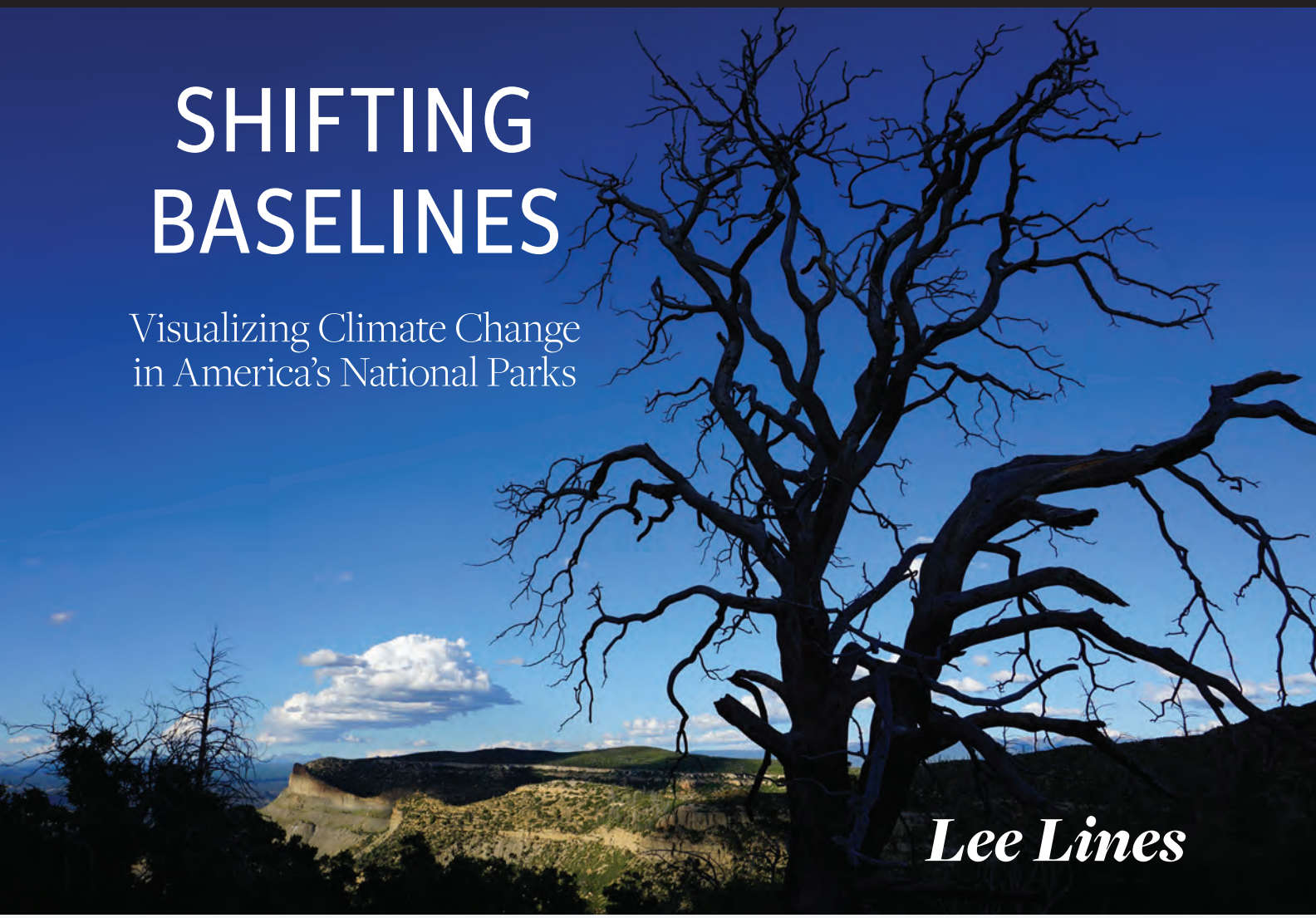
SHIFTING BASELINES

Visualizing Climate Change in America's National Parks



Lee Lines

The atmospheric gases driving the processes of human-induced climate change are mostly invisible, making it hard to focus public attention on the unprecedented changes taking place across our planet. Atmospheric carbon dioxide concentrations now exceed 420 parts per million, levels last reached over three million years ago, when global sea levels were more than 50 feet higher than today. The resulting shift in climate is generating a constellation of ecological changes across the North American continent, steadily reshaping many of America's most cherished national parks (Gonzalez 2020).

