



SECTION ONE

**Restoring Reciprocity,
Sustaining Sustenance**

Introduction

ABOUT A DECADE AGO, someone wrote a book about the island where I grew up. They described its 30 species of native orchids, glacial bogs, and old growth forests of oak, hickory, and chestnut along its hilly shoreline. This remembrance of my childhood island brought a tear to my eye — because the island where I grew up is Manhattan, and the natural habitats described in the book were from over 400 years ago.

We all live in habitats. Some of us live in habitats that are buried beneath pavement, some in habitats diminished by centuries of intensive land use. Some of us have yards and farms that contain remnant habitats of exceptional quality.

We live in habitats, but are unaccustomed to thinking of them that way. We've drawn a hard line between what is natural and what is human, to the detriment of all. We need human areas — urban and otherwise — that welcome wildlife, *and natural areas that welcome humans*.

How can we break down the divide between human-occupied spaces and what is “natural”? As direct participants in natural communities — as creatures who find food, medicine, and purpose in natural areas, whether those are our backyard, a city park, a farm, or a nature preserve.

This is a book about restoring your habitat: to abundance, beauty, function, and utility as well. For all wildlife — including us two-leggeds. Restoring habitats using edible and medicinal wild plants, in particular, welcomes us back to the natural community, because these species feed and heal us just like they do the other animals.

At the heart of ecological restoration is a reciprocal exchange. In exchange for the sustenance plants give us, we offer our human skills to restore and repair degraded plant habitats. Ecological restoration is a way of connecting to and healing nature, returning the gifts that we receive from the plants and the living earth.

This book will help you match plants to habitats, and plants to people. It is built around the idea of the plant community. If you find a place with one or two plants present, these indicate that other plants, other members of that community, may also thrive there. In addition to describing plant communities, this book illustrates the personality of each plant species — how they might fit into the community, if you will.

The time has come to reconnect with our habitats, right where we live, work, and play. Not as museum pieces, but as vital, sustaining elements of our lives, livelihoods, and lifeways.

The Farmer's Quandary

Recently I was at a small gathering of organic farmers at a friend's farm in central New Jersey, about an hour away from where I live. They were talking about their farm soils and how they are working to improve them. We were gathered in a circle in a friend's open pole barn, the mid-October evening chill working its way through our light autumn garb with every gust.

Many farmers there described composting, cover cropping, and no-till farming, and then the woman in front of me began to speak. Her farm was in the sandy coastal plain of New Jersey. She described how the soil pH started at around 4 (very acidic), and through copious application of lime they had brought it up to well over 7 (near

neutral, but much more alkaline than most native soils). Her farm had been a forest when they bought it, so they cut it down, pulled all of the stumps, and began to amend and alter the soil. Now she grows organic vegetable crops there.

I'm not here to second-guess her progressive farming practices, but to raise a question. Is there another way to produce food, medicine, and other economically and culturally important plant materials — without tearing down and replacing the natural habitats found in one's region? Because all farms, no matter how regenerative, were once natural habitats.

We modern humans are constantly seeking that perfect "river valley" soil — deep and loamy, neutral pH, highly fertile — wherever we garden or farm. Yet few of us live in natural soils that have this character, so we try to create it with whatever inputs and manipulations we can.

Affordable land here in heavily populated New Jersey is often marginal from a farmer's perspective — poorly drained clays or rocky hillsides. Much of the prime farmland has been developed or fetches a premium price — that farmland which once earned New Jersey the moniker "The Garden State." Often young farmers and homesteaders end up contending with conditions that are anathema to annual vegetable production, adding tons of compost and other inputs in an effort to "fix" clay or rocky soils. Another farmer



Picking fruit in the Pine Barrens.

at the same little gathering had dumped over a hundred tons of mushroom compost on two acres of land in a quest to make it arable.

Let's return for a moment to our coastal plain farmer, the one who started with a soil pH of 4. The coastal plain features sandy, highly drained soils that in former epochs were oceanfront and undersea. These silica-based sands leach nutrients and are generative of soils low in pH, and they tend to be very well drained. Not so great from a conventional horticultural perspective. However, the natural plant community in the coastal plain is wildly abundant with fruit- and nut-bearing woody plants, tea herbs, greens, and

medicinal roots and flowering tops. What would it look like to work with the existing native plant communities that our landscapes do or could support? That is what this book is about.

Two Human Paths

To speak simply, human existence can be divided into two different economic lifeways that spring from two very different food production systems.

