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1. Bud Break

Early May at the HJ Andrews Experimental Forest, near Blue River, Oregon, and after a long, snowy winter, spring is bursting. Everywhere I look vivid green buds are unfurling on shrubs and trees (even the conifers), the forest reawakening in what phenologists who study plant and animal life cycles call "bud break." Hosted by the USDA Forest Service, I'm here to write about this iconic old-growth forest landscape and its ecological responses to climate change. Established in 1948, the Andrews Forest is a National Science Foundation (NSF) Long-Term Ecological Research (LTER) site. In 1981, NSF created a network of twenty-six such stations to conduct multidisciplinary research on ecological issues that span decades and cover large geographic areas.

I've been here before to work on a book chapter on old-growth forest food webs and participate in the Blue River Writers gatherings sponsored by the Spring Creek Project. Under the auspices of the Oregon State University (OSU), the Spring Creek Project convenes scientists, philosophers, and creative writers to find inspiring new ways to understand and re-imagine our relationship with nature.

This time I'm staying in a new building, the GREEN House, which nestles into the forest on the edge of headquarters. NSF supported construction of this beautiful two-story, energy-efficient dwelling, GREEN standing for Green Research and Education for Ecological Networks. It provides a home for forest director Mark Schulze and visiting scientists, writers, and educators. Everything about the house is designed to minimize its carbon footprint, from the concrete floors in my apartment to the large, south-facing windows that let in the sunlight filtering through the forest canopy, to kitchen countertops and furnishings made of gnarled-down trees from the forest. Imbedded sensors monitor the house's energy use, air quality, and carbon footprint, collecting data every fifteen minutes and displaying it online.

The Andrews Forest covers the 16,000-acre Lookout Creek drainage in the Oregon Cascade Range. This ecologically diverse forest ranges in elevation from 1,350 to 5,340 feet. It contains Douglas fir (Pseudotsuga menziesii), western hemlock (Tsuga heterophylla), and western redcedar (Thuja plicata) forest stands at lower elevations and noble fir (Abies procera), Pacific silver fir (Abies amabilis), Douglas fir, and western hemlock up higher. Managers have set aside old-growth (stands that contain trees 500 years old and greater) on 40 percent of the Andrews. Timber harvest, which began in the 1950s, has created young plantation forests on another 30 percent of this landscape. This rainforest gets approximately 100 inches of rainfall per year, mostly between October and May. The conifers have adapted to this annual rain cycle, their needles enabling them to retain more moisture during warm, dry months.

Since the 1950s, ecologists have collaborated here on pioneering science to learn about forests at a watershed scale. Today, under the direction of principal investigator Michael Nelson, long-term research examines things such as air flow through steep stream drainages, carbon sequestration, disturbance regimes (like fire and floods), channel geomorphology, climate change, and phenology. Researchers have identified eight small, paired watersheds, in which they've established a network of permanent plots containing hundreds of sensors. This forest is wired, literally, with sensor data streamed online and freely accessible to the public. However, such technology doesn't diminish the power of this place due to its enormous trees and untamable geomorphology – like the prodigious debris flows that occasionally come roaring downslope, bearing minivan-sized boulders and rearranging the topography in a matter of seconds.

2. Into the Forest

I arrive at the Andrews on a late Monday afternoon after a hectic but fruitful day. At 8 a.m., I delivered an ecological restoration lecture to my class about how one creates a plan to save nature. Immediately after teaching, I submitted an NSF grant that had taken me one month to prepare. If successful, the grant will support some of the writing of my climate change book. After submitting the grant, I shared a phone conversation with leading climate change activist Bill McKibben and Brian Schott, the founding editor of Whitefish Review. We spoke via a shaky cellular connection during an airport layover for McKibben – a pit stop in his battle against climate change.

