The Mountain Lion: From Ashes to Policy

Tabitha Reed

Mountain Lion Foundation Intern

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Introduction:

This paper discusses the importance of mountain lions in our ecosystem and how wildfires impact their role. The paper will also touch on other human-mountain lion conflicts and what humans can do to coexist with mountain lions. Mountain lions are impacted just as much, if not more, as humans are by wildfires. It is important that people know that having defensible space cannot only help their property during a wildfire but it can also help the wildlife that may seek shelter during a fire. Defensible space is a buffer between a building and things that can catch on fire easily like grass, trees, and shrubs (Cal Fire, 2019). Humans are the main driver towards a decreasing mountain lion population and an increase in wildfires in California, which signifies the importance of why people need to care about protecting their wildlife and save these big cats from extinction.

The information found within this paper will help the public and policy makers make better choices and decisions to protect wildlife and protect their property during wildfires. The public, policy makers, firefighters, and home and land owners need this valuable information in order to make the best choices to protect their communities and wildlife with as little loss as possible. It's not commonly understood that humans play as much of a role in starting wildfires as nature does, and fires can devastate a landscape by damaging it repeatedly before the area can recover. Having high-quality, science-based information can support people in making the best decisions about protecting their property, which in turn will better protect the surrounding flora and fauna from wildfires.

The purpose of this paper is to evaluate the threats that wildfires and humans pose to mountain lions and to assess the steps being done to try and reduce those incidents and create new solutions that may work better in reducing the human-mountain lion conflict. People have more power than they realize, and if it is combined with the proper information, they have more motivation to make small steps to positively impact themselves and wildlife. Climate change and wildfires have a codependent behavior because climate change is being impacted by wildfires and wildfires are changing by getting hotter, larger, and more destructive as the global temperature increases. It would be ideal if the information in this paper was used in an educational class or through public information in the form of a brochure to help educate people about the dangers and what can be done to reduce them. Hopefully this information helps policymakers, the public, and firefighters all come together to figure out the best solution for all parties involved and solutions that protect wildlife.

Background, current range, and threats:

Mountain lions are the apex predator of California and are crucial to the biodiversity throughout the state. An apex predator is on the top of the food chain with no natural predators. The mountain lion is the fourth largest cat in the world, and the second largest in the Western Hemisphere (Williams, 2018). They range from Canada's southern Yukon territory through the United States and into Argentina and Chile (Williams, 2018). They used to roam in all of the lower 48 states in the United States, but are now extirpated in all states east of the Mississippi River. Today, they are known to exist only in 15 western states, except for a small population in Florida (Center for Biological Diversity & Mountain Lion Foundation, 2019; Williams, 2018).

California is 155,959 square miles of land with around half the state being suitable habitat for mountain lions (State Symbols USA, 2020; Mountain Lion Foundation, 2019; Torres et al., 1996). One organization states that 46% (Mountain Lion Foundation, 2019) of the state is suitable habitat; another says 50% (California Department of Fish and Wildlife, 2019); a third says 62% (U.S. Forest Service, 2020). All the organizations agree that a female mountain lion needs about 20 to 60 square miles of habitat (or 12,800-38,400 acres), while a male needs about 100 square miles of habitat (or 64,000 acres) (California Department of Fish and Wildlife, 2019; Mountain Lion Foundation, 2019; U.S. Forest Service, 2020). It is difficult to pinpoint the mountain lion population in California-- a 1984 study estimated the population to be around 4,000 to 6,000 individuals -- a number that is now widely questioned. (California Department of Fish and Wildlife, 2019; Mountain Lion Foundation, 2019). There are ten subpopulations of mountain lions in California, with six subpopulations facing stability challenges.

Out of growing concern for declining populations and shrinking habitat, the Center for Biological Diversity and the Mountain Lion Foundation petitioned to have mountain lions in six subpopulations listed as threatened or endangered (Center for Biological Diversity & Mountain Lion Foundation, 2019). The six most at-risk subpopulations inhabit the territories of the Central Coast North (Santa Cruz Mountains and East Bay), Central Coast Central, Central Coast South (Santa Monica Mountains), San Gabriel and San Bernardino Mountains, Santa Ana Mountains, and the Eastern Peninsular Range (Center for Biological Diversity, & Mountain Lion Foundation, 2019; Gustafson et al., 2018). The total population of these six subpopulations is believed to be between 255-510 individuals, which makes the claim of 4,000-6,000 mountain

lions in the state highly unlikely (Center for Biological Diversity & Mountain Lion Foundation, 2019; Gustafson et al., 2018).

