for the beauty of the earth

a christian vision for creation care

second edition

steven bouma-prediger

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For the Beauty of the Earth

For the beauty of the earth,
For the beauty of the skies,
For the love which from our birth,
Over and around us lies,
Lord of all, to thee we raise,
This, our hymn of grateful praise.

For the wonder of each hour,
Of the day and of the night,
Hill and vale and tree and flower,
Sun and moon and stars of light,
Lord of all, to thee we raise,
This, our hymn of grateful praise.

For the joy of ear and eye,
For the heart's and mind's delight,
For the mystic harmony,
Linking sense to sound and sight,
Lord of all, to thee we raise,
This, our hymn of grateful praise.

For the joy of human love,
Brother, sister, parent, child,
Friends on earth and friends above,
For all gentle thoughts and mild,
Lord of all, to thee we raise,
This, our hymn of grateful praise.

For thy Church that evermore,
Lifteth holy hands above,
Off'ring up on ev'ry shore,
Her pure sacrifice of love,
Lord of all, to thee we raise,
This, our hymn of grateful praise.

Folliott S. Pierpoint

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introduction

ecology and theology in dialogue

> Any error about creation also leads to an error about God.
>
> Thomas Aquinas[1]

"What does ecology have to do with theology?" Andrew asked, as I finished going over the course syllabus. Along with the standard fare of subjects usually found in a philosophical theology class—arguments for God's existence, the nature of religious experience, evidence for and against miracles, the problem of evil and human suffering—I had included ecology as one of the topics to be covered in a summer school course I was teaching at a seminary in California. This student (and many others, I was soon to discover) wondered what such a topic had to do with this class. What do sandhill cranes and chinook salmon have to do with God? What possible relevance does ecology have for Christian theology?

Susan's hand shot up in the air like fireworks on the Fourth of July in response to my question to the undergraduates in my Earth and Ethics course, "Who among you agrees with Wendell Berry's assertion that 'Our destruction of nature is not just bad stewardship, or stupid economics, or a betrayal of family responsibility; it is the most horrid blasphemy'?"[2] While Susan was persuaded that Berry was correct in his first three claims, she was certain he was wrong in his last. Our despoilation of creation was not, she strenuously argued, "the most horrid blasphemy." After Susan stated her case, others entered the fray to express their disagreement with Berry's seemingly outrageous claim. How can Berry assert that polluting a stream is worse than killing another human being or cursing God? Theologically speaking, what is so wrong with ecological degradation?

"How many of you have in the last year heard a sermon on stewardship?" This was my question to a group of thirty adults in a Sunday school class I was guest teaching at a local church. While I suspected I already knew the answer, I was genuinely curious about what my informal poll would reveal. Many people raised their hands to indicate they had heard such a sermon, but when I inquired about the specific content, it became clear that the message had been on tithing and had nothing to do with caring for the natural world. I already knew from previous discussions that most of the people in the class were avid gardeners, walked wherever they could, and bought produce at the local farmers' market. But they engaged in these activities, it seemed, not because of any explicit theological rationale but for other reasons. What connection, their responses implied, is there between caring for the earth and Christian faith? What has stewardship to do with earthkeeping?

These three anecdotes prompt a number of questions. Why did the seminary students so readily assume that attention to the earth is not a proper concern of Christian theology? The students were steeped in theology, but their theological convictions had no apparent connection to the earth. Why did the college students—persuaded that degradation of the natural world is a serious economic, ecological, and ethical issue—not attribute any theological relevance to their views of nature? These students had ecological awareness aplenty but saw no relationship between their ecological commitments and theological categories. Finally, why did the folks in the Sunday school class, who in fact engaged in various earth stewardship practices, not explain their actions in terms of their faith? These earthkeepers perceived little relationship between their behavior and their basic religious beliefs. In sum, why do many people see little, if any, connection between ecology and theology?