The first is what wild foods author Sam Thayer has artfully dubbed "ecoculture."¹ Some may be more familiar with terms like "hunter-gatherer," though this term seems inadequate to reflect the reciprocal tending of the non-human world found in these cultures. In ecoculture, we are keystone animals, participating in and constantly melding the natural ecology around us to be its most abundant and productive. Ecoculture management practices benefit an entire plant and animal community, and we humans thrive on the resulting abundance. This lifeway rewards awareness and deep knowledge of ecology, and produces cooperative relationships, including among humans, who typically live in egalitarian societies. The path of ecoculture is typical of many human cultures for the past 10,000 years, probably much more.

The second path is a type of agriculture based around monocrops of domesticated plants, usually annuals. Here, humans clear away natural communities and optimize

conditions for a narrow group of crop species intended to benefit ourselves exclusively. Nature becomes vilified as the weeds, pests, predators, and weather patterns that constantly threaten our fragile domesticates. Annual agriculture has brought about cultures deeply suspicious of nature, and societies that are hierarchical and characterized by servitude and exploitation.

The above two paragraphs can hardly do justice to the spectrum of human experience. Yet they lay a framework and pose a question. Our exploitative modern economy, rooted in monocrop agriculture, is leading to a dead end for nature and natural humans. Can we look to our other human lifeways such as ecoculture for answers on how to better structure our food production and our relationships with the natural world and each other?

This book is about practicing ecoculture in northeastern North America. Rooted in wild plant communities and the practice of ecological restoration, it explores food and medicinal plant species as well as techniques for their reintroduction and management, a skill set both old and cutting edge.

Who Is This Book For?

Many of my friends are young organic farmers and homesteaders, striving mightily to both detoxify and bring justice to our food system. They are repairing soils, building communities, and feeding the

needy. I don't write this book to second-guess them but as an offering. What if those pollinator strips the farmer plants also yield premium wild teas? What if the windbreak contains nutrient-dense native fruits and nuts? What if that marginal swamp or woodland area is the source of high-value medicinal roots? This book is a sourcebook on how to have a more economically as well as ecologically diversified farm or homestead.

This book is also written for my fellow ecological restoration practitioners. We are working to repair millions of acres of degraded landscapes, often with limited budgets and time frames. We can design and implement beautiful restorations yet despair of who will maintain them two or five years from now, let alone decades down the line. We desperately need a human culture to develop around land stewardship. We need humans to be keystone animals that steward and tend diverse wild communities. We need ecoculture, where our economic interests and culture are deeply enmeshed with the health and abundance of the natural landscape.

Perhaps you are a land steward at a nature preserve. What if the surrounding community showed up in droves to remove invasive species, tend rare plants, and disperse seeds and seedlings of desirable species? What if they did this continually, as part of their culture? What if every year, you could host the best potluck ever,



American hazelnuts (*Corylus americana*).

gathering your community of stewards to harvest and prepare a sumptuous meal from the abundance of the preserve, with wild meats, fish, fruits, nuts, herbs, shoots, and tubers featured in a deeply flavorful, nutrient-dense, health-promoting feast?

This book is also for gardeners, especially for those in the burgeoning native plant movement. Our gardens are expanding past the typical foundation plantings and ornamental beds, and becoming something else: landscape restorations at the scale of the home or schoolyard. Gardeners can be at the vanguard of ecological

restoration, learning details about growing, placing, propagating, and sharing plant species that exceed what is available in the scientific literature. It is time to expand our vision past supporting “birds, butterflies, and bees” and fully integrate the most challenging animal of all — the human being — into our native plant gardens.

A book on ecology needs to root into the particular, even if it is broadly applicable. Throughout, I tell stories based on my field experience as a botanist in New Jersey, or informed by my travels throughout the Northeast. The closer your region is to my home ecologically speaking, the more of an exact fit you’ll find in these stories and in my portrayal of plant communities. Nevertheless, much of what is here is relevant ecologically to eastern North America as a whole, and the ecological restoration approaches and ideas about culture may have a wider scope yet.

I see the path to healthy humans, healthy nature, and healthy societies as deeply entwined with our food and medicine economy. This book is offered to those who feel called to choose natural foods and medicines, native diversity, and cooperative relationships over the toxicity, antagonism, and competitive struggle of an extractive food economy and society. It is written from my experience as a field botanist, native plant grower, and forager, and most of all, from my desire to see wild plants and humans share community again.

CHAPTER 1

A Different Way

WHEN EUROPEAN COLONISTS first invaded what is now known as the Americas, they may not have had a concept that allowed them to understand the nature that they saw. We *still* don't have a word for the concept in English — a word for the Indigenous practice of honing ecosystems for food abundance while retaining native species diversity and function, though I prefer “ecoculture” to terms like “niche construction” and “engineered environment” used in the academic literature on the subject.

