

Nitrogen Overdose: Element quietly rivaling CO2 as a global climate threat

The Oakland Tribune, The Daily Review, Tri-Valley Herald, Alameda Times-Star, The Argus, San Mateo County Times, Times-Herald, August 12, 2007

by Suzanne Bohan, Staff writer

On an overcast day in April, Stuart Weiss stood in the rolling hills of a Bay Area nature preserve and lifted a bag of nitrogen-based fertilizer to his shoulder. The heavy sack, the Menlo Park ecologist explained to a small crowd gathered before him, symbolized the unprecedented release of nitrogen into the Earth's air, land and water, and the insidious environmental changes under way globally from the potent fertilizer.

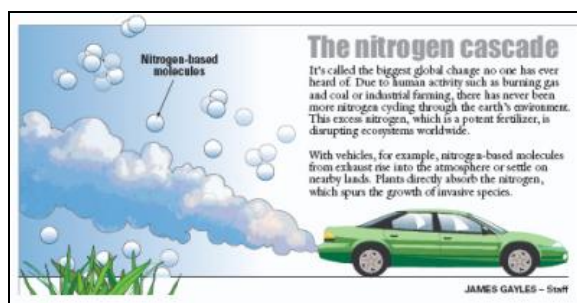


Ecologist Stuart Weiss holds up a bag of fertilizer during a ceremony introducing several endangered bay checkerspot butterflies into the Edgewood County Park in Redwood City. (Ron Lewis, Staff photos)

At Edgewood Park in Redwood City where he stood, nitrogen from vehicle exhaust on a nearby freeway has led to the local demise of a threatened butterfly population, according to research Weiss conducted. The clear link he established between the exhaust and the butterflies decline attracted international attention among the growing

federation of scientists studying nitrogen pollution.

I call it the biggest global change that nobody has ever heard of, Weiss said at the spring event. The planet has never seen this much nitrogen at any time. Human activity now releases 125 million metric tons of nitrogen from agricultural activities and fossil fuel combustion a year, compared to 113 million metric tons annually from natural sources, according to a 2007 United Nations report called Human Alteration of the Nitrogen Cycle.



In 1860, the U.N. report noted, there was virtually no release from human activity. The consequences of this spike, the report added, are profound.

Not only is this glut of nitrogen disrupting ecosystems, polluting waters and harming human health, but it's a silent partner, along with carbon dioxide, in changing the Earth's climate. Despite the countless initiatives under way to reduce CO2 levels to slow global warming, scientists warn that those efforts will prove moot unless nitrogen releases also are lowered.

One nitrogen compound is especially worrisome, as it lingers in the atmosphere for a century and is 300 times as potent a heat-trapping gas as carbon dioxide.

"We won't solve global warming without addressing nitrogen," said Elizabeth Holland, a senior scientist with the National

Center for Atmospheric Research in Boulder, Colorado.

"The changes to the nitrogen cycle are larger in magnitude and more profound than the changes to the carbon cycle," Holland continued. "But the nitrogen cycle is being neglected."

And that's a grave oversight, said Margaret Torn, the head of Climate Change and Carbon Management program at Lawrence Berkeley National Laboratory.

"Nitrogen should be on the radar," she said. "Unless we control that problem, we won't solve climate change."

Weiss, a Stanford University-trained scientist, focuses significant effort on researching nitrogen's far-reaching effects on ecosystems. But he also wears the hat of an advocate, pushing for more regulation of the potent element, and for greater public engagement in demanding more sustainable use of nitrogen.

To that end, Weiss eschews science-speak in addressing the public, and instead offers up memorable sound bites and photo ops, like his bag of fertilizer. He refers to the local demise of the bay checkerspot butterfly at Edgewood Park as "a drive-by extinction."

His strategy has worked, as the Edgewood Park scenario is not only referenced in scientific circles but in numerous media accounts.

Reaching policymakers and the public with an easy-to-grasp message has been one of the challenges in getting a grip on nitrogen pollution, Holland said.

"The scientific evidence for this being a problem is really accumulating," she said. "The issue is getting the word out. With the

carbon cycle, you can focus on CO₂. But with nitrogen, you have all these different compounds and it's a much harder story to tell."

Too much of a good thing

This element that's the focus of mounting concern is a building block of life. Without nitrogen, plants couldn't photosynthesize, proteins couldn't form, DNA wouldn't exist, and life as we know it would cease.

But too much of a good thing, especially one as potent as the mountains of nitrogen now manufactured and released annually, disrupts natural cycles eons in the making.

An inert form of nitrogen, N₂, actually comprises about 80 percent of the Earth's atmosphere. It stays to itself, however, thanks to powerful chemical bonds that keep the two nitrogen molecules tightly bound.

While nature on its own does separate them and create "reactive nitrogen," it's on a limited basis. This reactive form — which fuels life — has historically been a scarce commodity.

But in the early 20th century, two scientists found a way to convert inert nitrogen in the air into fertilizer. The invention revolutionized agriculture, lifting limits on food production and allowing the human population to expand exponentially.

