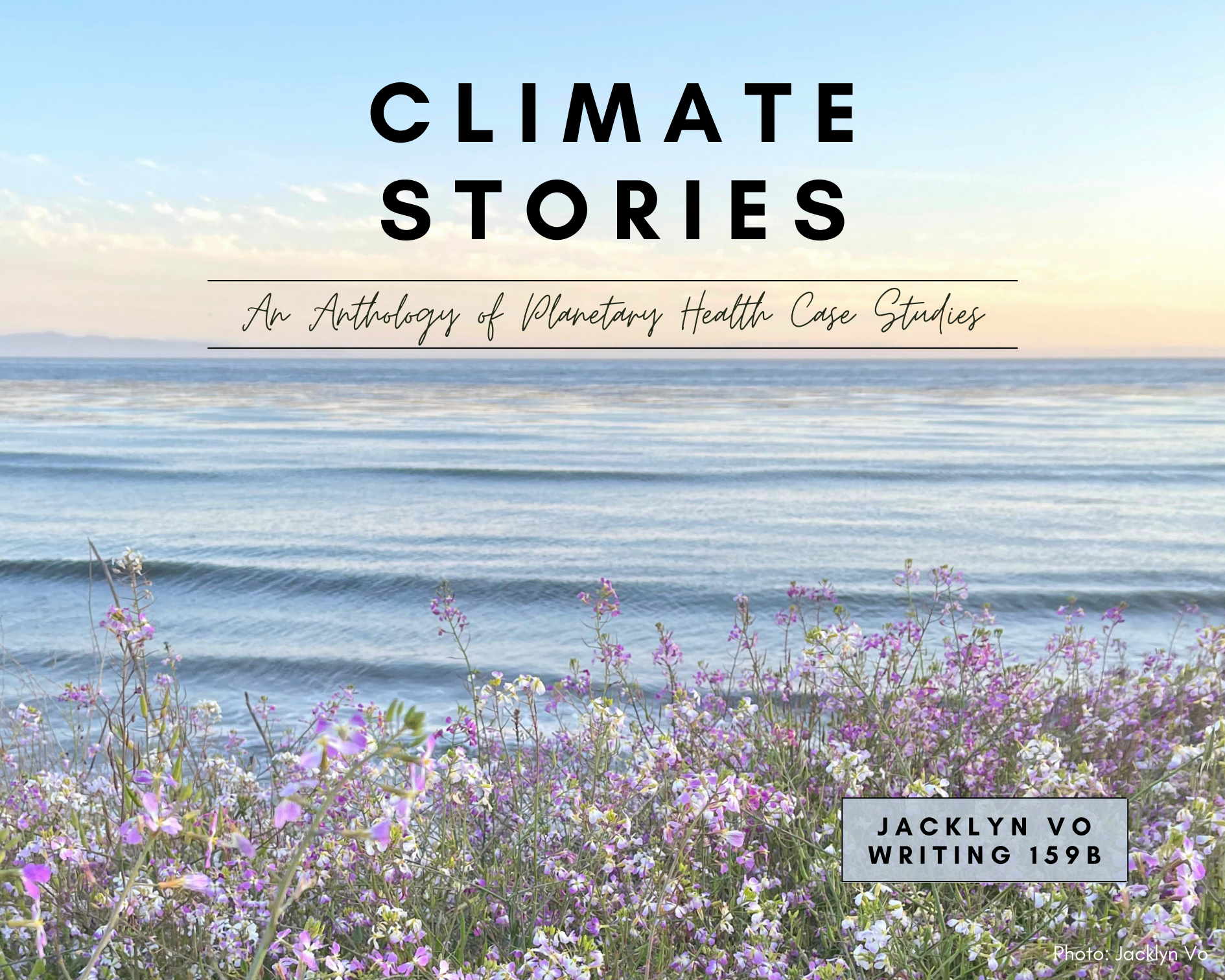
CLIMATE STORIES

An Anthology of Planetary Health Case Studies

JACKLYN VO
WRITING 159B



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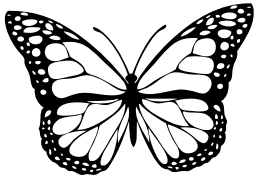