Recent archaeology suggests that populations of Indigenous peoples in the Americas were much higher in pre-Columbian times than previously reported. Current estimates are in the vicinity of 20 million people. By the 17th century when immigration from Europe became widespread, Eurasian diseases had already decimated populations of Indigenous people and lessened the imprint of Indigenous management practices on the land.²

Understanding this opens the door for an increasing awareness that Indigenous peoples transformed the landscape in fundamental ways across the Americas, ways that have not been appreciated or noticed by non-Indigenous explorers, scientists, or historians, and were rarely acknowledged by settlers in the Colonial era.

Many of the signature “wild” landscapes of the New World are now understood to be the result of partnerships between humans and other forces. Even the Amazon, that paragon of wildness and biodiversity, may have been in large part shaped by human activity. Likewise, both the tallgrass prairie and much of pre-colonial California were dependent on the cultural activities of people for the composition and type of habitats present. It is increasingly accepted that across the Americas, native peoples shaped the land to create productive systems of what we would now dub “permaculture,” “agroforestry,” “orcharding,” and “game management,” but in unique

iterations that spawned whole regional ecologies, melding technologies such as fire management, culling, pruning, planting, orcharding, mound and midden building, hydrological manipulation, and the creation of soils.

While recent archaeology is scant in our region, and the land so altered by colonial and modern development that it's hard to read into, accounts written by early European settlers are striking. Early accounts describe extensive parklike woods brimming with nut and fruit trees, and an explosion of wild fish and game. Coupled with evidence from palaeoecology and anthropology, this suggests that, throughout the Americas, Indigenous peoples managed a vast food landscape via fire, plant introductions, and other ecological management techniques.³ Unlike Eurasian agriculture, these practices didn't depend on the elimination of native species and diversity, or on the active and constant control of domesticated animals. Instead, the entire landscape was managed for abundance, for fruits, nuts, greens, tubers, medicine plants, craft plants, as well as game and fish.

Why is this still breaking news? By the time Europeans established a significant presence here, as much as 90% of Indigenous people may have *already* been wiped out by introduced Eurasian plagues. Once-vast cultural landscapes were already overgrown and untended, and in many

places the native peoples and cultures were reduced to a small group of survivors.

In addition, European settlers may have simply lacked the cognitive tools (or interest) to understand an ecologically managed food landscape. Instead, they held an intense prejudice against the Indigenous peoples, branding them as pagans, devil worshippers, and non-humans — a corollary to the usurpation of their territories.

In the Northeast, we rarely consider or recognize Indigenous cultural landscapes. Some are developed over or transformed beyond recognition. We might find groves of pawpaws, bur oaks, hazelnuts, wild plums, or honey locusts, and speculate that they could suggest a former Indigenous village site. Or “out-of-range” populations of other exceptional food plants like groundnut, persimmon, or Jerusalem artichoke. The totality of the system comprising plants, wildlife, and humans, and the ecological knowledge and management techniques that guided it is highly fragmented by colonial-era land appropriation and the aggressive suppression of Indigenous cultural practices.

There is a subset of archaeology known as experimental archaeology. Looking to immerse themselves in the material culturals they are studying, experimental archaeologists craft their own spearpoints and sandals, bowls and baskets, testing the time, effort, and materials necessary. By learning crafts “experimentally,” these

archaeologists involve themselves experientially in what otherwise might be a realm of abstract speculation.

We too can be like experimental archaeologists, trying materials, seeking techniques, arriving at a thing of beauty and utility. Rather than knapping flint or pressure flaking razor-sharp obsidian, our tools are plants, seeds, soil, fire, and water, as we experimentally replant and care for the once and future food forests of this continent. We're seeking neither the Garden of Eden nor the agriculturalist's yoke, but instead a third way, where everyone is invited to the potluck feast — plants, wildlife, and two-leggeds alike.

Some of the most diverse and productive landscapes on Earth are now understood to be anthropogenic — significantly modified, created, and maintained by people. Does this negate the power and glory of wild nature? No. But it also means that humans can do more than just destroy and defile. We've created sustainable, diverse food systems based around native ecology before, and we can do it again.

