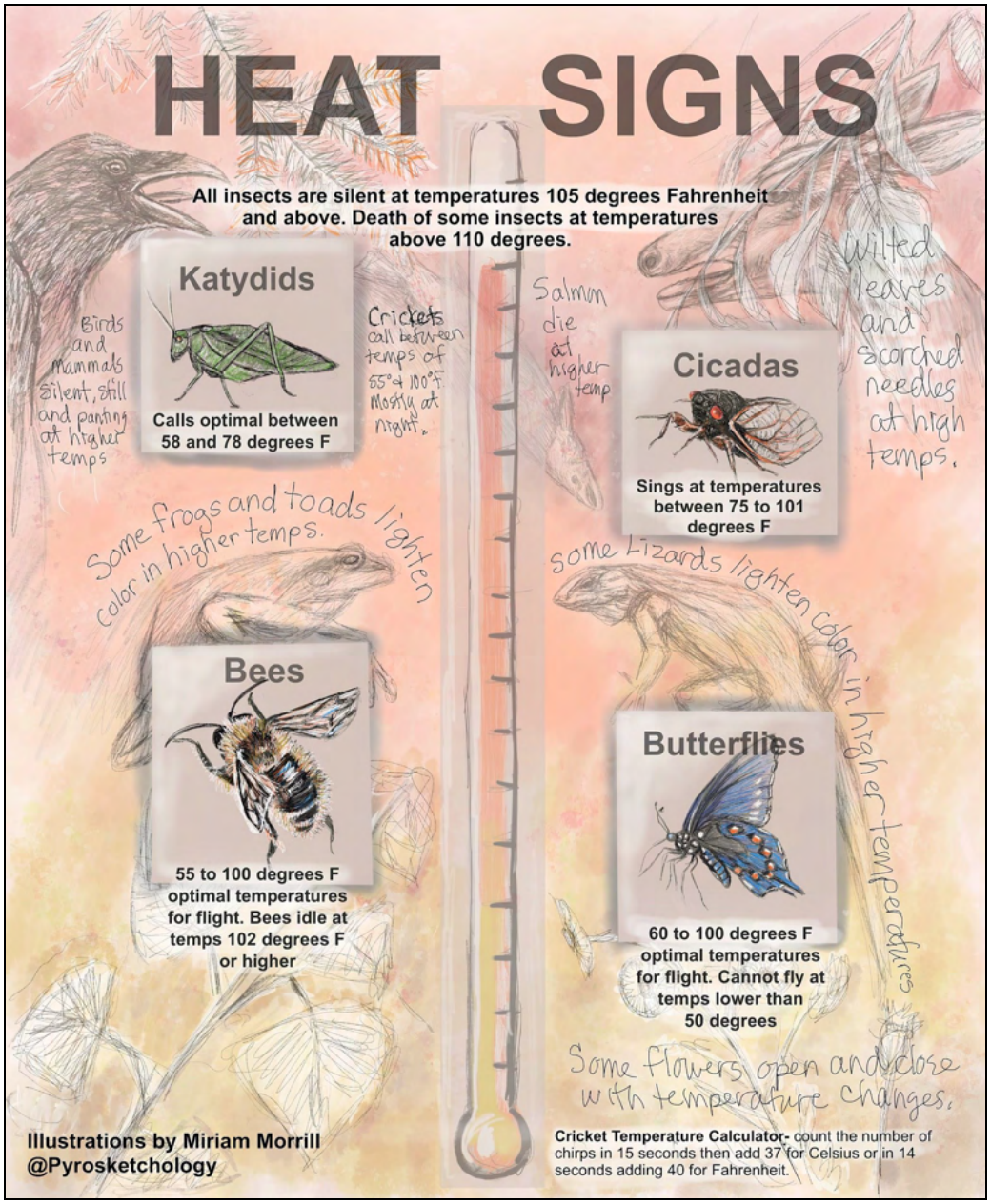
- Ask to spend the next 8 minutes looking at a plant and or animal (or animal signs like sounds/calls, spiderwebs, burrows, nests, tracks) and put one or more observations on their story zine. For instance, if they see thick bark on a tree or an animal burrow, sketch the observation and ask questions or make assumptions related to fire effects and vulnerability.

EXERCISE: CLIMATE, FIRE & HEAT SIGNS (20 Minutes)

In this last exercise, we are expanding from fire and smoke effects, vulnerability and adaptive capabilities to considering the broader fire environment and climate influences using plant and animal observations. In the context of weather and climate, we are focusing on temperature (hot) and precipitation (dry) conditions.

- Ask students if they can describe how hot temperatures and dry conditions can affect fire.