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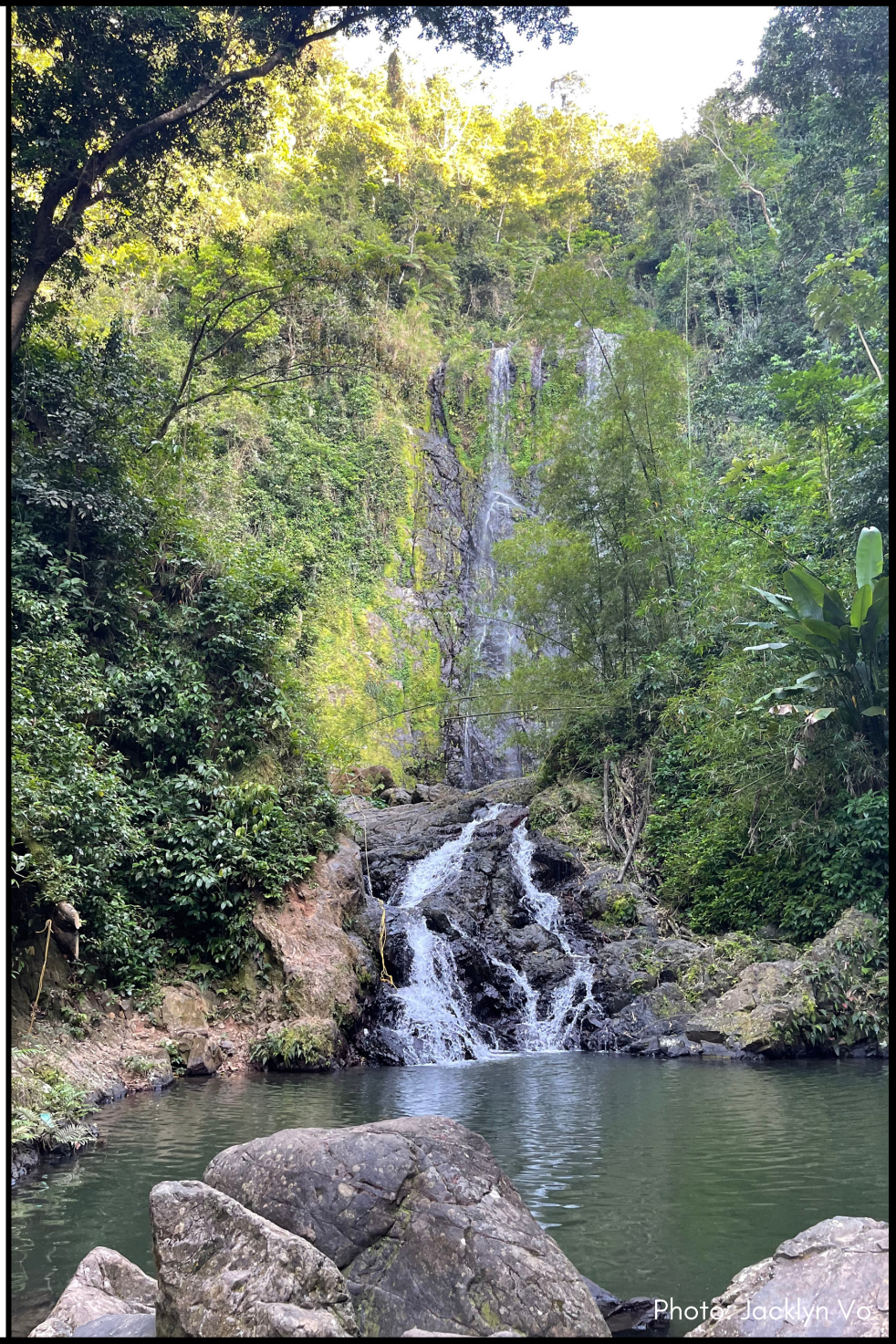

Photo: Jacklyn Vo

WHAT IS PLANETARY HEALTH?

