

A person is ziplining over a field of tall grass. The zipliner is suspended from a cable that runs across the top of the frame. The person is in mid-air, with their arms and legs outstretched. The background is a clear, bright blue sky. In the foreground, a person is running across the top of a grassy hill, silhouetted against the sky. The grass is tall and green, and the overall scene is bright and sunny.

HOT TRAIL SUMMER:

THE IMPACT OF A
WARMING CLIMATE ON
CLIMBING AND TRAIL SPORTS

SUMMER 2022

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EXECUTIVE SUMMARY

For the Outdoor State—the millions of Americans who love to get outside—the longer days and sunny weather of summer mean more time on the trail and at the crag; a few extra hours of light can mean the difference between packing it in early and sending a few more routes or bagging another peak. In short, summer has always been one of the best seasons to do what we love.

But summer as we know it is changing. This report, created in collaboration with master's students at UC Santa Barbara's Bren School of Environmental Science & Management, examines how climate change impacts the rock climbing, trail running, hiking and mountain biking communities and outlines what many of us already know: that no matter the season, a warming world has profound implications for outdoor recreation. As the IPCC's 2021 Assessment Report puts it, "human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years!" a trend that could make summer one of the worst times to get outside—unless we band together to advocate for systemic changes needed to protect the places, activities and lifestyles that we love.

In the following pages, you'll read about the numerous ways that climate change will affect summer recreation, but it all comes down to three main impacts that will hinder our ability to recreate:

- **Climate change will decrease access to trails and crags.** More frequent and severe wildfires will close large recreational areas due to actively burning wildfires, with residual impacts on trail systems such as charring and erosion. Meanwhile, hotter temperatures will make it uncomfortable to remain outdoors during the hottest parts of the day. Rock climbers will have shorter windows of conditions ideal for projecting, exploring and spending time at the crag.
- **Climate change will threaten the health and well-being of those who recreate outdoors.** Hotter temperatures increase the risk of heat-related illnesses such as heat exhaustion and heatstroke. Poor air quality due to wildfire smoke, increased dust levels due to drought and higher surface-level ozone concentrations mean that those who want to recreate outdoors in the summertime will face a difficult choice: stay inside and forgo the mental health benefits of recreating, or get outside and risk our health by exposing ourselves to dangerous conditions.
- **Climate change will diminish the experience of getting outdoors.** Poor air quality, water-starved ecosystems and charred swaths of land mean that the summer landscapes we've come to know and love won't look like we remember them. As a result decreased access to recreational opportunities will concentrate crowds in places that remain open.



BIKER: MICHELLE PARKER PHOTO: AARON BLATT

If these trends continue, they'll make it harder for us to get outside during the summer months and force us to be more selective about when and where we recreate. It could even mean the permanent loss of some recreation areas. And as our options for summer recreation dwindle, the \$450 billion outdoor industry that supports millions of jobs, livelihoods and families will also take a hit. This could spell disaster for the small, rural towns that rely on the Outdoor State for economic security.

But the goal of this report is not to add to the piles of literature that tell you how climate change is negatively affecting the world—it's to provide a common cause for summer sports enthusiasts to take action on. The Outdoor State is united by our pursuit of a better life through physical and psychological improvement, which includes protecting our local trails, crags, boulders and mountain bike tracks. It's not a job that one can do alone, but as a group, our collective voice can mean the difference between summers spent reluctantly inside and summers spent pursuing our passions outdoors.

And that's where organizations like Protect Our Winters can help. POW's mission is to help passionate outdoor people—just like you—protect the places you love from climate change by connecting you with opportunities to channel your passion for the outdoors into meaningful climate action. Collectively, America's 80 million trail sports athletes and 5 million rock climbers have the power to influence U.S. climate policy, and there's no better time to start than now.



PHOTO: MATT KOLLER

Join Team POW to learn more about how you can help protect the places you live and love.



CLIMATE IMPACTS ON TRAIL SPORTS



RUNNER: VANESSA CHAVARRIAGA PHOTO: SOFIA JARAMILLO



PHOTO: JEREMIAH WATT

As the climate continues to warm, several existing and emerging impacts will make it harder for trail sports enthusiasts to do what they love. These impacts can be grouped into three overarching categories: threats to access, threats to health and threats to experience. While there are regional differences in the severity of each threat, all will affect the trail sports community and their way of life.

THREATS TO **ACCESS**

Several climate impacts have been demonstrated to limit access to trail systems, including wildfires, erosion, extreme heat, sea-level rise and tree die-off. As global temperatures continue to rise, these five factors are increasingly expected to prevent trail sports enthusiasts from accessing the places they love.

THREATS TO **HEALTH**

Trail sports enthusiasts' personal health will be at greater risk while recreating due to changes in temperature, air quality, vector-borne disease spread and the mental health benefits received through recreation.

THREATS TO **EXPERIENCE**

Climate impacts such as wildfire and erosion damage the aesthetic value of trail systems and result in crowding. These changes will diminish the overall experience that trail sports enthusiasts seek when recreating.



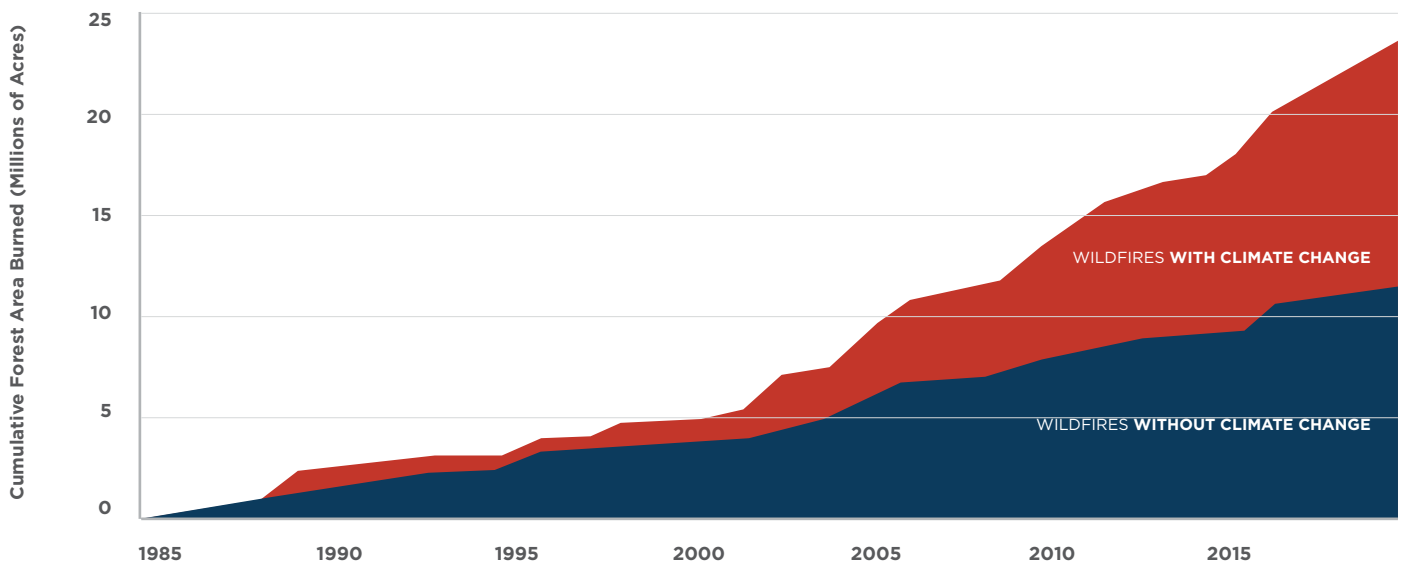
BIKER: PHIL HENDERSON PHOTO: DONNY O'NEILL

WILDFIRES

Although wildfire is a natural part of ecosystem dynamics in many regions, conditions that facilitate wildfires are increasingly common in the Western U.S.² Warmer temperatures create hotter and drier conditions that dry out vegetation, which increases the fuel stock for fires and leads to larger, more frequent wildfires and a longer fire season.^{2,3,4}

This means that the area of forest burned each year is increasing. By 2015, the average annual area burned in the Western U.S. was double what it was in the early 1980s. The average length of wildfire season also more than doubled in Western U.S. forests when comparing the 10-year period from 1973 to 1982 with 2003 to 2012.^{2,4} These wildfires have resulted in closures of trails and the surrounding infrastructure due to extensive damage. For example, in 2020, Arizona had a record-setting fire season that burned 978,000 acres and over 100 miles of the Arizona Trail, limiting the ability of trail users to access these recreational spaces.^{5,6}

“In 2020, Arizona had a record-setting fire season that burned 978,000 acres and over 100 miles of the Arizona Trail, limiting the ability of trail users to access these recreational spaces.”



This graphic, published in the Fourth National Climate Assessment, clearly illustrates what so many of us know: that climate change is increasing the frequency and severity of wildfires in the U.S.¹ In 2015, wildfires burned approximately twice the acreage they would have without climate change.

STORIES FROM THE FIELD - KURT REFSNIDER



For professional mountain biker Kurt Refsnider, trail closures due to wildfires mean that he frequently has to pivot where and when he's riding. In recent years, wildfire contingencies have become an integral part of his trip planning, but that doesn't always let him finish the rides he wants to. One example is the Oregon Timber Trail, a new, 700-mile series of connected trails across Oregon. As Refsnider, who also happens to have a Ph.D. in geological sciences, puts it,

“It’s very possible that the Oregon Timber Trail will never be entirely rideable in a single season due to fire closures and the resulting post-fire closures.”

KURT REFSNIDER


Similarly, the Western Wildlands Route, a 2,700-mile bikepacking route through Canada, Montana, Idaho, Utah and Arizona that Refsnider helped design, “has fire detours every year. Some are short because fire is threatening part of the route, and some are long, as area closures force people to go around public lands.”

THREATS TO ACCESS

EROSION

Warmer temperatures are expected to increase the intensity of heavy precipitation events as more water evaporates from the Earth's surface.² However, increasing evaporation rates will also lead to more frequent and extreme drought conditions.² Together, higher evaporation rates and extreme drought conditions will increase the potential for soil erosion.² Yet, it is not only dry conditions that affect erosion: there is a positive correlation between precipitation intensity and rates of trail degradation.⁷

As heavy precipitation events and drought conditions increase rates of erosion, it will become more difficult to access trail systems. In some places, this could result in trail closures. One example is the seven-year-long closure of the Young Gulch Trail in Poudre Canyon, Colorado, which was demolished by post-fire flooding.⁸



As a professional trail runner with a Ph.D. in Biology and Marine Biology, Peyton Thomas has both studied and experienced the impacts of climate change. Her biology research involves understanding the impacts of climate change on marine species, and, as she observes, “the Gulf Stream is warming, which is bringing a lot more hurricanes and tons of precipitation to the Southeastern U.S.”