In this book I intend to explore these questions by putting contemporary ecology (broadly construed) and Christian theology into dialogue. But this endeavor is more than a dialogue. It sets forth a thesis. It is, to be honest, a piece of rhetoric in the classical sense of the term. I mean in these pages not only to inform but to persuade. My central claim is simple: authentic Christian faith includes care for the earth. Earthkeeping is integral to Christian discipleship.

As the epigraph at the beginning of this chapter implies, much is at stake. Other luminaries in the Christian tradition could be cited, but St. Thomas Aquinas puts it succinctly: "Any error about creation also leads to an error about God." If we do not properly understand our home planet, we will not properly understand the nature and character of the God we worship and claim to serve. Nothing less than our understanding of God is at stake. There is, in other words, an inner theological rationale for attending to the blue-green planet we inhabit with its plethora of other earth-creatures.

But more is at stake. The earth is groaning, to use St. Paul's metaphor from Romans 8. As chapter 2 lays out in agonizing detail, the world in which we live is not doing well. Its vital signs are not healthy. This includes a great many

humans—humans who are hungry, sick, homeless. So human health and flourishing, as well as that of our many nonhuman neighbors, is at stake. The health of all earth-dwellers is at stake if we humans don't properly understand our place and calling in God's scheme of things. This leads to one more thing that is at stake: how we comprehend who we are and what we are supposed to do. Our own individual and collective self-understanding is at stake—in summary, how we understand God, the world, and ourselves.

The conversation and argument that follow are divided into eight chapters. Since I am convinced that much of our current malaise stems from not knowing our place, chapter 1 answers the question: where are we? In this stage of the dialogue, ecology has its say as we strive to increase what David Orr calls our "ecological literacy."[3] Do we really know our place? And what can we learn from our home planet? A survey of the current state of the planet follows in chapter 2: How goes it with earth, air, water, and fire? And what about claims by those who say that things aren't so bad? Amid the welter of data, where lies the truth?

The conclusion of many responsible earth-watchers is that the earth is not doing very well. A wealth of evidence supports the claim that creation is indeed groaning. Chapter 3 explores why this is so. More exactly, I address the claim that Christianity is the culprit—that the Christian tradition is the reason we are in this ecological mess. In dealing with what James Nash calls "the ecological complaint against Christianity,"[4] I sort out what is right and what is wrong. And I offer (ever so briefly) an alternative explanation for what ails us. As a number of perceptive historians conclude, while we Christians have much to confess, the real answers to the question of the origin of our ecological sins lie elsewhere.

For Christians, especially evangelical Christians, the Bible plays a central role in theological reflection—indeed, in all of life. We are people of the book. Is the Bible the problem, as some assert? Or are there ecological riches and resources in Scripture, if only we have the eyes to see? For example, with whom does God make a covenant (Gen. 6–9)? Who is at the center of things (Job 38–41)? What does God's good future look like (Rev. 21–22)? Chapter 4 addresses these questions and more. My central claim is that, properly understood, the Bible is not the problem but rather contains great wisdom and a winsome vision of the earth as our home and of humans as earthkeeping homemakers.[5]

How then should we think of the earth and its creating-redeeming God? What are the main tenets of an ecological theology informed by science and guided by Scripture? In chapter 5, I set forth an evangelical theology of care for the earth. More than merely a theology of creation, an ecological theology addresses the whole range of traditional topics in theology. I also lay out in this chapter a spectrum of different perspectives in ecological ethics, since many theories exist and sorting them out is not easy, and I indicate which overarching

ethical position from among these views is, in my estimation, most adequate and why.

Chapter 6 gives much fuller attention to ethics. Indeed, in it I develop my own ecological ethic. In contrast to much contemporary environmental ethics, my conviction is that a more fundamental question than, what ought we do? is, who must we be? More precisely, what kind of people ought we be in order to be faithful earthkeepers? What virtues ought we embody and need we enflesh to properly bear witness to the hope that lies within us? Phrasing the question this way directs attention to what I and others call "ecological virtues." This chapter zeros in on this important issue.