As humans are rapidly and abnormally changing our Earth's climate, it's vital that we evaluate the human and environmental consequences that are directly and indirectly caused. Planetary health focuses on characterizing the human health impacts of anthropogenic disruptions on Earth's natural systems (Planetary Health Alliance, 2021).

To me, planetary health is about merging environmental issues with human health and social equity on a global and local scale, as well as human impacts on organisms. Anthropogenic climate change is currently underway, and we are experiencing the beginning of it through events, like intensified fires in California and storms in Florida. Some other impacts include land use change affecting the transmission of disease, climate changing the habitats of certain organisms, and warmer climates affecting food accessibility. Through the case studies, the science behind how fires impact air quality and human health, warming global temperatures affect sea turtle hatching rates, and land-use change and warming climate affects butterfly migrations will be explained.

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THE THOMAS FIRE

Wildfire & Pulmonary Health

Santa Barbara & Ventura Counties, California

As I was studying for my astronomy final during dead week, I would hear my peers questioning whether they were going to evacuate the dorms to go home. While it was difficult to study, none of my professors had cancelled or postponed our finals due to the fire. At the University of California, Santa Barbara (UCSB), it was the last week of the Fall 2017 quarter. For me, it was my first finals season at UCSB; and while we were all frantic about what our next steps were, we still had the burden of finals lingering over our heads.

On December 4th, I saw the Thomas Fire being displayed on the news. I thought it was going to be a small and quick wildfire -- one that would be extinguished within the next couple of days -- but the fire became the largest wildfire in modern California history at the time.

Photo: George Rose/Getty Images

Background Context

Santa Ana winds are strong, warm, and dry winds that blow from the Great Basin to the coast of Southern California.

According to the California Department of Forestry and Fire Protection (CAL FIRE), the Thomas Fire burned over 281,893 acres of land in Santa Barbara and Ventura Counties (CAL FIRE, n.d.). Years of drought and high wind conditions, fueled by the **Santa Ana winds**, north of Santa Paula, California, caused power lines to come into contact with each other and eject molten metal material onto dry ground vegetation (VCFD, n.d.). Along with these winds, Santa Barbara Sundowners, which are gusty, nocturnal, offshore winds, helped intensify fire conditions (Cohen, 2018). Starting near Thomas Aquinas College, the Fire progressed northwest towards Ventura, Montecito, Carpinteria, and Santa Barbara until it was fully contained on January 12th, 2018. During this time, over 8,500 firefighters from all over the state came to extinguish the fire and 1,062 building structures were destroyed and 280 structures damaged (CAL FIRE, n.d.). This fire took the lives of one firefighter and one civilian, and caused about $2 billion in damages (Hersky, 2018).

Not only was the fire devastating, itself, but heavy rainfall exacerbated the natural disaster on January 9th, 2018. The rain caused massive mudslides in Montecito and Carpinteria, resulting in 21 deaths and thousands of homes devastated (Guidimadjegbe et al., 2019). The debris flow had destroyed trees, powerlines, natural gas lines, sewage systems, and left numerous injured or stranded. Disaster recovery efforts, including support from the Coastguard, National Guard, and Red Cross, all assisted in responding to this emergency.

Photo: Reed Saxon/AP

Photo: David McNew/Getty Images

A Student Perspective

Waking up during the first week of the fire, the first thing I noticed was my mouth, nose, and throat dry. I would open my window curtains and the lagoon outside my window would be gone. In its place, a cloudy, orangish-gray abyss had taken over.

In order to eat, I had to walk to the dining commons across from my dorm. Walking out there seemed like an apocalypse because there was not a single glimpse of the blue sky. No birds singing, people playing, or cars driving by. It felt like the world was ending. I wore a mask to walk outdoors because the air irritated my throat. The moment I stepped outside, I immediately wanted to go back in, away from the smoke and ash-filled air. I cannot imagine having to physically go to work anywhere outside my dorm.

With the poor air quality, fire inching closer, and uncertainty of finals continuing made studying impossible. Several friends were debating on going home while I was not leaving until my professor gave more instruction about my astronomy final.

