Ten Questions in the Andrews Forest

Bruce A. Byers, Spring Creek Project Visiting Scholar, October 2019

> *¿Cuál es el pájaro amarillo que llena el nido de limones?*
>
> Which is the yellow bird that fills its nest with lemons?
>
> -- Pablo Neruda, *El libro de las preguntas* (1974)

Why are rough-skinned newts so cute
and so laced with poison?

Do the vine maples know how their October red
pierces the green heart of the forest?

In whose language does the stream sing
her love songs to the forest?

And which owl language do they use when making love,
the barred and the spotted?

If I make it to the high ridge on Lookout Mountain,
what will I see?

Why does the lobster mushroom show off an even brighter orange
than its eponymous crustacean?

If I were blind
would I still marvel at this green?

How can a forest
hide in the trees?

Did the root thank
the lichen in the canopy of the tree?

With lifetimes more questions still to ask here,
can anyone talk seriously about "terraforming" Mars?

Explications and Sources:

Pablo Neruda's *El libro de las preguntas*, the "Book of Questions," (1974) was his last work, finished only months before his death. It is a series of imaginative and often fanciful questions – *preguntas* in Spanish – that are mostly poetic rather than scientific. I have found his poetic model to be a natural jumping-off point for "ecopoetics" or "ecopoetry": We can take a real observation (data, science), formulate a question about it, state that in a poetic and imaginative way (following Neruda), and leap to another level of emotional and/or philosophical inquiry. To me, this poetic form invented by Neruda is akin to Japanese *haiku* poetry, which has its philosophical roots in Zen *koan* – the answerless riddles that nevertheless point the way to deep psychological and spiritual insights.

Each of the Neruda-inspired questions from the Andrews Forest posed above is a launching pad – an opening image or excuse – for a shorter or longer explication or essay that follow below. Some photos, which I took as visual "field notes" are included, and some links to relevant research and other sources are also included there.

The Book of Questions (*El libro de las preguntas*) by Pablo Neruda (1974). Translated by William O'Daly (1991). Copper Canyon Press: Port Townsend, WA.

1) Rough-skinned Newts are Cute!

Pregunta: Why are rough-skinned newts so cute
and so laced with poison?

The rough-skinned newt, *Taricha granulosa*, is the official mascot of the Andrews Experimental Forest. Every day on my 30-minute run through the Forest Service's Mona Campground, now closed for the season, a half-mile down the road from the Andrews Headquarters where I'm staying, I see from half a dozen to dozens of them, depending on the weather (see data below*). They seem to like to hang out on the campground road. They are so cute! And they are full of one of the deadliest neurotoxins ever invented by evolution, tetrodotoxin. Same toxin as in pufferfish and a few other creatures. Why?

Rough-skinned newt on the Mona Campground loop, 13 October 2019

How did species as distantly related as spiny pufferfish and cute newts get to be laced with the same deadly neurotoxin? Well, apparently evolution is creative and entrepreneurial, and can reinvent the wheel again and again, as needed. "Convergent evolution," evolutionary biologists call it, when from different trajectories on the tree of life similar solutions are evolved. (Or no, please don't even make me think this!: that tetrodotoxin could be an example of how traits have leaped across the branches of the "tree of life" through "horizontal gene transfer," a la David Quammen's 2018 exposition in *The Tangled Tree: A Radical New History of Life*. But the biology of tetrodotoxin is so mysterious that, in fact, it could be a good candidate for an alternative to the convergent evolution hypothesis.)

When I was an undergraduate in college, I taught English in Japan for six months, and at the end of my stay, my students invited me to an elaborate "going away" party. We sat around low tables, and the first course was *fugu* – pufferfish. In Japan, chefs who serve this delicacy need a government license to guarantee that they know how to remove the poison before serving the thin slices of raw, translucent white fish. We immersed the strips of *fugu* in glasses of hot *sake* until it barely started to cook and turn white. There were plenty of half-serious jokes like "well, if the chef made a mistake, it was nice to know you! *Kampai*!" I survived, needless to report, or I wouldn't be newt-watching in the Andrews now.

Anthropologist Wade Davis, in his 1985 book *The Serpent and the Rainbow: A Harvard Scientist's Astonishing Journey into the Secret Societies of Haitian Voodoo, Zombies, and Magic*, made a case that tetrodotoxin from pufferfish was an ingredient in the concoctions that voodoo shamans used to create zombies. As far as I can determine, there are no ethnographic records of zombification among Native American shamans in the range of the rough-skinned newt. But who knows, so much indigenous knowledge and culture was lost in the rapid demise of the indigenous cultures of the Pacific Northwest that there could well have been medicinal or spiritual uses for preparations of this cute little amphibian. If so, the visions and insights that resulted have, unfortunately, been lost.

*Informal Study of Newts on the Mona Campground Loop

Independent variable: weather
Dependent variable: number of newts

4 October: a few showers during the day, 29 newts
5 October: after one dry sunny day, 9 newts
7 October: after three dry sunny days, 6 newts
8 October: light rain all day, 59 newts
10 October: dry sunny day but heavy frost last night, much cooler, 6 newts
11 October: after a second dry sunny day, but also very cool, 5 newts
15 October: after a string of dry days, warming up, 5 newts

Research and Sources:

- Rough-skinned Newt *Taricha granulosa*)
- Chau R, Kalaitzis JA, Neilan BA (Jul 2011). On the origins and biosynthesis of tetrodotoxin. *Aquatic Toxicology*. **104** (1–2): 61–72.
- Lago J, Rodríguez LP, Blanco L, Vieites JM, Cabado AG (2015). Tetrodotoxin, an Extremely Potent Marine Neurotoxin: Distribution, Toxicity, Origin and Therapeutical Uses. *Marine Drugs*. **13** (10): 6384–406.
- Quammen, David. 2018. The Tangled Tree: A Radical New History of Life. Simon & Schuster.

2) Red Vine Maples in Green Forests

Pregunta: Do the vine maples know how their October red
pierces the green heart of the forest?