I asked McKibben whether preserving connected landscapes filled with wild creatures and wild processes such as wildfire – what conservation biologists refer to as "rewilding" our planet – can help us address climate change. He replied that we can't really think about wildness the way we used to, given that we're changing the temperature for animals and everything else on every spot on Earth. The idea of wildness is becoming more relative every day. We talked about what a responsible life might look like and how activism can build community. When Schott brought up despair, McKibben said being engaged in the battle and being reminded of the stakes by his wife and daughter keep him hopeful.

After our conversation, which will appear in Whitefish Review, I finished packing, got into my fossil-fuel-burning field vehicle and drove 90 miles southeast of Corvallis, Oregon, to the Andrews. As I drove, I reflected on how, in some ways, McKibben had challenged much of what I hold sacred about the value of wildness as an ecologist and environmental writer.

He didn't give me much to hang my hopes on. Here I was, on my way to a one-week residency in one of the most intact, researched, chronicled, and storied old-growth forests in North America a forest that – due to the depth of what we've learned about how it functions, its vast carbon stores, and its potential resilience in the face of climate change – has become a powerful conservation symbol, and here was McKibben telling me that places like this are mattering less and less each day. During the course of my residency, I intended to think more about his words, and in doing so, consider the place of humans in nature, our relationship with forests, and the relevance of wildness to society as we address climate change.

Upon arriving in the late afternoon, I check in at headquarters, unpack my gear in my beautiful green lodging, and slip into the forest via a trail behind one of the main buildings. I immediately enter a lichen-draped world dominated by huge, old trees – a world of verdure and wild comfort. The sword ferns (Polystichum munitum) that hem the trail bear tender furled fronds, called fiddleheads, a spring delicacy packed with antioxidants and nutrients. But I'm not here to harvest wild edibles. I'm here to find solace and insights.

I make my way down to the rocky banks of Lookout Creek. The creek flows swiftly, swollen with snowmelt. I sit on a mossy log, taking deep lungfuls of the clean, wet forest air. Along the stream bank, an American dipper (Cinclus mexicanus) hops in and out of the water. Over the sound of water on rocks, from just inside the scrim of trees behind me, I hear the lively chitter of Pacific wrens (Troglodytes pacificus) foraging in the understory. After some long, nourishing moments, during which I try my best not to think but just open my senses to the sweetness, mystery, and timelessness of this place, I return to my quarters. I eat a simple supper, pick up Jon Luoma's natural history classic, The Hidden Forest, and read myself to sleep.[1]

3. A Natural History of Carbon

My first morning, I drive deep into the Andrews on a one-lane, potholed Forest Service Road, following a map to a research site. I have a mission on this gorgeous spring day: to learn via direct observation how the carbon cycle works here. In other words, I'll observe how trees store carbon, what happens to carbon as they rot, and what this process looks like on the ground in an old-growth forest. More than a mission, this is a pilgrimage, because I'm visiting one of forest ecologist Mark Harmon's log decomposition sites. The Spring Creek Project has designated it a Long-Term Ecological Reflections Site – a place writers and scholars are encouraged to visit to reflect on what we're learning from long-term research. Dozens of illustrious writers, including Robert Michael Pyle, Scott Slovic, Allison Demming, and many others, have visited this particular site and written about it.

Upon entering the forest I shed layers of clothes, as I've overdressed for this warm spring day. I shed other layers as well: of stress, for I've been working too hard as is typical for an early-career academic, and of the despair generated in me by McKibben's words about wildness and its relative irrelevance in the face of climate change. I'm not an activist. I'm a scientist who studies how mending food webs (e.g. restoring carnivores where they've been eliminated) can help us create healthier, more resilient ecosystems. I'm also an environmental writer who writes books that explore solutions to environmental problems such as carnivore conservation and climate change. My work as a scientist and writer falls within the purview of conservation biology – what Michael Soule, who founded this discipline in the 1980s, calls "the science of saving nature."[2] And here was McKibben telling me in essence that nature can't be saved and science doesn't matter.

