In the Shadow of Red Cedar

Wade Davis

In the shadow of red cedar, along a stream colored by salmon, in a place where plants draw food from the air and small creatures living on dew never touch the forest floor, it is difficult to imagine a time when the coastal temperate rainforests of North America did not exist. Today, these immense and mysterious forests, which in scale and wonder dwarf anything to be found in the tropics, extend in a vast arc from northern California 2,000 miles north and west to the Copper River and the Gulf of Alaska. Home to myriad species of plants and animals, a constellation of life unique on earth, they spread between sea and mountain peak, reaching across and defying national boundaries as they envelop all who live within their influence in an unrivaled frontier of the spirit.

It is a world anchored in the south by giant sequoias *(Sequoiadendron giganteum)*, the most massive of living beings, and coast redwoods *(Sequoia sempervirens)* that soar 300 feet above the fogbanks of Mendocino. In the north, two trees flourish: western hemlock *(Tsuga heterophylla)*, with its delicate foliage and finely furrowed bark; and Sitka spruce *(Picea sitchensis)*, most majestic of all, a stunningly beautiful species with blue-green needles that are salt tolerant and capable of extracting minerals and nutrients from sea spray. In between, along the silent reaches of the midcoast of British Columbia, behind a protective veil of Sitka spruce, rise enormous stands of Douglas fir *(Pseudotsuga menziesii)*. Intermingled with hemlock and fir, growing wherever the land is moist and the rains abundant, is perhaps the most important denizen of the Pacific slope, the western red cedar *(Thuja plicata)*, the tree that made possible the florescence of the great and ancient cultures of the coast.

To walk through these forests in the depths of winter, when the rain turns to mist and settles softly on the moss, is to step back in time. Two hundred million years ago vast coniferous forests formed a mantle across the entire planet. Dinosaurs evolved long supple necks to browse high among their branches. Then evolution took a great leap, and flowers were born. What made them remarkable was a mechanism of pollination and fertilization that changed the course of life on earth. In the more primitive conifers, the plant must produce the basic food for the seed with no certainty that it will be fertilized. In the flowering plants, by contrast, fertilization itself sparks the creation of the seed's food reserves. In other words, unlike the conifers, the flowering plants make no investment without the assurance that a viable seed will be produced. As a result of this and other evolutionary advances, the flowering plants came to dominate the earth in an astonishingly short time. Most conifers went extinct, and those that survived retreated to the margins of the world, where a small number of species maintained a foothold by adapting to particularly harsh conditions. Today, at a conservative estimate, there are over 250,000 species of flowering plants. The conifers have been reduced to a mere 700 species, and in the tropics, the hotbed of evolution, they have been almost completely displaced.

On all the earth, there is only one region of any size and significance where, because of particular climatic conditions, the conifers retain their former glory. Along the northwest coast of North America the summers are hot and dry, the winters cold and wet. Plants need water and light to create food. Here in the summer there is ample light for photosynthesis but not enough water for most deciduous trees, except in low-lying areas where broadleafed species such as red alder *(Alnus rubra)*, cottonwood *(Populus balsamifera* ssp. *trichocarpa)*, and vine maple *(Acer circinatum)* flourish. In the winter, when

Western red cedar and hemlock in Stoltmann Wilderness, British Columbia.

both water and light are sufficient, the low temperatures cause the flowering plants to lose their leaves and become dormant. The evergreen conifers, by contrast, are able to grow throughout the long winters, and since they use water more efficiently than broadleafed plants, they also thrive during the dry summer months. The result is an ecosystem so rich and so productive that the biomass in the best sites is easily four times as great as that of any comparable area of the tropics.

Indeed it is the scale and abundance of the coastal rainforests that overwhelm the visitor. White pine *(Pinus strobus)*, the tallest tree of the eastern deciduous forests, barely reaches two hundred feet; in the coastal rainforests there are thirteen species that grow higher, with the redwoods reaching nearly four hundred feet, taller than a twenty-five-story building. Red cedars can be twenty feet or more across at the base. The footprint of a Douglas fir would crush a small cabin. The trunk of a western hemlock, a miracle of biological engineering, stores thousands of gallons of water and supports branches festooned with as many as 70 million needles, all capturing the light of the sun. Spread out on the ground, the needles of a single tree would create a photosynthetic surface ten times the size of a football field.

