Climate Change Challenges and Science-Based Optimism

Patrick Gonzalez

Editor's note: This, the first edition of the new "Climate Change Solutions" column by Patrick Gonzalez, concisely reviews the latest science from the Intergovernmental Panel on Climate Change and reasons for hope, if you help with one meaningful carbon solution.

On a Christmas morning 36 years ago, I awoke on the floor of Yosemite Valley. Stepping out of my tent was like stepping into an Ansel Adams photograph—the brilliant white of the snow, the silver of the granite walls, the black canopy of the ponderosa pine trees.

Since that day in 1986, however, published scientific research shows that human-caused climate change has fundamentally altered that scene. Hotter temperatures, including a 1.2°C increase in Yosemite since 1895 (Gonzalez et al. 2018), have melted spring snowpack more than 20% in the Sierra Nevada (Pierce et al. 2008; Mote et al. 2018), doubled wildfire area above natural levels across the western United States (US) (Abatzoglou and Williams 2016), doubled tree mortality across the western US (van Mantgem et al. 2009), and shifted plant and animal species upslope in Yosemite (Millar et al. 2004; Moritz et al. 2008). Carbon pollution from cars, power plants, deforestation, and other human sources is damaging the integrity of ecosystems in Yosemite National Park and around the world.

Yet, recent actions using existing technologies and practices are now cutting carbon pollution in many countries. Solar, wind, and other renewable energy,

▲ Yosemite National Park, California, USA, June 2016. PATRICK GONZALEZ

energy efficiency and conservation, public transit, and other measures have enabled the US to cut greenhouse gas emissions 13% from 2005 to 2019 (US EPA 2022) and the European Union to cut emissions 24% from 1990 to 2019 (EU EEA 2021). This progress offers hope for the future.

I'm grateful for the opportunity to advance science-based action on climate change and biodiversity loss as the new executive director of the University of California, Berkeley, Institute for Parks, People, and Biodiversity. It's an honor to follow Jonathan Jarvis, the first executive director of the Institute and former director of the US National Park Service. He helped establish an institute that advances scientific insights for conservation solutions. I also appreciate the invitation from the editors of *Parks Stewardship Forum* to write a regular Point of View column. In each issue, I'll present the science of human-caused climate change and ecosystems and offer a specific solution that each of us can implement to reduce climate change and help protect natural areas globally.

The Intergovernmental Panel on Climate Change (IPCC) produces the authoritative scientific assessments of climate change, for which it was awarded a share of the 2007 Nobel Peace Prize. I've served as a lead author on four reports of the IPCC, including the latest assessment of climate change impacts (IPCC 2022a). IPCC results show that human activities pump twice as much carbon dioxide into the atmosphere as forests, oceans, and other ecosystems can naturally absorb (IPCC 2021). This has raised carbon dioxide in the atmosphere to its highest level in 2 million years, heating global temperature to its highest in 120,000 years (IPCC 2021).

Climate change acts at the same time as deforestation and other habitat destruction, overharvesting of plants and animals, air and water pollution, and other damaging activities. IPCC uses detection and attribution analyses to specifically determine when climate change dominates other factors in causing impacts. The latest analyses (IPCC 2022a) show, most gravely, that human-caused climate change has caused heat wave deaths of up to 19,000 people (Vicedo-Cabrera et al. 2021) and driven to extinction two animal species: the golden toad (*Incilius periglenes*) from Monteverde cloud forest, Costa Rica (Pounds et al. 2006), and the Bramble Cay melomys rodent (*Melomys rubicola*) from the Torres Strait, Australia (Waller et al. 2017). Climate change has also caused extirpations (local disappearances) of over 400 plant and anmal populations (Wiens 2016). Extirpations due to climate change have reduced bumblebee species richness as much as one-third in parts of North America and Europe (Soroye et al. 2020).

Human-caused climate change has damaged key aspects of ecological integrity (IPCC 2022a). In addition to the increases in wildfire and tree mortality in the western US described above, climate change has caused the drought-induced death of up to 20% of trees in the African Sahel (Gonzalez 2001; Gonzalez et al. 2012); biome shifts (displacement of major vegetation zones) up to 20 km latitudinally and 300 m upslope in tropical, temperate, and boreal ecosystems around the world (Gonzalez et al. 2010); and bleaching and death of up to half of coral area in parts of the Great Barrier Reef, Australia (Hughes et al. 2018). In the Amazon rainforest, deforestation for timber and livestock and the heat of climate change have combined to drive fires and tree mortality that now emit more carbon to the atmosphere than the forests naturally store through vegetation growth (Hubau et al. 2020; Qin et al. 2021).

