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.

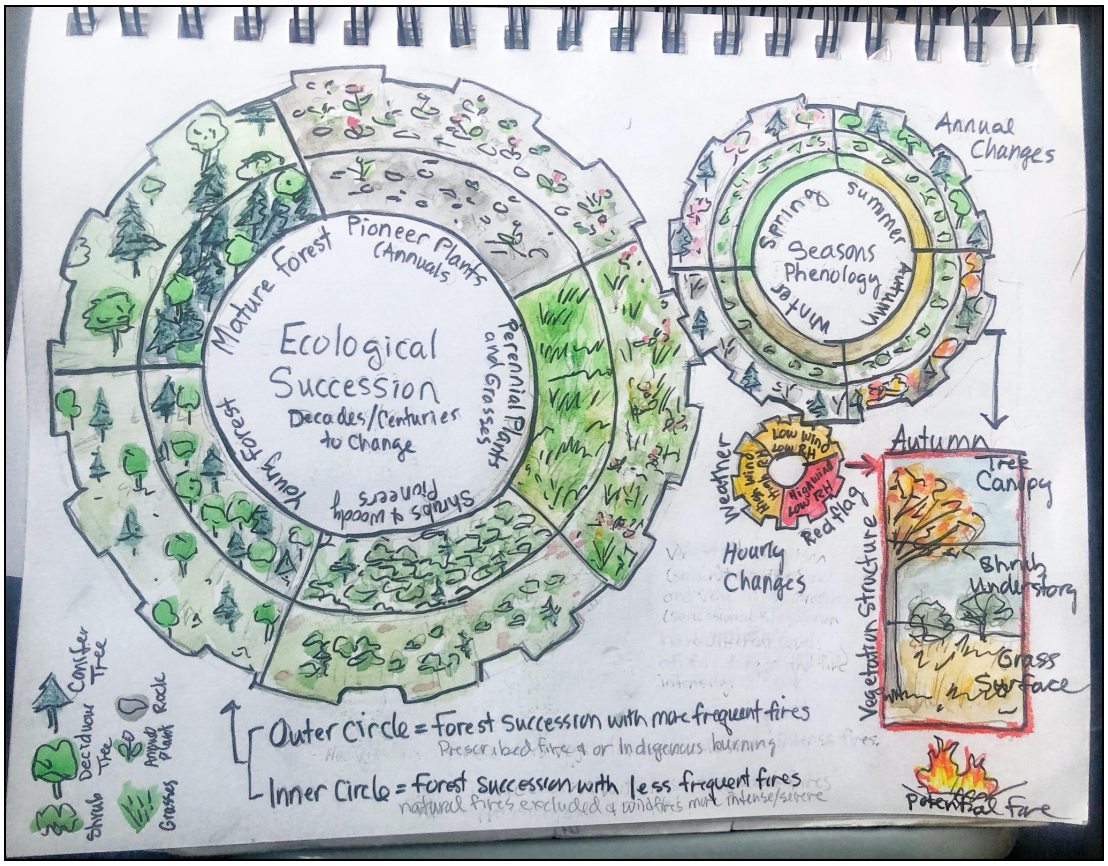
- Tell students that it's time to shift gears and to think visually. Ask students if they have ideas of how they would visualize and journal observations over time.

  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.



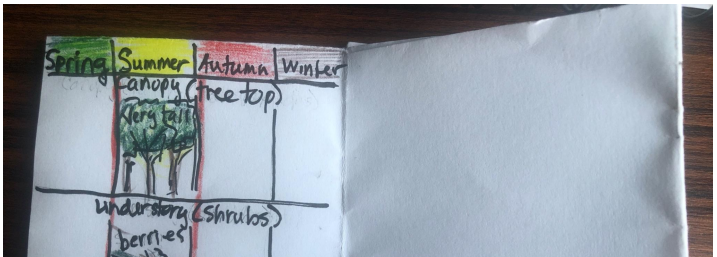
Sketch represents the interacting cycles, of different time duration, including ecological succession, seasonal phenology and weather. The sketch above includes symbolic representations of vegetation communities at different successional stages, colors to represent seasonal phenology changes such as 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