First of all: why green? Well, the standard – and true – answer is that plants have chlorophyll, and chlorophyll *reflects* light wavelengths of the color green. It doesn't absorb green wavelengths, which is why we see plant leaves as green. But why is chlorophyll green? Why doesn't it use the energy in the abundant green wavelengths of the solar spectrum? It turns out that's a very complicated scientific question to answer. Not to mention that, if chlorophyll also absorbed green, leaves and forests would be *black*, not green! I don't think I'd like that at all!

But to the scientific speculations about why chlorophyll "wastes" green light. For one thing, plants in full sunlight are often light-saturated, and need mechanisms to prevent the absorption of *too much* light, thereby risking damage to sensitive biological molecules like enzymes. Throwing away the fifteen percent of the solar spectrum that is green, while absorbing the rest, may be one way of doing that, a good compromise. And furthermore, the quantum physics of light-energy capture by the two types of chlorophyll and its subsequent transfer into the biochemical pathways that eventually synthesize sugar, called photosynthesis… is, well, complicated! Too complicated for me to explain here based on the mountain of research available through an online search.

And now, putting that explanation of why plants might want to throw away some of the energy potentially available to them in the green wavelengths of the solar spectrum behind us, where did this red come from in leaves that were green in summer? Although most people would imagine that scientists have a clear answer to this question, it turns out they still don't understand it completely.

Explaining yellow and orange colors in fall leaves – like those typical of vine maple's cousin, bigleaf maple – is easier, better understood. Those colors are caused by compounds called carotenoids, which are found in leaves throughout the year. They *do* absorb green light (and reflect yellow or orange) and are able to pass some of that "green" energy on to chlorophyll, hence enhancing the efficiency of photosynthesis. Carotenoids are also thought to protect leaves from excess light energy that could be damaging, like a kind of leaf sunscreen. When photosynthesis shuts down in deciduous plants in the fall, and green chlorophyll is no longer made and is recycled to recover the nutrients it contains, the yellow and orange carotenoids that have always been there are unmasked.

Red color in leaves is another story. It results from a class of pigments called anthocyanins, which apparently aren't present throughout the year, but are synthesized as autumn falls. Making red anthocyanin requires an input of energy… so why would a plant that is shutting down for the winter make that investment? The scientific research is rife with a range of hypotheses about that. One is that red acts as another sunscreen (beyond the carotenoids) for the leaves when green goes away, allowing them to stay on the tree longer so it can suck the last nutrients from the dying leaves back into branches, trunks, and roots.

Vine maple near Andrews Forest headquarters

And beyond the question of "why red," why are there both evergreen and deciduous plants anyway? The "evergreen" conifers that dominate these forests of the Andrews never give up their green or throw away their photosynthetic leaves (at least on a yearly schedule), and never have to turn yellow, orange, or red. A few evergreen broad-leaved, non-coniferous species of these forests keep their green leaves year-round too: Pacific rhododendron (*Rhododendron macrophyllum*), salal (*Gaultheria shallon*), and Oregon grape (*Mahonia aquifolium*). Why? What explains these different evolutionary strategies for making a living by staying put and drinking sunlight? One of the main hypotheses is that in places where there is a cold winter or a dry season – where evolution might generally favor losing leaves and being deciduous – evergreen plants could have an advantage in retaining nutrients, because deciduous trees inevitably lose nutrients whenever they drop their leaves.

Something in the deep evolutionary history of these rich, wet, dark forests of the Andrews clearly favored the evergreen conifers – but left a few niches for piercing red in the autumn evolutionary landscape. Ah!!!

Research and Sources:

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- Why Leaves Change Color. SUNY College of Environmental Science and Forestry.
- Plant Pigments: Carotenoids
- Sanderson, Katherine. 2007. Why autumn leaves turn red. Nature News.

3) Stream Singing to the Forest

Pregunta: In whose language does the stream sing
her love songs to the forest?

The H.J. Andrews Experimental Forest was established in 1948 – then called the Blue River Experimental Forest until it was renamed for Horace J. Andrews in 1953, after his untimely death in a car accident, because of his instrumental role in the selection of the site and establishment of the forest. Andrews and his colleagues were interested not only in the value of wood that could be harvested from Pacific Northwest forests, but also other forest-dependent values that were barely coming to be recognized, especially water in watersheds and spawning habitat for fish. At that time, the exact relationships between forests, water, fish, and what is now called “biodiversity” were not known, and the burgeoning timber industry really didn’t want to know anything that might slow down their program to cut all the “decadent” old-growth forests and replace them with “efficient” two-by-four-producing tree monocultures.