  Discussion- In previous lessons, we learned how weather (hot, dry, and windy) conditions create what is called fire weather. This is the period when fire behavior can be most extreme. These hot, dry and windy conditions influence fire season and fire weather, but what about ongoing trends over longer periods of time —climate? If hotter temperatures are occurring earlier, later or longer in a year or during nighttime hours when temperatures in the past were cooler, plants and animals can be impacted in many ways.



Discussion- In climate science, the temperature range that different plants and animals have adapted to is called a **climate envelope**. This is not just the comfort zone, but the temperature range needed for long term survivability of individual and sometimes species. We've seen the change in climate envelope happen across many mountain ranges in the United States including the Sierra Nevadas. The local climate and environmental conditions are changing and many plants and animals are trying to survive in conditions at the edge of their climate envelope. One approach to help plants and animals adapt during climate changes is called **assisted migration**. This is when specialists bring plants or animals into a different area where they may survive better than the species previously there and survive into future climate conditions. This tool has been used to bring tree seeds from lower elevations into some burned areas on federal lands in the 2018 Camp Fire area. Hopefully this will allow a new generation of trees to survive.

    - There are plant and animal signs we can observe that can inform us when the weather and climate are having negative effects. For instance, when trees are too hot, they close their stomata/pores in their leaves and can starve if hot conditions last too long. Sometimes, leaves are scorched and can no longer create food and sometimes, extreme cold and hot temperatures along with drought conditions can cause a stroke (embolism) in a tree's vascular system (xylem and phloem) crippling portions of the tree. When trees are under these stressful conditions, they struggle to fight off insect infestations like the beetle kill we've seen in many forests.

        - Signs of hot and dry conditions can include wilted or scorched leaves and needles and pitch streams coming down a tree trunk. Clear pitch is a sign that a tree might recover from the stress, but when there's dust from beetle larval activity (frass) that can give the pitch a red color, this is typically a sign the tree will die.

- Ask students to spend the next 10 minutes looking at the illustrations in this lesson and journaling their thoughts and memories about plant, animal and human responses to hot and dry conditions. If there is more time and the lesson is being conducted during the summer or early fall season, consider looking for heat signs and journaling observations. This is often more observable along the edge of a forest or open area where the plants and animals are more exposed.

    - Some of these signs may be from normal seasonal phenology changes (drying grass and seeds) and some may be signs from extreme events. Ongoing observations along with weather and climate data can help differentiate or add context, but are not required for this exercise and for becoming aware of the signs to look for.

9- ILLUMINATING FIRE PRACTICES: PLACE-BASED KNOWLEDGE

INTRODUCTION

This lesson gives an introduction to some fire readiness actions (Ready-Set-Go), risk perceptions, and trauma resilience and integrates elements learned in this guide. The lesson would be best served in teams or group discussions and if able to integrate parents and fire partners would be greatly enhanced. Although, this can be done alone or as an individual.

LESSON OVERVIEW & ESTIMATED TIME (60 MINUTES- with Optional Homework 1-4 hours)

- Student Lesson Introduction (2 Minutes)
- Fire Prevention, Mitigation and Readiness Overview (15 Minutes)
- Exercise: Nature Journaling Integration Comparison Table (18 Minutes)
- Exercise: Nature-Informed Ready-Set-Go (15 Minutes)
- Exercise: Personal Readiness Sentence and Story Zine (10 minutes)
- Optional Family Homework: Nature Journaling Support for Evacuation Planning (1- 4 hours)

MATERIALS & RESOURCES

- Journal or notebook
- Student story zine
- Graphite pencil, eraser, and optional color supplies

LOCATION

There are no field exercises in this lesson although a natural setting for the discussion and writing activities could be used and offer prompts from previous lessons. The optional family homework would require outdoor time around the home and evacuation route(s).

BACKGROUND FOR LESSON

There are many terms and approaches to enhancing fire readiness and resilience. It can be helpful to frame discussions by fire prevention, mitigation and readiness. In fire prevention the focus is on preventing unwanted human-caused ignitions, which is tied strongly to seasonal and fire weather elements that influence fuel moisture and the fire use and behavior actions that are a high ignition risk. Fire mitigation generally assumes that a fire will occur and that fuel reduction (reduce fuel continuity, ladder fuels and ember spread) projects can help reduce potential fire intensity and spread. Fire readiness can include land owner, homeowner, and fire agency planning and training, along with fire prevention and mitigation actions timed appropriately to address fire risk and hazards. The Ready-Set-Go program is a fire readiness approach that many fire agencies support in California and could tie in well with fire journaling practices.