Tending the Wild

Remember what I said about the Manhattan of 400 years ago? The book I read (that brought a tear to my eye) was called *Mannahatta*, as was the island we now know as a borough of New York City. In addition to its 30 species of native orchids and old growth forests, Mannahatta

featured 55 different ecological community types. According to author Eric Sanderson, Mannahatta had “more ecological communities per acre than Yellowstone, more native plant species per acre than Yosemite, and more birds than the Great Smoky Mountains National Park”.⁴ It was a stunning example of North American biodiversity.

But this older Manhattan was not an uninhabited wilderness. It was an incredibly diverse island, and it was inhabited by the Lenni Lenape people. Rather than destroy the island's biodiversity, it is likely that they contributed to it through their land management techniques, including the use of controlled fire. Sanderson suggests that “nearly all of the island may have burned on a patchwork, but regular basis.” In fact, Harlem was an open grassland at the time of initial Dutch exploration, a fertile meadow of approximately 150 acres over calcium-rich Inwood marble. It was maintained in its open condition through Lenape burning.⁵

How can we reconcile the presence of these people with the extraordinary biodiversity they lived alongside? It is typically expressed that Indigenous people lacked the wherewithal to destroy the habitats they lived in. I think this perspective reveals little about Indigenous lifeways, and rather more about the narrative of “progress” we've all been inculcated with. The need to tend and preserve biodiversity is

inherent within Indigenous lifeways such as those practiced by the Lenape. Whereas for most agricultural practices there is a need to replace natural habitats with cropping systems, Indigenous peoples who foraged, hunted, and practiced ecological

management depended on fully functional ecosystems. For gathering and hunting peoples, *biodiversity equals food diversity*.

Consider the following dietary diversity estimates from a range of Indigenous peoples across the globe:

Dietary diversity: Average number of plant species/cultigens consumed⁶

- Hausa: 119
- !Kung: 85
- Tibetan indigenous: 168
- Cherokee: 80
- Contemporary American: 30

Note how lacking in variety our contemporary diet is compared to that of peoples living within a diverse ecology. Consider the effects of that lack of diversity on our nutritional health and internal microbiome, both so important to resisting the chronic diseases that are a major cause of death in the “civilized” world.

What does it look like if we see people in a positive feedback loop with biodiversity, giving as well as taking?

The land management techniques of California’s Indigenous cultures natives are described in the book *Tending the Wild* by M. Kat Anderson. She describes how the gloriously abundant California landscapes perceived by Europeans (including nature lovers like John Muir) as untouched wildernesses were in fact the result of



Trout with milkweed tops, wood nettle, nodding onion, and bee balm (prepared with David Alexander).

different types of Indigenous management. Accordingly, “[t]he productive and diverse landscapes of California were in part the outcome of sophisticated and complex harvesting and management practices.” These practices included “coppicing, pruning, harrowing, sowing, weeding, burning, digging, thinning, and selective harvesting.” While we tend to think of human-caused disturbances as reducing abundance and biodiversity (when in service to agriculture or civilization building), California natives’ techniques maintained the vast wildflower fields containing edible camas bulbs,

ancient groves of oaks for harvesting of acorns, and numerous species for basketry, medicine, fiber, and other needs. California had one of the highest densities of hunter-gatherers anywhere on the planet, and they supported themselves and biodiversity in a healthy landscape — one that, by contrast, is now ravaged by wildfire, avalanches, and drought.

While the Northeast surely also featured extensive Indigenous land management, public records of these practices are scant because many eastern Indigenous peoples were killed, displaced, or forced to

Traditional Ecological Knowledge and This Book

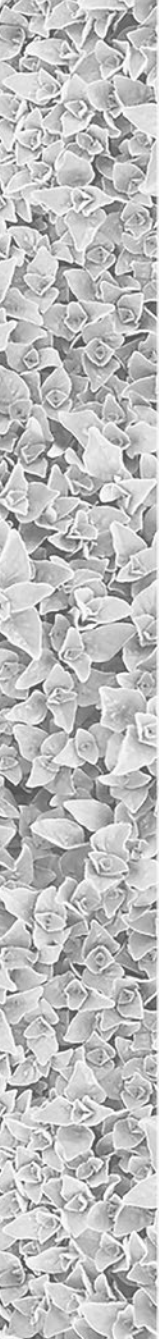
Sometimes land managers formulate goals about how habitats should look and function based on a supposition that the land was “natural” before 1492 and if we can just get it back to how it looked back then we’d be in great shape. On the one hand, sure! I’d love to take a walk through the Musconetcong Gorge or Delaware River Valley in 1491. It would be different, fascinating, revelatory. I’d probably be in tears. But not because I’d be encountering nature in a pure, “wild” state with people deleted from the picture.