When all is said and done, why care for the earth? Why worry about spotted owls and the Pacific yew tree? Why care about Kirtland's warblers and jack pine forests? Why be concerned for marmots and mountains and meadows? Chapter 7 presents an apologia for earth-care. More exactly, I offer ten arguments—moving from prudence to piety—for why people, especially Christians, ought to care for our home planet, this blue-green orb called earth.

As Aldo Leopold perceptively noted, "one of the penalties of an ecological education is that one lives alone in a world of wounds."[6] While many would challenge the claim that we ever really live alone, few these days would question the truth about living in a wounded world. To become ecologically literate is to open yourself to seeing and feeling the woundedness of the world. To lament the loss of that aged oak. To ache over a stream despoiled. To grieve over what is now gone—the Santa Barbara song sparrow and the solace of open spaces. In such a world, where is there hope? If one is a Christian, for what and in whom does one hope? I reflect on these questions in the concluding chapter.

I stated above that this book sets forth a thesis and contains an argument. But arguments, while important, have their limits. The best apologetic, as the venerable St. Augustine stated centuries ago, is a life well lived.[7] Or as one more recent theologian put it: "A believer is an evangelist primarily by who he is and how he lives—not by what he says. What he says is important; but unless his speaking tallies with what he is and does, he had better keep quiet."[8] Each of these theologians rightfully reminds us that the goal of theology is eminently practical—wisdom in living well. I intend for such a goal to infuse this entire work. Whether I realize this intention, only you the reader can judge.

A word about terminology: This is not a book about "the environment." While the term "environment" is for many the term of choice, it is not without its problems. For starters, it is abstract, lacking the concreteness of marmot or mountain or meadow. Few people describe where they live by speaking of their "environment." Furthermore, it suggests something that we live in but that is apart from us, rather than the home we inhabit and of which we are an integral part. In other words, it connotes a disjunction between human and nonhuman that is simply not true to the way things are. We do not exist over against something called "the environment." Finally, the term "environment" is

sterile. It fails to capture the plethora of creatures in dynamic interaction that is the natural world. The term "environment" is, in short, too tame.

Nor is this a book about "nature." As a number of scholars have argued, and as I have argued elsewhere,[9] the term "nature" all too often denotes something over against culture or history, as if humans are not a part of the natural world and as if nonhuman creatures have no history. We often assume, in other words, that "nature" excludes us—an often fatal presumption. In addition, for many the term "nature" implies a God-less universe, a cosmos for which there is no maker, whereas the term "creation" implies a Creator, a claim at the very heart of Christian faith and one very few Christians would be willing to give up. The term "nature," in sum, is too secular.

Nor, finally, is this a book about "creation." Though a much better term than "environment" or "nature," "creation" is, nevertheless, also problematic. As Christopher Kaiser insightfully points out, biblically the term "creation" includes everything except God: angels, humans, other creatures both celestial and terrestrial.[10] To speak of caring for creation, as many do, thus literally implies concern for angels, and for our moon, and for the constellation Draco, whatever that might mean. Does God really expect us to care about things distant in the cosmos? Does God expect us to care for all the heavenly host? Thus "creation" takes in too much. Unless it is delimited (as it often de facto is) to mean something like the terrestrial world—the seas, the land, the lower atmosphere, and all their inhabitants—it is too expansive and all-encompassing. The term "creation" is, then, too broad.

This book is about "the earth." The term "earth" is not abstract; it is concrete, denoting both the planet on which we live and the very stuff of which we are made. "Earth" does not imply that we humans are somehow separate from or above what is not human (nor does it necessarily imply that we humans are only so much oxygen and nitrogen and calcium); it includes us with all the other inhabitants of our spinning globe. "Earth" does not promote an unhealthy dualism of culture over against nature; creatures human and nonhuman together inhabit this one home planet. "Earth" does not carry a presumption of atheism; it can easily be seen as the work of God's hands. "Earth" does not refer to angels or stars or pulsars; it includes only that part of creation sometimes called the biosphere. "Earth" is anything but a sterile term. This book is about the earth—the earth God created and continues to lovingly sustain and redeem and will one day make whole—and it is about our responsibility and privilege as humans to care for the earth.