A big challenge in fire readiness is understanding and addressing risk perceptions and trauma responses. Risk is when something of human value is at stake and the outcome is uncertain. Studies have shown that what is meaningful about a place shapes how

people perceive and experience risk. A big disconnect in shaping fire risk and readiness is that fire has been excluded from the landscape and culture. The idea of fire as a regular part of the landscape is not well adapted or integrated into the individual and community sense of place. A sense of place is the personal characteristics we associate with a place that people build and adapt their lives around. For example, those living in areas with four seasons evolve and interweave their sense of time, habits, and home with those seasonal conditions. The uncertainty of fire effects and or effectiveness of fire readiness actions can have a crippling effect on people, especially with little understanding of how fire functions in the local environment. The goal for nature journaling the fire environment is in great part to help reconnect that awareness and understanding of fire in the local landscape, thereby reducing some level of uncertainty. There has been a growing level of support for Indigenous cultural burning practices which integrates the place-based knowledge of fire with cultural practices and sets a great example for a fire integrated sense of place.

The growing trauma associated with fire also contributes to the challenge of fire readiness. When the topic of fire is stressful and some sensory memories such as the smell of smoke can trigger traumatic memories, responses can be limited. Calming and warm up exercises can be integrated into nature journaling learning exercises or fire readiness efforts. Sensory exercises can be used to recalibrate associations with information and nature cues. Integrating nature observations into readiness planning and implementation may offer a more creative and trauma-resilient approach to fire readiness.

STUDENT LESSON INTRODUCTION (2 Minutes)

In this lesson we will review some concepts and approaches to fire readiness and you will consider and recommend how nature journaling can be used to support programs like Ready-Set-Go.

FIRE PREVENTION, MITIGATION & READINESS OVERVIEW (15 Minutes)

- Does anyone know what the word readiness means?
  Discussion: Readiness is a state of being fully prepared and willing to do something...we are relating readiness to fire.

- Can anyone describe different ways that we get ready for wildfire? Would this readiness be different for prescribed fire? What is the difference between a wildfire, prescribed fire, and cultural burn?
  Discussion: This can be a very open discussion but should touch on:
    - **Wildfire-** also known as wildland fire, is a fire that originates from an unplanned ignition. That ignition can be a natural ignition source like lightning or an unauthorized and accidental human caused ignition like an escaped campfire.

    - **Prescribed fire**- also known as a controlled burn, is a planned and prescribed fire set intentionally for the purpose of vegetation (fuels),

habitat, or agricultural management.

- **Cultural burn**- is a fire ignited by Indigenous custodians or people given their permission and guidance. The use of fire is specific to each location and cultural value such as a burn to reduce understory grassland or riparian vegetation conditions for basket weaving materials and food sources.

- **Fire prevention-** tracking and estimating when and where unwanted/unauthorized human caused fires may start (ignite) based on things like fuel moisture and fire weather and how to prevent them.

- **Fire mitigation**- reducing the intensity and spread of potential fires by clearing hazardous fuels around homes and neighborhoods. Think about fuels continuity, ladder fuels and ember materials and how those conditions can be improved.

- **Fire readiness**- is a state of being fully prepared for wildfire- land owners, homeowners, and fire agencies with plans, skills, training and projects in place before a fire puts that at risk.
  - The **Ready-Set-Go program** is a fire readiness approach that many fire agencies support in California and could tie in well with fire journaling practices.
    - **Ready**- fuel treatments in place to help reduce fire intensity and spread. Homes are built or updated with less flammable materials, screens cover vents and other things done to reduce the effects of a wildfire. Does anyone know where they can find information about making your home safe from a wildfire? Does anyone know of fuel treatment projects and activities around them?

    - **Set**- there is a home and community evacuation plan in place, with people and places identified for temporary relocation, people and animals have evacuation supplies/kits ready and within easy access. Everyone is familiar with the evacuation plan and knows how to communicate during an emergency.

    - **Go**- those people and places with an evacuation notice and or at risk of wildfire, are mentally and physically ready to go as early as possible. Everyone knows how to get alerts or notifications about evacuations and emergencies.

EXERCISE: NATURE JOURNALING INTEGRATION COMPARISON TABLE (18 Minutes)

- Ask students to get their journals out with a pen or pencil and create a comparison table with three columns labeled Prevention, Mitigation, and Readiness. Mitigation can include a mix of prescribed fire and cultural burning.

- As a class, facilitate a 10 minute discussion around what nature information and observations could be used to help with fire prevention, mitigation and readiness efforts. Students will discuss and add that information to their comparison table.

- Explain how some thoughts and information may fit in multiple columns and a tool to save space but make connections between categories is to use arrows, circles and icons to link the information. There are techniques used in graphic facilitation at meetings and conferences but also important ways to review and connect information and ideas within a journal page.