A framework that understands the pre-colonial land as “natural” risks writing people out of the equation, in this case Indigenous people who have been written out of the equation in very

pernicious ways for several centuries now. It’s a form of intellectual dispossession. It also reinforces a narrative that locks all of us humans out, by positing a goal of “naturalness” rather than acknowledging our universal potential and heritage as members of the ecological community.

It’s not just 1492, though. Contemporary Indigenous people often get written out of the dominant narrative on “nature” and what to do about it as well. It is another form of dispossession to speak of Indigenous cultures as only entities of an idealized past, with little or no modern relevance.

It is partially to address this that the concept of Traditional Ecological Knowledge (TEK)



has gained increasing recognition within the fields of ecology and land management.

“[Traditional Ecological Knowledge] is a cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment”⁷ writes Fikret Berkes, who studies natural resource management among Indigenous communities. Framing the ecological practices of contemporary Indigenous people as TEK has functioned to politically legitimize Indigenous practices as well as to lend them discursive power in fields dominated by scientific professionals and techniques.

Practically speaking, TEK involves the direct interaction of people with nature through activities such as gathering plants, hunting, fishing, herding, building, healing, and land management. It is not produced by a separate class of scientific professionals but is generated by the community, in the interest of survival, ethical behavior, sharing, and long-term stewardship. Some practices in TEK might have their roots thousands of years ago, but all cultures are incredibly fluid and it is not necessary to assume that an idea is deeply ancient just because it comes from Indigenous peoples, or in order to validate it. It is a combination of long-term residency as well as the direct participation of the community in ecology that gives TEK its practical applicability and social gravitas.

To deny that “[m]uch traditional knowledge has been lost to time and forced assimilation” as Robin Kimmerer and Frank Lake assert in their article about Indigenous prescribed burning (and its suppression) would be a form of historical denial. However, as they go on to write, “much persists in the oral tradition and practices of contemporary native communities, who are only rarely consulted as equal partners in land management.”⁸ Plant names, place names, ceremonial practices, management techniques, traditional stories, crafts, and all manner of intellectual and spiritual understandings carry Traditional Ecological Knowledge into the future.

As a non-Indigenous person, it may not be for me to know or decide which practices are current, dormant, or have been lost due to genocide, marginalization, dislocation, or just the changing needs of dynamic, living cultures. For this reason, I use the present tense in this book regarding Indigenous cultural practices except where my source explicitly places those practices in the past.

Traditional Ecological Knowledge is a cultural belonging of specific Indigenous nations. In this book, I have decided to convey practices that are already described in the public record, in academic and popular media. I hope I have done so with respect and in the service of the native ecology which is critical to all of us, indigenous to North America and otherwise.

practice their culture in secret well before the birth of any kind of respectful anthropology or ethnobotanical discipline. While the cultural practices which inform Indigenous land management may persist, the opportunity to implement practices such as controlled burning was vastly diminished in much of the Northeast by the 1700s.⁹

Eat Local

Can we extend the idea of eating locally to include eating locally native plant species?

There's a significant movement underway to consume locally produced goods. This is especially true of food. The movement to "eat local" supports local farmers and foodways and helps to disengage from the problems of mass transportation of food.

A great opportunity lies in the consumption of bioregional foods. These are native flora and fauna adapted to the particular place we inhabit. These indigenous foods are knit into the ecology of a place, supporting the vitality of the soil, water, and wild plant and wildlife communities, as well as human needs. These foods support our local ecology in a way that typical farm vegetables and row crops never can.

To truly eat locally is to eat the indigenous diet of a place. Imagine the following spring meal. Our freshly caught trout (probably a stocked trout these days, but once upon a time ...) is lightly smoked in hickory as it is cooked on an outdoor fire,

and sprinkled with bee balm and sea salt. As sides, we sauté milkweed shoots in maple syrup, and fry up some groundnut tubers until they are crispy on the outside and soft and starchy on the inside. For a piquant touch, we'll sizzle some morels with wild leek leaves in a skillet until the leaves puff up like fresh tortillas and the mushrooms are browned at the edges.

This is a truly high-end gourmet meal, ranking well in both flavor and nutrition. It epitomizes the indigenous culinary possibilities of our area, using all-native ingredients to create a meal that is so much more than "survival" food.

As much as I'd like to say we can all go out and forage this meal (and we probably should at least once), there may be too many humans in our area for this to be sustainable. So, should we give up and eat hydrolyzed soy protein with corn syrup instead?