The Southern California mountain lion population is decreasing, which poses more concern with inbreeding and threats of extirpation (Center for Biological Diversity & Mountain Lion Foundation, 2019; Gustafson et al., 2018). The Santa Ana Mountains and Santa Monica Mountains face extreme isolation due to roads and development, which has led to high levels of inbreeding. Inbreeding creates low genetic diversity and can result in health issues like a kinked tail or heart issues which weaken the health and longevity of the population (Center for Biological Diversity & Mountain Lion Foundation, 2019; Ernest et al. 2014). The inbreeding in the Santa Monica Mountains has resulted in the lowest genetic diversity globally, excepting the Florida panther population (Benson et al. 2019; Center for Biological Diversity & Mountain Lion Foundation, 2019; Ernest et al. 2014; Gustafson et al. 2018; Riley et al. 2014). These populations are trapped on an island of habitat surrounded by freeways and the Pacific Ocean (National Park Service, Lions in the Santa Monica Mountains, 2019). The Santa Ana subpopulation could face extirpation within the next 12 years, while the Santa Monica subpopulations could face extirpation within the next 15 years (Benson et al., 2016; Benson et al., 2019; Center for Biological Diversity & Mountain Lion Foundation, 2019). As of the writing of this paper it is believed that the Santa Monica Mountains have a subpopulation of five to ten individuals (Center for Biological Diversity & Mountain Lion Foundation, 2019; Gustafson, K.D. et al, 2018).

Wildlife connectivity is the ability of animals to move between core habitats, to maintain contact with distant populations, and to keep the gene pool strong (Williams, 2018). Mountain lions, like all species, need room and the ability to move among core habitats, migrate with the

seasons, chase their prey, and adjust to changes in habitats caused by plant diseases, insect outbreaks, wildfires, droughts, and longer-term climatic changes and trends (Williams, 2018). Wildlife crossings and corridors help connect these species between core habitats, which is why these systems must be protected (Williams, 2018). Humans encroachment on mountain lion habitat forces them to try and adapt to the decreasing habitat size. Adding to the threats on their survival, mountain lions have been hunted for much of the state's history, highways have been placed in the middle of their habitat, development has reduced the size of their habitat, and there have been conflicts with livestock and humans (Mountain Lion Foundation, 2019). All of these impacts affect connectivity and how well species can migrate to other areas of suitable habitat.

Connectivity is known to change as fires change the landscape. California, and the rest of the United States, has become very good at fighting fires resulting in unnaturally large amounts of mature forests that have an increased vulnerability to insects, disease, and wildfires (Struzik, 2017). The country became good at suppressing fires, which created a surplus of mature trees in the northern forests (Struzik, 2017). Fires, if allowed to take a more natural course, help make forests more resilient to drought, disease, and future fires (Struzik, 2017). It is believed that as climate change continues, wet areas will become wetter and dry areas will become drier (Merzdorf, 2019). Fires thrive in dry conditions with dried fuel which can occur after a fire has already gone through an area and the vegetation begins growing back (Merzdorf, 2019).

Wildfires are a natural occurrence in Southern California and are crucial to the proliferation of certain plant and animal species; however, humans have increased the rate at which fires occur, causing significant changes in the environment (Goldman, 2019; Syphard et al., 2007; Syphard et al., 2009). Since the early 1970s the wildfire season in the western United

States has grown from five months long to more than seven months (Zielinski & Zachos, 2018). Wildfires in Southern California historically have only occurred every 30 years, allowing the native chaparral and other plants ample time to grow back in between fires (SDNHM Wildfire, 2019).

While natural and infrequent wildfires play a vital role in habitat preservation and the overall health of the land, the additional impact of climate change and human-caused fires have an intensely negative impact. Fire changes the vegetation structure and can lead to increased erosion and a depletion of nutrients (Engstrom, 2010). Persistent fire can harm plant communities, reduce wildlife habitat, and increase future fire risk. If the landscape burns more than once in a 20-year span invasive weeds and grasses can establish themselves making the area more prone to fire (National Park Service, 2019). Invasive plant species are considered to be flashy fuels, since they have not adapted to fires and are more susceptible to wind-driven flames. (National Park Service, 2019). During a wildfire the chaparral foliage can create embers that the wind can carry over 5 miles away which continues spreading the fire (MTRP Fire, 2019).