  Discussion: In the comparison table columns or as notes, add ideas for the fire information/nature observations, journaling techniques and visuals thought could be used for the key fire prevention, mitigation, and readiness activities. For example, would you use the emergence of bees and butterflies to inform you when spring has arrived and you should start some of your early fire readiness efforts? Would you use phenology observations of grass drying and seeding to help inform you that fire season has started? What about the journaling exercise and visuals that you could use? When would you use a map, diagram, or table? Would you organize the information by physical location of the observations...sky observations at the top of a page and fuels observations at the bottom of the page? Would there be symbols or icons that could be used to help accentuate and organize key observations?

EXERCISE: NATURE-INFORMED FIRE READY-SET-GO (15 Minutes)

- Tell students they will have ten minutes to work independently looking back over previous REDI lessons and their journal pages and write about their thoughts on how to use nature signs and information to help with each phase of Ready-Set-Go.
  - For example, the Ready phase may include thoughts on the lesson about vegetation arrangement, the Set phase may include information from plant moisture and the Go phase may have thoughts from the weather lesson.

- Ask students to also include their feelings about fire and fire readiness. Explain how this is important in the preparation process because our feelings influence our motivation and learning abilities.
  - It's helpful to use journaling techniques to accentuate internal observations. You can create a special location on your journal page, a special table, color-coded or highlighted box or an icon like a heart. Personalizing your journal with your own meaningful icons and page design is key to developing a nature journal that is easy to look back on and used as a learning tool.
  - You can also develop specialized symbols, icons and emoticons to better accentuate sensory observations. For example, the nature journal page below was started with an outline on each page, which defines what information goes where and functions as a reminder for what to look for and observe while in the field. The portrait/facial images are used to connect and accentuate key sensory observations.

    - Students can use words, pictures and numbers to convey their thoughts about nature journaling and fire readiness and it can be helpful to frame their thoughts around ‘I notice…’. ‘I wonder…’, and ‘It reminds me of…’

- After 10 minutes, give students heads up that they need to wrap things up and that they will discuss and share their thoughts with the group. There are five minutes for this group discussion.

EXERCISE: PERSONAL READINESS MOTIVATIONAL SENTENCE & STORY ZINE (10 Minutes)

- Have students keep their journals open but also get out their story zine to a new page with their pencil/pen and some color supplies.

- Students have 10 minutes to create a severn word fire REDI story about themselves.
    - For the first 3 minutes, invite students to write words in their journal that best describe how they would feel and behave (actions and habits) if they were fire ready and fire REDI. They can use words out of the REDI guide introduction or come up with anything that defines how that way of being would look and feel.
        - If students are struggling, help them think about descriptive words they might use.
    - For the next 3 minutes, have them pick the best seven words out of their list. Have them think about the words that can be used in a sentence.
    - For the next 4 minutes, ask students to make a sentence out of those seven words and write that on their story zine page. They can add colors and or patterns to those words and or change the font size and shape to make the sentence more vibrant and interesting and to accentuate the more motivational words.

- A few minutes before their time is up, mention that they should add their name, school, grade, town, and community on the back page of the story zine.

END OF REDI MASTER GUIDE LESSONS (EXTRA HOMEWORK EXERCISE ON NEXT PAGE)

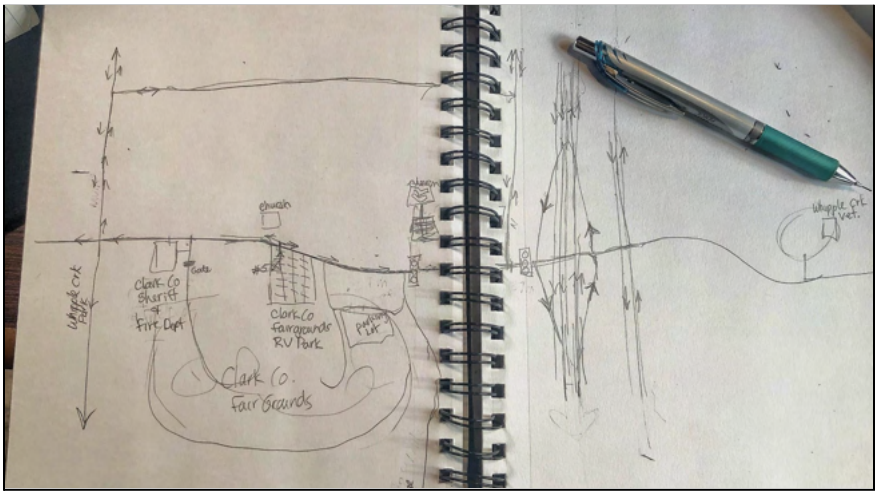
OPTIONAL FAMILY HOMEWORK: NATURE JOURNALING SUPPORT FOR EVACUATION PLANNING (1-4 Hours)

This exercise is recommended for a family but could also be conducted during a facilitated intergenerational evacuation planning workshop. This is not intended to replace or serve as an evacuation plan but demonstrates a process that puts your thoughts on paper and incorporates sensory and place-based information into your evacuation planning process. If there is an official community or city evacuation route, have a copy of that available to compare once you've completed this exercise so that you can compare what your personal and family thoughts and reactions are and how that may influence existing and expected evacuation routes.