These giant trees delight, but the real wonder of the forest lies in the details, in the astonishingly complex relationships: a pileated woodpecker living in the hollow of a snag, tiny seabirds laying their eggs among the roots of an ancient cedar, marbled murrelets nesting in a depression in the moss in the fork of a canopy tree, rufous hummingbirds returning each spring, their migrations timed to coincide with the flowering of salmonberries *(Rubus spectabilis)*. In forest streams dwell frogs with tails and lungless salamanders that live by absorbing oxygen through their skin. Strange amphibians, they lay their eggs not in water but on land, in moist debris and fallen logs.

Invertebrate life is remarkably diverse. The first survey to explore systematically the forest

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Vine maples, Acer circinatum, *near Lake Mills, Washington.*

Mossy branches of bigleaf maple, Acer macrophyllum, *Olympic Peninsula, Washington.*

earth, feeding, digesting, reproducing, and dying.

None of these creatures, of course, lives in isolation. In nature, no event stands alone. Every biological process, each chemical reaction, leads to the unfolding of other possibilities for life. Tracking these strands through an ecosystem is as complex as untangling the distant threads of memory from a myth. For years, even as industrial logging created clearcuts the size of small nations, the coastal rainforests were among the least studied ecosystems on the planet. Only within the last decade or two have biologists begun to understand and chart the dynamic forces and complex ecological relationships that allow these magnificent forests to exist.

One begins with wind and rain, the open expanse of the Pacific and the steep escarpment of mountains that makes possible the constant cycling of water between land and sea. Autumn rains last until those of spring, and months pass without a sign of the sun. Sometimes the rain falls as mist, and moisture is raked from the air by the canopy of the forest. At other times the storms are torrential, and daily precipitation is measured in inches. The rains draw nutrients from the soil, carrying vital food into rivers and streams that fall away to the sea and support the greatest coastal marine diversity on earth. In the estuaries and tidal flats of British Columbia, in shallows that merge with the wetlands, are six hundred types of seaweed, seventy species of sea stars. Farther offshore, vast, underwater kelp forests shelter hundreds of forms of life, which in turn support a food chain that reaches into the sky to nourish dozens of species of seabirds.

The land provides for life in the sea, but the sea in turn nurtures the land. Birds deposit

canopy in the Carmanah Valley of Vancouver Island yielded 15,000 species, a third of the invertebrates known to exist in all of Canada. Among the survey's collections were 500 species previously unknown to science. Life is equally rich and abundant on the forest floor. There are 12 species of slugs, slimy herbivores that in some areas account for as much as seventy percent of the animal biomass. A square meter of soil may support 2,000 earthworms, 40,000 insects, 120,000 mites, 120,000,000 nematodes, and millions upon millions of protozoa and bacteria, all alive, moving through the excrement in the moss, yielding tons of nitrogen and phosphorus that are washed into the soil by winter rains. Salmon return by the millions to their native streams, providing food for eagles and ravens, grizzly and black bears, killer whales, river otters, and more than twenty other mammals of the sea and forest. Their journey complete, the sockeye and coho, chinooks, chums, and pinks drift downstream in death and are slowly absorbed back into the nutrient cycle of life. In the end there is no separation between forest and ocean, between the creatures of the land and those of the sea. Every living thing on the raincoast ultimately responds to the same ecological rhythm. All are interdependent.

The plants that dwell on land nevertheless face particular challenges, especially that of securing nutrients from thin soils leached by rain throughout much of the year. The tangle of ecological adaptations that has evolved in response is nothing short of miraculous. As much as a fifth of the biomass in the foliage of an old-growth Douglas fir, for example, is an epiphytic lichen, *Lobaria oregana,* which fixes nitrogen directly from the air and passes it into the ecosystem. The needles of Sitka spruce absorb phosphorus, calcium, and magnesium, and their high rate of transpiration releases moisture to the canopy, allowing the lichens to flourish.