Mountain lions and the environment

Mountain lions are a keystone species, or an umbrella species that help provide for several other species (Williams, 2018). When a mountain lion makes a kill, that individual feeds itself as well as smaller mammals and scavengers such as condors (Williams, 2018). Mountain lions can eat up to 20 pounds of meat at a time (Williams, 2018). They usually eat about 15 pounds in the first 24 hours after a kill and eat 9 pounds per day after that, as scavengers close in on their kill (Williams, 2018). One study witnessed 275 species that benefited from the food that

mountain lions leave behind (Gross, 2019). Typically mountain lions will stay with a carcass for about three days (Williams, 2018). In some regions mountain lions are affected by kleptoparasitism, which is when they kill their prey but it is stolen from a dominant scavenger like bears or wolves (Johnston, 2020). Mountain lions can be considered ecosystem engineers by feeding multiple other species when they make a kill and are finished eating. They also change species' browsing habits which changes vegetation patterns as well as entire habits and soil composition (Williams, 2018). They have complex interactions with the environment which changes the structure, resilience, and biodiversity of many ecosystems (Center for Biological Diversity & Mountain Lion Foundation, 2019; Williams, 2018). Mountain lions also pump nutrients throughout the environment which helps drive biodiversity and ensures that everyone eats (Williams, 2018). They help provide nutrients through their kills which feeds other animals and absorbs into the soil (Gross, 2019; Williams, 2018). Insects are attracted to the decomposing kill and help carry the nutrients from the animal to the soil and plants (Gross, 2019). Mountain lions are not a predator that would stay and fight to protect their kill, so wolves and bears can steal their kill, which forces mountain lions to kill more often, while proving more for the environment (Gross, 2019; Williams, 2018). The absence of mountain lions alters the predator-prey and herbivore-plant interactions in the ecosystem (Luke, 2004).

If the mountain lion population decreases, the deer population will increase, resulting in the deer overgrazing vegetation which has repercussions to other species and habitats (Center for Biological Diversity & Mountain Lion Foundation, 2019; Ripple et al., 2014; Ripple and Beschta 2006; Ripple and Beschta 2008). For a healthy ecosystem we need mountain lions and other predators to help balance everything out and to continue the circle of life. Since mountain lions

help control the deer population they aid in reducing deer-vehicle accidents. It is estimated that 1.2 million deer-vehicle accidents occur every year in the United States resulting in about $1.66 billion in damages (Center for Biological Diversity & Mountain Lion Foundation, 2019; Gilbert et al., 2016). If humans want to reduce that number they just need to allow mountain lions to thrive in the habitat. An increase in deer also leads to an increase in ticks that carry Lyme disease which can infect more humans (Center for Biological Diversity & Mountain Lion Foundation, 2019; Côté et al. 2004; Telford, 2017). Mountain lions are crucial to controlling the deer population to prevent overgrazing, reduce deer-vehicle accidents, and reduce Lyme disease infections.

Without mountain lions there will be a low number of hydrophytic plants, wildflowers, amphibians, lizards, butterflies, and the resulting lack of bank vegetation contributes to erosion (Ripple & Beschta, 2006). Hydrophytic plants are plants that grow partly or fully in water and grow in anaerobic conditions, or low oxygen conditions (Department of Environmental Conservation, 2020). These plants can be rooted in the mud or floating without an anchor (Department of Environmental Conservation, 2020). The low number of these plants and animal species are due to the increase in deer which affect and change the ecosystem by having a lack of mountain lions in the area (Ripple & Beschta, 2006). In addition to the increase of deer in the area, this normally occurs in areas with an increase of human activity because mountain lions tend to avoid humans as much as they can (Ripple & Beschta, 2006). Although human-mountain lion conflict is a main threat to the mountain lion populations, increasing wildfires are becoming an increasing threat.

Two mountain lions died directly from the effects of the Santiago fire in October of 2007 and the Cedar fire of November 2003 (Boyce, 2008). The Santiago fire mountain lion was a two year old female who was forced to walk across the ground that was covered in hot coals, burning the pads off of her paws (Boyce, 2008). She was unable to hunt and lost more than 30 pounds (Boyce, 2008). When she was found she was so emaciated and unable to move that it was decided it was best to euthanize her (Boyce, 2008). She died on November 9, 2007, just 19 days after the fire started (Boyce, 2008). The Santiago fire burned 28,000 acres, which is the entire home range of one mountain lion that calls Camp Pendleton home (Boyce, 2008). The Cedar fire mountain lion was a three year old female who was found on a charred hillside with singed hair from the flames, scorched paw pads from the burning ground, and 30 pounds underweight from being unable to hunt (Boyce, 2008). The fire started in October and burned nearly 300,000 acres, more than 2,800 buildings, killed 15 people, and killed the mountain lion that was found in November (Boyce, 2008). The Cedar fire was the state's largest fire in its history, at that time (Boyce, 2008). Since then there have been a few larger fires, but the Cedar fire still remains one of the largest fires in the state of California.