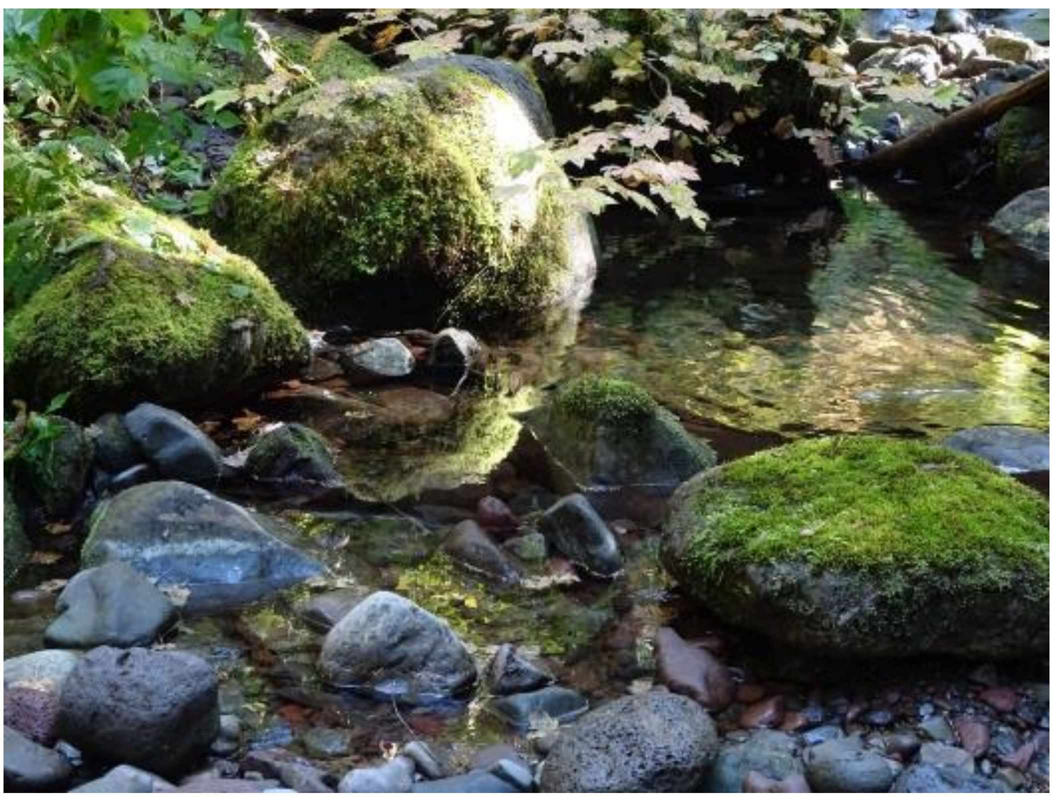
The site chosen for the experimental forest was the entire 16,000-acre watershed of Lookout Creek, whose water joins the Blue River, a tributary of the McKenzie River; the McKenzie flows westward from the Cascades into the Willamette River near Eugene, Oregon. The end result of many careers and decades of dedication by an interdisciplinary team of forest scientists was that the Andrews Experimental Forest became a key site for research in the International Biological Program, a founding member of the Long-Term Ecological Research (LTER) network, a UNESCO Man and the Biosphere Program biosphere reserve, and a launching pad for some of the most significant changes in forest management in history.

Curious and open-minded forest scientists working in the Andrews eventually selected eight small experimental watersheds, each of which flowed into Lookout Creek. Stream gauging began in the first three in 1952, each of which drained old-growth forest about 500 years old. After gathering baseline data, experimental treatments began in Watershed #1 in 1962; it was 100% clearcut, but using a cable logging system, new for that time, that required no road building, and it was burned in 1967. In Watershed #3, roads were constructed in 1959, and in 1963, 25% of the forest was clearcut in patches. Watershed #2, between these two drainages, was not harvested, providing an undisturbed, old-growth experimental control for the forest management experiments in the other two watersheds. Over the next three decades, five more small watersheds feeding Lookout Creek were brought into the research program. Of the eight watersheds, three were reference watersheds that flowed from undisturbed mature or old-growth forest. Maybe you can appreciate that this was unique, large-scale, long-term, applied forest ecology research – which is what has made the Andrews world-famous.


Stream-gauging station at Watershed #2, an old-growth reference/control watershed


Stream-guaging station at experimental Watershed #1

So… with up to almost seventy years of data to analyze, what have we learned? Has all of this heroic scientific effort, the research dollars, and numerous scientific careers, been worth it? Here's only one example. In 2016, Timothy Perry and Julia Jones published a paper in the scientific journal *Ecohydrology*, based mainly on research at H.J. Andrews, titled: "Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA." That might not sound provocative, but the first few sentences of the abstract pack a carefully-worded scientific punch with important implications. These scientists admit that the effects of forest management practices – namely clearcutting and replanting as forest plantations – needs more research. However, they then confirm that research clearly shows a dramatic impact of clearcutting and tree plantations on streamflow – a reduction in water flows at the end of the dry summer season of up to 50 percent that lasts decades. The low-flow decreases they report are important to cities demanding drinking water, farmers dependent on irrigation, and endangered salmon that need water to migrate and spawn. Their conclusions ramify far beyond the Andrews. The research suggests that because of the logging history of the region, most watersheds in the Pacific Northwest are probably experiencing significant, but previously unrecognized, summer streamflow deficits compared to mature and old forest conditions. Because the hydrological effects are caused by the physiology of young forests, it doesn't appear likely that changes in industrial forestry practices can reduce their harmful effect on stream flows. The only solution would seem to be reducing the area of forestry plantations and letting larger areas return to mature and old-growth forest conditions.



Upper Lookout Creek along the Old Growth Trail

This research at the Andrews cycles back around to the answer to the Neruda-*pregunta koan*:

The Language of Water

Rain near the headwaters
drops intercepted by needles, mosses
canopy lichens that fix nitrogen
wetting red-backed voles that feed
spotted owls.

Reaching the ground
soaking in, swelling the stream
flowing over bedrock sills
spreading out underground into
a mix of rocks, sediment, logs, old forest debris
churned in the blender of the last
big flood's flow
decades ago.

Gravity sucks you down
you duck underground
talk to roots, ancient logs
sand from volcanoes and
emerge to the surface and go under
again and again
and again.

You know the story
of what we do to the forest
up in the watershed where you fell
affects everything downstream.
Fish, people,
everything.

So tell us your story.
If we can hear it
maybe we can understand at least that
a raindrop had a long conversation
on its descent to our lips
and we were part of it.

Upper Lookout Creek

Gravel bar along Lookout Creek near Andrews Forest headquarters,
one of the Long-Term Ecological Reflections sites

One morning early in my stay at the Andrews, Dr. Steve Wondzell was showing a few of us the “hyporheic mesocosm” experiment housed at the stream-guaging station in Watershed #1. It has been simulating the flow of water underground in this watershed for the past two years, building on a couple of decades of studies that used small wells to measure groundwater flows under and alongside the watershed’s small stream. This one-of-a-kind, custom-engineered experimental apparatus helps these forest hydrologists talk to invisible, underground water, and ask: “What’s going on down there?”

Pregunta: What secrets does the stream whisper to the soil
during their hyporheic assignations?

The “Hyporheic Mesocosm” apparatus at Watershed #1, with Dr. Steve Wondzell

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- Robbins, William G. 2018. The H.J. Andrews Experimental Forest: Seventy Years of Pathbreaking Forest Research. Oregon Historical Society.
- Perry, Timothy D., and Julia A. Jones. 2016. Summer streamflow deficits from regenerating Douglas-fir forest in the Pacific Northwest, USA. Ecohydrology.