When training in Wilmington, North Carolina, Peyton frequented the 20-mile Neusiok Trail in Croatan National Forest. “A ton of people will go backpack it. A ton of runners will go run it. But when Hurricane Florence hit in 2018, it literally shut down the trail for around two and a half years. We were still doing trail work to open up the trail in 2021 because different pockets were completely covered with downed logs. For a region that doesn't have a ton of outdoor recreation access, it totally changes the way that people recreate. I know there's a ton of gravel roads that people bike on too, and so many of these roads have been closed and are just starting to open in 2022.” Similar impacts are also occurring in inland areas. As Peyton notes,

“If you go out to Asheville or Boone in the summer, it's drier, and in the winter, you get more precipitation. So you get way more landslides. Things are shifting a lot.”

PEYTON THOMAS

STORIES FROM
THE FIELD—
PEYTON THOMAS

PHOTO: NATALIA WEEDY

Wildfires in the Western U.S. can destabilize trails by burning away the vegetation that anchors the soil.⁹ The remaining soil becomes hydrophobic, which, combined with post-fire rain events, can trigger debris flow, mud slides and landslides—all of which can impact trail accessibility or even trap trail users in the outdoors.^{10,11} Both the intensity and risk of this debris flow are expected to grow as the length of the wildfire season in the Western U.S. increases.¹²

Rapid trail degradation is already well-documented, and projected increases in erosion can acutely impact mountain biking trails.²⁰ These trails will experience loosened track surfaces, soil displacement, linear rut development and the creation of secondary, user-created trails, compromising the ability of mountain bikers to ride on well-maintained trails.¹³

A professional mountain biker, Kurt Refsnider, is shown in action on a dirt trail. He is wearing a blue helmet, sunglasses, and a black long-sleeved jersey with 'FAST SHIMANO' branding. The background is a vast, arid desert landscape under a clear sky. The text 'STORIES FROM THE FIELD - KURT REFSNIDER' is overlaid on the right side of the image.

STORIES FROM THE FIELD - KURT REFSNIDER

Despite being well-protected from coastal storms and sea-level rise, inland areas are still threatened by erosion. For example, the Arizona Trail Association and countless volunteers, including professional mountain biker Kurt Refsnider, spent years restoring sections of the Arizona Trail. Then, after the 2020 Bighorn Fire near Mount Lemmon, Arizona, and a wet monsoon season, “the trail was brought back to conditions from 10 years ago,” observed Refsnider.

“The rains washed away all the trail restoration that had been done in recent years.”

KURT REFSNIDER

SHIFTED TIMING

Average annual temperatures in the U.S. have increased by 1.8°F (1°C) since 1900.² Alarmingly, average temperatures are expected to increase by an additional 2.5°F (1.4°C) over the next several decades and could increase by 3–12°F (1.6–6.6°C) by 2100, depending on future greenhouse gas emissions.² Temperature increases will be particularly acute in the Southwestern U.S. (California, Nevada, Utah, Colorado, New Mexico and Arizona)¹⁵, and parts of this region could experience 45 additional days with high temperatures exceeding 90°F every year.² Additionally, summer heat waves are projected to become hotter and longer.¹⁵

These high temperatures can limit daily and seasonal access to trails due to both compromised performance and potential heat-related health impacts, which are discussed in greater detail in the “Threats to Health” section. For example, cyclists often opt for early morning or evening rides during periods of warm weather to avoid the midday heat¹⁶, an approach that trail users are likely to adopt. In short, trail users are likely to forgo or cut short recreational pursuits when temperatures are extremely hot.

In more extreme cases, high temperatures can lead to trail closures. For example, in 2021, the city of Phoenix approved a pilot program designed to restrict the use of certain trails during extreme heat to protect the safety of the public and first responders.¹⁷ As global temperatures rise, closures such as these are increasingly likely to directly limit outdoor recreation opportunities for trail sports enthusiasts.

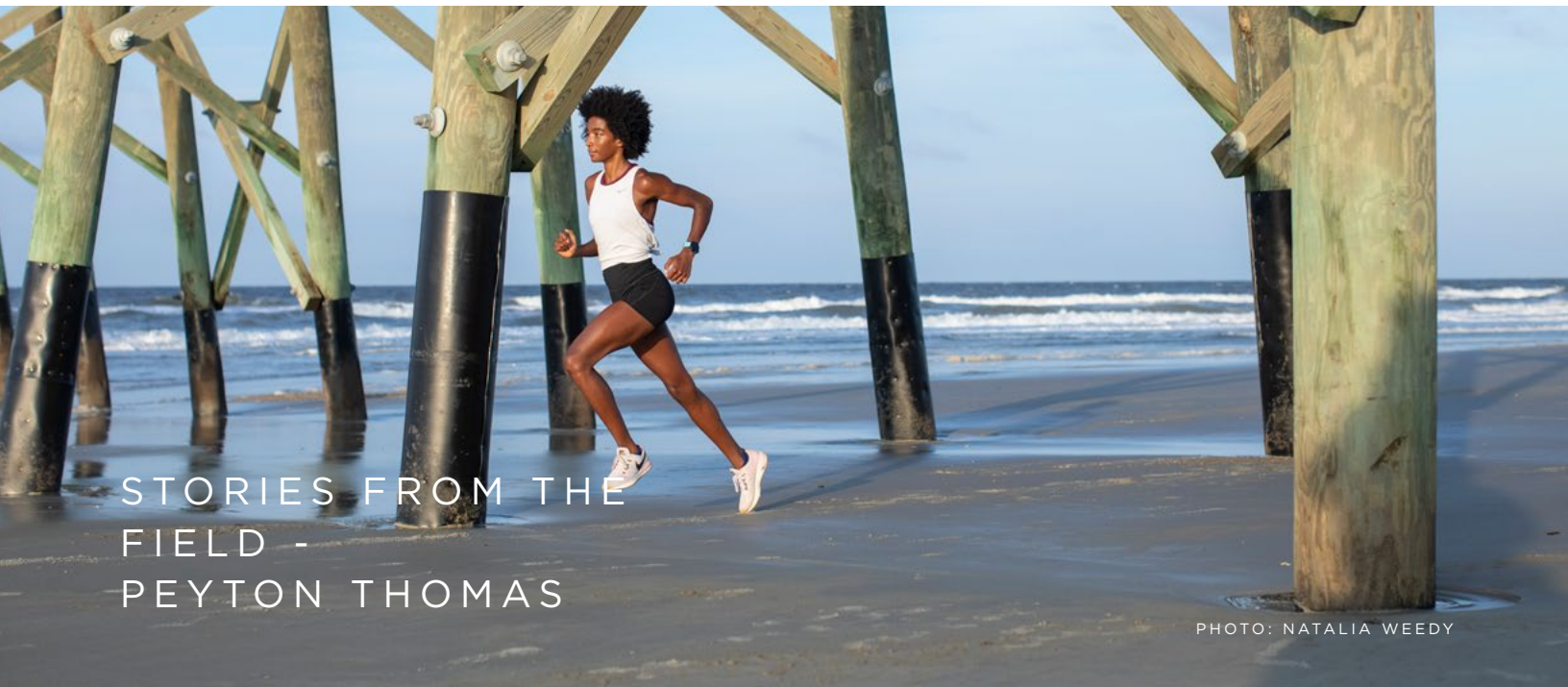
“High temperatures can limit daily access and seasonal access to trails due to both compromised performance and potential heat-related health impacts.”



THREATS TO ACCESS

SEA-LEVEL RISE

Warmer temperatures are melting Earth's glaciers and ice sheets, increasing the ocean's volume.¹ Additionally, the ocean absorbs heat as the atmosphere warms, which causes seawater to expand. These two factors—more water, taking up more space—raise sea levels and threaten lowland trails in coastal communities. Case studies have primarily focused on urban areas such as Philadelphia, which could lose 57% of its off-street trail mileage by 2100 due to sea-level rise¹⁹, but similar effects are expected for many lowland coastal trails.¹⁸



STORIES FROM THE
FIELD -
PEYTON THOMAS

PHOTO: NATALIA WEEDY

In 2018, professional trail runner Peyton Thomas weathered Hurricane Florence as it moved through Wilmington, North Carolina. “That was not only devastating to me but to the entire coast of North Carolina,” notes Thomas. In the aftermath of the hurricane, Thomas found that “the trails and places I would recreate were flooded and damaged. In Carolina Beach State Park, changes in the water levels are occurring more frequently, so you see lots of flooding in different pockets of the trail system. There’s been a ton of saltwater intrusion into the park too, so you can see huge dead stands of trees. That impacts the stability of the land, and those areas were pretty devastated by the hurricane.”

As a Biology and Marine Biology Ph.D. student, Thomas was curious about the link between climate change and Hurricane Florence, and confirmed her hunch after reading follow-up studies that found that it was fueled by climate change. And Hurricane Florence wasn’t the last. As Thomas explains, “these massive storm events are occurring way more frequently. We’ve been tracking this with climate change models, and in 2022 it is projected that we’ll have four or five major hurricanes hit the East Coast.” While daunting, this forecast is also a call to action for Thomas. “Wilmington has already been designated a high flood risk and an important area for sea level rise resilience,” says Thomas. “Wilmington needs to come up with some sort of infrastructure plan in order to preserve the integrity of the city, but the city council and some state representatives have gone back and forth with changes in development in response to sea level rise.” This means Thomas and other coastal residents can help elect officials that prioritize sea level rise resilience to protect Wilmington and other coastal areas.

THREATS TO ACCESS

FOREST DIE-OFF

The U.S. Forest Service manages nearly 159,000 miles of trails.⁵⁴ Combined with thousands of additional miles of trails on lands owned by other national, state and local agencies (not to mention private holders) forest trails provide ample opportunities for recreation in the U.S. However, wildfires, severe drought and harmful insect outbreaks damage U.S. forests and can limit recreational opportunities within them. For example, insects like bark beetles flourish in drought conditions and higher temperatures²¹ and have killed more trees than wildfire over the past 30 years in the Western U.S.²² From 2010 to 2018, bark beetle infestations killed trees across more than 50 million acres of the Western U.S.²

In addition to providing fuel for wildfires, these dead trees can damage infrastructure and block trails when they fall. This can cause trail users to cut a hike or ride short and make it particularly difficult for athletes seeking personal bests to compare their performance against others on a particular trail.