I believe we have another option, one of benefit to ourselves and to the wild world. We can restore the degraded habitats that humans created, stock them with indigenous food plants (and thus, teeming wildlife), and create a truly local food system. One that's not based on monocultures of domesticated annual plants from every continent, but from a bioregional palette of deeply delicious, nourishing, and ecologically restorative species.

This book is a guide to the sustaining plants of the Northeast — those that

bring us food and medicine. It is a guide to communities — how these plants assemble into mutually supportive groupings in response to specific habitat conditions.

And it is a guide to restoring those communities — with ourselves as members of the community.

CHAPTER 2

Plants in Relationship

BELIEVE THAT WE CAN practice ecological restoration in a way that explicitly addresses the human animal's need for sustenance and relationships.

Without relationships, individual parts lack meaning. Consider an example from the world of native plants and wildlife. Cardinal flower is a stunning wildflower whose blooms have long red tubular corollas with a sweet nectar reward at their base. Ruby-throated hummingbirds have long tongues and bills that can reach deep into the scarlet flowers to retrieve sustenance. Cardinal flower feeds hummingbird, and hummingbird helps effect reproduction for cardinal flower. Without each other, each one is decontextualized, strange. It is actually the relationship that is emergent and meaningful.

There are many broken relationships in our ecologically devastated world, but perhaps the most broken of all is our relationship with the rest of the natural world. Therefore, a potent ecological restoration



Cardinal flower (*Lobelia cardinalis*).

practice doesn't just repair "nature" — with the human realm edited out — but explicitly focuses on relinking us errant, individualistic, decontextualized animals to each other and to the living Earth of which we are a part.

Plant Planet

Gaia theorists describe the Earth as a biogeochemical entity that creates the conditions for its own persistence, with life itself maintaining the oxygen content of the air, the salinity of ocean water, and the water cycles that seed the clouds with rain.

Plants are the primary converters of the sun's energy into sustenance for all the other terrestrial life on the planet, and important components of the cycles that maintain the atmosphere and the infiltration and transpiration of water. Plants mediate the energy of the sun and make it available to all other life on the planet. Much of the oxygen we breathe comes from plants. They supply fuel, food, shelter, clothing, medicine — all of life's essentials. As animals, it is our doom and our gift to live off the work of others, consuming plants, or herbivores that process plants for us. Like all gifts, it is one we have an opportunity to reciprocate.

Because plants are so important to planetary flows of energy, water and gasses, as well as to our basic needs as animals, many of the problems civilized humans have created can be addressed with plants.

Carbon and Soils

Imagine you are standing in a tall grassland in late summer. Indian grass is head high — you are face-to-face with its seedheads. Run your hand up the stem and your palm fills with golden seeds as you strip the narrow panicle, spikelets shedding easily, seeds begging to be dispersed. Interspersed among the tufted grasses, you see the candelabra blooms of showy goldenrod, the intense purple disks of late purple aster, and the already dry seedheads of wild bergamot, with their thyme-like aroma volatilizing in the heat. Migrating monarch butterflies are nectaring at the asters while a throng of bumblebees visits the goldenrod's yellow spikes.

A beautiful place, and one deeply important to solving the problems of our time.

The roots of Indian grass reach at least ten feet into the earth. Grasslands are extremely productive of soils, and some prairies had 100 feet of topsoil before being destroyed by John Deere's plow.

A single acre of intact grasslands can sequester two to five tons of carbon per year. Plants take what is one of the biggest problems of our time — excess atmospheric carbon — *and turn it into sugar*.

Plants can be likened to carbon straws that pull gasses out of the atmosphere and into the soil, uptake water and minerals, and fuel it all with sunlight.¹⁰

Sun to sugar.

These sugars, simple and complex, are used to build plant tissues, and to feed the soil biome that supports plant growth. Some of that carbon ends up in plants, some in the digestive tracts of aboveground animals. A lot is exuded into the soil to support bacterial and fungal communities that return the favor by providing water and nutrients to the plants.

Here's some good news. The amount of carbon stored in soils (2,500 billion tons) and plant and animal life (560 billion tons) is nearly *four* times that in the atmosphere (800 billion tons).¹¹

So: reducing fossil fuel emissions is critical. We don't want to be adding to the problem. However, the ultimate goal is the re-placement of carbon into terrestrial pools in soils, flora, and fauna.

That's what plants do. They are a 100% solar-powered, pollution-free, renewables-based, honed over millions of years solution to excess atmospheric carbon.

