MONTEREY PENINSULA RPD

CLIMATE CHANGE IN

PALO CORONA'S REDWOODS

Redwoods in Palo Corona

Redwood forests actually make up the second largest habitat in Palo Corona Regional Park (Palo Corona), at 962.1 acres (MPRPD). Most of the redwoods can be found in the backcountry, in the valleys between ridges alongside streams (MPRPD).

Redwood forests are an important habitat not only for this ancient species, but also for many other plants and animals. While redwoods make up the largest portion of redwood forests, lots of other trees can be found there, too, including Douglas-fir, tan oak, and Bishop and Monterey pines (County of Monterey). Redwood forests are home to many different species, including the California red-legged frog, and the spotted owl, which prefers old-growth redwoods for mating habitats (County of Monterey).

"Redwoods... teach us about climate change. They teach us about resilience, and they can help us humans understand and adapt and plan for climate change in the future... You are looking at nature's number one way of absorbing carbon. Redwoods are a story of resilience, a story of change, and definitely a story of hope"
- Ranger Greg, Redwoods NPS

Image: Savannah Peña

Redwoods in Palo Corona: Quick Facts

Coast Redwoods are the tallest trees on earth. Their trunks can grow more than 27 feet wide, and they can grow to be more than 320 feet tall; that's higher than a 30 floor skyscraper (STEM Humboldt). Redwood trees can live for over 2,000 years, meaning some redwoods alive today have outlived the Roman Empire, predate the invention of paper in China, and lived during the time when Genghis Khan walked the earth (STEM Humboldt). Redwoods can actually absorb water from the air using their needles, which is why they thrive in places like Palo Corona and the Monterey Peninsula, where we have so much fog (Save the Redwoods). Some of the water that isn't absorbed collects on their needles and falls to the ground as rain, watering their roots and other plants nearby who can't absorb the fog - sort of like picking something off of a high shelf to share with a friend who can't reach (Save the Redwoods).

The earliest redwood fossils date back to over 200 million years ago, when dinosaurs still roamed the earth (STEM Humboldt). Before the logging boom in the 1850s, coast redwoods grew all the way from just south of Palo Corona to the Oregon border, covering about 2 million acres (STEM Humboldt). Today, only 5 percent of the original old-growth redwood forest remains along California's coast, due to over-logging in the 1800s (STEM Humboldt).

Most of California's redwoods, including in Palo Corona, are what's called second-growth forests: younger forests which have grown back after the original old-growth forest was cut down (NPS). While old-growth forests are expected to be resilient to climate changes, and have actually benefited from increased carbon in the atmosphere since the 1970s, we still have a lot to learn and understand (NPS). Park rangers and other scientists are conducting research to try to understand how redwoods will be affected if climate change continues to accelerate, and make areas where redwoods now thrive uninhabitable (NPS).

Species of Interest in Palo Corona

Palo Corona isn't only home to redwoods - it's home to more than 500 different species of plants (MPRPD)! Like redwoods, many of these plants are vulnerable to changes in climate, and are in danger from climate change. Marsh microseris (M. paludosa) is a flower found in Palo Corona designated Endangered by the e California Native Plant Society (MPRPD). The Monterey pine forest and coastal terrace prairie are two very unique habitats in Palo Corona (MPRPD).

Palo Corona is also home to several other animal and insect species which are of interest: California red-legged frog, California tiger salamander, Smith's blue butterfly, and steelhead trout (MPRPD). The California red-legged frog is listed as endangered. There's lots to protect at Palo Corona!

Marsh Microseris / Marsh Scorzonella
(Microseris paludosa)
Image: Michael Mitchell

Coastal Terrace Prairie is made of dense grasses and wildflowers. It can be found in the Front Ranch area of Palo Corona, on the slopes descending toward the ocean.
Image: Michael Mitchell

California Red-Legged Frog
(Rana draytonii)
Image: NPS / Will Elder

California Tiger Salamander
(Ambystoma californiense)
Image: John Cleckler, USFWS

Monterey Pine
(Pinus radiata)
Image: Michael Mitchell

Steelhead Trout
(Oncoryhnchus mykiss)
Image: NOAA

Smith's Blue Butterfly
(Euphilotes enoptes smithi)
Image: Don Robertson

Redwoods in Palo Corona

Redwoods may have been living on earth for more than 200 million years, and can teach us a lot about the history of earth's climate (STEM Humboldt).