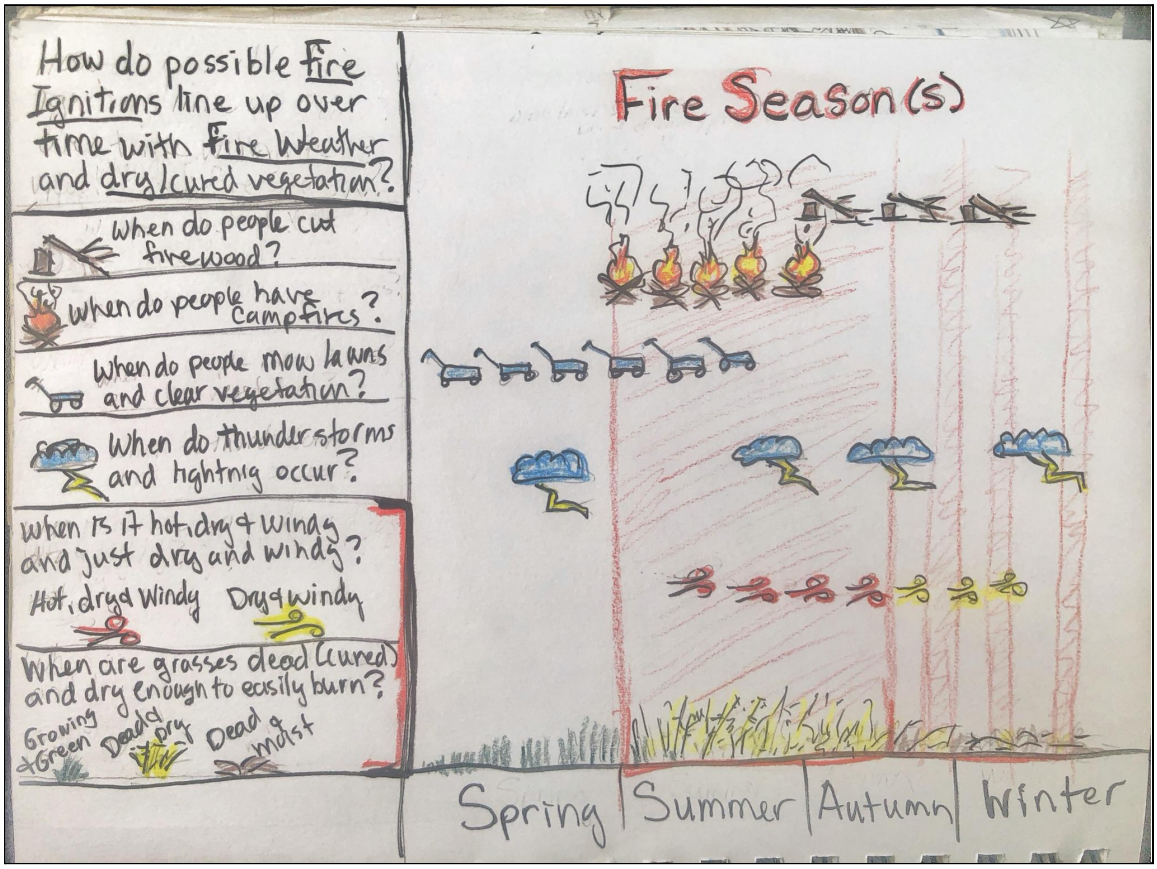
- Tell students that we are going to get out our story zine and go to page two. You will need a pencil and something to add colors. A ruler or something to help create the four-columned table would be helpful.

- 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.