The Woolsey fire started on November 8, 2018 in the Santa Monica Mountains, which is made up of 156,671 acres (National Park Service, 2018). It burned 100,000 acres in the Santa Monica Mountains and burned about 88% of the total acres in the National Park Service area (National Park Service, 2018). When wildfires are destroying almost all of the habitat mountain lions use we are all impacted by it. When the Santa Monica mountain lion subpopulation is estimated to be between five and ten individuals and there is one fire in the area burning 100,000 acres out of 156,671 it becomes possible to have an entire subpopulation be extirpated with one

wildfire (Center for Biological Diversity, & Mountain Lion Foundation, 2019; National Park Service, 2018).

Policy involving mountain lions:

In 1973 congress passed the Federal Endangered Species Act which was created to protect critically imperiled species from extinction and the ecosystems those species depend on (Mountain Lion Foundation, 2019; U.S. Fish and Wildlife Service, 2020). Between 1907 and 1972, 12,500 mountain lions were killed for bounty and sport in California (Williams, 2018). Having mountain lions hunted and killed more in California than any other state helped create new policy so mountain lions can be protected (Mountain Lion Foundation, 2019). In 1990 California banned sport hunting of mountain lions (California Department of Fish and Wildlife, 2019; Mountain Lion Foundation, 2019). On June 5, 1990 Proposition 117-the *Mountain Lion Initiative*- was passed which reclassified mountain lions in California as a 'specially protected mammal' (California Department of Fish and Wildlife, 2019; Mountain Lion Foundation, 2019). This also permanently banned sport hunting of mountain lions. Mountain lions are the only species in California with the title of specially protected (California Department of Fish and Wildlife, 2019; Mountain Lion Foundation, 2019). Although they are classified as a specially protected mammal, Prop 117 does not ensure that their core habitats and connectivity are protected from development, highways, and other threats (Center for Biological Diversity & Mountain Lion Foundation, 2019). Additionally, the California Environmental Quality Act (CEQA) allowed highways and development to occur in mountain lion habitat (Center for Biological Diversity & Mountain Lion Foundation, 2019).

The United States Fish and Wildlife Service recognizes that there are mountain lion subspecies, or subpopulations, under the federal Endangered Species Act (ESA), and two subspecies have been protected under the ESA due to their low population size (California Department of Fish and Wildlife, 2019; Center for Biological Diversity & Mountain Lion Foundation, 2019). These populations are the eastern cougar and the Florida panther (Center for Biological Diversity & Mountain Lion Foundation, 2019; USFWS, 2008). They are both listed as endangered, however, the eastern cougar is thought to be extinct with the last recorded sighting occurring in 1938 (Center for Biological Diversity & Mountain Lion Foundation, 2019; USFWS, 2008). The mountain lions in California must be protected to save them from the same fate as the eastern cougar.

In 1994 the Mountain Lion Foundation petitioned the United States Fish and Wildlife Service to recognize California mountain lions (*Puma concolor californica*) in the Santa Ana Mountains as endangered (Center for Biological Diversity & Mountain Lion Foundation, 2019; USFWS, 2020). They agreed to recognize them as a subspecies but as of April 2020 a decision in regards to this petition to list them as endangered has not been made (Center for Biological Diversity & Mountain Lion Foundation, 2019, USFWS, 2020). On September 6, 2013 Governor Jerry Brown signed Senate Bill 132 into law that protects mountain lions that wander into human-populated areas (California Legislative Information, 2013; Mountain Lion Foundation, 2019). On June 25, 2019 a petition went to the California Fish and Game Commission to have mountain lions protected under the California Endangered Species Act (Mountain Lion Foundation, 2019).

On April 16, 2020 the California Fish and Game Commission voted unanimously 5-0 to advance the Southern California and Central Coast mountain lion populations for candidacy under the California Endangered Species Act (Center for Biological Diversity, 2020). This ruling begins a year-long study and review by the department to determine if these mountain lion populations should be added to the California Endangered Species Act list (Center for Biological Diversity, 2020). To do what is best for the species the department provides immediate protection under the act to ensure they can gather the needed information and data without risking further damages or potential extinction to the species during the candidacy study (Center for Biological Diversity, 2020).