More than that, they're one of the most important resources we have for fighting climate change: all plants hold carbon dioxide, a greenhouse gas, but redwoods absorb the most carbon per acre over any other forest on earth (Redwood NPS). In fact, just one acre of redwoods can hold 1,000 metric tons of carbon (What Good Is a Redwood?). For a little perspective, one car releases about 4.7 metric tons of carbon a year (NSCEP).

Let's do a little math

One acre of redwoods holds 1,000 tons of carbon.
Palo Corona has 962.1 acres of redwoods - let's round that to 960.

960 acres x 1,000 tons per acre = 960,000 tons of carbon!

Now, let's compare that to our cars:
We know that one car releases about 4.7 metric tons a year, but let's round that to 5.

$$\frac{960,000 \text{ tons}}{5 \text{ tons per car}} = 192,000 \text{ cars}$$

So, our 962.1 acres of redwoods can hold up to 960,000 tons of carbon, which is like taking 192,000 cars off the road for one year!

Image: Savannah Peña

Intro to Climate Change

When we burn fossil fuels like coal, oil and gas, we release excess amounts of carbon dioxide into the atmosphere, which acts like a blanket around the earth, holding the earth's heat in (NNOCCI). This is the main driver of climate change, and what is causing the atmosphere and the ocean to warm. The more carbon dioxide we add, the more heat is trapped, and the more problems we experience.

What does this mean for the Monterey Peninsula?

As a whole, California is expected to contend with problems including increases in temperature, water shortages, wildfires and sea level (State of California). How big of an increase we see depends on how much we're able to decrease our greenhouse gas emissions (State of California).

The city of Carmel-by-the-Sea's Climate Committee also found that inland areas like Palo Corona are expected to be at higher risk for wildfires, stronger storms, more droughts, increased temperatures, and fog changes (Climate Committee).

Weather vs Climate

Weather is short-term atmospheric conditions at a given place (like if it rained in Monterey on Tuesday). Climate is the average weather patterns of a region over a long period of time (like the Monterey peninsula having a Mediterranean climate). You can think of it as the difference between what a baseball player hits in one game, versus that player's overall statistics.

the heat trapping blanket metaphor

The Heat Trapping Blanket Metaphor has been developed by the National Network for Ocean and Climate Change Interpretation (NNOCCI) and the Frameworks Institute as part of a larger project to help educators talk to people about climate change. It's part of a series of tested metaphors which have been shown to effectively communicate ideas about climate science with the public.

Redwoods and Climate Change

Redwoods in the southern part of their natural coastal range – meaning right here in Monterey and throughout the San Francisco Bay Area – could be at risk from climate change by as early as 2030 (McClosky). But why is this the case?

How is Fog Formed?

Fog is a cloud that's here on earth instead of in the sky! Fog is formed when very humid air reaches what's called the dew point temperature (What conditions produce fog?). Then, the water vapor in the air condenses around microscopic particles like dust or sea salt (National Geographic).

There are several different types of fog, but one of the most common in the Monterey Peninsula is advection fog, which forms when warm, moist air passes over the cooler Pacific Ocean; as the air cools down, the moisture it's holding condenses, making fog (National Geographic).

An important part of it actually has to do with fog. Redwoods require very specific conditions to thrive: they like the air to be very foggy so they can absorb moisture from the air, and prefer mild temperatures year-round (County of Monterey). Any major changes in these conditions, and redwoods can no longer survive (National Parks Service). This means that concerns about changes in temperature, rain and fog are concerns about the future of our redwoods, too.

Image: Michael Mitchell

Redwoods & Climate Change

Okay, we understand why changes in rain and fog affect redwood trees... but how does climate change and warming temperatures cause these changes?

Part of it has to do with the currents off the coast of California. The California Current brings cold water from the north down along California's coast, along with cool temperatures and fog to help redwoods thrive (STEM Humboldt). With global climate change, however, researchers suggest that we may see changes in the pattern of the currents, which could then change weather patterns along the California coast (STEM Humboldt).

Because fog relies on a small, specific temperature range to form, increased heating of earth's atmosphere could reduce coastal fog, which redwoods depend on to get enough water (Gonzalez). Together, warming temperatures and changes in our currents could potentially change the regions where fog can form, and where redwoods can grow.