Photo: Amanda McMillan Lequieu / Edge Effects

Respiratory Health

I was lucky that I didn't have to be anywhere but my dorm room that week. I couldn't imagine going outside to do anything, nevertheless strenuous work. As **anthropogenic climate change** persists, fires are suspected to increase in intensity and frequency. Not only are fires destructive to landscape and infrastructure, but they release harmful levels of smoke into the atmosphere. Fires emit toxic levels of air pollutants, such as carbon monoxide, ozone precursors, and particulate matter, that get dispersed throughout the surrounding region and inhaled by those exposed (Kollanus et al., 2016).

The component of wildfire smoke that is of most health concern is **particulate matter 2.5 (PM2.5).** PM2.5 is defined as liquid or solid particles with diameters of 2.5 micrometers or smaller (EPA, 2016). The inhalation of fire-specific PM2.5 poses respiratory health concerns, such as exacerbated asthma and **chronic obstructive pulmonary disease (COPD)**, because of its small size and ability to travel further through the lungs, into the alveoli, and bloodstream (Reid et al., 2016; EPA, 2016). Alveoli are tiny air sacs where the lungs exchange gases, like oxygen and carbon dioxide, with the blood. If PM2.5, or any other pollutant, penetrates through the alveolar sacs and into the bloodstream, these toxicants can travel throughout the rest of the body and impair lung function, pulmonary health, and cardiovascular health (Aguilera et al., 2021; Nakayama Wong et al., 2011; Reid et al., 2016).

Anthropogenic climate change
Our current climate is changing at rates faster than our natural systems can restore balance. This is due to the excess release of greenhouse gases from human industrial activities and natural sources. We are in a race to limit the amount of fossil fuels used in order to mitigate the effects of global warming.

Fun fact: a particle that is 2.5 microns is about 30 times smaller than the diameter of an average human hair strand!

Chronic Obstructive Pulmonary Disease (COPD) refers to a group of airflow blockage and breathing-related diseases, including emphysema and chronic bronchitis.

Farmworkers

Waking up during the first week of the fire, the first thing I noticed was my mouth, nose, and throat dry. I would open my window curtains and the lagoon outside my window would be gone. In its place, a cloudy, orangish-gray abyss had taken over.

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Photo: CAUSE

Farmworker Health Vulnerabilities

Heat Exhaustion

Agricultural workers are doing physically demanding tasks under the sun and could experience heat exhaustion and other heat-related illnesses when dehydrated and overworked. Heat exhaustion can have individuals feeling symptoms of headache, dizziness, fainting, and rapid heart rate, where physical activity can intensify these conditions (Corrieri et al., 2019). Wildfires only intensify their heat-related health risks because they are required to work in hot, insolated, and polluted environments where they risk the chance of experiencing heat exhaustion, stroke, or even death (Austin et al., 2020; Corrieri et al., 2019).

Photo: United Farm Workers

Pesticides

Pesticide exposure is another health concern to individuals working in the fields. Pesticides are substances used to kill, repel, or control organisms or plants harmful to the cultivation of plants; but while pesticides are meant to target pests, residue can be transported by farmworker clothes and bodies, air, water, soil, and food (Saxton, 2015; Lee et al., 2011). Pesticide exposure is linked to detrimental impacts on neurological, reproductive, endocrine, metabolic, thyroid, and respiratory health (Mamane et al., 2015; Fix et al., 2020; Curl et al., 2020). Regarding respiratory health, occupational exposure to pesticides is associated with asthma and chronic bronchitis, where the inhalation of pesticides during fumigation is the route of exposure (Mamane et al., 2015). Ventura County farmworkers have said that sometimes employers make pesticide “sprayers stay 30 feet behind us [farmworkers] to pressure us and make us work faster” (2015a,b). This inhumane threat is not only contributing to their overall health but stresses their mental health and could lead to exhaustion.