4) Spotted Owls and Barred Owls

Pregunta: And which owl language do they use when making love,
the barred and the spotted?

I saw it fly up from the side of Forest Road 320 just where it turned up from the Lookout Creek road. It perched on an angled branch about twenty feet above the road and stared with its dark eyes. Beautiful! An owl!

It was a barred owl, nemesis of the endangered spotted owl, the endangered flagship species of these old-growth forests. I zoomed my camera and snapped a few pictures before it spooked and flew off deeper into the trees. I was surprised to see it. I had been hoping to see a spotted owl during my time at the Andrews. But I've come to think this unexpected visitation by a barred owl was some kind of message from the forest.

I love to hear the call of barred owls in the few acres of tall oak, red maple and tuliptree woods behind my house in northern Virginia. It gives a tiny feeling of wildness even inside the Interstate 495 Capital Beltway:

Hoo-hoo, hoo-hoo…. Hoo-hoo, hoo-hooooooo!

Some birding websites suggest "Who cooks for you, who cooks for you all?" as the mnemonic phrase to help remember the barred owl's common vocalization. The northern spotted owl typically calls with a "hoo-hoo, hoo-hoo," much higher-pitched and hurried – almost chirp-like – in contrast. Hamer *et al*., in their 1994 paper "Hybridization Between Barred and Spotted Owl**s,"** discuss how vocalizations of hybrid owls differ from their parent species, and shows a few sonograms of the hybrid calls. The one recording that turns up when googling for vocalizations of hybrid "sparred" (spotted X barred – get it?) owls sounds to me mostly like a barred owl, although maybe a slightly confused one.

Owls have always fascinated me. As a graduate student, I studied the diets of long-eared owls that overwintered near Boulder, Colorado. I picked apart hundreds of their "pellets," the regurgitated fur-balls containing the bones and skulls of their prey, which I collected under their daytime roosting trees.

I don't harbor any biases toward one owl species or another, but in the Oregon woods, the northern spotted owl, *Strix occidentalis caurinia*, has legendary status as the endangered species that triggered the forest policy battle that led eventually to the Northwest Forest Plan of 1994 and a dramatic change in forest management policy and practice on public lands in the Pacific Northwest – a sudden pivot from a "get rid of over-mature old-growth as soon as possible to make way for efficient young forests that will grow 2X4s fast" to "maybe we should try to protect the last small areas of natural old-growth forest ecosystems and their dependent species until we can study and understand them a little bit better." Those were the days when you would see bumperstickers on pickups in timber country that said "Save a Logger – Shoot an Owl."

Barred owl (*Strix varia*) along the Lookout Creek Road, 9 October 2019

Barred owls have been expanding their range westward across North America for the past century, until at just about the time spotted owls were becoming endangered from loss of their old-growth forest habitat in the Pacific Northwest, they showed up here. They threw a "monkeywrench" into the best laid plans of mice and men (the "men" in this case being the forest ecologists who developed the Northwest Forest Plan). Kent Livezey has analyzed the timing and geography of the range expansion of barred owls and the reasons for it. In a scientific paper in 2009 he concluded that:

> *Overall, it appears the historical lack of trees in the Great Plains acted as a barrier to the range expansion and recent increases in forests broke down this barrier. Increases in forest distribution along the Missouri River and its tributaries apparently provided Barred Owls with sufficient foraging habitat, protection from the weather, and, possibly, concealment from avian predators to allow Barred Owls to move westward. Decades later, increases in forests in the northern Great Plains allowed Barred Owls to connect their eastern and western distributions across southern Canada. These increases in forests evidently were caused by European settlers excluding fires historically set by Native Americans, suppressing fires and planting trees. … Accordingly, it appears the range expansion was prohibited for millennia by actions of Native Americans and recently facilitated by actions of European settlers.*

If Livezey and his colleagues are right, my encounter with a barred owl in the Andrews has deep roots, reaching back more than a century; if they are right, it's an ecological story that started long before the crisis caused by forestry policies to replace old-growth forests in the Pacific Northwest with young forest plantations.

Fast forward to the present, as conservation biologists and federal land managers try to catch up with the implications of the range expansion of the barred owl. It has turned out that when and where these two closely-related owls of the genus *Strix* meet – which they do now, broadly, throughout the Pacific Northwest – they sometimes mate and produce interspecific-hybrid offspring that themselves can reproduce. On one front of the scientific effort to understand the implications of this ecological reality, cutting-edge molecular genetic tools are being used to assess the implications of this hybridization. Zachary Hanna reported, in a 2018 symposium presentation on “Extent of Introgression Detected in Spotted Owls and Western Barred Owls,” that “Although it is well documented that barred owls ecologically displace spotted owls, debate remains as to whether the situation is being exacerbated via hybridization between these two species.” Hanna mentions that this eco-evolutionary contact between spotted and barred owls represents a unique opportunity to study, in real time, such a situation – in this case, at least partly the result of the human modification of ecosystems spanning a continent.

Hanna and his colleague Jack Dumbacher propose that because of climate change, the ranges of many species are expanding, often facilitated or enhanced by other anthropogenic ecological changes. Species that have been geographically separated for, in some cases, millions of years, are now coming into contact again. The story of the barred owl’s range expansion and overlap with the northern spotted owl may be one case study of that scenario, but certainly not the only one.