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If the world does not cut net greenhouse gas emissions to zero by 2050, climate change could eventually increase global temperature 4°C above pre-industrial levels (IPCC 2021). That could cause the death of 250,000 more people per year in heat waves and from heat-related illnesses and extinction of 3–39% of the plant and animal species on Earth, more than the number of species driven extinct through habitat destruction by people in the past 12,000 years (IPCC 2022a). Moreover, the increased heat could melt glaciers and the ice caps enough to inundate all or part

of many small island nations, including Kiribati in the Pacific Ocean, increase the area burned by wildfire up to 70% globally, and dissolve coral reefs (IPCC 2022a).

Climate change has increased global average surface temperature 1.1°C above the pre-industrial level (1850–1900) (IPCC 2021). The world needs to limit heating to 1.5°C to 2°C above pre-industrial to avoid the most drastic impacts of climate change to people and nature (IPCC 2021, 2022a). This is the scientific basis of the Paris Agreement Goal of the UN Framework Convention on Climate Change, under which all 194 independent nations in the world have pledged to set emissions reductions targets.

At current rates of burning coal, oil, and other fossil fuels, global temperature could increase 1.5°C above the pre-industrial level by 2032 and 2°C by 2050 (IPCC 2021). To meet the 1.5°C goal, the world can only emit 105 billion more tons of carbon (Friedlingstein et al. 2022). This is our remaining carbon budget. It requires us to cut carbon pollution in half by 2030 and to zero by 2050 (UNEP 2022; UNFCCC 2022). Every gram of carbon pushes us closer to the limit.

If everyone with a car in the US parked one day a week instead of drove, that could cut 42 million tons of carbon pollution a year, equivalent to three times the emissions from all sources in Sweden, or nearly 3% of total US emissions.

In the US, transportation generates more carbon pollution than any other sector (US EPA 2022). If US cars and light trucks were a separate country, they would be the eighth-biggest carbon polluter in the world— producing more than the emissions from all sources in Canada and France combined (Friedlingstein et al. 2022). Cars are inherently inefficient. Combustion engines generally lose at least two-thirds of the energy burned as waste heat, while most of the remainder goes to moving the heavy weight of the metal, not the person. The US transportation sector loses 80% of energy burned as waste heat (US Department of Energy 2022a). Recall that we need to cut carbon emissions to zero—that means no fossil fuel-powered cars.

The deaths of people and extinction of plant and animal species due to climate change are very saddening. You can take meaningful action to avert those impacts by cutting your individual carbon pollution through walking, biking, or taking public transit rather than driving a car. Published scientific research shows this could cut your personal transportation emissions up to 99% (Chester and Horvath 2009; US Department of Transportation 2010; Nordelöf et al. 2019; Bonilla-Alicea et al. 2020; Knobloch et al. 2020). Global adoption of bicycle riding as much as people in the Netherlands could cut an amount of carbon pollution from cars equivalent to the emissions from all sources in Germany (Chen et al. 2022). I live a car-free life by walking, biking, and taking public transit and encourage all of you to live car-free too.

In addition to reducing climate change, a car-free life provides a cleaner, healthier environment through reduced air and water pollution; better health through walking; improved well-being by being outdoors in nature (Barragan-Jason et al. 2023); money saved by avoiding car loans, repairs, and gas purchases; reduced stress by avoiding traffic; and reduced probability of dying in a car accident, which sadly claimed the lives of 43,000 people in the US in 2021 (US Department of Transportation 2022).

If you can't immediately go car-free, every week try parking the car one day that you might otherwise drive. If everyone with a car in the US parked one day a week instead of drove, that could cut 42 million tons of carbon pollution a year, equivalent to three times the emissions from all sources in Sweden (Friedlingstein et al. 2022) or nearly 3% of total US emissions (US EPA 2022).