Image Source: Savannah Peña

Looking forward: What can you do to help?

Just because we're facing changes doesn't mean there's no hope for the redwoods! Remember that old-growth redwoods have actually benefitted from the extra carbon in the atmosphere over recent decades, and are expected to be resilient to changes in climate (NPS, N.D.). Given how many redwoods are found along streams in their southern range, scientists think these waterways may serve as micro refuges, where redwoods will be able to survive despite the changing climate around them (McClosky, 2020). Science is innovation, and there are always new possibilities and reasons for hope.

Something needs to be done about climate change. While personal actions are important, the best way to prevent climate change isn't working alone - it's working together with your community. Working with your community means you'll have a bigger impact, and be able to make changes more specific to your ecosystem's needs. Some ideas include:

- Advocate for the preservation & restoration of redwood forests to store carbon
- Volunteer with local or national conservation organizations - you can find some opportunities here: www.mprpd.org/volunteer-community-alive
- Write or call your local or state representatives to let them know you are concerned about climate change and want them to take action. (Also: encourage adults in your life to vote!)
- Start a native tree planting group to help draw down carbon dioxide, or hold a school Arbor Day planting: www.arborday.org/
- Petition for your school to ban plastics
- Start a community food garden (which will help keep people fed while lowering carbon emissions)
- Find more ideas here: https://www.fws.gov/sacramento/es_species/Accounts/Amphibians-Reptiles/Documents/What_You_Can_Do.pdf

Whatever you do, you're sure to have a bigger impact when you do it with friends, and you'll be more likely to want to continue taking action.

Teaching Resources

Activities
- Accompanying Student Worksheet:
  - Google Doc:
    https://docs.google.com/document/d/1wSwX02Z4CQBYoQkDepH6Or8o7uhiY5qNR7lT_ZqIg1E/edit?usp=sharing
  - Canva Doc:
    https://www.canva.com/design/DAEvXyckPoU/VpDSZqJTMu_cQQdukoxNjw/view?utm_content=DAEvXyckPoU&utm_campaign=designshare&utm_medium=link&utm_source=sharebutton&mode=preview
- Palo Corona Plant Scavenger Hunt:
  https://www.canva.com/design/DAEuCy7hBv8/tCWmDkeklRvgngF39zthww/view?utm_content=DAEuCy7hBv8&utm_campaign=designshare&utm_medium=link&utm_source=sharebutton&mode=preview

Redwood Resources
- Redwood Ed: A Guide to the Coast Redwoods for Teachers and Learners (CDPR):
  https://www.parks.ca.gov/?page_id=25395
- Redwood Curriculum (Save the Redwoods League):
  https://www.savetheredwoods.org/learning-center/educators/redwood-curriculum/
- Redwoods Treasure Hunt Handout: https://cdn.savetheredwoods.org/wp-content/uploads/files/Toolkit_Redwoods-Treasure-Hunt.pdf
- Redwood Curriculum (STEM Humboldt): https://stem.hcoe.net/redwoods/

Climate Change Resources
- NPS: Interpreting Climate Change Module 4 Learning Companion (nps.gov) (April 2016)
- NPS National Climate Change Interpretation and Education Strategy Communication Toolkit - Best Practices: http://www.nps.gov/subjects/climatechange/toolkit-bestpractices.htm
- The Climate Change Response Program (CCRP) Hope Video Series: Envisioning the Future in a Changing Climate video series - Climate Change (U.S. National Park Service) (nps.gov): https://www.nps.gov/subjects/climatechange/futurevideos.htm
- A video created in partnership with CCRP and No Barriers Mudkarts: PSA: Mudkarts on Vimeo: https://vimeo.com/109059485
- Changing the Conversation about Climate Change: A Theoretical Framework for Place-Based Climate Change Engagement by Sarah Schweizer, Shawn Davis, and Jessica Leigh Thompson
- The Listening Project: http://www.listeningproject.info/index.php
- Facilitating Reflection – A Manual for Leaders and Educators: Facilitating Reflection: A Manual for Leaders and Educators (uvm.edu): http://www.uvm.edu/~dewey/reflection_manual/
- 21st Century Engagement community of practice: https://sites.google.com/site/nps21ce/

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