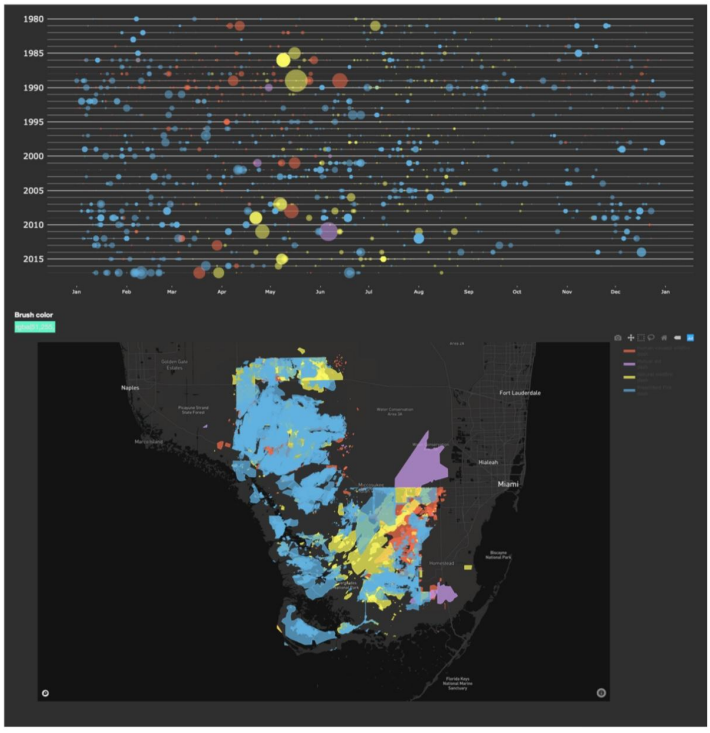
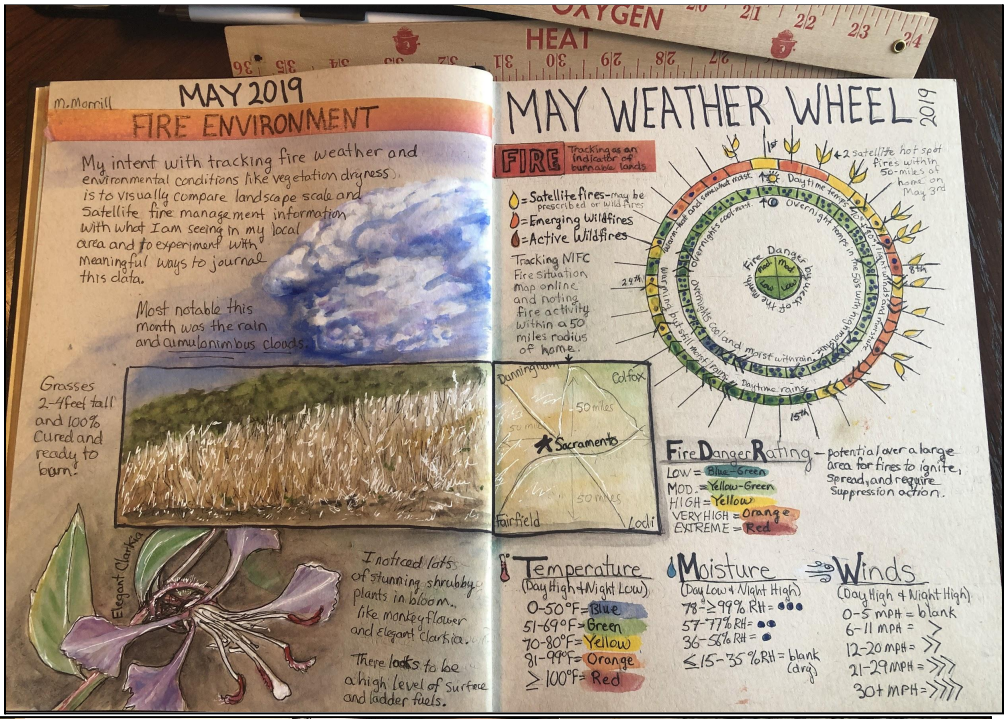
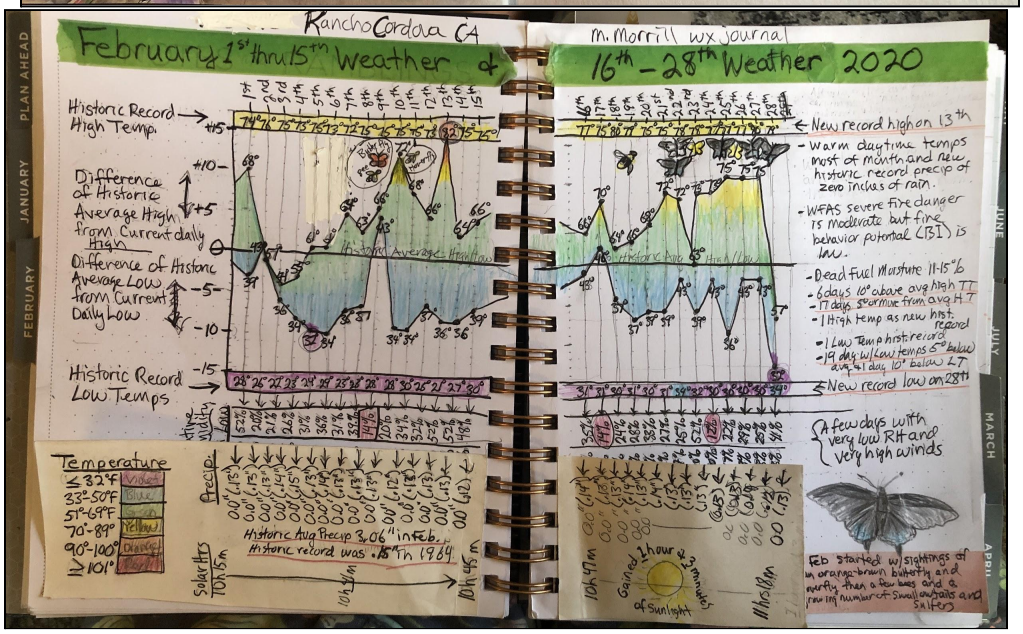