“...people [in Western states] either don’t know or don’t want to know that their backyard could be next on the chopping block.”

DILLON OSLEGER



STORIES FROM THE FIELD - DILLON OSLEGER

In addition to being a professional mountain biker on the Enduro World Series, Dillon Osleger also holds a master's degree in Earth Sciences and Geology and worked for The Nature Conservancy studying the impacts of rangeland agriculture on public lands. This background has given him an intimate understanding of how climate change affects forests: "drought, blister rust and beetles are killing millions of trees," he says. The impact of beetles is particularly concerning, as warming temperatures are worsening droughts and expanding the habitat of spruce beetles and pine bark beetles beyond their historical ranges. As Osleger laments, "people [in Western States] either don't know or don't want to know that their backyard could be next on the chopping block." After trees die, they can fall across trails and provide fuel for wildfires, both of which make it difficult for users to access trails.

These days, Osleger is focused on addressing these damages through trail stewardship and advocacy. As the executive director of the Sage Trail Alliance, he works to restore trails impacted by climate-related disasters and promote equitable access by building new trails in densely populated or economically depressed regions. However, Osleger will need continued help in these efforts: he estimates that "in 2020, wildfires in California destroyed 1,023 miles of trail, 80 bridges, and kiosks and signs that were collectively worth somewhere between \$20-40 million."



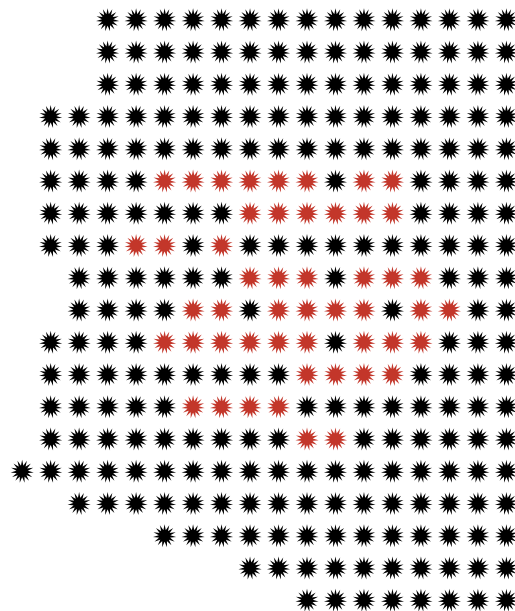
TEMPERATURE

As mentioned, average annual temperatures in the U.S. have increased by 1.8°F (1°C) since 1900 and are expected to increase by 2.5°F (1.4°C) over the next several decades.² These temperature increases are expected to be more dramatic during the summer months, meaning trail sports enthusiasts will be recreating in increasingly warmer conditions.²

As most outdoor enthusiasts know from personal experience, hot temperatures directly inhibit athletic performance. This collective understanding is supported by medical experts, as a panel convened by the International Olympic Committee determined that higher temperatures can severely impair physical performance across a wide range of sports.²³ According to their comprehensive review, higher temperatures strain cardiovascular, thermoregulatory, metabolic, neural and cognitive functions, all of which play a role in athletic performance.²³

In extreme situations, excessive heat can completely compromise the body's ability to regulate its internal temperature and result in heat-related illnesses such as heat exhaustion and heatstroke.²⁴ Increases in the likelihood of both heat-related morbidity and mortality events as temperatures rise are well-documented.²⁵ Across the U.S., hotter temperatures are putting trail sports enthusiasts' performance and health at risk.

Furthermore, communities of color and economically disadvantaged communities experience greater exposure to extreme heat, meaning they are more likely to experience heat-related illnesses.²⁶ These differences arise due to differences in neighborhood vegetation, less access to resources like air-conditioning, greater exposure in work environments and less access to healthcare, among other factors.²⁶ For trail sports enthusiasts from communities of color and economically disadvantaged communities, hotter temperatures can exacerbate existing inequities through heat exposure and the related health impacts.



Arizona currently averages over 50 'dangerous heat days' per year (heat index of 105°F or higher) and that is projected to increase to almost 80 days per year (States at Risk 2022).¹⁶⁷

“In more extreme situations, excessive heat can completely compromise the body’s ability to regulate its internal temperature and result in heat-related illnesses such as heat exhaustion and heat stroke.”

AIR QUALITY

As noted, climate change is increasing wildfire size and frequency, which produces more wildfire smoke. Wildfire smoke can contain carbon monoxide (CO), nitrogen dioxide (NO₂), ozone, particulate matter (PM), polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs), all of which are harmful to humans.²⁷

In the short-term, prolonged exposure to particulate matter from wildfires can cause shortness of breath, heart rate variability, lung function decline, sore throat, coughing, itchy and watery eyes and congestion.²⁸ On longer time scales, breathing wildfire smoke and its associated particulates is correlated with increased mortality and respiratory issues such as asthma, chronic obstructive pulmonary disease (COPD), chronic bronchitis and pneumonia.^{29,30}

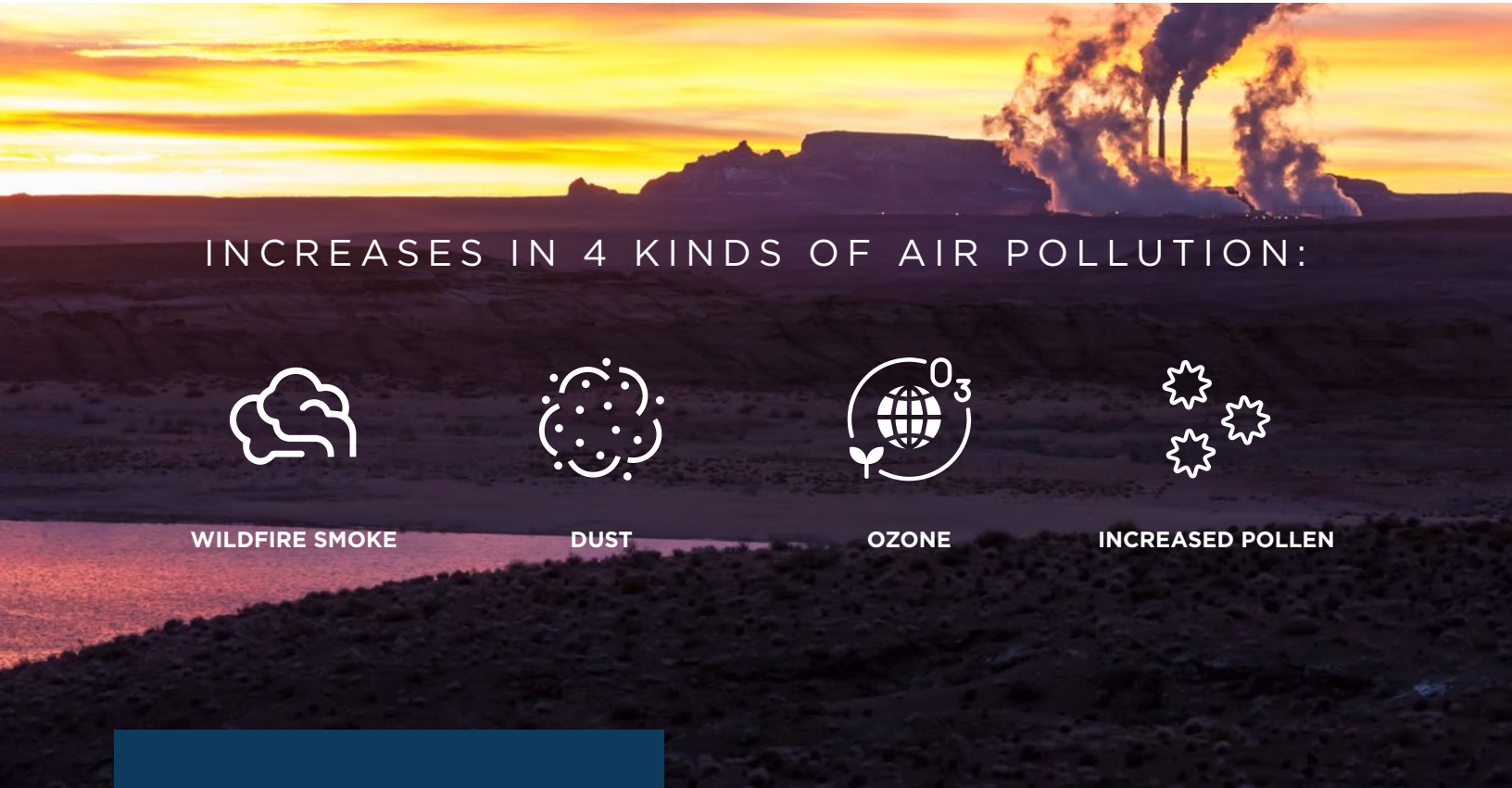
While smoke from Western wildfires has reached as far east as New Hampshire³¹, the impact of wildfires will be most severe in the Western U.S. From 2016 to 2020, most counties in the Western U.S. experienced four or more weeks of wildfire smoke exposure per year.³²

“From 2016 to 2020, most counties in Western U.S. experienced four or more weeks of wildfire smoke exposure per year.”



However, climate-related health impacts are not limited to smoke. Drier and warmer fall conditions increase the amount of ground-level ozone in many states, which can induce shortness of breath, aggravate asthma, worsen allergies, compromise lung function and result in hospitalization.³³ While regional increases are projected to be more severe in urban areas, trail sports enthusiasts across the U.S. are likely to experience greater exposure to ozone.

Dust also represents an increasing threat to air quality in the U.S. As a result of climate change, soils are drying out faster in the Western plains and desert regions of the U.S., increasing airborne dust levels.³⁴ In turn, breathing dust increases hospitalizations due to cardiovascular and respiratory illness and can result in premature mortality.³⁵ This trend is already being observed: Research suggests that total non-accidental mortality attributed to dust exposure increased by 7.4% between 1993 and 2005.³⁶



INCREASES IN 4 KINDS OF AIR POLLUTION:



WILDFIRE SMOKE



DUST



OZONE



INCREASED POLLEN

“...communities of color and economically disadvantaged communities experience greater exposure to poor air quality due to various environmental inequities and higher rates of respiratory illness.”