"What does ecology have to do with theology?" my student asked. Many today pose, in one form or another, this very same question. Pioneering ecological theologian Joseph Sittler, whose eloquence and insight on these matters remain unsurpassed, years ago offered his answer to this important and timely question. His hard but honest words fittingly conclude this introduction and launch us on our journey into chapter 1.

When we turn the attention of the church to a definition of the Christian relationship with the natural world, we are not stepping away from grave and proper theological ideas; we are stepping right into the middle of them. There is a deeply rooted, genuinely Christian motivation for attention to God's creation, despite the fact that many church people consider ecology to be a secular concern. "What does environmental preservation have to do with Jesus Christ and his church?" they ask. They could not be more shallow or more wrong.[11]

1

where are we?

an ecological perception of place

> An individual is not distinct from his place; he is that place.
>
> Gabriel Marcel[1]

What do you remember from your childhood about the earth? What from your growing-up years comes most to mind when you think about the natural world? Perhaps you remember your family flower garden—daffodils, geraniums, impatiens, petunias. Or maybe it is the vegetable garden—sweet corn, string beans, radishes, lettuce, rhubarb. Or maybe it is playing in the local creek—looking for tadpoles, stalking salamanders, catching crayfish. Or maybe you remember walks in the local park or swinging under the shade trees in the school playground down the street.

What animals come to mind? Pet dog Fido or cat Florence? Horses or chickens or pigs? A turtle or a parakeet or a snake? Deer (or its scat), skunk (or its smell), raccoon (or its print)? Or do you remember a particular tree: sap-rich white pine, scaly sycamore, white-bark birch, bent-topped hemlock, towering maple or oak or beech?

Or maybe what you remember are the seasons. The sweet scent of spring—that freshness of early April when the breathing earth sucks in carbon dioxide and exhales oxygen for us, the days that grow slowly longer, the night rains that wash our fields and sidewalks and souls. The lushness and fullness of summer—freshly cut grass, swimming in the local lake or pond or pool, family camping

trips at Ludington or Yellowstone or Grandma's backyard. The waning light of autumn—a crisp chill in the October air, dead leaves, cold rain, and the first flakes of snow. The wonder of winter—short days, frosted windows, snowdrifts covered with footprints and snow angels and animal tracks.

But, alas, these are, by and large, memories from the American upper Midwest.

If you grew up in another part of North America, maybe in your mind's eye you see southern magnolia, or feel a Pacific silver fir, or smell the delicious vanilla-cinnamon aroma of ponderosa pine. Or perhaps your memories include sighting California condors, or catching Mississippi catfish, or swatting the Minnesota state bird—the mosquito. Or maybe you hear the crash of the North Sea surf, or the trickle of a meadow stream high up in the Alps, or the cry of howler monkeys in the muggy Belizean night. In your mind's eye right now, what do you remember? What do you see and hear, smell and taste and feel?

But these are memories of places rural and wild. Most of us these days grow up and live in cities and towns. So perhaps what you hear is the cooing of mourning doves or the caw-caw-caw of crows in the treetops. Maybe what you see are blue jays at the feeder or an opossum dead by the side of the road. Even in large cities you may smell a skunk or spy a falcon roosting atop a skyscraper. Such urban memories, like their country cousins, attest to at least some knowledge of and feeling for particular places. And these remembrances point to the power of place in shaping who we are and how we see the world. As Spanish philosopher Jose Ortega y Gasset famously put it, "Tell me the landscape in which you live and I will tell you who you are."[2]

Such musings, furthermore, prompt the following questions: Do we know our place? Do we know where we are? What exactly does that mean? And what might greater knowledge of place mean for how and why we care for the earth? Or put differently, could it be that contemporary ecological degradation is a result, in part, of us not knowing our places, our own local habitats on this our home planet? All too often, I fear, we do not know our places, and such ignorance contributes to the ecological despoilation we see today. Precisely what the nature and extent of that degradation is will be discussed in the next chapter. Here our focus is on places and what we can learn about ourselves and the earth if we attend with care to what is around us.