Farmworker Health Vulnerabilities

Dust Inhalation

California's increasingly arid climate, drought and wildfire conditions contribute to the formation of dust and spread of infectious diseases (Pearson et al., 2019). When farmland is perturbed, soil dust particles and spores are lifted in the air and could be inhaled by individuals in the area (Schenker, 2000). Similar to how the inhalation of PM2.5 affects the respiratory system, dust inhalation and the pathogens in the soil spores can have detrimental impacts on health. The chronic exposure to organic and inorganic dust particles have been linked to asthma, COPD, chronic bronchitis, pneumoconiosis, farmer's lung, and interstitial fibrosis (Nordgren & Bailey, 2017; Noda et al., 2007; Schenker et al., 2009; Cormier, 2007). Additionally, exposure to pathogenic bacteria or fungi could lead to illnesses, like valley fever (Pearson et al., 2019). Even though the health effects of the chronic inhalation of dust particles are considered separate from fire smoke inhalation, both sources contain PM2.5 and contribute to the exacerbation to respiratory illnesses. Dust inhalation is only one other health risk factor agricultural workers are exposed to and may be disproportionately affected by its pulmonary and cardiovascular health effects, opposed to non-farmworkers.

Photo: United Farm Workers

Fire Smoke

Black, Latinx, and Native Americans are 50 percent more vulnerable to wildfires compared to other census tracts (Davies et al., 2018). Among three agricultural regions in California (Salinas Valley, San Joaquin Valley, and Imperial Valley), agricultural employers expressed that wildfires and associated smoke are not a concern for which they have developed protocols (Riden et al., 2020). Even though smoke, stress, and respiratory issues are found to be the most common health concerns when thinking about fire health threats in the agricultural setting, a study employing an interactive webinar found that only about 45% of a group of 30 agricultural employers believed that education on wildfire health effects were effective (Corrieri et al., 2019).

Photo: CAUSE

Interventions for Farmworker Justice

The Central Coast Alliance United for a Sustainable Economy (CAUSE) and Mixteco Indigena Community Organizing Project (MICOP) are all working to improve the protections and rights of farmworkers during disasters and in general. CAUSE is a "base-building organization committed to social, economic, and environmental justice for working-class and immigrant communities in California's Central Coast" (CAUSE, n.d.). Through civic engagement, leadership development, community organization, policy research, and advocacy, CAUSE defends immigrant rights, promotes health equity, and environmental restoration. On the other hand, MICOP is a group that organizes and empowers indigenous migrant communities in California's Central Coast.

For wildfires, CAUSE provides disaster aid to immigrant families, language access to emergency information, and safety protections for outdoor workers. They hold community meetings to hear about what farmworkers want in terms of improving their working and living conditions.

N95 masks
It is important to note that the use of bandanas and fabric face coverings are not sufficient enough to filter PM2.5 particles and other air pollutants.

During the Thomas Fire, these community-based organizations distributed over 15,000 **N95 masks** to farmworkers because employers were not required to provide workers with PPE at the time. When employers do not enforce safety measures, like providing PPE or educating outdoor workers on the health effects of inhaling smoke, farmworkers are left to work in the hazardous smoke wave with inadequate safety gear or none at all. The immense aid and mask distribution to farmworkers during the Thomas Fire initiated the nation's first occupational safety standards for wildfires, "requiring outdoor employers to provide respirator masks when air quality is measured to be harmful" (CAUSE, n.d.a). Despite the new regulations mandated, the use of masks is not always ideal for farmworkers because they are physically active, exerting arduous energy to fulfill shipments. This results in not wearing N95 masks properly during their entire shift or resorting to bandanas or other masks to protect themselves during smoke waves. This is where education on fire smoke health effects and inclusion of medical providers and emergency centers in public health and disaster response plans could be useful in minimizing fire-smoke risks (Corrieri et al., 2019).

Photo: Mark Ralston/AFP/Getty Images

Photo: Wally Skalij/Los Angeles Times

Conclusion - Wildfires and Planetary Health

Wildfires are expected to increase in frequency and intensity as global warming continues. Warmer temperatures cultivate hotter temperatures, drier vegetation, and extreme weather events, creating ideal fire conditions. While many people are able to escape from the flames of fire, others may not have the time or resources to evacuate. Furthermore, public health officials recommend locals to take health precautions to protect their respiratory health; however, many essential farmworkers are required to rush to the fields to save crops from falling ash. Typically, these individuals are not provided proper equipment by their employers or are uncomfortable wearing masks because they are strenuously working. This disproportionately results in farmworkers being exposed to toxic pollutants while individuals that have the means and time can purchase their own equipment or stay indoors. Non-profit organizations, such as MICOP and CAUSE, step in to provide farmworkers with these health resources. Other organizations strive to demand changes in occupational policy to become more inclusive and strict. As a result of the incident during the Thomas Fire, employers are now required by Occupational Safety and Health Administration (OSHA) to evaluate if conditions are safe for farmworkers to be in the fields and provide masks when there are unhealthy air quality conditions. While we cannot predict when a fire happens, we can take steps to build community resilience and improve natural disaster responses to be more inclusive. Continuously, we can better engage in stricter occupational protection enforcements, fire management protocols, and climate miitigation efforts.