STEP 1 (DISCUSS): As a group or family, discuss what elements you would put on a map to describe access in and out of your home and property. Should you include your

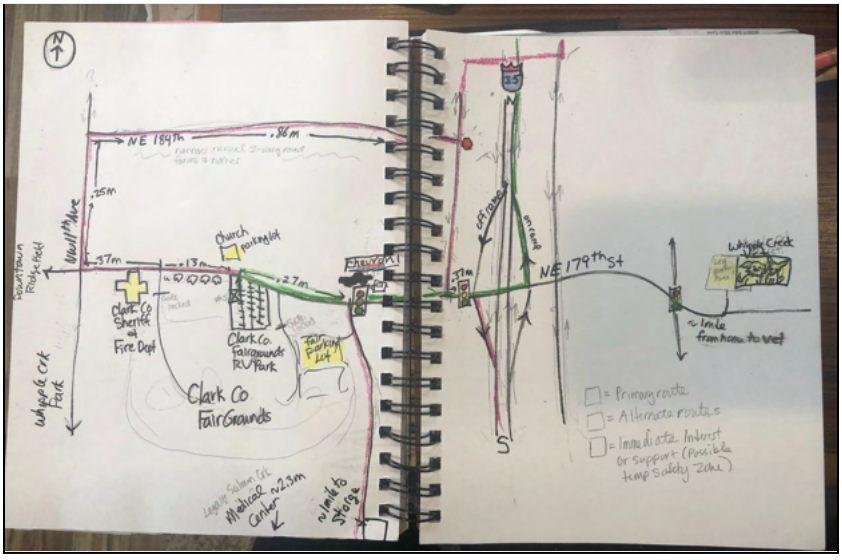
home, other buildings, walkways, and roads? What about vegetation elements and terrain?

STEP 2 (IMAGINE / REMEMBER):



Use a pencil to create a hand map of what you remember or assume is your physical evacuation route. Leave lots of blank space and don't worry about exact measurements or proportions.

STEP 3 (GROUND TRUTH / OBSERVATIONS)



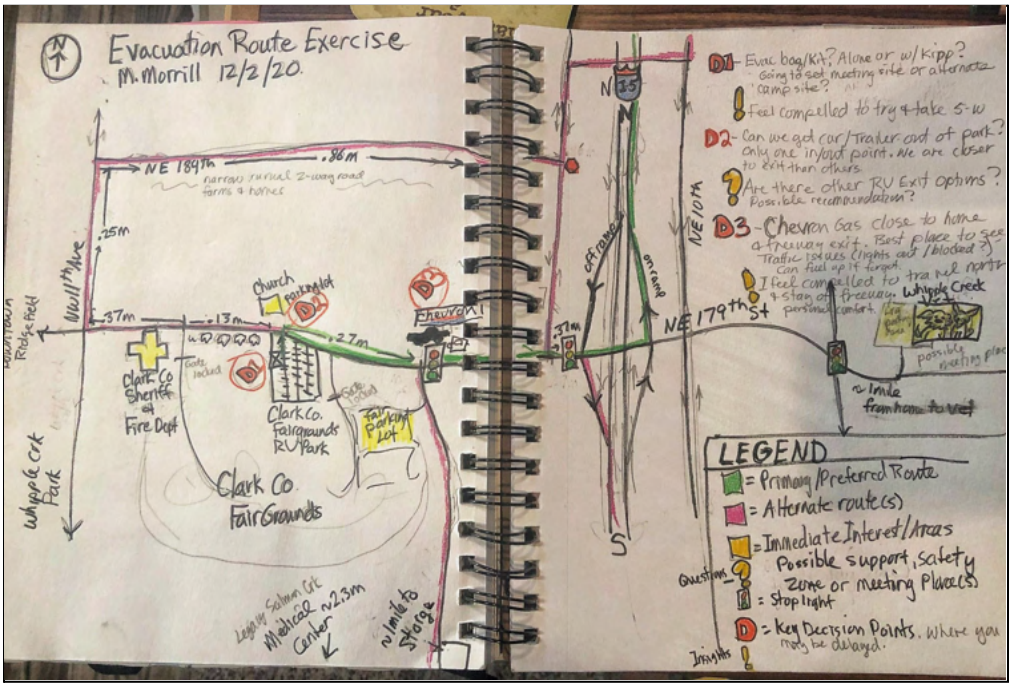
Bring your journal or sketchbook with pencil and color mark-making materials and walk and or drive a portion or all of your evacuation route. Add the key visuals and data about your route with darker and or colored materials to accentuate and differentiate. You don't want to add too much information and make your journal page and evacuation too complicated to look at.