Because the anthropogenically enabled range expansion of the barred owl into the critical habitat of a species protected under the Endangered Species Act has created a dilemma, the U.S. Fish and Wildlife Service has engaged in experiments to determine how killing barred owls might help spotted owls. It’s almost as if barred owls have replaced loggers as the new enemies, and a new bumpersticker might say “Save a Spotted – Shoot a Barred.” How is *that* working? The most recent analysis comes in a 2019 USGS report from J. David Wiens and colleagues, with the title of “Effects of Barred Owl (*Strix varia*) Removal on Population Demography of Northern Spotted Owls (*Strix occidentalis caurina*) in Washington and Oregon, 2015–18.” A total of a total of 1,439 Barred Owls were “removed using 12-gauge shotguns loaded with non-toxic shot,” they write, describing the methodology of this experiment. The results aren’t especially convincing or conclusive:

> *In 2018 we detected consistent or increasing numbers of resident Spotted Owls in treatment areas relative to previous years, with correspondingly sharp declines in control areas without removals. Collectively, these initial results provide an indicator that removal efforts may be beginning to positively influence territory occupancy, apparent survival, and population trend of Spotted Owls in our study areas. We emphasize, however, that numbers of Spotted Owls remaining in our study areas have reached exceptionally low levels and that annual reproduction during our study period was the lowest recorded over a 28-year period. Continued removal effort in all study areas is needed to confirm positive results*

> *we observed in 2018 and reduce current uncertainties associated with the effectiveness of removals in benefitting Spotted Owls.*

Almost a decade ago Kent Livezey warned that recent and ongoing range expansions of many species, not just barred owls, would lead to a large number of similar conservation conundrums. Almost 20 percent of North American birds recently expanded their breeding ranges, 14 species expanded their ranges into more states and provinces than did barred owls, and range expansions driven by climate change and other human-caused ecological changes will continue. Livezey concluded that "If thousands of Barred Owls are killed because they expanded their range and are competing with a species of concern, it seems likely USFWS soon would need to consider whether to lethally intervene in conflicts between many other species of native birds due to the high frequency and large extent of range expansions, probability that range expansions will continue, increases in number of listed species, and further documentation of negative effects between species."

From an evolutionary perspective, one interesting question is whether barred owls will pick up some spotted owl genes, and/or vice versa, through hybridization, and blend the species? Or will the barred owl outcompete the spotted and cause its demise? Tim Fox, a spotted owl researcher, in an essay titled "Continuity and Change," published in a collection of writing from the Andrews Forest (*Forest Under Story: Creative Inquiry in an Old-Growth Forest*, University of Washington Press, 2016), imagined that perhaps the admixture of genes from the spotted owl will temper the aggressive personality of the barred owl, over time fitting it to this pacific forest.

Modern humans – we, the species dubbed *Homo sapiens*, in Latin meaning "Man, the wise" despite convincing evidence of our *lack* of wisdom – have an admixture of genes from our evolutionary cousins, *Homo neandertalensis*, and also from Denisovan ancestors, as we have learned only recently. When the events through which we acquired those genes through interbreeding with closely related congeners were happening, there may have been petroglyphs on cave walls (or bumperstickers on Flintstones cars?) that meant to say "Kill a *sapiens* -- Save a *neandertalensis*." Did the genes we absorbed from Neanderthal and Denisovan relatives mellow and temper *our* aggressive, invasive species as it was expanding out of Africa into Eurasia, in an earlier era of natural, not anthropogenic, climate change? Does our patience, toughness, humor, cold tolerance, or other traits come from those forgotten ancestors?

Shooting barred owls to give them a competitive edge over spotted owls and preserve a *status quo ante* that our species itself has disrupted? That seems like what has been called "playing god." And wouldn't that be almost the most *anthropocentric* – rather than ecocentric – thing we could do? Who are we – a species that invaded, interbred with, outcompeted, and eventually overwhelmed a closely related sibling species or two – to play "god" with evolution?

No, we don't need to play god. In fact, we finally need to stop playing god, and act, as Aldo Leopold said, as a "plain member and citizen" of the biotic community. No, we need to step back in humility and stay out of this evolutionary dialogue between the barred and the spotted, even though we may be at a part of its cause, or at least its hastening.

<u>Research and Sources:</u>

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5) Walking the Lookout Mountain Ridge

Pregunta: If I make it to the high ridge on Lookout Mountain, what will I see?

"Every poet has trembled on the verge of science." -- Henry David Thoreau

"Does there not exist a high ridge where the mountainside of "scientific" knowledge joins the opposite slope of "artistic" imagination?" -- Vladimir Nabakov

After a day of rain on Tuesday, the forecast for Wednesday was clear. Sure enough, it had cleared in the night, and the morning was sunny. My goal was to climb Lookout Mountain, the highest point within the Andrews Forest, a little over 5,200 feet above sea level. Lookout Creek, whose watershed defines the boundaries of the Andrews Experimental Forest, wraps around the north side of the mountain, and Mack Creek, the major tributary of Lookout Creek, circles it to the south. These watersheds, both glaciated in their upper reaches during the Pleistocene, cup the flanks of Lookout Mountain like a pair of hands. This peak defines the central viewpoint of the Andrews Forest. I was determined to try to see the view from there.

Lookout Mountain from Forest Road 1506 along Lookout Creek, 8 October 2019

The map showed the trail taking off from the watershed-defining ridge about twelve miles up Forest Road 1506, which climbs the drainage to the Frissell Ridge. I drove up and up on the cold, sunny morning, but didn't expect to hit snow, which appeared on the trees and roadside at about 4,000 feet. When I got to the trailhead, there was an inch of new snow on everything, and clouds still hung on the peaks and ridges. My goal had been to get the "view," and it didn't look too auspicious. So, I adaptively managed my plan for the day, and went to visit Experimental Watersheds 6, 7, and 8 instead. On Thursday – another glorious sunny day – I was pinned down at the Andrews Headquarters with scheduled phone calls and a meeting. But Friday, after another clear night of hard frost and a morning of promising sun I knew I had to attempt Lookout Mountain again.

At the trailhead, now with only small patches of leftover snow in the shadiest nooks, I set off along the ridge through a forest very different from the dark Douglas-fir, hemlock, and red cedar old growth a couple-thousand feet lower. This forest was dominated by Pacific silver fir (*Abies amabilis*), whose trunks and branches were draped with *Alectoria*, a snow-loving lichen that hangs like pale green, pointy beards on branches and trunks. After a mile or so I missed the side trail up the ridge to the peak, even though I'd been warned to watch for it. My Garmin GPS eventually helped me realize the mistake, and I backtracked to find the obscure cut-off up to Lookout Mountain. The trail got more and more faint, winding up through understory meadows of beargrass and huckleberry, flagged with orange flagging in a few places. Those signs that someone had been here before kept up my confidence, but I realized that if I'd tried this two days ago with snow covering everything, I wouldn't have been able to navigate this obscure track. My decision to postpone was fortuitous.