Photo: Terra Satellite

Sea Turtle Arribadas

How Community Conservation Improves Hatchling Rates

Ostional, Guanacaste, Costa Rica

On the last night of patrol, not a single sea turtle was in sight. Amidst a thunderstorm, the research team and I walked up and down Ostional Beach for three hours before taking a seat on the wet sand. We watched lightning strike over the water as we debated whether we should continue patrol or go home.

Just as we were about to walk back to the station, two large sea turtles emerged from the water—one on both sides of us. With lightning and thunder in the background, it felt as if we were living in **prehistoric times**. We watched as the mama sea turtles find a place to lay their eggs. Once she found a spot, we rushed to her to count her eggs, time her birth, measure her carapace, and tag her flipper. These parameters were collected to monitor sea turtle nesting behaviors and better understand the nature of solitary and mass nestings.

Fun fact: sea turtles were living with the dinosaurs back during the Mesozoic Era!!

Photo: Jacklyn Vo


Photo: Jacklyn Vo

Olive Ridley Sea Turtles

The Olive Ridley sea turtle (Lepidochelys olivacea) is the main species that nest on **Ostional beach**, along with the occasional occurrences of Leatherback (Dermochelys coriacea) and Green (Chelonia mydas agassizii) sea turtles. The Olive Ridley is one of seven sea turtle species and is listed on the **International Union for the Conservation of Nature (IUCN) Red List** as a vulnerable species. This sea turtle is olive/grayish-green in color, with a heart-shaped carapace or shell. Each four flippers have one or two claws, and the size of the turtle varies from region to region. Sea turtles are marine reptiles and require air to breathe and return to land to lay their eggs in the sand. Sea turtles are incredible navigators and usually return to the beach they were hatched.

One characteristic that makes Olive Ridley unique from the other species is their ability to engage in both independent (**solitary**) and mass (synchronized) nesting.

Ostional beach is considered a national wildlife refuge, governed by Costa Rica's Ministry of the Energy and Environment.

The **IUCN** is an international organization that practices nature conservation and sustainable use of natural resources. This entity identifies the population status of organisms.

Solitary nesting is when a turtle nests on the beach by themselves.

Arribadas

Mass nestings are also called “arribadas” in Spanish, meaning “arrival”. This phenomenon is when thousands of sea turtles come to nest along a few miles of beach within a two to five-day span. At Ostional, arribadas occur most months but are unpredictable. Increasing global temperatures due to anthropogenic climate change, poaching, and high nesting density pose several threats to the Olive Ridley sea turtles. This is why Costa Rica’s **Ministerio de Ambiente y Energia (MINAE)** and **Asociación de Desarrollo Integral de Ostional (ADIO)** developed a monitoring program to study, conserve these majestic creatures, and **boost community participation** and well-being.

Arribadas are fascinating events; however, the vast number of nesting sea turtles in a small beach area affects the hatching success rate. As sea turtles come to nest, they often trample over and lay their eggs in close proximity to each other. Often, sea turtles dig up nests that have been laid before, breaking the eggs and creating an environment for microbes to decompose organic material. Scientific literature suggests that the higher the microbial abundance, the lower the egg hatching success rate (Bezy et al., 2015). High microbial loads are generated by the decomposition of eggs broken by nesting turtles, especially during densely populated arribada events. The deprivation of oxygen and higher surface temperatures become the ideal environment for microbes to decompose organic material and increase microbial activity. In turn, the high microbial load decreases the hatching success rate of the Olive Ridley sea turtles and contributes to the list of threats this species faces.