On average there are 61,375 human-caused fires resulting in more than 2.8 million acres being burned each year here in the United States (NIFC, 2018). Between 95% and 97% of all fires in California are human caused (Syphard et al., 2007; Balch et al., 2017). Most wildfires result from human-related causes such as power lines, arson, improperly disposed cigarette butts, burning debris, fireworks, campfires, and sparks from cars or equipment (Center for Biological Diversity & Mountain Lion Foundation, 2019; Balch et al., 2017; Bistinas et al., 2013; Keeley and Fotheringham, 2003; Radeloff et al., 2018; Syphard et al., 2007; Syphard et al., 2012; Syphard et al., 2019).

The United States Forest Service was founded in 1905 and the National Park Service was founded in 1915 and both had fire management as an afterthought (Struzik, 2017). The US Forest Service spends $52 million annually on fire research (Struzik, 2017). The US Forest Service is also mandated to fight fires (Struzik, 2017). Throughout the past century intensive efforts have been made to suppress wildfires in California (Devall, 2006). California focused

their firefighting efforts on reducing fuel loads which meant removing vegetation (Devall, 2006). Prescribed burns are burns conducted by firefighters to eliminate the fuel between people or property and the fire or to burn vegetation that can cause an uproar if there was a fire and it is a standard firefighting and forest management objective (National Park Service Wildland Fire, 2020). Prescribed burns are helpful because they encourage the growth of plants that need fire to germinate.

Currently California spends the most money per acre on fire suppression, because the state is heavily forested in places, hot, and often very dry (Struzik, 2017). The state also spends the most because it has so many people living in and around wildlands where it is difficult and expensive for firefighters to suppress fires (Struzik, 2017). Between 1990 and 2017, seven of the ten costliest wildfires that burned in the United States occurred in California (Struzik, 2017).

Impacts of wildfires on the environment:

Wildfires need to be seen as a birther, rather than a destroyer, because fires give new life (Struzik, 2017). Plant growth is always higher in protein after a fire (Komarek, 1969). There is calcium, phosphate, potash, and other necessary nutrients for animal growth found in the plants after a fire (Komarek, 1969). Since there is so much nutrient content in the soil some plants that grow after a fire can continue to grow in a dry spell without any precipitation, because they have a higher nutrient content (Komarek, 1969). Fires may increase the ‘patchiness’ of a forest (Zielinski & Zachos, 2018). Patchiness in the previous sentence means that the forest is not one full forest, rather it is broken up into several smaller pieces of forest with open land between the forest sections. Several plant species in California's shrubland regenerate endogenously, meaning

they germinate from a seed bank or resprout from vegeative parts already in place after a fire (van Mantgem, 2015).

Southern California is impacted by Santa Ana winds that come down from the Great Basin. The winds are more common from October to March, which is also the peak of Southern California's wildfire season. The winds can sweep in and greatly increase the size of a wildfire and destroy everything in its path (Boyce, 2008). As wildfires get bigger, and natural habitat shrinks, it becomes harder for mountain lions and other wildlife to survive the disaster (Boyce, 2008).

Wildlife tends to be the forgotten victim in California's raging fire storms (Boyce, 2008). Wildfires are essential to a healthy functioning ecosystem by sustaining ecological functions (Devall, 2006). There are some plants that germinate only after a wildfire occurs as some plants need smoke from a fire in order to germinate (Devall, 2006; Luke, 2004). Mountain lions are greatly affected by wildfires in a variety of ways. Fires change the landscape condition of an area and may make hunting more difficult (Jennings et al., 2016). Like most predators, mountain lions will follow their prey, so when their prey flees during a fire they tend to do the same. Mountain lions opportunistically use recently-burned areas in the first few years after a fire but they tend to avoid grassland vegetation types and areas of sparse cover (Jennings et al., 2016). For example, although wildfires can make hunting difficult, mountain lions adapted to this change by using burned habitats as an opportunity to catch prey fleeing from a fire (Jennings et al., 2016). One study has found that mountain lions favor an area that has been burned 2-5 years after the fire (Jennings et al., 2006). Some animals in fire prone zones have been able to adapt to natural fires in their environment (Engstrom, 2010). One study found that many animals in a fire prone area

do not have an innate fear of fire (Komarek, 1969). This may seem like good news, however, these species can withstand the natural wildfires the land is supposed to endure, not these hotter, faster, longer burning human caused wildfires that occur frequently.