Many times, I found myself remarking to my hiking companion (myself) "It's so quiet!" Coming to a break in the trees along the trail, and not expecting it, I suddenly caught a glimpse of the white volcanoes to the east – the Three Sisters, only about twenty-five miles away, across a huge expanse of landscape that appeared mostly wild. Ranged along the horizon northward from the Sisters, I could see Mount Washington, Three-Fingered Jack, Mount Jefferson, and Mount Hood, almost a hundred miles away.

The slope steepened as the ridge narrowed and the track got rocky, chunky volcanic rocks and gravel, loose underfoot. Since I was alone, I was being very careful of my footing, although I was carrying the heavy black Forest Service radio I'd been assigned, and could have communicated in an emergency. The vegetation looked very dry. The trees here were all different from the Pacific silver fir snow forest at the trailhead, and very different from the old-growth Doug-fir *et al*. forest in the valleys below. Krummholz-like, their sprawling lower branches showed they were buried in snow part of the year, and their wind-blasted tops were a telltale record of the climate on this high ridge.


On the Lookout Mountain ridge, 11 October 2019

But today the occasional breeze was gentle and the sun warm. As I ate lunch, I started noticing them: butterflies passing by along the ridge! I didn't expect to see ridge-topping butterflies at this time of year, after a light snow two days ago, and several clear nights with heavy frost. Four fluttered by, and the general impression was "orange". One dallied around me awhile as I ate, perhaps attracted by my rust-orange wind shell. Did that big expanse of orangish color register in its butterfly brain as what in animal behavior is called a "supernormal stimulus"? Did I look like one big sexy butterfly? It finally settled nearby, resting on the ground and warming itself with spread wings, just long enough for me to zoom in and get a picture – a California Tortoiseshell.

California Tortoiseshell (*Nymphalis californica*), Lookout Mountain ridge, 11 October 2019

I thought of Robert Michael Pyle, the Ph.D. lepidopterist whose book *Wintergreen* won the John Burroughs Medal for nature writing in 1987. I took an environmental writing workshop from Bob in 2003, and it was from him that I first heard Vladimir Nabakov's statement about "the high ridge" where science and art meet. Nabokov was a Russian-American lepidopterist and novelist, author of *Lolita*. It was then I also became aware of Bob's writer's autobiography titled *Walking the High Ridge: Life as a Field Trip*. It all made sense. Butterfly-chasers like Bob is, and like Nabokov was, often look for their quarry on ridge tops, because many species of butterflies congregate there looking for mates. Much easier to find a conspecific butterfly of the opposite sex on a narrow ridge that wandering all over a large landscape looking. I didn't imagine, when I set out for Lookout Mountain, that a ridge-topping California Tortoiseshell would bring me a message from Nabokov and Pyle about the meeting and mating of science and the artistic imagination.

It has always felt natural to me to mix scientific and artistic ways of perceiving the world. When I was an undergraduate and in graduate school there was much talk of "the two cultures": science was supposedly one, the arts and humanities the other. British chemist and novelist C.P. Snow had made the phrase famous through a lecture and subsequent book, *The Two Cultures and the Scientific Revolution*, both from 1959, in which he lamented what he saw as a fundamental split in western intellectual life between science and the arts and humanities, and which he said was hindering solutions to urgent problems. Many people then thought of science and art as very different ways of experiencing and knowing the world – and many still do, it seems. They imagine that there is a gulf between science and the arts; some people even think of them somehow as “opposites.” I have tried hard to understand this purported cultural schizophrenia, which I have never felt.

In fact, scientists and artists are very similar in their modes of perception and methods of working. The commonalities are that artists and scientists observe carefully, but seek underlying patterns below the surface of sensory information, which they abstract and represent symbolically, whether in hypotheses, paintings, or poems. For an artist, or an ecologist, the deeper pattern is where the meaning lies. And, in fact, observation and attention to pattern are fundamental to the survival of all animals, not only humans, not only scientists and artists. Because evolution has tuned all of us to observe and pay attention to patterns in our environment, science and art are part of our deep evolutionary heritage, inextricably intertwined in our genes. The supposed gap between scientific and artistic ways of perceiving the world is a fundamental misunderstanding. Our evolution did not make us a dichotomous, scientist-or-artist species.

Lookout Mountain from Lookout Ridge Road (Forest Road 1507), 14 October 2019

Science, at the Andrews Forest and elsewhere, during the International Biological Program and later in the Long-Term Ecological Research (LTER) network funded by the National Science Foundation, developed under a model of research by interdisciplinary teams. Interdisciplinary, that is, within scientific disciplines. At the Andrews, the “interdisciplinary” model has been admirably expanded, through the Spring Creek Project, to include the “disciplines” of the humanities and arts in the “interdisciplinary” mix. But it makes me a little uneasy that this model seems still, perhaps, to come from a dichotomous, two cultures, “science and humanities” worldview.

We should be asking ourselves whether the way forward toward the holistic worldview we need and are seeking is to engage scientists and their "data" in conversations with humanists and artists who bring "values" (implying that scientists don't do that) *or* … to reject and transcend that "two cultures" dichotomy, and educate a new generation of individuals who are both scientists and poets Who bring both values and data to the table. Humboldt, Thoreau, Muir, Leopold, Ricketts, and Rachel Carson were both, did both. They were all walking the high ridge, providing models of what whole human beings are. We need such high-ridge-walkers more than ever now.

Forest above Lookout Creek, 16 October 2019

Somehow, my first attempt at Lookout Mountain in the snow put in mind an equivalence with "Cold Mountain," subject of many poems by the Chinese Tang Dynasty poet Han Shan, whose 9th century poetry lies at the boundary of Taoism and Zen Buddhism. One of Han Shan's poem has been translated by Gary Snyder:

Clambering up the Cold Mountain path,
The Cold Mountain trail goes on and on:
The long gorge choked with scree and boulders,
The wide creek, the mist-blurred grass.
The moss is slippery, though there's been no rain
The pine sings, but there's no wind.
Who can leap the world's ties
And sit with me among the white clouds?