He's right. If we don't come together as a society to drastically reduce our carbon footprint, we'll soon be seeing the end of nature as we know it. Yet in this old-growth forest, as I walk on the narrow trail worn by the footsteps of scientists, technicians, and writers into what's at once one of the most numinous and profane of this LTER's research sites, I'm filled with wonder, curiosity, and, yes (dare I say it), hope that what we're learning in places like this can help us get it right.

Carbon is fundamental to all life, its cycle the heartbeat of the Earth. The carbon cycle's rhythm begins during daylight hours with photosynthesis, when plants take in carbon dioxide ($CO2$) from the atmosphere and create carbohydrates. Their carbon pulse continues at night, when, like animals, trees and all green plants breathe, releasing some $CO2$ back into the atmosphere. Historically, photosynthesis and respiration fluxed in synchrony, maintaining the amount of $CO2$ in the atmosphere in a steady state. As they grow, trees develop thick boles and leafy canopies, storing $CO2$ in these tissues – a process called carbon sequestration. When plants or animals die, bacteria and insects break down dead organisms, thereby slowly releasing some $CO2$ into the atmosphere. Organic matter that doesn't decompose (due to lack of oxygen, like a tree that dies in a swampy area), turns into fossil fuel over millions of years. Since the beginning of the industrial era in the 1830s, rapacious human consumption of fossil fuels has been releasing billions of tons of $CO2$ into the atmosphere. At the same time, we've liquidated 95 percent of the old-growth forest that once covered North America, releasing yet more carbon into the atmosphere. Since the mid-1880s, carbon dioxide, a greenhouse gas, has caused the Earth's temperature to skyrocket. All of this has been graphically presented by the United Nations International Panel on Climate Change in its 2014 report; however, scientists have been voicing serious concern about climate change since the mid-1980s. [3]

Loosely paralleling a slender stream whose name I don't know, the trail meanders upslope through a profligately green primeval old-growth hemlock stand, taking me past many mossy down trees. To allow safe passage, forest managers have cut apart some of the giant logs that have fallen across the trail. Filtered green sunlight shafts through the lacy canopy hundreds of feet above my head. The snow has recently melted, but already trillium (Trillium ovatum) carpet the forest floor, just coming into bloom, their pearly three-petal blossoms heralding spring. Frilly, lime-green scraps of lobaria (Lobaria oregana and L. pulmonaria), an ecologically important lichen that only thrives in the canopy of old-growth forest, litter the ground. I look skyward and see lobaria garlands hanging from the upper boughs of the ancient hemlocks. It was in the Andrews that scientists discovered that lobaria harbors nitrogen-fixing bacteria. Rain washes off this bacteria, thereby leaching nitrogen into the soil, making this key nutrient available to trees and other plants. This lichen also transfers nitrogen to the forest when it falls to the ground during windstorms.

Ecological facts such as the mechanics of nitrogen fixation only heighten this forest's allure for me. Filled with paradoxes, this place feels sempiternal yet constantly changing. The air smells slightly acidic, the forest preternaturally silent except for the soft soughing of the breeze in the trees. I let this place fill my senses and hold my mind and imagination captive as a scientist and creative writer.

After a few minutes, the trail levels, and pink surveyor's tape tied to a tree marks my entry into another world. I step into a glade that contains log segments strewn seemingly haphazardly on the forest floor. The logs bear metal tags and have pieces of hard, white plastic tubing about one foot in diameter protruding from their sides. The velvet moss that has grown around the bases of some of the tubes only adds to this hardware's incongruity. I walk gingerly around the research logs, given the uneven, spongy topography created by the rotted bones of the many trees that have naturally fallen and decayed here across the centuries. I peer into one of the tubes and see wire mesh positioned to collect the leaf litter and other detritus that falls within. Given the primordial forest setting, I find these research artifacts a tad surreal. And I wonder, in addition to the carbon in the tagged and tubed logs, how much more carbon lies in the splendidly decomposing forest duff beneath my feet.