On the forest floor thick mats of sphagnum and other mosses filter rainwater and protect the mycelia of hundreds of species of fungi; these elements form one of the richest mushroom floras on earth. Mycelia are the vegetative phase of a fungus, small hairlike filaments that spread through the organic layer at the surface of the soil, absorbing food and precipitating decay. A mushroom is simply the fruiting structure, the reproductive body. As the mycelia grow, they constantly encounter tree roots. If the species combination is the right one, a remarkable biological event unfolds. Fungus and tree come together to form mycorrhizae, a symbiotic partnership that allows both to benefit. The tree provides the fungus with sugars created from sunlight. The mycelia in turn enhance the tree's ability to absorb nutrients and water from the soil. They also produce growth-regulating chemicals that promote the production of new roots and enhance the immune system. Without this union, no tree could thrive. Western hemlocks are so dependent on mycorrhizal fungi that their roots barely pierce the surface of the earth, even as their trunks soar into the canopy.

The story only gets better. All life requires nitrogen for the creation of proteins. Nitrates, a basic source, are virtually absent from the acidic, heavily leached soils of the rainforest. The mycorrhizae, however, contain not only nitrogen-fixing bacteria that produce this vital raw material but also a yeast culture that promotes the growth of both the bacteria and the fungus. There are scores of different mycorrhizae—the roots of a single Douglas fir may have as many as forty types—and, like any other form of life, the fungus must compete, reproduce, and find a means to disperse its spore. The fruiting body in many cases is an underground mushroom or a truffle. When mature, it emits a pungent odor that seeps through the soil to attract rodents, flying squirrels, and red-backed voles, delicate creatures that live exclusively on a refined diet of truffles. As the voles move about the forest, they scatter droppings, neat little bundles of feces that contain yeast culture, fungal spores, and nitrogen-fixing bacteria—in short, all that is required to inoculate roots and prompt the creation of new mycorrhizae.

Fungi bring life to the forest both by their ability to draw nutrients to the living and by their capacity to transform the dead. In old-growth forests twenty percent of the biomass—as much as six hundred tons per hectare—is retained in fallen debris and snags. There is as much nutrition on the ground as there is within it. The moss on the forest floor is so dense that virtually all seedlings sprout from the surface of rotting stumps and logs, which may take several hundred years to decay.

When a tree falls in the forest, it is immediately attacked by fungi and a multitude of insects. The wood provides a solid diet of carbohydrates. To secure proteins and other nutrients, the fungi deploy natural antibiotics to kill nitrogen-fixing bacteria. Chemical attractants emitted by the fungi draw in other prey, such as nematode worms, which are dispatched with exploding poison sacs and an astonishing arse-

Western red cedar near Port Angeles, Washington.

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Douglas firs at sunrise.

nal of microscopic weapons. The assault on the log comes from many quarters. Certain insects, incapable of digesting wood directly, exploit fungi to do the work. Ambrosia beetles, for example, deposit fungal spores in tunnels bored into the wood. After the spores germinate, the tiny insects cultivate the mushrooms on miniature farms that flourish in the dark.

In time other creatures appear—mites and termites, carpenter ants that chew long galleries in the wood and establish captive colonies of aphids that produce honeydew from the sap of plants. Eventually, as the log progresses through various stages of decay, other scavengers join the fray, including those that consume white cellulose, turning wood blood-red and reducing the heartwood to dust. An inch of soil may take a thousand years to accumulate. Organic debris may persist for centuries. Dead trees are the life of the forest, but their potential is realized only slowly and with great patience.

This observation leads to perhaps the most extraordinary mystery of all. Lush and astonishingly prolific, the coastal temperate rainforests are richer in their capacity to produce the raw material of life than any other terrestrial ecosystem on earth. The generation of this immense natural wealth is made possible by a vast array of biological interactions so complex and sophisticated as to suggest an evolutionary lineage drifting back to the dawn of time. Yet all evidence indicates that these forests emerged only within the last few thousand years. In aspect and species composition they may invoke the great coniferous forests of the distant geologic past, but as a discrete and evolving ecosystem the coastal temperate rainforests are still wet with the innocence of birth.