The 2023 *National Park Service Climate Change Response Strategy Update* identifies four cornerstones of action on climate change in the parks—Understand, Adapt, Mitigate, and Communicate—with an overarching objective to integrate climate-informed practices into all park service operations. Specifically, under the action of *Communicate*, the park service will "communicate about the effects of climate change on our national parks, what we are doing to address them, and what we are learning through our efforts." While effective climate change communication is already well established at many park visitor centers, there are untapped opportunities to extend this communication to other high-visibility locations farther afield.

This visual essay highlights four national parks where the impacts of climate change are well-documented and visually compelling (Everglades, Mesa Verde, Joshua Tree, and Mount Rainier). In drawing attention to these visible climate impacts and effectively interpreting the changes *in situ*, the park service can play a key role in clarifying the issue of climate change for the American public. Park managers and other park professionals have undoubtedly identified locations in their own management units offering similar opportunities to engage visitors in the science of climate change (either through on-site signage or ranger-led programs). The photographs comprising this visual essay, taken over eight weeks of fieldwork from 2017 to 2024, are intended to spark ideas and move the conversation forward.

Despite a strong scientific consensus that human activity is altering the earth's climate, much of the wider public is woefully misinformed about the issue. Recent surveys of the American public document a significant pattern of misunderstanding regarding the causes of climate change, the science of climate change, and its potential impacts on society (Pew Research Center 2023). Many factors play a role in these misconceptions; however, one clear factor is the overall scope of the problem. Time frames and spatial scales associated with human-induced climate change can make the problem seem abstract and distant from people's everyday experience with the weather. Visible climate-driven changes already underway in our national parks offer place-based opportunities to engage the American public in ways that are both tangible and compelling.

The impacts of climate change are visible throughout the US national park system. Rising temperatures and extreme droughts are degrading habitats across the American West, altering the fire ecology of pinyon pine–juniper forests and threatening cliff dwellings at Mesa Verde National Park (Holtz et al. 2014). Rising temperatures and changes in fire ecology also threaten the continued existence of the Joshua tree in its eponymous national park (Wilkening et al. 2022). In Florida, rising sea levels and storm surges are impacting vulnerable locations in multiple park service units, increasing groundwater salinity and shifting the boundary between salt-tolerant mangroves and freshwater habitats in Everglades National Park (Stabenau et al. 2011). In the Pacific Northwest, rising temperatures and shifting precipitation patterns are causing the thinning or retreat of all 25 glaciers at Mount Rainier National Park, increasing the risk from flooding and debris flows, burying old-growth forests in sediment, and threatening iconic 1920s park structures (Beason et al. 2011).

Most of these human-induced climate changes are unfolding over the course of decades, making it difficult for the casual park visitor to fully comprehend their cumulative impacts, especially in the absence of clear reference points. Visible changes already underway in US national parks provide such reference points, grounded in specific places where the impacts of climate change (and park service efforts to address the issue) are easy to observe. There is great power in the role of America's national parks as cherished landscapes. This power can be harnessed in the effort to inspire the American public to fully address the issue of climate change.

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overleaf Mesa Verde National Park

Mangrove forest impacted by hurricane storm surge
Everglades National Park

Rising sea levels (>10 inches since 1900), higher storm surges, and changes in freshwater flows are reshaping the coastal habitats of Everglades National Park. This black mangrove forest, visible from the road near Flamingo, was heavily impacted by Hurricane Irma in 2017.