Additionally, increased temperatures are lengthening the growing seasons of plants in certain regions. This results in a longer pollen season and increases the amount of pollen that plants produce, elevating the frequency and intensity of related allergic reactions and increasing new cases of asthma.²

Regardless of geographic location, deteriorating air quality threatens the health of trail sports enthusiasts. Health professionals have noted that the risks related to poor air quality increase as levels of physical exertion increase³⁷, making this impact of particular concern: the more a trail sports enthusiast exerts themselves, the more they are putting themselves at risk. Furthermore, communities of color and economically disadvantaged communities experience greater exposure to poor air quality due to various environmental inequities and higher rates of respiratory illness.^{38,39} As such, trail sports enthusiasts from these communities will experience greater negative health impacts related to climate change.

STORIES FROM THE FIELD— KAIT BOYLE

In the summer of 2021, professional mountain biker Kait Boyle had big objectives planned. However, a series of climate-related events derailed almost all of them. When her first race of the year, the Butte Montana 100, was canceled in early July due to smoke, race organizers offered deferrals to the next year's event. The decision, as Boyle notes, "was a tough financial call for directors. They had to cancel the previous year's race due to COVID, too."

Later that summer, the Pierre's Hole 50/100K Mountain Bike race in Targhee, Idaho, was canceled due to a smoke storm, and Boyle headed home again without competing. "It's frustrating to not be able to race and to not be able to do your job," she says about the experience. "Summers are feeling more off-limits to big objectives now. Mountain bike race and event calendars haven't shifted yet, but they might." But, as she notes, even more important than the frustration of canceled events is the "sorrow and sadness for loss of place and quality of life in those communities."



STORIES FROM THE FIELD— KURT REFSNIDER

In the summer of 2021, professional mountain biker Kurt Refsnider spent a month in Idaho training and racing, but he found that the "smoke was so bad that he completely skipped some of the racing. That month, you're just looking at the AQI trying to figure out, 'where can I go?' For me, I have asthma, so it's even more of an issue when determining where I go." Training in poor air quality is an issue affecting athletes across the entire Western U.S. "For planning racing and adventures, the northwestern Rockies region is one to avoid from July through August, which is crazy because it's such a huge area," he says.

Refsnider also notes that professional athletes are unique compared to others: "For folks like us [who] structure our lives around where we need to be and have the means to travel, it's okay. But some folks don't have the means to work remotely or don't have money to travel and are stuck recreating where they are, which can have serious long-term health impacts depending on conditions. Some athletes are willing to go out in those conditions, but for folks who are doing it for a living or [are] more sensitive to it, it's a serious concern."



STORIES FROM THE FIELD - CLARE GALLAGHER

Professional trail runner Clare Gallagher was set to race in The North Face 50-Mile Championships in Marin, California, in November 2018. However, smoke from the Camp Fire resulted in persistently poor Air Quality Index (AQI) readings, and the race was canceled.

“Since that season, I have had to be more choosy,” she says. “I think long and hard about signing up for fire-season races in Colorado, and attempting FKT’s* is difficult. How much are we holding ourselves back out of fear of not being able to breathe? I do not ever remember summers being so dictated by if you can even see the mountains.

*FKT’s, or fastest known times, are the speed records for running, hiking or biking specific routes.

PHOTO: MIKE THURK

*“It’s no longer a question of **where** are you running today;
it’s now, **are** you running today?”*

CLARE GALLAGHER

THREATS TO HEALTH

MENTAL HEALTH BENEFITS

Outdoor recreation provides trail sports enthusiasts with significant mental health benefits. For example, exercise typically decreases anxiety⁴², while time spent in forests and natural settings is positively correlated with stress reduction, improved mood and enhanced cognitive function.⁴³ Therefore, decreases in recreational access due to poor air quality, wildfire risk or increased temperatures reduce these mental health benefits. Additionally, as contact with nature decreases, so too does a sense of connectedness with nature and the associated benefits to well-being.⁴⁴ As such, access to trails and outdoor recreation are closely tied to mental health benefits for the trail sports community.

POW Alliance member Dakota Jones sees this impact first hand. “Climate change is a global problem, and it’s incredibly hard to feel like anything one person does can make a difference. This sense of helplessness can be heartbreaking, especially when our ways of coping with difficult situations—getting outside into quiet, natural spaces—are seriously impacted by the effects of climate change via forest fires, droughts, flooding, extreme heat, and more. The solution is to work together, and I started Footprints Running to empower people with effective responses to climate change. This may not make the problem any smaller, but our mental health is much better when we can do work that matters to address it.”

“Exercise typically decreases anxiety, while time spent in forests and natural settings is positively correlated with stress reduction, improved mood, and enhanced cognitive function.”



RUNNER: DAKOTA JONES PHOTO: MARTINA VALMASSOI

THREATS TO HEALTH

VECTOR-BORNE DISEASE SPREAD

Climate change is expected to increase the rates of vector-borne diseases transmitted by insects and pests.² Warmer temperatures have allowed many tick species to increase their habitat range and relative abundance.^{40,41} As a result of this expansion in habitat range, tick-borne diseases are expected to rise in humans, livestock and companion animals. For trail sports enthusiasts, the spread of ticks will likely result in increased exposure rates to ticks and tick-borne diseases such as Lyme disease.

AESTHETIC VALUE

Wildfires damage the aesthetic quality of recreational sites and vistas⁴⁵, while smoke days reduce visibility and limit opportunities to appreciate outdoor scenery.² One study found that fire and smoke affect 400,000 and 1 million visitor-days across the U.S. each year, respectively.⁴⁶ Another study found that hikers' and bikers' recreation demand decreased in areas that have been burned, indicating that trail users enjoy aesthetic value while recreating.⁵⁰

Increased drought stress is also projected to decrease forest biomass for all but the most drought-resistant trees.⁴⁷ Between droughts, wildfires and bark beetles, climate change is causing significant damage to U.S. forests.⁴⁸ Since trail users prefer to recreate on trails with more primary vegetation⁴⁹, these changes are likely to compromise their overall experience in many locations⁴⁵ and could reduce trail sports enthusiasts' desire to recreate.



STORIES FROM THE FIELD - STEPHANIE HOWE

For the 11 years that professional trail runner Stephanie Howe lived in Bend, Oregon, wildfires were more than just a nuisance. "It was no longer if we'll get wildfires, but when. And many of these fires were close to town. There were several times we had our bags packed and ready to go in case we had to evacuate," she says. However, wildfires impact a place long after they've burned out.

"So many places I liked to run are still closed years later, and there hasn't been maintenance work since. Even for trails that have reopened, when running, it's not the same. You're breathing in ash and dust, and there's no tree cover, making these trails exposed, hot and dusty. Visually, there are burn scars and leftover charred tree trunks. It's heartbreaking."

PHOTO COURTESY STEPHANIE HOWE

"...fire and smoke already affect 400,000 and 1 million visitor-days across the U.S. each year, respectively."

CROWDING



The USDA predicts that the total number of adults in the U.S. who participate in hiking will increase from 78.3 million in 2008 to 102.2 million by 2030, an increase of over 30%.⁵³ At the same time, wildfires, erosion, extreme heat, sea-level rise and tree die-off are all expected to limit the number of accessible trails. Further accentuating the issue of access is the backlog of federal trail repairs. The U.S. Forest Service manages approximately 159,000 miles of trails, but roughly 120,000 require maintenance or repair.⁵⁴ The backlog on forest roads and bridges alone is estimated to cost \$3.4 billion and has been increasing over time.⁵⁴ Taken together, these factors suggest that climate change could dramatically increase crowding on available trails.

While that may not appear to be an issue, recreation demand modeling suggests that individuals have a lower desire to visit sites they anticipate will be crowded with other people.⁵¹ Another stated preference study found similar results, with respondents indicating that their personal enjoyment decreased as trail congestion increased.⁵² These results suggest that trail sports enthusiasts will enjoy their time on the trails less as crowding increases.



CLIMATE IMPACTS ON ROCK CLIMBING

PHOTO: JEREMIAH WATT

Climate change is likely to impact the rock climbing community in several ways. Since rock climbing frequently requires the use of designated trail systems, most of the climate impacts outlined in the previous pages will also affect climbers. However, there are a variety of climb-specific impacts that can be grouped into the same three overarching categories: threats to access, threats to health and threats to experience. Although there are regional differences in the severity of each threat, climate change is projected to affect all rock climbers across the U.S.

THREATS TO **ACCESS**

Access to outdoor rock climbing locations typically requires trail use or wilderness access. Warming temperatures will threaten access to approach trails and climbing areas alike by increasing instances of wildfires, erosion, extreme heat and forest die-off.

THREATS TO **HEALTH**

Changes in temperature, air quality, the spread of vector-borne disease and the mental health benefits received through rock climbing all threaten the health of rock climbing enthusiasts.

THREATS TO **EXPERIENCE**

Rock climbers enjoy unique views due to the difficulty of accessing climbing spots, especially at high elevation. However, changes in the aesthetic quality of recreation areas and increased crowding are likely to diminish the experience that rock climbers have historically enjoyed.