Ecological Perception of Place

Do you know where you are? Certainly you can state that you are on 12th Street or 10th Avenue, in Lansing or Lincoln or Los Angeles, in Oregon or Ontario, in the United States or the United Kingdom or the United Arab Emirates. But ecologically speaking, do you know where you are? In a more than geopolitical

sense, do you know where you are? What is your ecological perception of place? Some questions might help us gauge our awareness of where we are.

What is the soil like around your home? Silty loam? Loamy sand? Sandy clay? Rocks and pebbles? Wet or dry? A few precious inches of soil atop ancient Canadian shield, or eighteen inches of rich, fertile gardener's gold? What are five agricultural plants in your region? Corn, wheat, alfalfa, beans, sorgum? Or maybe grapes or cherries or oranges? And how long is the growing season? A precious few weeks? Or all year long? What geological events or processes have influenced the land where you live? Glaciers, volcanoes, earthquakes? Uplifting mountains or rivers carving canyons to the sea? What confluence of water and wind?

What trees live where you do? Sitka spruce or Douglas fir, bald cypress or incense cedar, Norway maple or American chestnut? Northern white cedar or western hemlock, Ohio buckeye or California live oak, beech or basswood or birch? Desert mesquite or water-loving cottonwood? Young upstart poplar or ancient bristlecone pine? What about birds, resident and migratory? The common loon or the uncommon meadowlark? Mallard or merganser? House finch or goldfinch? A goose with a gaggle or a murder of crows? Yellow-bellied sapsucker or white-crested warbler? Bluebird or blackbird or redheaded woodpecker? Kingfisher or cormorant or sandhill crane? What raptors roam the skies above your house? Osprey, northern harrier, red-tailed hawk? What owls dine at night? Barred owl, barn owl, burrowing owl?

What flowers bloom where you live? Poppies or peonies? Tiger lilies or tulips? Daisies or daffodils? Crocus or columbine? Bird-of-paradise or star-of-Bethlehem? What animals share your place? Long-tailed weasel or white-tailed deer? Grey wolf or red fox? Alligator or armadillo? Manatee or marmot or moose? Which animals are extinct in your neck of the woods? Wolverine, grizzly bear, passenger pigeon, prairie dog?

How many days until the moon is full? And what kind of moon is it: waxing or waning, crescent or gibbous? Were the stars out last night? If so, what constellations did you see? When did it last rain or snow or sleet or hail? From where you are reading this, which way is north? From what direction do the prevailing winds blow? From where does your water come? To where does your garbage go?

These questions test our knowledge of our place. And they all too often, truth be told, expose our ecological ignorance. To face such a battery of questions forcibly reminds us of how little we know about the world and how it works. Do we know our place? Do we know the natural history of the land? Do we know its flora and fauna? And perhaps most importantly, do we know how what we do affects the world around us?

If the answer to these questions is "no," then we really do not know where we are. Despite our education we remain ecologically illiterate. Or perhaps because of our education we remain ignorant of how the world works. As Aldo Leopold

perceptively puts it: "One of the requisites for an ecological comprehension of land is an understanding of ecology, and this is by no means co-extensive with 'education'; in fact, much higher education seems deliberately to avoid ecological concepts."[3] Contemporary environmental activist and culture critic David Orr agrees. In no uncertain terms he presents the challenge ahead.