Shifting saltwater–freshwater boundary
Everglades National Park

Increasing groundwater salinity and storm surge inundation are shifting the boundary between coastal mangroves and interior freshwater habitats. Salt-tolerant red mangroves have been expanding landward in many areas of the park since the mid-20th century. This ecotone is clearly visible along the main park highway just south of the turnoff for Mahogany Hammock.

Newly Constructed Hotel on Florida Bay at Flamingo
Everglades National Park

The original Flamingo Lodge (1959–2009) was damaged beyond repair by the storm surges from Hurricanes Wilma and Katrina in 2005. Rooms at the newly constructed Flamingo Lodge (2023) are elevated roughly 16 feet to mitigate the impact of rising sea levels and hurricane storm surges.

Charred juniper on Wetherill Mesa
Mesa Verde National Park

The pinyon pine–juniper forests of Mesa Verde National Park are changing dramatically in response to human-induced climate change. In the early 2000s, a combination of rising temperatures, drought conditions, earlier snowpack melt, and a major bark beetle infestation led to devastating wildfires across much of the park.

Pinyon pine–juniper forest before and after wildfires
Mesa Verde National Park

As regional climates continue to warm, many sections of Mesa Verde are increasingly vulnerable to large wildfires. Many post-fire recovery areas from the early 2000s are failing to regenerate wildlife-rich pinyon pine–juniper forests (top), leaving a drier landscape dominated by grasses and the skeletal remains of dead trees (bottom).

Signs of fire near Spruce Tree House
Mesa Verde National Park

Wildfires (and the fire retardants used to control them) can easily damage sandstone archaeological structures through direct heat, staining (here appearing as red), and combustion deposition. Sparse vegetation cover in post-fire landscapes facilitates increased flooding and erosion, posing a threat to the roughly 600 cliff dwellings and 5,000 archaeological sites in the park.

Vital role for the Joshua tree
Joshua Tree National Park

As the largest plant species in the Mojave Desert, Joshua trees provide refuge for many species of birds (e.g., ladder-backed woodpecker), reptiles (e.g., desert night lizard) and insects (e.g., yucca moth). The complex structure of the Joshua tree creates a moderate, sheltered habitat for dozens of animal species in an otherwise harsh desert landscape.

Joshua tree reproduction limited by fire
Joshua Tree National Park

Joshua tree seedlings and juveniles are disproportionally impacted by wildfires and extreme climate events. The self-reinforcing combination of increasing wildfires, invasive grasses, and extreme droughts is skewing the population of Joshua trees in the park toward older individuals, placing the future of this unique plant community at risk.

Uncertain future for Joshua trees
Joshua Tree National Park

Population models suggest that increasingly extreme droughts and wildfires may eliminate Joshua trees from most of their historical geographic range in Joshua Tree National Park. These plants and their unique ecological communities are found only in the Mojave Desert of the American Southwest and no other place on earth.

Retreating Nisqually Glacier
Mount Rainier National Park

Increasing temperatures and changing precipitation patterns are reshaping glaciers at Mount Rainier. Nisqually Glacier, whose extent is now at a historic minimum, has retreated more than 1.5 miles upslope since 1857. Comparing the photo on the top (taken by Asahel Curtis in 1917) and the one on the bottom (taken in 2017) shows the change in the glacier's size and position.

Changing Nisqually River
Mount Rainier National Park

As the Nisqually streambed fills with glacial sediment, its elevation is rising more than three feet per decade (more than six times the historical rate). In downstream locations throughout the park, flooding and debris flows from melting glaciers are altering landscapes, threatening historic park buildings, and burying old-growth forests in sediment.

Protecting the National Historic District at Longmire
Mount Rainier National Park

Much of the iconic 1920s-era National Historic District at Longmire now lies roughly 30 feet below the adjacent Nisqually river, protected from flooding by an artificial levee (top). This levee protects the 57 buildings at Longmire, including many of the best examples of rustic architecture in the US National Park system.

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