PHOTO: IZZY NAWFAL

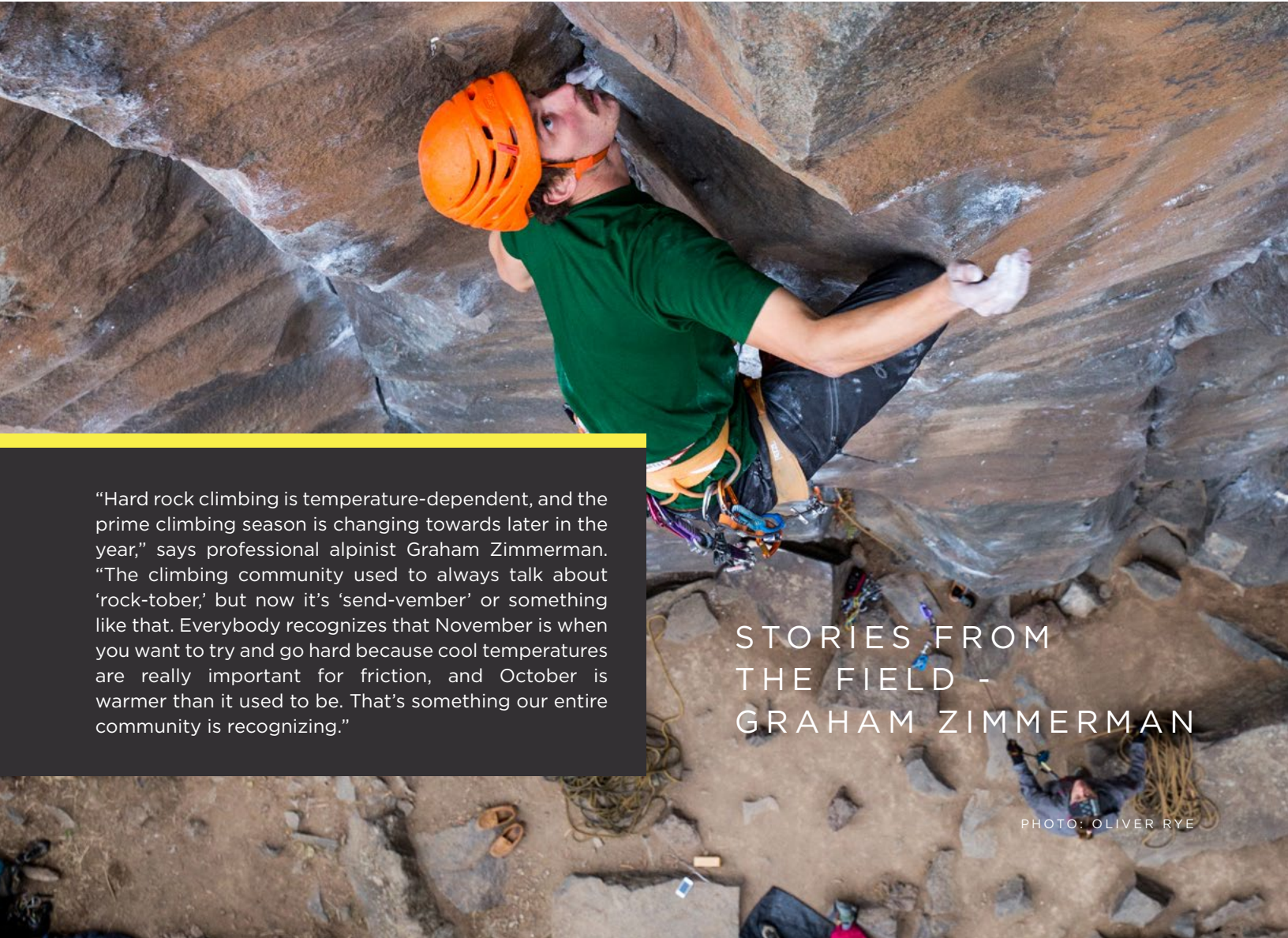
THREATS TO ACCESS

TEMPORAL SHIFTS

Rock climbing is made possible by contact security, which measures a climber's ability to safely and efficiently move from one series of holds to the next and is contingent upon a climber's ability to establish secure contact where their hands and feet meet the rock.¹⁴ It is difficult to establish contact security when friction is reduced or rock integrity is damaged.

As temperatures rise, the coefficient of friction, also known as slip resistance, declines on holds due to increased perspiration on hands and rubber deformation on shoe soles.^{59,60} In a sport where performance is often reliant on thin margins, a reduced coefficient of friction is likely to be more than just an inconvenience, and can even result in a loss of access to certain routes.¹⁴ As the global climate warms, rock climbers are likely to shift their recreational windows to avoid periods when hot temperatures will reduce their contact security.

Climate-induced heat events are also likely to restrict climbing when temperatures rise above participants' physical tolerance thresholds. In areas where daytime temperatures already prohibit climbing activities, climbers typically shift their recreational windows away from peak temperatures or move to a more temperate location.

A photograph of a rock climber in a green shirt and orange helmet climbing a rock face. The climber is positioned in the center of the frame, facing right. The rock face is a mix of brown and grey tones. In the background, another climber is visible on a lower part of the rock. The ground below is rocky and has some climbing gear scattered on it.

“Hard rock climbing is temperature-dependent, and the prime climbing season is changing towards later in the year,” says professional alpinist Graham Zimmerman. “The climbing community used to always talk about ‘rock-tober,’ but now it’s ‘send-venber’ or something like that. Everybody recognizes that November is when you want to try and go hard because cool temperatures are really important for friction, and October is warmer than it used to be. That’s something our entire community is recognizing.”

STORIES FROM
THE FIELD -
GRAHAM ZIMMERMAN

PHOTO: OLIVER RYE

Intentionally climbing outside of daylight hours to avoid peak sun exposure has long been practiced by amateurs and elites alike. However, nighttime climbing presents its own challenges, including decreased visibility, and is a largely undesirable alternative for most climbers.

Moving to a more temperate location is another common approach since different locations have better climbing conditions in different seasons. For example, in the summer months, rock climbers often seek cooler, higher-altitude regions such as California's High Sierra, Nevada's Spring Mountains, Wyoming's Wind River Range and Colorado's Rocky Mountain National Park. However, hotter summer temperatures are likely to draw additional climbers to these cooler regions, exacerbating the impacts of crowding, and thus posing additional challenges for both climbers and land managers. As temperatures continue to rise, even these locations could become too hot to climb, further limiting access.

PHOTO: GRAHAM ZIMMERMAN



THREATS TO ACCESS

WILDFIRES

Wildfires threaten many rock climbing locations since a significant portion of America's rock-climbing activity takes place in the semi-arid, forested mountain regions of the Western U.S. These regions are prone to wildfire activity and, in recent years, have experienced record-breaking wildfire frequency and size that have led to higher incidences of land closures.^{2,3,56} For example, the 2012 Waldo Canyon fire in central Colorado closed down all of Rampart Range Road for two years, preventing access to climbing spots like Parachute Rock, Devil's Head, Scorpio Crack, Jackson Creek, Split Rock, The Taj Mahal and Cabin Ridge Rock.⁵⁷

It has long been known that wildfires can permanently degrade the integrity of rock climbing faces and affect their suitability for climbing. In fact, wildfire is the most significant element affecting rock weathering.⁵⁸ When intense fires burn close to rock formations, the outer portion of the rock quickly expands, overcoming the tensile strength of the rock matrix and leaving a fractured, "scaly" outer layer prone to exfoliation.^{55,58} In this state, the rock integrity is severely compromised and offers little to no value to climbers.

Furthermore, all rock types exposed to extreme wildfire conditions have exhibited extensive and permanent damage, meaning that no climbing area prone to wildfire activity is safe.⁵⁸ Additionally, the load-bearing capacity of fixed hardware (i.e., bolts) can become compromised if located in fire-impacted rock, rendering such hardware potentially hazardous for future climbers. Finally, because wildfire damage changes the fundamental structure of rocks, more frequent and intense wildfires will likely lead to the permanent loss of climbing sites.⁵⁸

"All rock types exposed to extreme wildfire conditions have exhibited extensive and permanent damage, meaning that no climbing area prone to wildfire activity is safe."

STORIES FROM THE FIELD - TOMMY CALDWELL

Warmer temperatures aren't the only thing shifting climbing season—wildfire smoke is changing things as well. "I never used to climb in Yosemite in November, but now it's almost ideal," says professional climber Tommy Caldwell. "October used to be the target time frame, so it's shifted by a month. That's alarming. I think three out of the last five seasons, I had to leave Yosemite early because of smoke in the valley. Everything becomes inaccessible."



PHOTO: COREY RICH

THREATS TO ACCESS

FOREST DIE-OFF

In addition to wildfires, severe drought and insect outbreaks will also damage forests across the U.S. Insects like bark beetles thrive under warmer, drier conditions and have caused tree mortality across over 50 million acres of the Western U.S.^{2,21} In addition to fueling wildfires, these dead trees can fall across trails and roads, resulting in maintenance closures, added inconvenience to approaches and potential safety hazards to those nearby.

“...dead trees can fall across trails and roads, resulting in maintenance closures, added inconvenience to approaches and potential safety hazards to those nearby.”



PHOTO: DONNY O'NEILL

Aftermath of the 2016 Cold Springs Fire in Nederland, Colorado.

THREATS TO ACCESS

EROSION

As with trail sports, projected increases in heavy precipitation and extreme drought conditions are expected to increase rates of soil erosion.² Similarly, as more frequent wildfires burn through vegetation and destabilize the soils below, the likelihood of debris flow, mud slides and landslides will all increase.^{10,12} These impacts can result in the closure or complete loss of roads and trails leading to climbing access points, limiting or prohibiting access to some rock climbing locations.

THREATS TO HEALTH

TEMPERATURE

As noted, average annual temperatures in the U.S. have increased by 1.8°F (1°C) since 1900 and are expected to increase by 2.5°F (1.4°C) over the next several decades.² Additionally, more dramatic temperature increases during the summer months mean that rock climbers will face increasingly hot conditions in many locations.²

Like trail athletes, hot temperatures can directly impact rock climbers' physical health and performance. Higher temperatures present severe challenges to cardiovascular, thermoregulatory, metabolic, neural and cognitive functions²³, which can wreak havoc on climbers who require fine motor control and intense focus to perform. Additionally, the risk of heat-related illness^{24,25} is another significant concern for rock climbers, who often exert themselves in exposed locations for hours at a time. As such, rising temperatures threaten both the health and performance of rock climbers.



PHOTO: JAMES Q MARTIN

“Higher temperatures present severe challenges to cardiovascular, thermoregulatory, metabolic, neural and cognitive functions, which can wreak havoc on climbers who require both fine motor control and intense focus to perform.”

AIR QUALITY

As discussed, climate change is expected to increase airborne concentrations of wildfire smoke, ground-level ozone, dust and pollen.^{2,3,33,34} These compounds are associated with negative health impacts that range from itchy eyes to increased mortality.^{2,27,29,30,33,35} Since rock climbing occurs in regions where these compounds can be found, participants are at risk of adverse health impacts. Additionally, because rock climbers often exert themselves for extended periods, they increase their risk of negative health effects when breathing air that contains these compounds.³⁷ Even previously pristine mountain air enjoyed by climbers in remote regions is becoming increasingly dangerous to breathe.