Here is my poetic echo – with “palm-to-palm” acknowledgement to Han Shan and Snyder – about looking for the trail to Lookout Mountain from the dead-end of Forest Road 1507 on Lookout Ridge on 14 October 2019, after I’d already climbed it from the other side and found the ridge-topping Tortoiseshells:

Looking for the Lookout Mountain path,
The trail marked on the map doesn’t exist:
Someone has flagged a route straight uphill,
The long slope of downed trees and deadfall,
The meadows of bracken and beargrass.
Elk trails crisscross here and there, until the flagging runs out.
Who will sit with me on Lookout Mountain
Marveling at the white peaks?

The Three Sisters from Lookout Mountain, 11 October 2019

Research and Sources:

- Henry David Thoreau. The Poetry Foundation (biography).
- A World of Butterflies. Book review by Vladimir Nabokov. New York Times. Sunday 28 December 1952.
- California Tortoiseshell (*Nymphalis californica)*

- Walking the High Ridge: Life as a Field Trip. Robert Michael Pyle. 2000.
- Two of Nabokov's Many Cultures. Steve Coates. 31 March 2009. New York Times Arts Beat blog.
- Chadwick, Ian. 2014. Snyder's Translation of Han Shan: Cold Mountain Poems.
- Snyder, Gary. 1959. Riprap and Cold Mountain Poems.

6) Lobster Mushrooms

Pregunta: Why does the lobster mushroom show off an even brighter orange than its eponymous crustacean?

Lobster mushroom, Lookout Creek Old Growth Trail, 6 October 2019

Lobsters – cooked orange claws and tails – were poking up everywhere on my first hikes on the trails of the Andrews Forest. On the short "Discovery Trail," a nature trail just up from the headquarters. On the first couple of miles of the Lookout Creek "Old Growth" trail. Everywhere.

Being a mycological neophyte, I googled for some more information: "The Lobster mushroom, *Hypomyces lactifluorum*, contrary to its common name, is not a mushroom, but rather a parasitic ascomycete fungus that grows on certain species of mushrooms, turning them a reddish orange color that resembles the outer shell of a cooked lobster." Hunh? No, this doesn't make scientific sense. I think what Wikipedia is trying to say is that lobster "mushrooms" are actually a combination of two fungi from very different evolutionary branches of the biological kingdom Fungi. In creating "lobsters," a fungus of the division Ascomycota colonizes a mushroom from the division Basidiomycota… and works its firming and oranging magic. It turns the gills of the base mushroom into a texture that looks pitted or smooth, and *orange*. Why? And why orange? Is the Ascomycete really parasitizing the Basidiomycete? Or could this be just another case of mysterious mutualism, with both species benefitting somehow, only unknown to us?

Research and Sources:

- Lobster Mushroom (*Hypomyces lactiflourum*)

7) Blindness and Greenness

Pregunta: If I were blind
would I still marvel at this green?

Oregon oxalis (*Oxalis oregana*) in the Andrews Forest

The Concord Transcendentalists, searching for ways to bridge the gap between rapidly emerging science and traditional Western philosophy and religion, were open to many influences. “Transcendentalism, pantheism, and related ideas were all in the air, asserting the unity of spirit and matter and each claiming that it offered the best marriage of science and the imagination,” wrote Donald Worster in his 2008 biography of John Muir.

One of those Concord Transcendentalists, Henry David Thoreau, protégé of Ralph Waldo Emerson, was responsible for publishing the first translation of a Buddhist text in English. As the editor of the “Ethnical Scriptures” section of the Transcendentalist magazine, *The Dial,* he was always on the lookout for provocative spiritual and philosophical texts, and sometime in 1843 he found an article, in French, by Eugene Burnouf, a Paris-based scholar of Pali and Sanskrit. It was a translation from Sanskrit of the *Saddharmapundarika Sutra,* or “Sutra of the Lotus of the Good Law,” one of the fundamental scriptures of Mahayana Buddhism, which had been sent to him by a British government official posted at the court of Nepal. Having learned French (and several other classical and modern languages) at Harvard, Thoreau translated the introduction to the Lotus Sutra from Bernouf’s article, and it was published as “The Preaching of the Buddha” the January 1844 issue of *The Dial*:

> *And when other men reply to the man born blind, there are diversities of color and spectators of these diverse colors; there is a sun and a moon, and constellations and stars, and spectators who see the stars, the man born blind believes them not, and wishes to have no relations with them.*

On August 5th, 1851, Thoreau wrote in his journal "the question is not what you look at, but what you see," echoing back, perhaps, to the passage on blindness and seeing he had translated from the Lotus Sutra.

Science can help us "see," extending our senses with technology to wavelengths our eyes can't see and ears can't hear, and to small and large spatial scales beyond our ken. In one sense, we are all blind to the "diversities of color," as the Lotus Sutra called them, in this wide and wonderful cosmos. And beyond science, philosophies, spiritual traditions, and worldviews can also help us "see."

Does a blind person see green? It is sort of like the Zen *koan*, attributed to Hakuin Zenji: "What is the sound of one hand clapping?"

Or, in a way, similar to the question in the Western philosophical tradition: "If a tree falls in the forest and there is no one there to hear it, does it make a sound?"

Your answers, please!

<u>Research and Sources:</u>

- Worster, Donald. 2008. A Passion for Nature: The Life of John Muir. Oxford University Press.
- Fields, Rick. 1992. How the Swans Came to the Lake: A Narrative History of Buddhism in America. Shambala Publications.

8) Forest for the Trees

Pregunta: How can a forest
hide in the trees?

The common phrase "can't see the forest for the trees" refers to a situation in which a holistic, "big picture" view (in time or space) is blocked because of giving too much attention and weight to details in the foreground. I also think of it as referring to reductionistic sciences, which atomize observations and silo knowledge – in contrast to holistic sciences, such as ecology, that synthesize and integrate observations to seek the big picture. This phrase has apparently been a proverb in the English language since the 1500s.