This is the 'I notice' approach in nature journaling and is looking at observations (words, pictures and numbers like title for a landmark, symbol for a stop sign and mileage for distance.

Also stop and use all sense to acquire information. Do you smell trees, a bakery or cattle? Add those notes as well.

Imagine if it is dark out or smokey. Will things look different? What might stand out and be a good landmark?

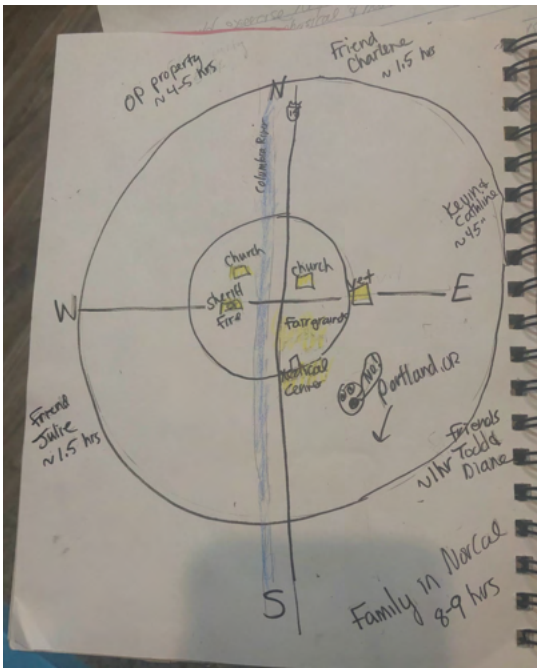
STEP 4 (ANALYSE / QUESTIONS):



Discuss what you noticed and what questions and thoughts you have about the evacuation route. Do these questions come up at certain points along your evacuation route?

Add key decision points, questions, and insights along your route. Think about and discuss what physical elements or scenarios might complicate the evacuation process. Will certain times of year or day be different? What if one route is not available or you need to walk instead of drive?

Use icons along the map and add more details in another space or page to capture this thought process.



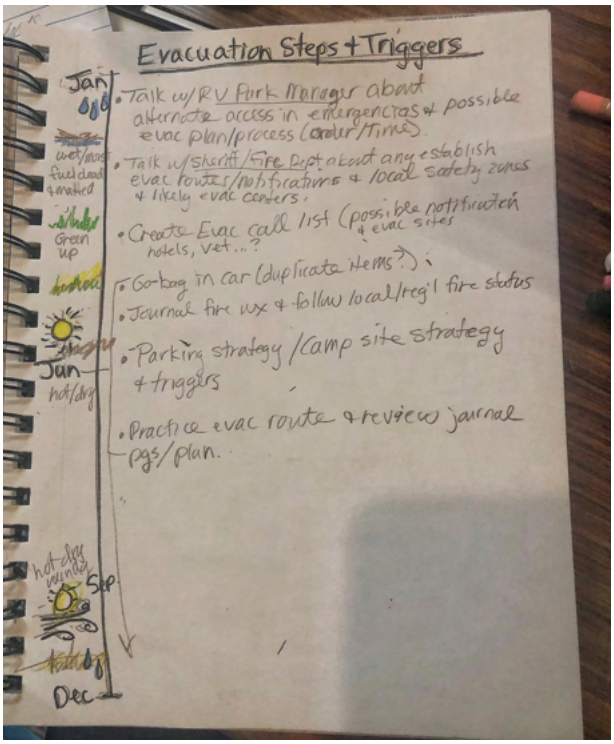
STEP 4 (ZOOM OUT/ SEE DIFFERENTLY):

In nature journaling and observation skill development, it is important to look at things in different ways. For evacuation planning, it could be helpful to shift the discussion and analysis based on mode of travel.

Discuss if you needed to travel on foot. How far would you travel? What are the landmarks and elements within that area?

Create a circle diagram (X/Y axis/cardinal directions) that has a close/on foot zone and expanded considerations in blank space or another page (I wonder). Were there any insights or questions? Write down your thoughts and feelings in your journal and use symbols or colors to accentuate information follow up or personally sensitive considerations that may need more discussion or support.

STEP 4 (TEMPORAL CONSIDERATIONS):



Go to a blank page in your journal and discuss timeline considerations. This is a good section to integrate Ready-Set-Go and nature informed observations like seasonal observations and fire weather triggers.

This is also a good exercise to consider when and where you get your alerts and adding additional notifications such as fire weather (red flag) and adding that information review into your timeline.

Add a timeline line/diagram with icons and notes for things to remember based on the thoughts and issues from your maps (It reminds me of).