In 1985, Ohio State University researcher Mark Harmon felled some trees, bucked them into twenty-foot-logs, and then systematically placed them in six sites representing a spectrum of environmental conditions. These logs included specimens of four tree species: Pacific silver fur, western hemlock, Douglas fir, and western redcedar, which have a range of decay rates, from fast to slow, respectively. In this study, planned to endure for 200 years, Harmon is looking at carbon sequestration, the nutrient flow generated by the decay process, and the habitat decaying wood provides for invertebrate species such as beetles. While still in its infancy, the study has already shed light on the ecological role of decaying wood and the value of down logs in carbon sequestration. In a sense these logs can be considered the living dead. Not only do they continue to hold a tremendous amount of carbon, but they provide a home for the universe of organisms (bacteria, fungi, mites, protozoa, and nematodes) that are part of the decay process. Recent scientific journal articles assert that down trees are important carbon stores that support high levels of biodiversity. And anyone who's tried to walk off trail through an old forest knows that this forest type contains far more down wood (and therefore carbon) than any young forest.

4. The Blind Men and the Elephant

On my third day in this forest, Julia Jones and Fred Swanson, eminent researchers who, between them, have spent nearly seventy years studying this forest, join me afield. Both are geomorphologists: scientists who study the processes that shape landforms. For the past two decades Jones has led important research on stream flow in the Andrews Forest, and until five years ago Swanson was the lead scientist here. Their long-term datasets are enabling them to begin to tell the climate change story as it pertains to this forest. It's a complicated story. At one point, Julia likens it to the Hindu parable of the blind men and the elephant.

As the parable goes, several blind men touch an elephant to discover what it is. Each one touches only one part of the elephant: one touches the trunk, another touches its tail, and yet another touches a tusk. Each comes away with a completely different impression of what an elephant is, each correct, but only partly so. After arguing for a while, the blind men learn that regardless of the truth of what each has observed, only by combining their experiences can they learn what an elephant really is. While this may be somewhat too strong of an analogy to describe climate studies at the Andrews, each of the scientists trying to characterize how climate change affects this place is coming up with a slightly different picture.

In a nutshell, temperature and streamflow in this forest haven't changed significantly since 1950. Some say this is because old-growth forest, which may be up to ten thousand years old in places in this landscape, may be more resilient to climate change and can function as a buffer. On the other hand, when scientists look at climate trends on a fine scale, such as the pooling of cool air in some of the Andrews watersheds, or minimum and maximum temperatures seasonally or by elevation, a much stronger climate change signature emerges.

Jones and Swanson take me to Reference Stand 2, a permanent one-hectare research plot in an old-growth forest stand in Watershed 2. The Andrews has 38 such vegetation plots established in the 1970s to furnish examples of the major forest communities in this region and the ecological conditions that can affect a forest – from cold, wet sites to warm, dry sites. Reference stands have been positioned in steep, mountainous terrain with landforms ranging from ridgetops, sideslopes, and benches, to terraces and floodplains along major streams.

We bushwhack into the center of Reference Stand 2 past nurse logs – down trees that have dozens of young hemlocks sprouting from them. At the plot center, Jones helps me clamber up a massive log. A climate station extends from a nearby tree, its metal arm bearing a white-ribbed sensor. As in every reference site, in this plot each tree five centimeters in diameter and larger has been measured and numbered. Over time, scientists follow each stem – as they call the individual trees – to document forest dynamics. Swanson explains that this particular reference stand is representative of a wet, old-growth hemlock forest with an Oregon grape (Berberis nervosa) understory.

As we stand there, Jones tells me this plot's story. In the mid-1990s, a windstorm toppled several of the largest trees in this stand. Overnight, this "windthrow" created a large opening in this formerly closed-canopy site. Young trees quickly began to grow into that opening. But the dead trees also drew bark beetles, which rapidly killed some of the older standing trees. And in just a handful of years, this plot was transformed from a densely forested site to a heterogeneous, open one being rapidly colonized by young trees. Living trees consume lots of water. When they die, the water is released into the soil, making it available for other trees. Big old trees also create shade, thereby cooling the landscape. But surprisingly, the sensors here haven't detected a significant change over time in mean annual temperature, air humidity, or soil moisture. We talk about why this might be. Nobody knows, but we surmise that this site's apparent resilience to climate change may have something to do with its position near the base of an alluvial fan where cool air pools at times, or with the ancient trees still present here (which can reduce their moisture intake during drought years), or with the deep soils that have accumulated in this plot over millennia.