Research at the Andrews Experimental Forest has been guided by an integrative, interdisciplinary vision from the beginning. Scientists at the Andrews were interested not only in silvicultural research aimed at maximizing wood production from the second-growth forests that would replace clearcut old-growth, but also in understanding how to protect forest watersheds and their benefits for water supply, native fish, and flood control. Understanding those other benefits and values of forests and watersheds would require understanding how they function ecologically. Since its establishment in 1948, the Andrews Experimental Forest has managed to guide its research programs toward "seeing the forest," not just looking at the trees.

Old stump and replanted Douglas-fir forest from 1975 clearcut, Experimental Watershed #10

9) Canopy Lichens

Pregunta: Did the root thank
the lichen in the canopy of the tree?

Loberia oregana, a nitrogen-fixing lichen abundant in the canopy of old-growth forests in the Andrews (a fallen piece of lichen on the forest floor)

Jon Luoma, in his book about the Andrews, *The Hidden Forest: The Biography of an Ecosystem*, quotes Bill Denison, who did the pioneering research on the old-growth-canopy lichen, *Loberia oregana*: “I don’t think there’s any doubt that *Loberia* is a major contributor of nitrogen to the forest.” In fact, Denison found, it’s the largest source of nitrogen. The problem is that *Loberia* doesn’t colonize forests until they are a hundred years old, and doesn’t thrive until they reach two hundred. Denison found that these symbiotic canopy lichens sort of tag-team the nitrogen-fixing red alders (*Alnus rubra*) and snowbrush (*Ceanothus velutinus*) of early-successional forests here, taking over about the time they have reached the end of their lifespans and starting to provide fixed nitrogen before the conifers have exhausted the soil-nitrogen bank they left. Nine of Denison’s papers turn up in a search of the publications on the Andrews Forest website. In a 1979 conference paper, he reported that the weight of *Loberia* in an old-growth Douglas-fir is five percent of the weight of the tree’s own foliage. Amazing! Are the roots thanking the lichens? ¡*Por supuesto*! Of course!

Research and Sources:

- Luoma, Jon R. 2006. The Hidden Forest: The Biography of an Ecosystem. Oregon State University Press. http://osupress.oregonstate.edu/book/hidden-forest
- Denison, William C. 1979. *Lobaria oregana*, a nitrogen-fixing lichen in old-growth Douglas-fir forests.

10) Terraforming Mars?

Pregunta: With lifetimes more questions still to ask here,
can anyone talk seriously about "terraforming" Mars?

What are we thinking!?!

Some ecologists these days seem to think that we can reconstruct functioning ecosystems after we've destroyed them – or even construct them from scratch. In an opinion piece in the September 2017 issue of *Frontiers in Ecology and the Environment*, the monthly publication of the Ecological Society of America, an ecologist from Texas A&M University (who shall remain unnamed by me here) wrote: "The time when ecological science is deliberately applied to reconstruct components of the natural world at a much broader scope may arrive sooner than you think. Imagine building, replicating, and manufacturing functional ecosystems across multiple scales, from managing selected flora in the human gut with a pill to terraforming planetary bodies across the cosmos."

That anthropocentric hubris is a far cry from Aldo Leopold's admonition that "the first rule of intelligent tinkering is to save all the cogs and wheels" of functioning ecosystems – perhaps the first statement of what came to be called the "precautionary principle." That ecological principle could be paraphrased as "If you don't know enough to know how badly you can screw it up, DON'T DO IT!"

And we don't know enough. We still don't know, after seventy years of science at the Andrews Experimental Forest, how this amazing, mysterious forest really functions. We keep learning new things on a regular basis. And if we don't know how ecosystems work well enough to keep from further damaging them, how could we possibly imagine "building, replicating, and manufacturing functional ecosystems" from scratch? I responded to this opinion piece in ESA's *Frontiers* with a letter criticizing and challenging its fundamental assumptions, titled "Ecology, the humbling science," which was published in April 2018.

Time and time again during my couple of weeks exploring the Andrews, I came upon research sites with arrays of strange scientific gear and gizmos. Three-pronged stainless-steel spikes on tripods, rivers of wires running up the trunk of a giant Douglas-fir to instruments so high up I couldn't see them, delicate leaf-like sensors to measure surface moisture, belts of wire to measure the diameter of trees to the millimeter, temperature loggers sheltered under half-rounds of white PVC pipe, groundwater wells to measure hyporheic flow along streams… What flashed in mind was that if an exploring expedition from an alien planet happened to touch down in the Andrews, they might deploy a mysterious array of sensors that would look very similar.

Perhaps not so far-fetched an image, I came to think. Scientists in the Andrews are trying to understand the functioning of an ecosystem on a planet which, although we inhabit it, we barely know at all. These strange gizmos and gadgets scattered through the Andrews Forest are the tools of my own species – and I thought: *we* are alien invaders also, in these ancient ecosystems that evolved without our presence for hundreds of millions of years.

If an alien species were to have a chance at colonizing another living planet, and constructing a sustainable colony there, they would have to first understand the living system into which they proposed to insert themselves. So far, our human species, which exploded out of Africa an eyeblink ago in evolutionary time, has failed to do that. We are like alien invaders from space as far as most ecosystems of Earth, including the Andrews Forest, are concerned.

Maybe that's why these strange tripods in the forest and wires going up into huge old trees made me smile. Maybe we can study and understand this planet, this ecosystem, this forest, before we destroy it – and thereby destroy ourselves. Our curiosity and resolve to understand our own home planet are, for me, a sign of hope.

Instrumentation array at the base of the "Discovery Tree" near the Andrews Forest headquarters.

The “Discovery Tree,” an instrumented Douglas-fir near the Andrews Forest headquarters

Dendrometer and spiderweb at the “Discovery Tree” near Andrews Forest headquarters


Water-monitoring intake at Watershed #1

DIRT (Detrital Input and Removal Treatments) study site, landscaping cloth cover for experimental removal of deadfall from the canopy above

Research and Sources:

DIRT (Detrital Input and Removal Treatments) study publications.

Byers, Bruce A. 2018. Ecology, the humbling science. Frontiers in Ecology and the Environment, April 2018.