MINAE, in English, translates to the Ministry of Environment and Energy. This national entity is responsible for managing and implementing solutions regarding natural resources in the country.

ADIO, in English, translates to Ostional's Integral Development Association. This organization practices conservation and scientific monitoring of the olive ridleys. ADIO also implements the legal harvesting program for human consumption.

Ostional community participation
Locals are employed by ADIO to harvest eggs during the first three days of an arribada. This solution assists to increase hatching success rates and feed the community. Check out the "Interventions for sea turtles and community" to learn more!

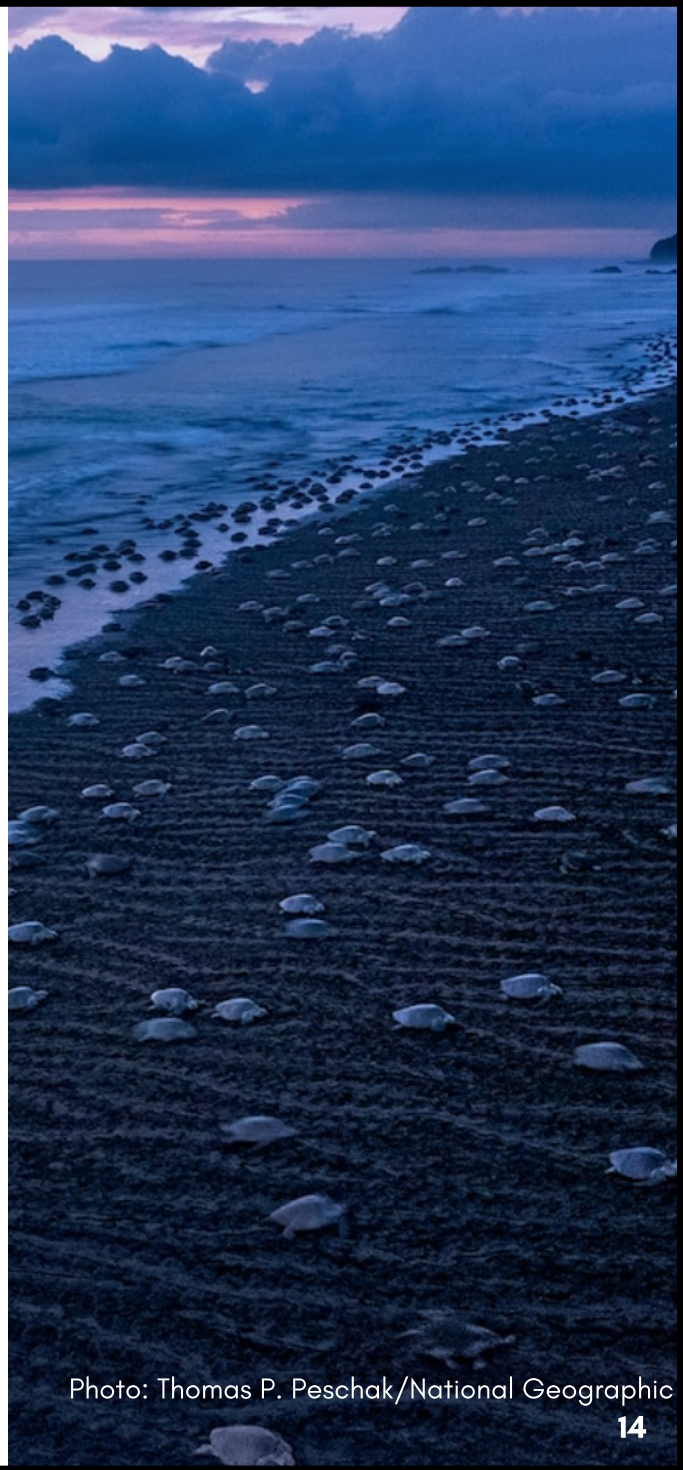

Photo: Thomas P. Peschak/National Geographic

Interventions for Olive Ridley Sea Turtles & the Ostional Community

MINAE and the University of Costa Rica (UCR) co-manage ADIO, an organization that implements a community-based solution to assist humans, the environment, and social equity. In order to increase hatching rates, ADIO works with and employs Ostional locals to collect and distribute eggs, guard the refuge against poachers, and monitor sea turtle behaviors. This integrated approach encourages locals to protect the sea turtles and reinforces the program.