As Jones and Swanson talk, I look at their animated faces, which are filled with curiosity and wonder. These are the faces of veteran scientists who study North American forests, showing me, rather than telling me, what science looks like on the ground in all its messiness and paradoxes and occasional Eureka moments.

I return to Reference Stand 2 the next day, alone. The weather has held. On my way into the plot I nearly trip over a red-spotted garter snake (Thamnophis sirtalis concinnus) warming itself in a patch of sunlight on the trail. I go to the log on which I stood with Jones and Swanson, lie down on it, and gaze up at the canopy far above. I take in the scale of this place, its many mysteries, and try to parse some of its lessons. The down tree on which I'm lying has been dead for two decades. Its moss makes a soft cushion beneath my body, but its bole feels firm and solid. Still lying there, I marvel at the many tons of carbon sequestered under and all around me in this forest. A refuge, Jones called it. Old-growth forest provides a refuge against climate change.

I ponder what would happen if we stopped cutting old forests and let a portion of younger forests mature into older forests. How much carbon can this world hold in safekeeping for our children's children? What could we accomplish if we combined such stewardship with a sharp reduction in fossil-fuel carbon emissions? What if our governments supported such acts? I sit up and write in my field notebook, a nondescript Rite in the Rain notebook that has accompanied me to Antarctica, where Adélie penguins are going extinct due to melting sea ice; to the high Arctic, where polar bears are starving to death due to ice melt; to the Alaska Range, where permafrost melt is releasing million-year-old carbon stores into the atmosphere and eliminating some of the lichens caribou need to survive; and to old-growth forests such as the Andrews – where I am finding hope.

5. The Ecology of Hope

As I walk back out of Reference Stand 2, I think about the conundrum instilled in me by my conversation with McKibben. During my time at the Andrews, I learned both how right he is and how wrong he is. He is absolutely right in insisting that reducing fossil-fuel carbon emissions is the only thing that will save life on this Earth. However, he is wrong in his perspective that this is the only thing that matters. The Andrews Forest has illustrated for me the important role of science and its insights and future discoveries. For as much as we have learned, there is much more we will learn – about how forests function and why big, ancient trees are essential to the wellbeing of all life on this planet. And as long as there are humans staring up at a shoal of stars in the night sky, wondering about the mystery of life and how we can live more ethically on Earth, there will be a need for environmental writers to set pencil down on paper in the woods, at a stream, in a prairie, on a farm, in a city, and transcribe Earth's stories, share them with others in the bardic tradition, and discover as a community how to live better.

[1] Jon R. Luoma, The Hidden Forest: The Biography of an Ecosystem (Oregon State University Press, 2006).

[2] Cristina Eisenberg, The Carnivore Way: Coexisting with and Conserving North America's Carnivores (Washington, DC, Island Press), 23.

[3] IPCC (Intergovernmental Panel on Climate Change)-Working Group I, The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (New York: Cambridge University Press, 2014).

Author's Note:

"The Ecology of Hope" was inspired by my conversation with Bill McKibben and a subsequent writing residency in an old-growth forest. During my time at the H. J. Andrews Forest, I learned that Bill is absolutely right in insisting that reducing fossil-fuel carbon emissions is the only thing that will save life on Earth. However, the Andrews Forest showed me the important role of science and environmental writing in helping humans find a path forward. For as much as we have learned, there is much more to learn about why big, ancient trees are essential to the wellbeing of life on Earth. And as long as there are humans wondering about the mystery of life, there will be a need for environmental writers to set pencil down on paper in the forest, on a farm, and transcribe what's in our hearts to help us discover how to live more rightly.