> The crisis of sustainability, the fit between humanity and its habitat, is manifest in varying ways and degrees everywhere on earth. It is not only a permanent feature on the public agenda; for all practical purposes it is *the* agenda. No other issue of politics, economics, and public policy will remain unaffected by the crisis of resources, population, climate change, species extinction, acid rain, deforestation, ozone depletion, and soil loss. Sustainability is about the terms and conditions of human survival, and yet we still educate at all levels as if no such crisis existed.[4]

Hence, we desperately need, according to Orr, increased ecological literacy. Just as we educate for numeracy, or the ability to calculate, and literacy, or the ability to read, so also we must educate for the ability to understand how the world works—"ecolacy," as famous biologist Garrett Hardin calls it. Like Orr, Hardin argues that such a mental filter or way of viewing the world is absolutely essential if we are to live responsibly and wisely.[5]

But what exactly is ecolacy? What does it mean to be ecologically literate? In a clear and compelling account, Orr argues that the essence of ecological literacy is "that quality of mind that seeks out connections."[6] In contrast to the narrow specialization that characterizes so much education today—across virtually all the academic disciplines—an ecological frame of mind seeks to integrate, to bring together, to see things whole. In Orr's words, "The ecologically literate person has the knowledge necessary to comprehend interrelatedness, and an attitude of care or stewardship," and this must be accompanied by "the practical competence required to act on the basis of knowledge and feeling." Hence "knowing, caring, and practical competence constitute the basis of ecological literacy."[7] Not only must we know; we must care. And not only must we care, but we must have the wherewithal to act responsibly, informed by such knowledge and passion.

But concretely what does this mean? If we are truly to know our place, what do we need to learn? Orr offers a list of five necessary components of seeing things whole. First, we need "a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably."[8] This presumes knowledge of how the world as a biophysical system works—knowledge of keystone species and succession, entropy and energy flow, niches and food chains. Ecological literacy, in short, implies a modicum of knowledge about the inextricable interconnectedness of all creatures great and small.[9]

Second, we need to know "something of the speed of the crisis that is upon us."[10] While some would argue that "crisis" is too strong a term, the preponderance of evidence suggests otherwise.[11] Hence, we need to know the vital signs of our home planet—the trends concerning population growth and climate change, soil loss and species extinction, deforestation and desertification, energy use and air pollution.[12] A prescription is only as good as the diagnosis on which it is based. Our attempts to achieve wellness must, therefore, be based on a sober and honest assessment of the health of the earth.

Third, ecological literacy, according to Orr, "requires a comprehension of the dynamics of the modern world."[13] In other words, we need some understanding of the historical, political, economic, and religious forces that have molded the modern world. What social pressures have brought us to where we are today? What economic and political systems mold our everyday life? And that all too often neglected question: how has religion played a part in shaping the world in which we live? To be more specific, how did "the Columbian exchange" of 1492 and subsequent years influence both old and new worlds?[14] What was (and still is) nature's role in American history?[15] And how exactly do societies choose to fail or succeed, and what are the major contributing factors to societal collapse or flourishing?[16] In short, what ideas and forces have shaped the world in which we live?

Fourth, ecological literacy requires "broad familiarity with the development of ecological consciousness."[17] Of special importance here is explicit attention to ethics and the nature of nature. Environmental issues are laden with questions of value. Are we humans, for example, "conqueror of the land-community" or "plain member and citizen of it?"[18] Do animals or plants or endangered species or ecosystems have value, and if so, why? And how do we portray the natural world: as "red in tooth and claw," as an Edenic paradise, or neither? Whether and how we "follow nature," to use Holmes Rolston's phrase,[19] depends in large part on our idea of what it is. Is it nature or Nature or the environment or the biosphere or Creation? Are humans included in it? Is God? Ecological literacy does not require an elaborate answer to each of these questions, but it does presuppose some wrestling with issues such as these.