For the Locals & Equity

Since the 1930s, locals have relied on the eggs for consumption, since Ostional is in the rural region of Guanacaste. The town is very small and sometimes gets isolated from transportation routes for weeks during flood seasons. Eating sea turtle eggs are a part of the Ostional culture and integral to feeding the community. This harvesting program collects eggs that would have been destroyed anyway.

When an arribada starts, locals collect eggs in bags for three days. Once eggs are harvested, there is a special procedure to carry the bag of eggs to homes for cleaning and then to the ADIO building for a secondary sanitation and packaging process. The first cleaning process consists of submerging the turtle eggs in salt water to stop the growth of the egg. This kills the embryo inside because the turtle breathes oxygen through the egg membrane. Furthermore, the second dunking of eggs cleans the egg from diseases, like salmonella. The eggs then get packaged in containers with an ADIO logo to be sold in local markets and to locals for cheap. Locals can purchase a maximum number of 200 eggs at a rate of 500 cents per egg. Locals don't always buy the eggs, but when they do, they need a permit to prove their legal purchases.

This program provides the community with jobs, incentives for student and maternity leave, and retirement benefits. Since the start of the program in 1973, the project has generated over $6 million to the community, in which 70% goes to locals employed through the project (Muchna, 2014). These incentives and benefits entice locals to continue supporting the project by addressing potential negative social equity implications of committing to extreme solutions, like banning egg harvesting.

Photo: Jacklyn Vo
My host family & I: Li, Fabi, Mama Andreina, & Tribet

For the Sea Turtles

The project produces a mutual benefit for both humans and the environment. As the removal of eggs helps provide food and income to locals, it also decreases microbial loads during arribadas. This consequently results in increased hatchling rates and the chance of sea turtle survival because there are not as many eggs being destroyed by nesting sea turtles or microbes. Along with microbial abundance, higher incubation temperatures and lower oxygen levels contribute to higher embryo mortality (Clusella Trullas & Paladino, 2007). As anthropogenic climate change continues to increase global temperatures, this poses a threat to sea turtle hatching rates and survival. To address this, our governments could strengthen climate mitigation plans and environmental entities could install shade equipment for the turtles.


Photo: Jacklyn Vo

Baby turtles going to sea


Photo: costarica.org

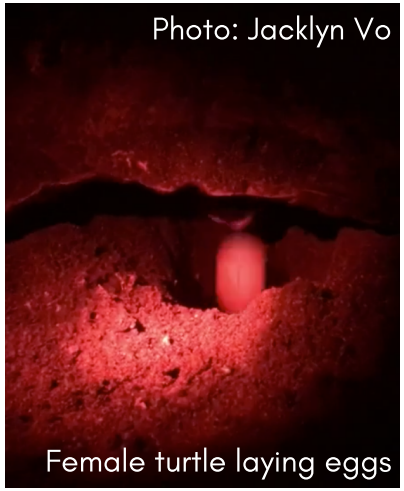
Photo: Jacklyn Vo

Female turtle laying eggs

Conclusion - Sea Turtles & Climate Change

While sea turtles remain vulnerable to extinction, humans must intervene with planetary health solutions to best benefit all aspects of the problem, including human health, environmental health, and social equality. The sea turtle program at Ostional is a prime example of a planetary approach that encompasses works with locals to reinforce the program for both their well-being and animal welfare. With climate change increasing global temperatures, sea turtles face another threat to their survival. In the future, hopefully, the community could implement a similar project that would address these problems. Other organizations and entities should address environmental issues, using Ostional as a model framework to build their solutions.

Butterflies Fly Away

Goleta Butterfly Grove & Mental Health

Goleta Butterfly Grove, California

To be continued...

Photo: Goleta Butterfly Grove

COVID-19 & MENTAL HEALTH

The Pandemic & Community Resilience

Worldwide

To be continued...

Photo: Jacklyn Vo

To be continued...


Photo: Jacklyn Vo