Most people are aware of the thousands of wildfires that burned over 7 million acres of the Amazon rainforest (Bittel, 2019). The Amazon is home to one in ten species on earth, which magnifies the importance this area places on biodiversity (Bittel, 2019). Several reports came out discussing the over 500 jaguars died or were displaced, but many people didn't think about the mountain lions that also roamed those forests and had their habitats burned down (Bittel, 2019). These fires were started by humans trying to clear the forests out for development, oil, drilling, logging, and intensive agriculture (Bittel, 2019). During long periods of intense heat the soil dries leading to the roots of the trees to exploit what little moisture is left (Struzik, 2017). The soil continues to dry out resulting in the roots to die off causing the tree to weaken and become unable to take up enough moisture and nutrients to keep it alive and it dies (Struzik, 2017). When trees die drought increases which brings disease and insects (Struzik, 2017).

Some regions of California wildlife have a long-standing relationship with fire, since fire is a natural part of the landscape (Weiss, et al., 2019). There tends to be mass movements of small invertebrates fleeing from the flames ahead of the fire (Zielinski & Zachos, 2018). Once an area is burned the behavior of the animal species found within that area changes and that area begins to attract more predators (Komarek, 1969). The United States spent half a century practicing fire suppression resulting in too many thick stands of trees and not enough roots and berries to sustain animals like grizzly bears (Struzik, 2017). Grizzly bears do well in burned areas, like many other animals, and they eat animals that perished in the fire like mountain lions

will do (Struzik, 2017). Southern California is a biodiversity hotspot that supports a great number of threatened and endangered species in the United States (Luke, 2004). Increasing fire frequency can affect mountain lion habitat suitability and connectivity in the future (Jennings et al., 2016).

How climate change is affecting the risk of wildfires:

Climate change is the biggest driver of wildfires due to increased droughts, fuel build up, earlier spring seasons and higher temperatures (Daley, 2017). Fire frequencies in parts of Southern California are increasing beyond the threshold to which the ecosystem is resilient (Jennings et al., 2016). This leads to more invasive grasslands taking over the land, and since grasslands provide less coverage mountain lions avoid grasslands. Climate change is increasing the likelihood of invasive vegetation as available fuel and overall temperature allowing fires to occur every 4 to 15 years in the same area. Environmental changes affect the vegetation, which in turn affects the animals that eat the vegetation, and travel up the food chain and affect the predators that eat the vegetation eating animals (Turner, 1997).

As temperatures increase, humidity decreases which leads to strong, dry winds that occur more often and later in the season when fuel loads are at their highest and fuel moisture is at its lowest (Jennings et al., 2006). Southern California used to have a fire season, but now fires are occurring year round with the most intense and largest fires commonly occurring in October and November, in conjunction with the Santa Ana winds (Jennings et al., 2006). Forests are becoming drier and burning more easily and to a greater extent (Mistry et al., 2016). These increasing temperatures also cause snow-top mountains to melt, leading to forests being deprived

of moisture, resulting in them being more susceptible to burning (Zielinski & Zachos, 2018). A study was done and it was determined that snow in burned forests melted faster than snow in unburned forests (Merzdorf, 2019).

California wildfires are becoming so large and hot that they are creating their own pyrocumulus cloud systems that can be as high as five miles in the sky (Siler, 2018). These types of clouds are more commonly seen over volcanic eruptions. These pyrocumulus clouds are filled with moisture and ash and can rain down water filled ash across a fire. Sometimes these clouds can hold enough moisture that they trigger a heavy rainfall that sometimes can help extinguish a fire (Zielinski & Zachos, 2018). The intense heat from the fire burns the moisture out of the vegetation and accumulates on smoke particles which rapidly condense and rise (Siler, 2018). The speed at which these clouds form, combined with the heat of the fire, can lead to massive temperature swings in the atmosphere and create unpredictable and severe winds (Siler, 2018). These reactions exacerbate the intensity of wildfires and cause them to move in unpredictable ways, which makes it more difficult for fire extinguishing efforts to control the fire (Siler, 2018). These severe winds can also help fan the flames which aids in spreading the fire (Zielinski & Zachos, 2018).