Some twenty thousand years ago, what is today British Columbia was a place of turmoil and ice. The land was young, unstable, given to explosive eruptions that burst over the shore. A glacial sheet more than 6,000 feet deep covered the interior of the province, forging mountains and grinding away valleys as it moved over the land, determining for all time the fate of rivers. On the coast, giant tongues of ice carved deep fjords beneath the sea. The sea levels fell by 300 feet, and the sheer weight of ice depressed the shoreline to some 750 feet below its current level. Fourteen thousand years ago, an instant in geologic time, the ice began to melt, and the glaciers retreated for the last time. The ocean invaded the shore, inundating coastal valleys and islands. But the land, freed at last of the weight of eons, literally sprang up. Within a mere one thousand years, the water drained back into the sea, and the coastline became established more or less as it is today.

Only in the wake of these staggering geological events did the forests come into being. At first the land was dry and cold, an open landscape of aspen and lodgepole pine *(Pinus contorta).* Around ten thousand years ago, even as the first humans appeared on the coast, the air became more moist and Douglas fir slowly began to displace the pine. Sitka spruce flourished, though hemlock and red cedar remained rare. Gradually the climate became warmer, with long seasons without frost. As more and more rain fell, endless banks of clouds sheltered the trees from the radiant sun. Western hemlock and red cedar expanded their hold on the south coast, working their way north at the expense of both fir and Sitka spruce.

For the first people of the raincoast, this ecological transition became an image from the dawn of time, a memory of an era when Raven slipped from the shadow of cedar to steal sunlight and cast the moon and stars into the heavens. Mythology enshrined natural history, for it was the diffusion of red cedar that allowed the great cultures of the Pacific Northwest to emerge. The nomadic hunters and gatherers who for centuries had drifted with the seas along the western shores of North America were highly adaptive, capable of taking advantage of every new opportunity for life. Although humans had inhabited the coast for at least five thousand years, specialized tools first appear in the archaeological record around 3000 B.C., roughly the period when red cedar came into its present dominance in the forests. Over the next millennium, a dramatic shift in technology and culture occurred. Large cedar structures were in use a thousand years before the Christian era. A highly distinct art form developed by 500 B.C. Stone mauls and wooden wedges, obsidian blades and shells honed to a razor's edge allowed the highly durable wood to be worked into an astonishing array of objects, which in turn expanded the potential of the environment.

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In Oregon and Washington only ten percent of the original coastal rainforest remains. In California only four percent of the redwoods have been set aside. In British Columbia, roughly sixty percent has been logged, largely since 1950. In the last two decades, over half of all timber ever extracted from the public forests of British Columbia has been taken. At current rates of harvest, roughly 1.5 square miles of old growth per day, the next twenty years will see the destruction of every unprotected valley of ancient rainforest in the province.

In truth, no one really knows what will happen to these lands once they are logged. Forests are extraordinarily complex ecosystems. Biologists have yet to identify all of the species, let alone understand the relationships among them. Although we speak with unbridled confidence of our ability to reproduce the ecological conditions of a forest and to grow wood indefinitely, there is no place on earth that is currently cutting a fourth generation of timber on an industrial scale. The more imprecise a science, the more dogmatically its proponents cling to their ability to anticipate and predict phenomena.

Forestry as traditionally practiced in the Pacific Northwest is less a science than an ideology, a set of ideas reflecting not empirical truths, but the social needs and aspirations of a closed group of professionals with a vested interest in validating its practices and existence. The very language of the discipline is disingenuous, as if conceived to mislead. The "annual allowable cut" is not a limit never to be exceeded but a quota to be met. The "fall down effect," the planned decline in timber production as the old growth is depleted, is promoted as if it were a natural phenomenon when it is in fact a stunning admission that the forests have been drastically overcut every year since modern forestry was implemented in the 1940s. "Multiple-use forestry"—which implies that the forests are managed for a variety of purposes, including recreation, tourism, and wildlife—begins with a clearcut. Old growth is "harvested," though it was never planted and no one expects it to grow back. Ancient forests are "decadent" and "overmature," when by any ecological definition they are at their richest and most biologically diverse state.