Electric vehicles can reduce emissions but they are only as clean as the source of electricity. If the electricity comes from burning coal, an electric vehicle can pollute more than a gasoline car. Fortunately, the US has installed enough renewable energy that an electric vehicle, on average nationally, generates one-third the carbon pollution of a gasoline car, while in California, an electric vehicle generates just one-sixth the carbon pollution of a gasoline car (US Department of Energy 2022b).

Note this refers to emissions just from fuel, not for the entire production-to-waste life cycle.

Here, I've focused on individual action. Of course, success in halting climate change requires action at all levels—governments, corporations, individuals. The scale of the effort is too large for anyone to sit by and wish that someone else does something.

Our challenge is substantial, yet recent results show progress on carbon solutions. From 2000 to 2021, the world quadrupled renewable energy capacity globally, adding solar, wind, and other renewable energy equivalent to 6,500 coal plants (IRENA 2022). In the US, renewable energy sources exceeded coal in 2019 for the first time since 1880 (US Department of Energy 2022c). Consequently, as stated above, the US cut carbon emissions 13% from 2005 to 2019 (US EPA 2022). California cut carbon pollution 11% from 2000 to 2019 even as state population increased 17% and economic production increased 63% (California ARB 2022). We did this by reducing emissions per person 24% and emissions per dollar of economic production 45%, powering the future with solar, wind, energy efficiency and conservation, public transit, and other sustainable solutions (California ARB 2022). These data provide me with science-based optimism.

The US has generated 21% of all carbon pollution produced in the world since 1850 (Friedlingstein et al. 2022). Therefore, Americans bear a particular responsibility today for cutting emissions. Currently, the US emits 4.8 tons of carbon per person per year—more than double the global average of 1.8 tons (World

▼ Bicyclist riding up the Ohlone Greenway, by the Bay Area Rapid Transit (BART) tracks, Albany and Berkeley, California, USA. PATRICK GONZALEZ

Resources Institute 2022). For comparison, the average in France is 1.4 tons of carbon per person per year. This shows that it is entirely possible to reduce our carbon pollution and maintain a healthy lifestyle.

IPCC has assessed carbon solutions and concluded that we can meet the Paris Agreement goal of limiting the global temperature increase to 1.5 to 2°C with concerted global action, using existing technologies and practices (IPCC 2022b). You, me, and all of us together can reduce climate change and protect our Earth. Billions of small unsustainable actions caused the problem of climate change, so billions of sustainable actions, however small, will help solve it.

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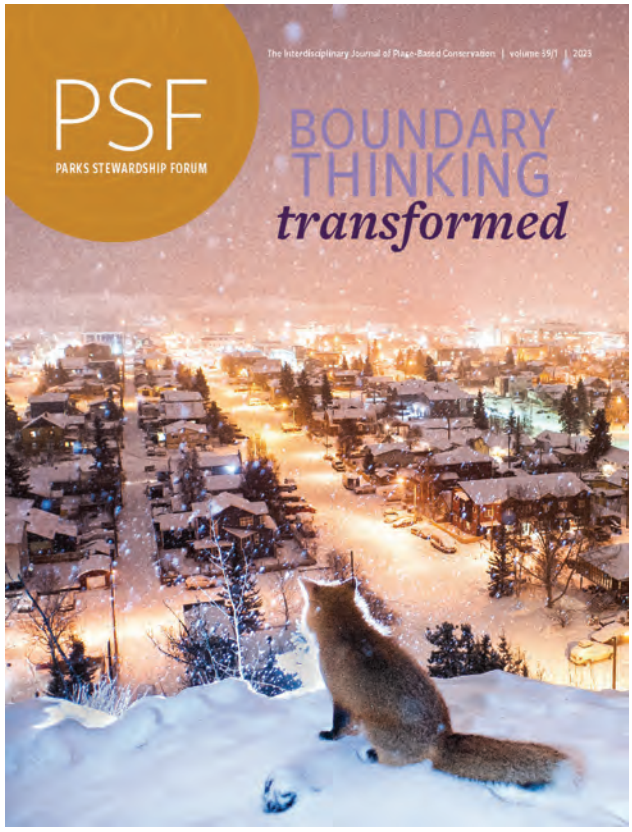

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A red fox on the clay cliffs above the city of Whitehorse, Yukon Territory.
PETER MATHER