Effective evacuation planning considers not only developing,reviewing and practicing evacuation routes, but the best timing to have the go-bag ready and the best time to leave based on the unique place-based situation.

OTHER FIRE JOURNALING RESOURCES

TRAUMA-INFORMED AND OUTDOOR EDUCATION RESOURCES

1. San Mateo County Office of Education
   Environmental Literacy and Sustainability Initiative (ELSI)
   http://workshops.sjcoe.org/Uploads/81220198145795862.pdf
2. Southern Oregon Fire Ecology Education (SOFEE)
   Website for Community Relief:
   https://www.soesd.k12.or.us/southern-oregon-fire-ecology-education-wildfire-recovery-relief/
3. Environmental and Climate Change Literacy Project and Summit (ECCLPS):
   "ECCLPS brings together educators, faculty, and researchers across the University of California and California State University systems, as well as environmental advocates and policymakers, to advance PK–12 environmental and climate change literacy by focusing on the preparation of current and future teachers. ECCLPS is grounded in the idea that, now more than ever, climate change is an urgent issue that must be addressed and education must be part of the solution."
   https://sites.google.com/tenstrands.org/ecclps/report
4. The models of the international Trauma Resource Institute:
   "The Trauma Resiliency Model (TRM)® and Community Resiliency Model (CRM)® are designed to help individuals understand the biology of traumatic stress reactions and learn specific skills to return the body, mind and spirit back to balance after experiencing traumatic events."
5. Outdoor Equity Grants Program
   California Department of Parks and Recreation
   "The Outdoor Equity Grants Program (OEP) will increase the ability of residents in low income urban and rural communities to participate in outdoor experiences at state parks and other public lands."
   http://www.parks.ca.gov/?page_id=30443
6. Paradise Recreation and Park District
   Trauma informed summer camps, presentations, and school site support consulting. samick@paradiseprpd.com

Wrap Around Services/Ongoing Projects*:* A mental health cost-savings formula can be applied to reduce future costs. Once a buffer system is in place, it will save billions of dollars in physical and mental health care. Recent indicators show our biological need for nature healing. Local projects and programs:

- Wrap around services and a system of resilience in place for the community.
- Pop-up camps and resources prepared to support youth before the next wildfire.
- Integrating climate justice and Social Emotional Learning standards.
- *Healing Trauma Through Nature*
  The grant will help coordinate and encourage partnerships with organizations throughout Butte County with the goal to expand outdoor experiences designed to heal youth. 40 local practitioners will be available to provide services. Early participation by local charter schools.

- Resources organized in Paradise can be in place and ready for students after a disaster. Setup for a community center post-disaster (pop-up camps for children impacted by wildfire.)

SENSORY TUNING & TIPS FROM SCOTT AMICK

As part of the REDI guide, Scott Amick M.A., with Paradise Park and Recreation District has outlined some sensory tuning theory and tips to best utilize your senses in order to get the most benefit out of the journaling practices that have come to be a staple in many nature related professions: nature therapy, fire preparation, outdoor education, social-emotional learning programs, and many more. Below you will find a few articles and exercises on the concepts and theories behind sensory tuning, sensory attenuation, sensory deprivation, and sensory awareness.

> *"Getting rid of all sensory input allows the 'constantly-make-sure-you're-not-dying' part of your brain to chill out for a second, allowing the creative, relaxed part of your brain to come out and play.*
>
> *Without the constant pressure of analyzing the world around you, your body lowers its levels of cortisol, the main chemical component of stress. "Your brain also releases elevated levels of dopamine and endorphins, the neurotransmitters of happiness," Graham continues. "Not having to fight gravity lets your muscles, joints, and bones take a well-deserved break. Without the gravity pushing you down, your spine lengthens an inch, chronic pain is relieved, and your muscles get to fully rest."*
>
> *- Seth Stevenson*

Sensory Deprivation
Belle Beth Cooper Article for Buffer - The Power of Shutting Down your Senses:How to Boost Your Creativity and Have a Clear Mind

Summary: By depriving our senses we train our brains to be hypersensitive to input upon reengaging them, which has a myriad of benefits.

Scott's Thoughts: Genius humans such as Leonardi Di Vinci and Nikola Tesla followed napping schedules that resemble sensory deprivation exercises. They were allegedly AGGRESSIVE nappers. How can taking a nap boost sensory input?
Read this article to nerd out on the theory.

Sensory Tuning: Wiki Link on Neuronal Tuning

Research Paper - Why sensory neurons are tuned to multiple stimulus features
This research theorizes that our eyes work very closely with our ears and other sensory input to create very highly detailed sensory input beyond what has been thought to be possible.