Climate change is already impacting 82% of key ecological processes that form the foundation of a healthy ecosystem, so wildfires only increase the destruction of the ecosystem that humans rely on (Center for Biological Diversity & Mountain Lion Foundation, 2019; Scheffers et al., 2016). In the American West it is believed that wildfires are expected to double and possibly triple the area burned in places by 2050, as the climate continues to warm (Struzik, 2017). The western Arctic is warming twice as fast as the rest of the world (Struzik, 2017).

Russia has fires that burn bigger than any place on Earth (Struzik, 2017). Scientists in Canada have conducted studies about the prolonged fire season and warming weather, which have led to 12% more lightning with every 1.8 F temperature increase (Struzik, 2017). This data raises questions as to whether wildfires caused by lightning should be considered to be natural or human-caused.

The dangers of increased wildfire:

Climate change, deforestation, and the expansion of agriculture are the major drivers for the increasing frequency of wildfires, and they all are human driven (Mistry et al., 2016). Fire behavior has a much greater potential to affect animals than plants (van Mantgem, 2015). Plants recover endogenously, meaning they grow and develop internally, although fire size plays a role in determining their recovery patterns (van Mantegeln, 2015). Animals that depend on recolonization of burned sites from metapopulations may be greatly affected by the size of the fire (van Mantgem, 2015). The hotter the fire is, the more the soil burns meaning more mercury enters the air before settling in another place (Struzik, 2017). As the frequency of fires increases it causes shifts in natural fires regimes creating large scale landscape changes which includes a change in vegetation type and habitat fragmentation (Center for Biological Diversity & Mountain Lion Foundation, 2019; Jennings, 2018).

Pyrodiversity is the effect fire creates and promotes on biodiversity in an environment, and the process is abundant in southern California (Kelly & Broton, 2017). Pyrodiversity is a really important event in wildlife habitat, however, today we have more fires that are burning hotter and larger than what the habitat can handle (Goldman, 2019). This is leading to a decline

in pyrodiversity (Goldman, 2019). These hotter, faster, and rapidly recurring fires have massive implications for the various flora and fauna in California, including the mountain lion. These fires can turn into megafires, which are fires that burn at least 100,00 acres and they are occurring more often in places where humans live, work, and recreate (Struzik, 2017). Wildfires maintain the biodiversity among insects, vegetation, birds, animals, and fire is needed to keep the habitat healthy by decreasing diseases (Struzik, 2017).

The rate of fire spread and fire intensity do not appear to play an important role in plant recovery, however, it does play an important role in determining survivorship of some animal populations (van Mantegen, 2015). Without trees, vegetation and a stable soil structure can not absorb the heavy rains that will eventually follow a wildfire (Struzik, 2017). This will also cause lots of ash, debris, heavy metals and nutrients to be flushed through and into the watershed, which will stay there for several years (Struzik, 2017). The water becomes tainted and unhealthy which leads to an increase in flooding, and by having nitrogen and phosphorus enter the water after a wildfire, algae and other plants begin growing very fast (Struzik, 2017). Insects and macroinvertebrates will then feed on these plants which increases the size and diversity of these populations (Struzik, 2017). This will lead to trout and other fish feeding on these insects and macroinvertebrates and in turn they will grow bigger and grow faster (Struzik, 2017). Most municipalities in the United States get their drinking water from forested areas that can be affected by wildfires, so this watershed issue affects everyone (Struzik, 2017).

How humans can coexist with mountain lions:

Rewilding is “returning, restoring, and protecting a bit of nature’s most fundamental process to places where those processes have broken down” (Williams, 2018). Rewilding is based off of the three C’s; *Core* habitat, *connections* between habitat, and *carnivores* playing their natural role (Williams, 2018). Encroachment of urban land and agricultural development has reduced native vegetation, which increases the chance of invasive plant species and increases wildfire risk (Luke, 2004). This affects mountain lions because if there is not appropriate dense vegetative cover for them to move through they will not disperse and their chance of extirpation increases (Luke, 2004). Immediate steps landowners can take include planting native plants around their properties to help native wildlife thrive, paying attention to where planned development sites are going, and advocating to protect much-needed land for wildlife that will help ensure connectivity.

The most famous mountain lion is P-22 who resides in Griffith Park in Los Angeles, California. He accomplished the nearly impossible task of crossing the 101 and 405 freeways and survived. He now lives in an extremely small area for a male mountain lion. To honor his journey it has been declared that October 22nd is P-22 Day in Los Angeles (Center for Biological Diversity & Mountain Lion Foundation, 2019).