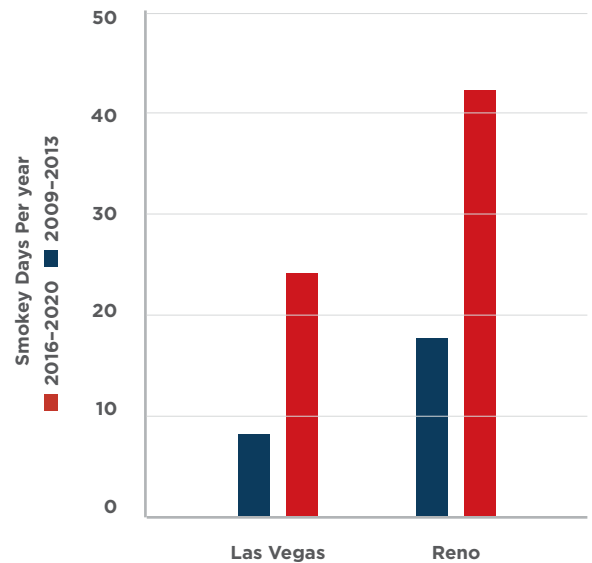


PHOTO: JEREMIAH WATT

For many climbers, including professional alpinist Graham Zimmerman, wildfire smoke already severely impacts their endeavors. “Living in Bend, the biggest effect here is honestly smoke. As we move into that prime climbing season in the fall, it’s been more and more affected by that ‘fifth’ season—of smoke. That can really get in the way of climbing. Particularly for me as an endurance athlete, I have to be super careful about my lungs, so I do not go and train outside when the AQI is above 80 to 100. You just can’t go climb outside.” In addition to the personal impacts, Zimmerman and each of the athletes that contributed to this report pointed out that there are far more significant impacts to take into account. As Zimmerman notes, “if [lost recreation opportunities are] my loss, I’ll be fine. The social equity of that is kind of absurd. Don’t worry about me. Worry about my buddy Rasool in Pakistan and folks who work outside during fire season.”

THREATS TO HEALTH

MENTAL HEALTH BENEFITS

Rock climbing enthusiasts receive significant mental health benefits from outdoor recreation. For example, rock climbing has been demonstrated to decrease anxiety and improve self-confidence.⁶¹ Time spent in forests and natural settings is also positively correlated with stress reduction, improved mood and enhanced cognitive function.⁴³ As contact with nature decreases, so too does a sense of connectedness with nature and its associated benefits to well-being.⁴⁴ Therefore, lost access to rock climbing opportunities due to poor air quality, site closures or increased temperatures can deny rock climbers of the mental health benefits that are an intrinsic reason for climbing in the outdoors.

“Rock climbing has been demonstrated to both decrease anxiety and improve self-confidence”



PHOTO: JEREMIAH WATT

THREATS TO HEALTH

VECTOR-BORNE DISEASE SPREAD

Tick species are expected to increase their habitat range and relative abundance due to climate change.^{40,41} As a result, the incidence of tick-borne diseases is also expected to rise. For rock climbers who regularly hike through grasses and brush to reach secluded climbing spots, the spread of ticks will likely increase exposure to tick-borne diseases such as Lyme disease.

“...wildfires damage the natural beauty that surrounds rock climbing sites, while wildfire smoke reduces the ability to see scenery even at unburned sites.”

THREATS TO EXPERIENCE

AESTHETIC VALUE

As with trail sports, wildfires damage the natural beauty that surrounds rock climbing sites, while wildfire smoke reduces the ability to view scenery even at unburned sites.^{2,45} In addition to the aesthetic value of the rock face and the vistas revealed upon summiting, rock climbers also enjoy the unique flora and fauna found in mountain and cliff area ecosystems.⁶² Unfortunately, climate change is expected to shift the territory and migration patterns of multiple species, diminishing the vibrance of familiar landscapes and leading to potential new area closures to protect those species.² Some of these closures may overlap with climbing areas and could be seasonal, or year-round.²

Furthermore, like much of the alpine environment, cliff ecosystems tend to be fragile and can be negatively impacted by increased climbing activity.^{63,64} As area closures and increased participation concentrate climbers within specific regions, they may cause unintentional harm to this flora and fauna, diminishing the experience for future rock climbers. For example, increases in climbing in certain locations have been observed to influence bird behavior and interfere with breeding, predator detection, foraging and nesting.⁶⁵ Therefore, climate change impacts both the living and visual aesthetics of rock climbing venues.



PHOTO: DONNY O'NEILL

CROWDING



PHOTO: ELIZA EARLE

Rock climbing has become increasingly popular in recent years, adding an estimated 1.2 million new participants in the United States between 2007 and 2016.⁶⁴ At the same time, increases in wildfires, erosion, extreme heat and forest die-off will limit outdoor climbing opportunities. Due to these factors, crowding is projected to increase for the foreseeable future.⁶⁵ This results in lost enjoyment for rock climbers. For example, in a survey on preferred climbing conditions, climbers listed crowding as a significant concern due to a desire for more solitary experiences.⁶⁶ While more aggressive management could alleviate crowding, the impacts of climate change will help ensure that crowding remains an issue for the foreseeable future. Additionally, crowding can cause extensive erosion at climbing sites and result in closures lasting years.⁶⁷

WHAT'S AT STAKE



PHOTO: MATT KOLLER

ACCESS
SUPPORTS
LIFESTYLES.
ACCESS
SUPPORTS
ECONOMIES.

The world is full of challenges, and, in the grand scheme of things, access to your favorite trail or crag may seem somewhat trivial. But climate change isn't just threatening your favorite spot—it's threatening the activities that bring us life. The ability to run a trail at sunset, hike your favorite peaks, rip down a forested singletrack or send a new route are a part of what defines us. For the Outdoor State, getting outside is more than just a hobby—it's a lifestyle. And it's a lifestyle that has a profound impact on our nation's thriving outdoor recreation economy. The contributions of the U.S. recreation economy are nationwide in scale but also financially support many local communities dependent upon outdoor recreation.

The impacts of climate change threaten outdoor recreation economies—both now and in the future.



PHOTO: JEREMIAH WATT

THE U.S.
SUMMER
RECREATION
ECONOMY

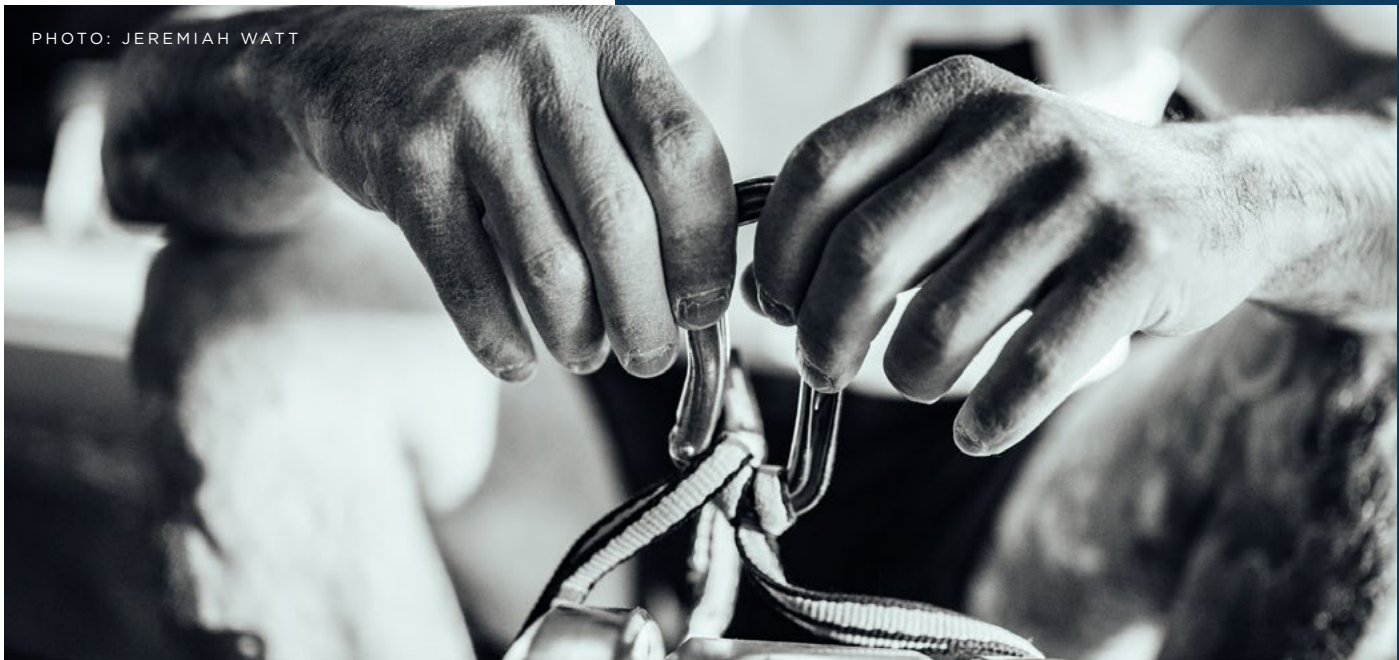
Outdoor recreation in the U.S. is a major economic driver, and summer sports play an important role in generating revenue. The U.S. Bureau of Economic Analysis (BEA) assesses the total added value of outdoor recreation at the national level each year, and in 2019, the outdoor recreation economy accounted for 2.1% (\$459.8 billion) of U.S. Gross Domestic Product (GDP) while supporting over five million directly-dependent jobs.⁶⁸ Like much of the available economic data, these figures focus on past and projected productivity, which highlights the potential magnitude of economic losses as climate change impacts these communities.

\$459.8 BILLION

Value of US outdoor recreation economy in 2019.⁶⁸

In addition to outlining the total added value of outdoor recreation at the national level, the Bureau of Economic Analysis also generates sport-specific estimates of the “real outdoor recreation value added.” In 2020, the real value added by bicycling was \$2.11 billion, and the real value added by climbing/hiking/tent camping was \$3.69 billion.⁶⁹ However, these estimates include only direct economic value added, and exclude supporting activities (such as construction, travel and tourism, local trips and government expenditures). As such, these numbers grossly underestimate total economic contribution.

Similarly, a 2020 U.S. Forest Service report found that visitors spent approximately \$10 billion in the areas near national forests and grasslands in FY2019.⁷⁰ Those expenditures ultimately contributed \$12 billion to the national GDP and supported approximately 154,000 jobs⁷⁰—and that was only one subset of public lands. The combination of real value and supporting activities make outdoor recreation a significant driver of the U.S. economy.