Fifth and finally, Orr maintains that we need "alternative measures of well-being" and "a different approach to technology."[20] For example, in contrast to the typical indicators of societal well-being, such as the Gross Domestic Product (GDP), we need more inclusive and more accurate metrics to honestly assess how our society is doing.[21] For example, the Index of Sustainable Economic Welfare (ISEW) includes the depletion of nonrenewable natural resources and the costs of water and air pollution in its calculation of overall welfare, as does the Genuine Progress Indicator (GPI), while the Weighted Index of Social Progress (WISP) includes both social and environmental conditions.[22] What all these indicators show is that while GDP has grown in the United States over the last decades, genuine well-being has not. And along with these alternative

measures of well-being we need to rethink our use of technology. The work of E. F. Schumacher, to mention only one well-known example, illustrates how technology can and must be appropriate to the scale and needs of a people and its culture.[23] Many other examples exist, almost all of which emphasize sustainability and a proper sense of place.[24]

Ecological literacy, Orr states in summary, echoing one of the central tenets of the Christian tradition, is "built on a view of ourselves as finite and fallible creatures living in a world limited by natural laws."[25] Ecological literacy, in other words, is founded upon the theological insight that we are creatures—limited and liable to error—living in a world not of our own making. Being ecologically literate, hence, ought to engender humility and a thoughtful keeping of God's earth.

Such a detailed description of ecological literacy may seem quite daunting. How is it possible to learn so much? Gain knowledge of entropy, economic history, ethics? Read Thoreau, Ehrlich, Schumacher? Build bat houses and compost bins? Surely, some may argue, such a program of "knowing, caring, and practical competence" is utterly unrealistic—a pipe dream unattainable for those paddling upstream in the powerful currents of popular culture. While it may be difficult, increasing one's ecological literacy is not as daunting, nor as dour, as it may seem. Learning more about how the world works is interesting and exciting. And it can be a joy-filled learning process in countless ways as we go about our everyday lives.[26] Regardless of difficulty, David Orr is right: "the fit between humanity and its habitat" is *the* agenda of the twenty-first century, a matter of human survival. We simply must become more ecologically literate. We have no choice.

Learning from Our Home Planet

If ecological literacy of the sort described by Orr is a desideratum of knowing where we are, how best do we gain the kinds of knowledge described above? How do we develop the ability to see things whole? How do we attain the "knowing, caring, and practical competence" required to live properly in our place? The hardest piece of this puzzle has to do with cultivating an attitude of care. Knowledge of the second law of thermodynamics and the ability to build a compost bin mean nothing without an affection for place (and the placed people) that puts that knowledge and skill to work. So one fruitful beginning point for cultivating care is reflection on specific places.

My modest strategy here is simply to focus on three places and see what can be learned about the natural world and our role in it. These places have not been randomly selected. They are, rather, places that have taught me something about how the world works and fostered in me a care-full attitude toward the earth.[27] We all have such places. As Gabriel Marcel states in the epigraph for this chapter,

in a real sense we are the places that have formed us. And more than that, we have an inbuilt love of place. To use the neologism of cultural geographer Yi-Fu Tuan, we humans exhibit topophilia.[28] Not only are we formed by places, but we have an abiding affection for places. Here are three of my favorites.

Forest

A riot of green visually greets you as you first encounter the rain forest in Belize. Shades and hues of green abound in all directions. One hundred thirty feet and more into the sky, an emergent layer of scattered trees towers above the canopy, itself sixty to ninety feet from the floor. With sunlight aplenty and a seemingly impenetrable ceiling of chlorophyll green, the canopy produces 80 percent of the forest's food. Tropical rain forests are impressive solar collectors, capturing more sunlight per unit area than any other natural ecosystem.[29] Though you can see little of it, the sunlight-bathed canopy is abuzz with a plethora of living things: flowering trees, lianas, orchids, bromeliads, not to mention bees, bats, and a profusion of birds. And of course there are larger (and more well-known) animals, such as howler monkeys and three-toed sloths.