But copious amounts of fertilizer are now used in agriculture, with the excess draining into rivers, lakes and the ocean.

Combustion of gasoline, natural gas and coal also releases enormous quantities of nitrogen-based compounds into the atmosphere, much of which settles on land and water. Animal waste is another major source of nitrogen.

With fertilizer literally falling from the sky, plants — many of them invasive weeds — get turbocharged from nitrogen, altering natural habitats by driving out native plants and the animals that rely on them.

California is at particular risk for this disruption, and the Bay Area is designated as one of the nation's "hot spots" for nitrogen-induced ecological shifts. Weiss estimates that in some Bay Area regions, auto emissions deliver up to 20 pounds per acre a year of nitrogen — about half the amount typically used on lawns.

And of the 225 plant species in California listed as threatened or endangered by the federal and state government, 101 are exposed to levels of nitrogen suspected of causing ecological disruption, according to a May 2006 California Energy Commission study prepared by Weiss.

The nitrogen also alters bodies of water by inducing algae growth. At Lake Tahoe, for example, algae growth is contributing to the steady loss of clarity in the lake's famously clear waters.

"We've actually found that about 55 percent of the nitrogen that gets into the lake comes from the air," said John Reuter, acting associate director of the University of California, Davis Tahoe Environmental Research Center. "So the sky is literally falling for that."

Excess nitrogen also harms human health — through contaminated water, air pollutants and by its role in spreading mosquito-borne diseases like West Nile disease by increasing algal food sources in water, according to a 2003 study on human health and excess nitrogen.

'Drive-by extinction'

Edgewood Park, located next to Interstate 280 in southern San Mateo County, is becoming a classic example within scientific circles of nitrogen's disruptive ecological effects.

Cars whizzing by on I-280 leave in their wake a trail of nitrogen. Plants absorb it, while some nitrogen also settles and accumulates in the nutrient-poor soil at Edgewood.

That extra dose of nitrogen enabled Italian rye grass, an aggressive nonnative, to drive out plantain, a favorite food of the bay checkerspot butterfly.

In 2002, nine years after the land was set aside as a preserve, the threatened butterfly disappeared from the area. This spring, after mowing down the rye grass, Weiss and others re-introduced the butterfly to the park.

Weiss believes a similar process is under way at Antioch Dunes National Wildlife Refuge, a

55-acre parcel in Antioch that's the last of the ancient San Joaquin River dune system. Invasive grasses have overtaken the sandy dunes, driving out a buckwheat plant native to the area. The Lange's Metalmark butterfly, which makes its only home in the dunes, feeds on the buckwheat, and the insect's numbers are rapidly declining. Two endangered wildflowers, the Antioch Dunes evening primrose and Contra Costa wallflower, are also struggling against the onslaught of invasive grass.

This list goes on: In the Mohave and Sonoran deserts, scientists believe that nitrogen deposition explains the spread of nonnative grasses. These grasses fuel fires that are devastating to a desert ecosystem

poorly equipped to regenerate after a blaze, according to a 2003 study on nitrogen deposition in the western United States.

Populations of lichen and fungi, which perform fundamental roles in sustaining healthy ecosystems, are plummeting in some regions of California, due to nitrogen overload, the 2003 study added, with potentially dire consequences to the plant species that evolved symbiotic relationships with them.

Globally, studies also cite numerous additional examples of major ecosystem shifts from nitrogen, including heathlands converting to grasslands in Europe.

Weiss advocates for increased regulation of nitrogen as one solution, which would include better controls on nitrogen in vehicle and power plant emissions, as well as more judicious use of fertilizer.

The Environmental Protection Agency and the California Air Resources Board regulate some nitrogen compounds created during combustion, but leave unregulated many other forms.

The air resources board also takes no stance regarding evidence that nitrogen deposition is changing the state's landscape.

"The ARB has not taken a position regarding the assertion of some scientists that (nitrogen compounds) from vehicle exhaust are altering ecosystems," said Karen Caesar, a spokeswoman for the air resources board.

But many hundreds of studies support scientists' concerns about nitrogen, and Weiss said there's no other plausible explanation for why so many non-native species have taken root in nutrient-poor soil over the past two decades.

"Those of us who are studying it are pretty scared," Weiss said.

"It's just an insidious environmental change that's happening," he continued, "and we feel like there's just a few of us who are aware of it, and on top of it and concerned about it.

"Call it 'Club N.'"

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At a Glance

It may not be the *Kyoto Protocol*, but the *2004 Nanjing Declaration on Nitrogen Management* guides nations in establishing sustainable uses of nitrogen, a potent fertilizer that's disrupting ecosystems worldwide.

Some of its recommendations to governments:

- Support research on the health and environmental consequences of excess nitrogen.
- Create policies for using fertilizer far more efficiently, as most of it is wasted.
- Support research for reducing nitrogen levels released during combustion of fossil fuels.

Simple steps to reduce your own "nitrogen footprint":

- Drive slower — higher speeds increase nitrogen emissions.
- Drive a fuel-efficient car.
- Eat less meat and animal products, as animal waste is a major contributor to nitrogen pollution.

Source: MediaNews Group research