Along with contributions at the national level, outdoor recreation is also a vital source of economic productivity in specific regions and communities across the country. A series of studies conducted in 2018 by Outdoor Alliance shed light on some of these contributions. According to their research, mountain bikers visiting North Carolina’s Nantahala and Pisgah National Forests contributed \$30.2 million in regional expenditures, supporting 366 full-time jobs and \$9 million in regional job income in the process.⁷⁶ Within Colorado’s Grand Mesa, Uncompahgre and Gunnison National Forests, mountain bikers spent \$24 million, supporting 315 jobs and \$7.9 million in regional job income in the process.⁷⁴ And within Montana’s Custer Gallatin National Forest, mountain bikers spent \$24 million, supporting 315 jobs and \$7.9 million in regional job income.⁷⁵

CASE STUDY: GEAR SALES

Within the outdoor recreation economy, equipment and gear sales make up a significant portion of total economic productivity. Without proper equipment (i.e. a reliable bike for mountain bikers, specialty shoes for climbers) many outdoor sports simply aren’t possible, and participants consistently demonstrate a high willingness to pay for this kind of gear. In 2017, bicycle sales in the U.S. totaled \$1.4 billion⁷², while in 2019, hiking gear sales across North America reached approximately \$2.8 billion.⁷³ Even climbers, despite popular caricatures of frugality, have been shown to spend over \$1,200 more than the average outdoor participant on gear and apparel⁶⁵, shelling out approximately \$169 million on gear in the U.S. in 2018 alone.⁶⁵

In addition, a separate report assessed the value of several trail systems located on public lands within Mesa County, Colorado and found that trail usage contributed approximately \$14.5 million to Gross Regional Product (a local equivalent of Gross Domestic Product) over the course of a single year.⁷⁷

The majority of rock climbing areas—nearly 60%—are located on public lands. Similar to the influence of trail sports enthusiasts in the regions listed above, rock climbers also significantly contribute to regional economies. According to a 2019 study produced by Eastern Kentucky University in partnership with Access Fund, a rock climbing advocacy organization, non-local climbers visiting West Virginia’s New River Gorge contributed approximately \$12.1 million to the local economy in 2019. This supported an estimated 168 local jobs and \$6.3 million in regional wages.⁷⁸ While the New River Gorge is known for high-quality climbing, its reputation pales in comparison to larger, internationally known venues like Moab, Indian Creek, the Red River Gorge, Red Rocks and Yosemite Valley, and the economic impacts of recreation in these better-known areas likely far exceeds the \$12.1 million generated in West Virginia.



CASE STUDY: WILDFIRE AND ECONOMIC LOSSES IN UTAH

A study on Utah’s five National Parks identified a significant decline in annual visitation due to wildfires, with a loss of approximately 11,125 to 30,851 annual visitors.⁸⁸ Direct losses in visitor spending were estimated to be between \$780,000 and \$2.34 million annually, and the regional economic impact of wildfires was estimated to be between \$1.22 million and \$3.65 million.⁸⁸

PHOTO: ADAM CLARK

Additionally, while it is likely that most recreationists will continue to access such iconic outdoor areas through travel, an increasing number of Americans—empowered by remote work and motivated by a desire to live where they play—are choosing to relocate to the often-rural “gateway communities” adjacent to prized recreation areas.⁷⁹ According to 2020 polling data from Gallup, nearly half (48%) of Americans would relocate to a town or rural setting if given the opportunity—a 9% increase from just two years prior.⁸⁰ And despite various challenges, including congestion and increased cost of living, the economic boon brought to gateway communities through such “amenity migration” has prompted certain states and municipalities to offer generous cash incentives and recreation packages to those courting the area.^{79,81,82,83} These programs underscore the value of the tax base supported by recent and recreation-motivated residents. But as climate change threatens access to regional recreation opportunities, the allure of such destinations may be undermined, threatening recreation-dependent economies in the process.

Summer sports take place all across the U.S., on trails and crags, in forests and deserts, and—with few exceptions—without the organized monitoring of recreation that relies on snow and resorts. As a result, quantifying the economic value of summer sports at the national, state and regional levels is a complex challenge. Additionally, as summer temperatures continue to rise, increased heat stress is expected to negatively impact outdoor recreation jobs.⁷¹

The figures and reports highlighted above reveal that, although understudied, recreationists pursuing rock climbing and trail-related activities generate sizable economic value. Participation in these sports significantly contributes to the outdoor industry at the national level and supports regional and local economies that depend upon tourism and retail spending. Left unchecked, the impacts of climate change could decrease participation in outdoor activities, resulting in economic losses for the industries and regions that depend on them. In short, climate change will affect more than just recreational access—it will affect livelihoods too.

But just as climate-related challenges are growing, so too is the Outdoor State, and together, we can mitigate emissions to save the places we love.



CASE STUDY: HEAT STRESS AND JOB LOSS

In 2019, the International Labour Organization published a report suggesting that workplace exposure to higher temperatures and resultant heat stress will be responsible for a total financial loss of approximately \$2.4 trillion globally by 2030.⁷¹ Heat stress primarily affects those who work outside, including individuals employed in the tourism and recreation industries. The report also found that by 2030, 2.2% of the total global hours worked could be lost due to high temperatures, resulting in productivity losses equivalent to 80 million full-time jobs.⁷¹ While the exact proportion of this figure comprised by outdoor recreation employment is unclear, increased temperatures are certain to threaten industry stability in regions of greatest exposure. Considering that in 2019 the U.S. outdoor recreation economy supported 5.2 million jobs, summer recreation employment is likely to be significantly impacted by heat.⁶⁸

THE PATH FORWARD



BIKER: MICHELLE PARKER PHOTO: AARON BLATT

It's clear that climate change will make it harder to enjoy the outdoors in the summertime. Wildfires of unprecedented size and frequency, persistently poor air quality and hot temperatures will all make it more difficult for America's millions of trail sports enthusiasts and rock climbers to access the places they love. But rock climbers, mountain bikers, hikers and trail runners aren't alone.

As lovers of open terrain, they share common ground with the millions of Americans who care deeply about protecting the great outdoors. Collectively, the Outdoor State has the power to advocate for climate solutions that protect our favorite spaces from climate change. The Outdoor State is large, influential and growing—and much of that growth is related to summer recreation. According to a 2021 report published by the Outdoor Foundation, 2020 saw 7.1 million more Americans engage in outdoor recreation than in 2019.

CURRENT PARTICIPATION

Summer sports enthusiasts are one of the largest segments of the Outdoor State: in 2019, trail sports and rock climbing participants made up approximately 26% (80,020,000) and 1.5% (4,583,000) of the total U.S. population (302,756,603).⁸⁴ Respectively, bicycling, hiking and camping were among the outdoor activities of greatest interest to non-participants of all income and age levels in 2019.⁸⁴ Summer recreation appeals to tens of millions of people, many of whom care deeply about these places and want to see them protected.

TRAIL

10,660,000

Backpackers

8,666,000

Mountain Bikers

19,997,000

Trail Runners

49,697,000

Hikers

CLIMBING

2,183,000

Sport/Boulder Climbers

2,400,000

Traditional/Ice/
Mountaineering Climbers

Estimated 2019 sport-specific breakdown⁸⁴

GROWING PARTICIPATION

These participation numbers are only expected to increase in the coming years. According to the USDA, the total number of adult hikers in the U.S. is projected to rise from 78.3 million in 2008 to 102.2 million by 2030—an increase of over 30%⁸³, while rock climbing added an estimated 1.2 million new participants in the United States between 2007 and 2016.⁸⁴ The Outdoor State is growing every year, adding millions of potential outdoor enthusiasts who can use their collective voice to advocate for change.

Additionally, despite disproportionate socioeconomic barriers to participation and a long history of social and environmental inequities, participation in outdoor recreation by historically marginalized communities has continued to grow at increasing rates.^{84,85,86} This diversification of the Outdoor State presents an opportunity to engage a broader audience of outdoor enthusiasts in climate advocacy—one that is more representative of demographics and lived experiences across the U.S.



PHOTO: MIKE THURK

Runners Clare Gallagher and Anton Krupicka run to the polls in Boulder, CO.

POTENTIAL IMPACT

Given the proper tools and support, the Outdoor State can shift our nation's response to the climate crisis. The sheer size of the Outdoor State and the diversity of locations and conditions in which it recreates mean that these communities will experience a wide range of climate impacts. Yet, this diversity—of geographic location, experience and background—also means that the Outdoor State wields significant power to advocate for climate solutions. This community can accelerate the transition to a clean energy economy—reducing our reliance upon fossil fuels, creating clean jobs for our communities, and, ultimately, shifting our state and federal responses to climate change—but only if it's done together.



WHAT
WE CAN DO

POW ALLIANCE MEMBER VANESSA CHAVARRIAGA

Climate change can seem like an insurmountable problem, especially after reading about all the ways it will make it harder to get outside during the summer months. And temperatures will keep rising for the next few years regardless of what we do—but we still have time to change what happens in the long run. What summers look like in a few decades will depend on how we address our greenhouse gas emissions now.

By quickly transitioning to an economy powered by clean and renewable energy, we can limit temperature increases to protect the places and lifestyles we hold dear. One voice can make a difference, but millions of people acting together can change the world.

Now, more than ever, it is important that we become climate advocates and work to implement systemic climate solutions. We—the Outdoor State—can help promote positive societal change, and here’s how we can do it:

EDUCATE YOURSELF

Dive a little deeper into climate change by reading the news, popular blogs or books or listening to a podcast on climate science and solutions. An informed Outdoor State is better positioned to influence decision-makers!

Climate News Recommendations: sign up for daily and/or weekly newsletters from [E&E News](#), [Climate Nexus](#), [The Daily Climate](#), [The New York Times’ Climate Forward](#), [Axios Generate](#) and/or [The Hot Take](#).

Movies: “[The Merchants of Doubt](#)” (Book and Film), “[Time to Choose](#)”

Books: “[Eaarth](#),” “[The Uninhabitable Earth](#),” “[All We Can Save](#),” “[Drawdown](#),” “[The New Climate War](#),” “[This Changes Everything: Capitalism vs. Climate](#),” “[The Last Winter](#)”

Podcasts: [Drilled](#), [How to Save a Planet](#), [Climate Changers](#)

Websites: [Grist](#), [Skeptical Science](#), [IPCC panel on Climate Change](#), [Climate.gov](#)

CONTRIBUTE TO SCIENCE

Citizen science is a powerful way to contribute to our collective understanding of climate change. Download the EPA’s Smoke Sense app to help assess how wildland fire smoke affects health and productivity, the Mountain Rain or Snow app to help scientists better understand precipitation patterns in the mountains, get involved with Science on the Fly to help better understand water quality in rivers that we love or help measure snowpack with Community Snow Observations.