The most misleading of these terms is "sustained yield," for it has led the public to believe that the trees are growing back as fast as they are being cut. But they are not. In British

Columbia alone there are 8.7 million acres of insufficiently restocked lands. We continue to cut at a rate of 650,000 acres per year. Every year 2.5 million logging-truck loads roll down the highways of the province. Lined up bumper to bumper, they would encircle the earth twice. In practice, sustained-yield forestry remains an untested hypothesis: after three generations we are still cutting into our biological capital, the irreplaceable old-growth forests. As a scientific concept, sustained yield loses all relevance when applied to an ecological situation the basic parameters of which remain unknown. At best, sustained yield is a theoretical possibility; at worst, a semantic sleight of hand, intended only to deceive.

Anyone who has flown over Vancouver Island, or seen the endless clearcuts of the interior of the province, grows wary of the rhetoric and empty promises of the forest industry. Fishermen and women become skeptical when they learn that logging has driven 142 salmon stocks to extinction and left 624 others on the brink. Timber for British Columbia mills now comes from Manitoba. Truck drivers from Quesnel, a pulp-and-paper town in the center of the province, haul loads hundreds of miles south from Yukon. Just one of the clearcuts southeast of Prince George covers five hundred square kilometers, five times the area of the city of Toronto. This, after sixty years of official commitment to sustained-yield forestry. The lament of the old-time foresters—that if only the public understood, it would appreciate what we do—falls flat. The public understands but does not like what it sees.

Fortunately, this orthodoxy is now being challenged. Many in the Pacific Northwest, including the best and brightest of professional foresters, recognize the need to move beyond, to an era in which resource decisions are truly based on ecological imperatives, in which the goal of economic sustainability is transformed from a cliché into an article of faith. To make this transition will not be easy, and it will involve much more than tinkering with the edges of an industry that generates $15.9 billion a year in the province of British Columbia alone. Dispatching delegations to Europe to reassure customers, or devising new regulations that if implemented may mitigate some of the worst ecological impacts, will neither restore the public's confidence and trust nor address the underlying challenge of transforming the economy.

Any worker who has wielded a saw or ripped logs from a setting knows that in the end it all comes down to production. The enormous wealth generated over the last fifty years has been possible only because we have been willing to indulge egregious practices in the woods that have little to do with the actual promise of forestry. Spreading clearcuts ever deeper into the hinterland is a policy of the past, crude and anachronistic, certain to lead to a dramatic decline in the forestry sector and to bitterness and disappointment in the communities that rely upon the forests for both spiritual and material well-being. Revitalizing cutover lands with vibrant tree plantations, implementing intensive silviculture to increase yields, establishing the finest model of forest management on a finite land base—these are initiatives that will both allow communities to prosper and enable them to fulfill a moral obligation to leave to the future as healthy an environment as the one they inherited.

There is no better place to pursue a new way of thinking than in the temperate rainforests of the coast. At the moment, less than six percent has been protected; the remainder is slated to be logged. If anything, this ratio should be reversed. We live at the edge of the clearcut; our hands will determine the fate of these forests. If we do nothing, they will be lost within our lifetimes, and we will be left to explain our inaction. If we preserve these ancient forests, they will stand for all generations and for all time as symbols of the geography of hope. They are called old growth not because they are frail but because they shelter all of our history and embrace all of our dreams.

Wade Davis is an ethnobotanist and prolific writer. This article is excerpted from his most recent book, *Shadows in the Sun: Travels to Landscapes of Spirit and Desire*, published by Island Press/Shearwater Books (1.800.828.1302 or www.islandpress.org).

Photographer Graham Osborne specializes in alpine and coast subjects. The photographs in this article and on the covers have been published in his book *Rainforest*, published by Chelsea Green, Vermont.