Those Indian grass seeds in your hand? There are many places in this country they could go. Forty-five million acres of turf grasses, shorn for monocultural lawns. One hundred million acres of road medians — about the same amount of space as all the state and national parks combined! We also have over 900 million acres of farmland, largely in annual crops. Much of it conventionally farmed, not very biodiverse, not building soils. Imagine that land restored to native plant communities that sequester



Indian grass (*Sorghastrum nutans*) in flower.

carbon more effectively, while providing food, medicine, and nature connection for people.

Temperature and Water

We are in a deep forest. Red oaks and sugar maples form the canopy, with a few tuliptrees and sassafras that grew up



Mayapples (*Podophyllum peltatum*) after the rain.

in light gaps. In the understory below, witch hazels thrust loping trunks towards sunny gaps. Black cohosh, bloodroot, rosy sedge, marginal woodfern, and other herbs grow from the moist soil, punctuated with boulders clad in mosses and lichen. Chanterelle mushrooms are borne from mycorrhizae that live in symbiosis with the oak trees. These fungi derive their carbohydrates from fine tree roots while returning

minerals and water to the tree roots, extending their range and capabilities.

It is a hot summer day, but beneath the foliage of the oaks and witch hazels the rocks are still cold to the touch and the mosses a verdant green.

Northeastern forests are cool, moist environments. Plants, especially trees, lower temperatures in two ways: by providing shade, and through evapotranspiration.

Shaded habitats can be 20–45°F cooler than the peak temperatures of unshaded places, shielded from the direct heat of the sun's light.

Evapotranspiration can reduce peak summer temperatures by 2–9°F. Plants pull water from deep in soils, and in the course of photosynthesis, they open leaf pores that release water vapor. This vapor can directly form clouds, and it can act in concert with another process, where organic aerosols released by trees and other plants form particles that “seed” clouds. These processes can bring about rain directly, and can also change climate patterns. In the Amazon, the seasonal increase in rain caused by trees shifts wind patterns and brings even more water from the ocean.¹² Some climate scientists suggest that water dynamics and the moderation of temperatures resulting from evapotranspiration are actually far more important than atmospheric carbon in driving climate dynamics.

When rain falls to the ground, it is largely through the agency of plants that it remains

in place. First, plant cover shields soils from raindrop impacts which otherwise cause run-off and erosion. Second, organic matter from plants builds soils that have large pore structures. These pores infiltrate and retain water in much the same way as a sponge.

Given organic matter from decaying plants, rain seeded from trees, oxygen from copious pore spaces, and direct sustenance in the form of exudates from plant roots, a diverse soil biology forms that perpetuates the very processes by which it is sustained. Plants have been shown to feed their soil biomes (including the mycosphere, like those chanterelles) with as much as 40% of the carbohydrates they derive from photosynthesis. It is this reciprocal exchange that allows trees to tower a hundred feet over the soil and dozens of feet deep (one report documents a tree's roots extending 174 feet into the soil, though this is clearly exceptional).¹³

We feel this viscerally on a hot summer day, when we walk from a hot parking lot or sunny meadow onto a woodland trail. Beneath the towering oaks and maples, the air is cooler and moister. Leaf litter and coarse woody debris are damp on their undersides. We find salamanders beneath logs and under rocks, and the soil is soft and hydrated beneath our feet.

Wild Plants as Food

What is the characteristic diet of the human animal? Because we inhabit so many

of the Earth's ecosystems, and have derived sustenance in many ways, the human diet is characterized by diversity.

Homo sapiens has walked this planet for the last 300,000 years. Perhaps 10,000 years of these have featured agriculture as we know it. Thus, all *Homo sapiens* subsisted on non-domesticated food sources for the majority of our time as a species. Our internal ecology has evolved in the context of consuming non-domesticated species.

During the domestication process, cultigens (domesticated species) often lose nutrient content and phytochemical diversity relative to their wild relatives. Important characteristics of wild plants are removed during the domestication process. Domestication creates larger fruits (but not necessarily with more flavor), less challenging flavors (such as the removal of bitters), softer leafy tissue, and other characteristics for which plants are bred, such as shelf life or easy germination.

Wild plants respond to the rigors of wild living, including herbivory, pathogens, and other environmental stresses, through the production of a diverse palette of phytochemicals. Domesticated plants no longer need to produce adaptive phytochemicals, because many environmental stresses that wild plants face are managed by humans through supplemental watering, weeding, insect control, and soil amendment.

Wild plant species are generally superior to domesticates in their content of

pro-vitamin A, vitamin C, minerals such as calcium, phosphorus, iron, and potassium, polyphenols (which help prevent cancer and various degenerative diseases), and omega-3 fatty acids.