SHOW UP

Not every decision is made in DC, and often the country follows innovative ideas that have already been proven at the state and local levels. You can get involved in how your local community makes decisions by showing up at a town council meeting or energy board meeting. If one town can make a difference, then think about what towns and cities across the country can do to meaningfully reduce our collective emissions. All of us play a role in how our community implements climate solutions.

SPEAK OUT



We know that talking about climate change can be tough, whether it’s with your family, friends and co-workers or with decision makers. But these very same people trust what we have to say—so let’s take the opportunity to teach them what we’ve learned! One way to start is with POW’s Cost of Carbon Calculator, which helps us understand why we need systemic solutions to climate change. Even better, we can talk to our representatives, senators, state and local government officials about climate impacts and solutions. Climate change is important to us—so let’s make sure they know that! The most effective way is to make a phone call, but you can also email them, or even better, show up at a meeting or hearing and share your opinion in person. **Learn more about POW’s current campaigns at [protectourwinters.org](#) and use this QR code to contact your elected official!**

VOTE

Vote—now, more than ever, your vote matters—and not just in presidential election years! State and local elected officials have a lot of power to reduce emissions and are on our ballots every year. So make sure you’re registered to vote, and use your voice every election season to vote to protect the places you live and the lifestyles you love.

JOIN TEAM POW!

Do you want to get more involved, but aren’t sure where or how to start? Team POW is your front door to climate and lifestyle advocacy. We’ll make sure you’re informed and armed with the latest science, up to date on current climate-forward legislation in your state and connected to like-minded individuals. And, if that’s not enough, you’ll also get a great discount on POW gear.



FIRED UP?

Send this report to your elected officials
and ask them to protect the places you live
and the lifestyles you love today.



CONCLUSION

A person in a blue jacket and dark pants is walking away from the camera on a wide, reddish-brown dirt road. The road has visible tire tracks and leads towards a large, rugged mountain with prominent red rock formations. The mountain is partially covered with green trees and shrubs. The sky is clear and blue.

PHOTO: JOHNIE GALL

Across the U.S., climate change is changing summer as we know it. Temperatures are going to continue to rise. Wildfires are going to get larger and burn more frequently. Trails will be lost to erosion. These impacts will make it harder for you to access the places that you love, and adverse conditions may force you to risk your health when you do get outside. Summer is no longer characterized by long, sunny days with clear blue skies—the new norm is hot afternoons, smoky skies and the threat of wildfire.

We also cannot overlook the potential economic costs of these impacts. Outdoor recreation makes up a small but significant portion of national GDP and offers employment opportunities across the country. At the local level, outdoor recreation can be a vital source of economic productivity, and the warming climate puts that productivity at risk. Climate doesn't just threaten lifestyles—it threatens livelihoods.

There are no if's, and's or but's about these impacts—but the Outdoor State isn't a group that sits on the sidelines. The Outdoor State shows up and speaks out and, with midterm elections coming up, votes to make our voices heard. If we work together, we have the opportunity to change the course of U.S. climate policy at the federal, state and local levels.

Together, we can help save summer as we know it. By turning our passion into purpose, we can help everyone who loves the outdoors stay outside and create the systemic change needed to prevent some of climate change's severe, long-term impacts. In doing so, we can also help the billions of people across the globe who are and will continue to be impacted by climate change while saving a little slice of what's important to us. This is an opportunity to create positive change. This is a chance to leave things better than you found them. This is an invitation to protect the places and lifestyles we love.



PHOTO: JAKE BLACK

METHODS



It is difficult to directly quantify how climate change will impact the trail sports and rock climbing communities, and there isn't much research on the topic. As such, this report focuses on identifying how climate change is currently impacting—and is projected to impact—factors relevant to those communities, including access to the resources needed to recreate and conditions under which recreation occurs (e.g., temperature, AQI).

We did not conduct primary research; instead, we performed an extensive literature review and consulted with experts to identify potential factors. We then sought to determine how changes in these factors could impact the trail sports and rock climbing communities. This report is a first pass at outlining how climate change affects trail sports and rock climbing participants and lays the groundwork for future studies that can better quantify specific climate impacts.

Methods Used For Literature Review and Informal Discussions

The literature review involved searching peer-reviewed publications, UCSB's library resources, Google Scholar, government publications, and reports from non-profit and government organizations for various combinations of the following search terms:

- "Climate change" / "Climate change impact(s)"
- "Economic(s)" / "Economic impact(s)"
- "Rock climbing"
- "Trail sport(s)"
- "Hike"/ "Hiker" / "Hiking"
- "Trail run" / "Trail running" / "Trail runner"
- "Mountain bike" / "Mountain biking" / "Mountain biker"
- "Arizona" / "Colorado" / "Nevada" / "Montana" / "Utah"

We reviewed all publications identified by these searches and identified additional resources by noting studies they cited or were cited by. We read more than 300 studies, journal articles and reports, including studies and reports highlighting the economic benefits of these sport categories.

To guide our research, we conducted informational discussions with athletes, scientists, economists and policy experts. These discussions were structured as informal conversations, where one group member led the conversation and others could raise additional considerations. We provided a brief overview of our project goals before asking the individual to share what they knew or were learning about the impacts of climate change on the trail sports and rock climbing communities. Individuals were asked to share specific examples of observed or otherwise relevant climate change impacts and we used these conversations to inform our research directions and identify new case studies.

Note: At no point in this project were an individual's responses generalized to suggest that their responses were representative of a larger group.

Difficulty of Quantifying Climate Impacts for Summer Sports

It has long been established that warmer winter temperatures will result in more precipitation falling as rain instead of snow, directly affecting the resource that snow sports participants rely upon for recreational pursuits. Therefore, it is easy to see how climate change impacts snow sports: in a warmer world, there is less snow, and with less snow, you can't ski as much.

Additionally, snow sports are primarily performed at discrete locations, such as ski resorts, that closely monitor weather conditions and annual trends. This makes it fairly straightforward to identify how, for example, more precipitation falling as rain instead of snow affects snow sports communities. However, identifying the current and projected impacts of climate on trail sports and rock climbing participants is less straightforward for several reasons:

1. Nature of resource required to recreate: Snow sports participants require a single resource to recreate: snow. Trail sports participants require trails; however, the composition of trails is highly variable across regions. Rock climbers require a rock surface to climb; however, the nature of the rock varies across different climbing areas and regions. Given that these resources are not uniformly affected by climate change, it is difficult to say that climate change uniformly impacts these sports communities. Furthermore, the non-uniform impacts of climate change across the U.S. create regional differences in the relevant impacts on these communities.
2. Lack of oversight/management: Except for day passes in limited access areas and permits pulled for multi-day activities in national wilderness areas, trail sports and rock climbing participants are not uniformly required to “check in” or report on activities. Trail and climbing activities are not regulated or overseen by a network of governing bodies in the same way as snow sports.
3. Disparate locations: Hikers, mountain bikers and trail runners are typically independent participants that recreate using trail networks not actively monitored, while rock climbing resources are scattered throughout the country. While some recreational pursuits require overnight and backcountry permitting administered by local, state and federal governments, these recreational locations are less clearly defined than they are for snow sports. For example, ski resorts and government entities like NOAA are well-known for tracking their daily, weekly and annual snow totals, making it easier to identify changes in this resource in a specific recreational area with a large concentration of snow sports participants.

Observed vs. Projected Climate Impacts

There is an important distinction between climate impacts: observed impacts (impacts currently being experienced) vs. projected impacts (impacts expected to occur based on modeling or inference). Observed impacts tend to be visible, easy to communicate and clearly connected to increased barriers to recreation. For example, miles of trail burned by wildfires is an observed impact that can be easily quantified and messaged. On the other hand, projected changes are changes that have yet to be observed, making it more difficult to directly connect these impacts to the experiences of target audiences.

ASSUMPTIONS ABOUT CLIMATE IMPACT

Most of the climate impacts we outlined clearly affect recreational communities and experiences in a negative way. However, some impacts are nuanced and require us to make the following assumptions:

- **Assumption 1: Changing conditions will create negative impacts.** We assumed that a change in relevant recreational factors would negatively impact sports participants; however, these impacts vary by region. For example, a 1.5°C temperature increase in Arizona (a state where heat already limits activity through documented area closures) is likely to have a stronger negative impact on participants than a 1.5°C temperature increase in Montana (a state currently less prone to excessive heat days). Despite this regional variability, we assumed that temperature increases would negatively impact athletes across the U.S. due to the well-documented relationship between increased temperatures and heat-related illness. Impacts on overall experience are similarly variable due to individual preferences and tolerance levels but were considered to negatively impact recreational opportunities at the national level.
- **Assumption 2: Current economic value is at risk.** The economic data we found largely focuses on past and current productivity and is used as a proxy to indicate potential economic losses due to climate impacts. Examples include total mountain bike sales in North America and case studies assessing the economic impact of rock climbing in particular regions. Demonstrating the current economic value of these sports highlights the potential magnitude of the economic losses that could occur should climate change negatively impact these sports communities.

AUTHORS

This report was written in collaboration with master's students from UC Santa Barbara's Bren School of Environmental Science & Management.



Matt Koller is a writer, photographer and environmental educator who aims to use his personal experiences and training in environmental science to inspire conservation of the natural world and advocate for policies that promote the sustainable use of resources. While at Bren, Matt specialized in Coastal Marine and Resources Management and Strategic Environmental Communications and Media. He loves spending his free time moving outdoors, whether it's surfing, skiing, biking, hiking, or dancing in the moonlight.



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Sage Kime is an energy and environmental justice professional with experience in the renewable energy industry and environmental/social justice research. While at Bren, Sage specialized in Energy & Climate and researched the equity implications of low carbon energy transitions. Sage loves collecting vintage clothing, organizing community markets and spending time outdoors with her two dogs.



Will Geiken is a climate policy professional who hopes to help institute policies that mitigate both climate change and societal inequities. While at Bren, Will specialized in Economics and Politics of the Environment with a focus in Strategic Environmental Communication and Media. In his free time, Will pursues competitive distance running, mediocre surfing and the requisite amounts of eating and reading that make those activities possible.



Sam Fearer is a passionate outdoorsperson who hopes to leverage a "connection to place" in order to support meaningful environmental action. In his free time, Sam loves surfing, backcountry climbing and making the most of daylight hours. While at Bren, Sam specialized in Corporate Environmental Management, Coast & Marine Resource Management and Strategic Environmental Communications.

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