California loses around 100 mountain lions a year to vehicle strikes (Center for Biological Diversity & Mountain Lion Foundation, 2019; Pollard 2016). Depredation killings account for 94% of all reported human-caused mountain lion mortalities in California (Mountain Lion Foundation, 2019). Mountain lions are also being killed by depredation, rodenticide poisoning, disease, poaching, starvation, public safety removal, and human-caused wildfires (Center for Biological Diversity & Mountain Lion Foundation, 2019). Intraspecific strife, male

aggression towards siblings, female offspring, or previous mates, are the primary cause of mortality in the Central Coast and Southern California subpopulations (Center for Biological Diversity & Mountain Lion Foundation, 2019; Riley et al., 2014). Individuals can take the following steps to avoid contributing to these preventable fatalities. Always look out for wildlife while driving and pay close attention when driving in low light. Protect your livestock and pets so there is no need for a depredation permit. Do not use rodenticides, since the poison travels up the food chain and can cause harm to mountain lions and other predators that eat the rodents. Not using rodenticides can also protect your or your neighbors' pets from accidental ingestion.

What humans can do to reduce the risk of wildfires:

Today, politics control how a fire is managed, the timing of evacuations, and the manners in which the damage might have been minimized (Struzik, 2017). Sometimes politics, or the amount of wildfires in the surrounding areas, will determine the firefighting resources available, which can force the fire department to go into triage mode to determine which fires can be fought now and which ones need to wait (Struzik, 2017). The fire department should let the public know what they can and can not do. Fire departments also need to work together and listen to those who have been through similar fires in the past.

Having defensible space around a home and other structures increases safety from both mountain lions and wildfires. Achieving this defensible space only requires clearing out vegetation and hiding cover near the building. Mountain lions, coyotes, and other small predators like to use vegetation to hide, so clearing this out will help eliminate conflict with multiple species. Removing the vegetation will also create more space between your house and a wildfire

which gives the house a little more protection and helps protect firefighters defending the building (Cal Fire, 2019). Ideally the building should be clear of debris, dead or dry leaves and pine needles and vegetation extending 30 feet on the sides and 100 feet in the back (Cal Fire, 2019). That is not always possible, however the most space you can create the better. It is also helpful to ensure that there is six feet of vertical spacing, making sure tree branches are high off the ground (Cal Fire, 2019). San Diego County currently requires 50 feet of clearance between the building and the vegetation that can catch fire (Cal Fire, 2019). It also helps to plant native fire-resistant plants, which also helps conserve water (Cal Fire, 2019). In California Cal Fire usually is the first to respond to wildfires.

Cal Fire chose to follow in the footsteps of the U.S. Forest Service by creating their own fire related mascot in June 2019 (McGough, 2019). The U.S. Forest Service has Smokey Bear whose motto is “only you can prevent wildfires” (Evans, 2018). Cal Fire decided to go with a mountain lion as their mascot, because the mountain lion is ubiquitous to California, is a California icon and is found all over the state, according to Cal Fire Director Thom Porter (McGough, 2019). Cal Fire named their mountain lion mascot Captain Cal and his motto is “safety starts with you” (McGough, 2019). In addition to Smokey the Bear and Captain Cal the National Fire Protection Association has Sparky the Fire dog, who is a dalmatian teaching people how to stay safe from fire (National Fire Protection Association, 2016).

Another thing that people can do that will help deter wildlife from their yards is to not feed wildlife. If you don’t want mountain lions in your yard, do not feed and attract deer, because the mountain lion will follow their prey. Also, do not feed pets outside. Raccoons, coyotes, foxes, and mountain lions will stop by to see what your pet ate outside. If the predator species is

hungry and your pet is still outside, your pet can become dinner. It is best to keep your pets inside from dusk until dawn and in low light (Mountain Lion Foundation, 2019). If your animals must stay outside make sure they are in mountain lion proof enclosures, which the Mountain Lion Foundation can help you with (Mountain Lion Foundation, 2019).

Conclusion:

People need to know that wildfires are natural but they are becoming too hot for the fire-prone environment to handle. Everyone can take small steps in reducing their risk of starting a wildfire and preventing fires in general. They can also take actions to better help wildlife by reducing conflicts, helping make their property safer in terms of human-wildlife conflicts and during wildfire season, and by not using rodenticides. Climate change impacts wildfires and vise versa, so it is crucial that everyone works together to reduce wildfires and hopefully help reduce the risks caused by climate change. The information in this paper can help policymakers, the public, and firefighters figure out the best solution to protect wildlife and how to coexist with wildlife like the mountain lion.

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