Figure 4. Everglades National Park and Big Cypress National Preserve fire history data, 1980-2017, depicting natural (yellow), human-caused (red), prescribed (blue), and mutual aid (purple) fires. The size of each point on the chart (top) corresponds to the fire's size. An interactive map (bottom)

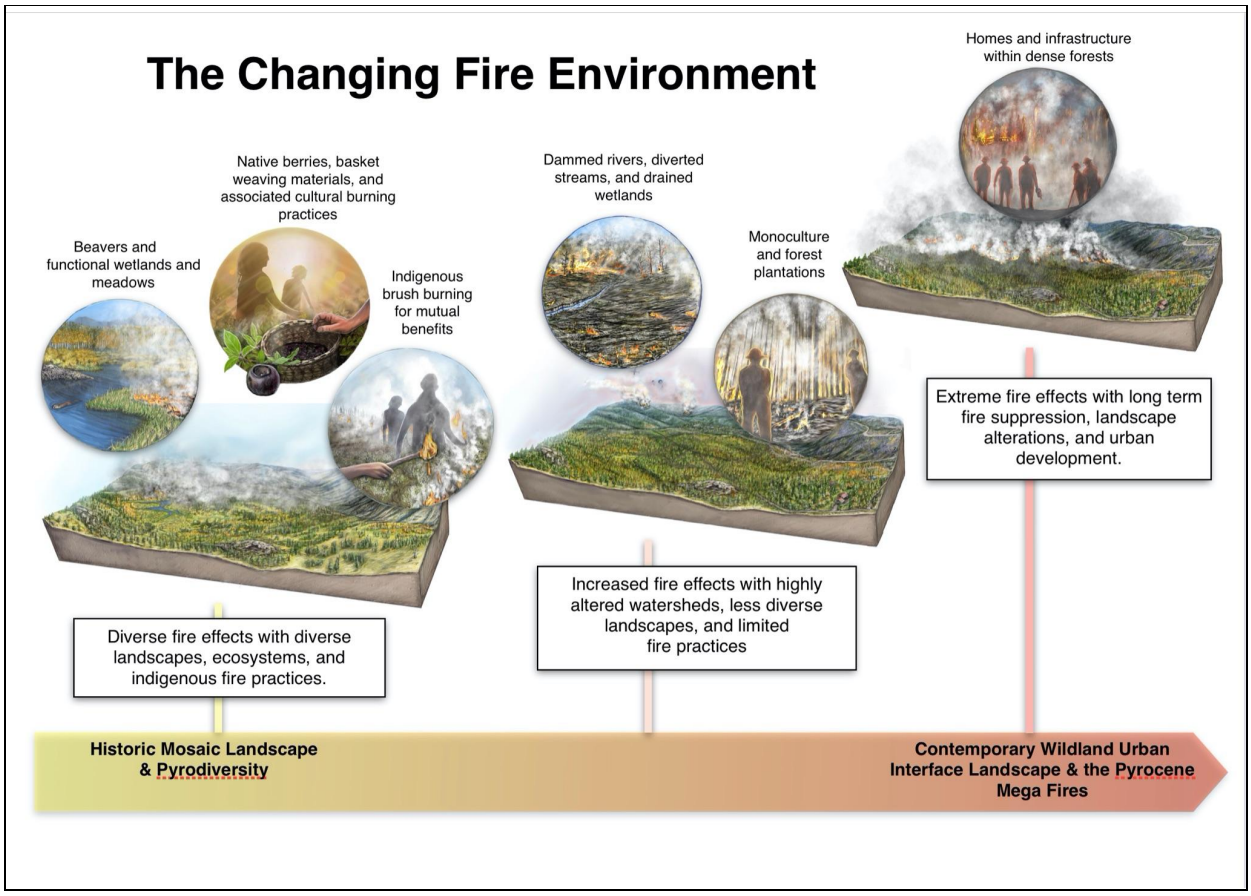
This visual from a research study created two graphics that show different fires, of different size, over time, in a graph and by season and then an accompanying map showing where on the ground those fires have occurred. Look at the combination of horizontal lines layered over time and the associated 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.