Botanist Arthur Haines writes, “[o]ur body’s ability to carry out metabolic processes, heal from injury or sickness, and defend itself from pathogens has evolved concurrently with a [wild foods] diet that is very different from the one most people experience today.”¹⁴ In addition to containing critical nutrients and vitamins, wild plant

foods trigger body processes from digestive enzyme secretion to immune response, and modulate our internal ecology — the bacterial symbionts that live within us. Now we suffer from everything from digestive issues to depression because our internal ecology is disconnected from the external ecology in which we evolved. A modern diet of simple starches and muscle meat may not suffice in supplying our need for biological complexity in our diet.

Wild Plants as Medicine

I appreciate the way that herbalists think. They consider the ecology of the human body. Their healing practices utilize concepts that I think are useful for ecological restoration.

Herbalists often contrast their practice with conventional medicine — the dominant medical model. Conventional medicine must be credited for its efficacy in trauma medicine — keeping people alive in the midst of an acute crisis like a heart attack or the aftermath of an auto accident. If I have a shattered bone sticking out of my flesh, by all means bring me to the hospital.

Conventional medicine is good at acute crises, but often fails to support the continued health or recovery of fundamentally healthy people. It offers little for the *prevention* of the chronic illnesses that are leading causes of death and suffering in much of the world. It is not so good at



Giant Solomon’s seal shoots and wild leek foliage.

what I would consider healing: prompting and supporting the body's numerous mechanisms for self-repair and recovery.

Herbalists seek to use plants to modulate our inner ecology, support the body's ability to heal itself, and trigger enzymes, hormones, and systemic responses. Part of the genius of plant medicine is that it acknowledges our fundamental kinship with plants. Plants exist in the same terrestrial habitats we do, and need to respond to many of the same challenges. Because they have neither animal mobility nor mammalian immune systems, plants have addressed many environmental challenges through the production of phytochemicals. These challenges include bacteria, viruses, fungal attack, heat, cold, and oxidative stress. Plants offer medicines that serve us directly in dealing with these kinds of environmental stresses. And because they've had 400 million years or so to evolve these defense mechanisms, the solutions arrived at by plants can be more sophisticated than pharmaceuticals created in a laboratory setting.

Contrast, for example, the way that pharmaceuticals and some plants deal with bacteria. There are many species of potentially pathogenic bacteria that reside in our bodies as elements of our internal biome, including species such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Streptococcus* spp., and *Escherichia coli*. These are commonly thought of as disease-causing "germs." However, these

species only become problematic when our internal ecosystem is so disrupted that they can begin to multiply, proliferate, and overwhelm our body systems.

Conventional medicine prescribes antibiotics for these bacteria. Antibiotics are chemical agents meant to kill bacteria. However, antibiotics are problematic because they also kill a lot of other species in our internal biome, species that are crucial for processes like digestion, and killing pathogenic species tends to breed for resistant bacteria.¹⁵

By contrast, an interesting class of plant chemicals takes a different approach to suppressing pathogenic bacteria, by inhibiting quorum sensing.

What makes bacteria so dangerous is their ability to form larger entities such as biofilms and plaques where a multitude of bacteria "team up" and dominate infected areas of the body to the detriment of bodily function. In order for bacteria to team up and become pathogenic, they utilize a system of communication known as quorum sensing. Essentially, this is like bacteria asking, "Do I have a crew?" It is a precursor to the formation of biofilms and plaques.

Rather than rely exclusively on antibiotics, the plant kingdom has developed a number of chemicals that inhibit quorum sensing. Phytochemicals including quercetin, sinensetin, apigenin, and naringenin display anti-biofilm formation activity against bacteria.



Plant tinctures.

This is an elegant solution that does not foster resistance the way that antibiotics do. Phytochemicals with anti-quorum sensing activity merely inhibit the ability of potentially dangerous bacteria to enter into a disease-causing state, thus rendering them virtually harmless.

Not all herbalists view plants in the strictly functionalist terms I describe above. Many consider the spiritual, ceremonial, and emotional powers of plants, and the cultural practices associated with them, to be of equal or greater importance. Certainly this is true of many Indigenous medicine practices, and this way of interacting with plants deserves acknowledgment and respect.

Ultimately, herbalists are healing internal terrain using plants, and restoration practitioners are healing external terrain using plants. For ecological restorationists, herbal medicine can serve as a metaphor and an outside reference point. It is a mirror for what we might strive to do in the best ecological restorations, which is to support an ecosystem's ability to heal itself, possibly even with some plant medicine of our own. We benefit from cross-disciplinary conversations.