Scott's Thoughts: Ever seen a tuning fork? Ever pressed the fork up against your skull? That's right, your senses have a vibrational frequency that they have adapted to interact with. Beyond vibration; light frequencies, temperature frequencies, scent frequencies, and sound frequencies are crucial concepts to understanding the nature of how our senses interact with our environments. What happens when our senses are maladapted or "out of tune" with what they were intended to identify? Short answer, not good outcomes!

Sensory Intelligence and Exercises for increasing Acuity

1. Reduce Visual Input
    a. Lay down in a dark room
    b. Wear tinted lenses
        i. Blue Light Lenses
        ii. Yellow Lenses
        iii. Polarized Lenses
2. Shut out the Noise
    a. Noise canceling earphones
    b. Foam earplugs
    c. Sound insulated locations
        i. Automobiles
        ii. Libraries
        iii. Isolation from populations
3. Reduce Excitatory Tastes
    a. Eliminate sugar for extended periods of time
        i. Its in everything, this one is tough
    b. Eliminate Alcohol
    c. Eliminate Salts
4. Seek out a Sensory Deprivation Tank
    a. SDT's are more and more popular
        i. Read this article on the benefits - also known as float centers
5. "Do the opposite" of the sense you are tuning
    a. A tough one for Scott - Take a vow of silence for a few days to appreciate speaking and the sound of your voice.
    b. Borrow a wheelchair for a few days, or hours, to appreciate the ability to walk.
    c. Keep your music off in the car while driving towards your nature destination.
    d. Read a book instead of watching TV.
    e. Wear gloves to sensitize your hands.
    f. Experience cold to appreciate warmth and vice versa.
    g. Wear a "night mask" after looking at a computer screen for long periods of time.
    h. Wear a swimmers nose plug when you get out of the car and walk with your nose plugged for a few minutes before removing it - you will be surprised at what you can smell.

Note: Each of these recommendations and exercises has a "sweet spot". Be patient with yourself and with your senses, you are both constantly overwhelmed with input.

Each of these suggestions comes with the self awareness option - ask a trusted person/advisor to help you tune your senses and to offer their sensory perspective. The two of you may find out that your senses are tuned perfectly or in complete opposition.

Aim for precision.

Write everything down.

For more on sensory intelligence, sensory tuning, and the correction of maladapted senses, please research Applied Kinesiology or reach out to Scott at samick@paradiseprpd.com.

OTHER REFERENCES & RESOURCES

There are a wide range of nature journalers with different backgrounds and approaches around the world. For those using social media, there is a Facebook group called 'The Nature Journal Club' which is a great place to start. The Nature Journal Club

Roseann Hanson is a great resource for adult and field scientist journaling workshops and guides.

MORE YOUTH FIRE EDUCATION NEARBY

Wildfire in the Foothills
6th-Grade Program from the Butte County Fire Safe Council

Wildfire in the Foothills was updated in 2021 to support students who live in fire-prone areas and to build more fire-resilient communities in Butte County. The program consists of seven one-hour lessons with accompanying PowerPoint presentations for projection in the classroom. The program also offers a Jeopardy-style review game and a culmination activity in the form of a Firewise community meeting and discussion.
Wildfire in the Foothills

FireWorks
Elementary, Middle School, and High School level lessons
The FireWorks Educational Program is produced by the Fire Modeling Institute of the US Forest Service, Rocky Mountain Research Station, Fire, Fuel, and Smoke Science Program.

FireWorks is designed for students in grades K-12 and provides students with interactive, hands-on materials to study wildland fire. While many of the activities can be used in any ecosystem, many are applicable to specific regions. FireWorks has specialized curricula to learn about the Sierra Nevada and Northern California Oak Woodlands. Lessons can be accessed through the FRAMES website.
FRAMES

Outdoor Classroom
A field trip program through CSU, Chico at the Butte Creek Ecological Preserve and Big Chico Creek Ecological Reserve for grades 3-5.

Students participate in California state standards based science activities in which they study plant and animal populations. They work with professional scientists, graduate student researchers, and undergraduates from a number of disciplines. Field trip options include a focus on fire and forest health with live fire demonstrations and experiments. Learn More: Outdoor Classroom

Butte Cal-TREX
Prescribed Fire Training Exchange
https://www.bcrcd.org/trex
Educators and first-time fire practitioners have opportunities to learn about prescribed fire and participate in Butte County TREX trainings.

Project Learning Tree
Stem: Living With Fire
Engage students in STEM as they learn about the importance of fire as a management tool in forestry.
https://www.plt.org/stem-strategies/living-with-fire/

Collected Fire Curriculum
A variety of hands-on lessons and activities that could be used in conjunction with the REDI Jedi guide.
https://drive.google.com/drive/folders/120C0QDmuOp8-DqfZS08u_Mol-jro7fnn?usp=sharing