Of the trees perhaps the most conspicuous to your eye is the cecropia or trumpet tree, with its thin, gray, circular-ringed trunk and large deeply lobed leaves spread umbrella-like above you. Growing up to eight feet a year, this pioneering tree flourishes in forest gaps where there is abundant sunlight. Living inside the stem of the cecropia are biting ants (genus *Azteca*), feeding on the nectar produced at the leaf axil, where the leaf attaches to the stem. In exchange for room and board, the ants trim the tree of vines and air plants, which would otherwise shade the cecropia and thus inhibit its growth, and also attack any intruder, whether human or nonhuman, that tries to cut or damage the tree. This is but one example of rain forest symbiosis—in this case, mutualism, a relationship between two different organisms that is mutually beneficial.

The sacred tree of the Mayans, the ceiba or kapok, also grows exceedingly fast—up to ten feet a year. What strikes you immediately about this light-loving tree is its buttressed roots—large above-ground roots flaring out in all directions from the base. With most nutrients located not in the soil but in the forest floor and litter,[30] the roots of the ceiba break through the earth and grow along the ground. Common along forest edges and river banks, the ceiba is deciduous, dropping its leaves in the dry season. A single ceiba flowers only every five to ten years, though it is capable of producing five hundred to four thousand fruit, each with two hundred or more seeds. Hence, a single ceiba tree can produce as many as eight hundred thousand seeds in one year of flowering.[31] Surrounded by silky fibers called kapok (thus the name), the seeds are easily dispersed by the wind, especially since the flowering occurs after the leaves drop. A better example of floral reproductive effectiveness would be difficult to find.

All around you see vines of various sorts. Lianas entwine the trees and hang from the crowns. Other vines, the climbers, go straight up the trunks. And still others, the stranglers, wrap themselves around the trees, often killing them. The strangler fig, for example, begins from a seed dropped by a bird or monkey into the tree crown that grows down and around the tree, eventually putting its own roots into the ground. After penetrating the forest floor, the fig sucks up much more water and grows more quickly than the tree it surrounds. Because of either constriction or shading, or both, the host tree often dies and decomposes, leaving the fig standing alone.

Perhaps most amazing among the flora of the rain forest are the epiphytes, or air plants. These plants live on trees, with no roots connecting them to the earth. They draw their nutrients from the decayed remains of algae, moss, and leaves and absorb needed moisture through their tissue from rainfall and/or via their roots from the damp air. For example, bromeliads trap water with their overlapping leaf pattern. This tiny pool of water provides not only sustenance for the plant but also habitat for mosquitoes, tree frogs, salamanders, and snails. Some species of crabs "complete their lifecycles in the tiny aquatic habitats provided by the cuplike interiors of bromeliads."[32] With roughly thirty thousand species of epiphytes in the tropics, you see them virtually everywhere, for in this Central American rain forest they constitute approximately one-quarter of the flora.[33] Neither harming nor benefiting their host, these nonparasitic plants display yet another form of symbiosis, namely, commensalism.

The canopy is dense, so dense that little sunlight filters through to the floor beneath. Even with a blazing sun in a clear sky, inside the rain forest it is dark, so dark that it is not easy to see the vibrant bird life in the understory or the various inhabitants on the forest floor. Though unable to see much, you very readily hear all manner of sounds. Indeed, the cacophony of sound is at times deafening, especially early in the morning. The cicadas provide the background music with their sawing sounds. A trogon softly calls "cow, cow, cow," while tree frogs squeak their "peep, peep, peep" and a woodpecker sounds its staccato "rap-tap-tap." On a lucky day (or more likely at the zoo) you might see the brightly colored scarlet macaw—red chest, blue and yellow tail feathers, white beak and face—or perhaps a keel-billed toucan, with its yellow throat and long banana-shaped green, orange, and red beak.

As your eyes adjust to the darkness, you notice on the ground a hairy brown lump meandering slowly away from you. As you bend down to get a better look, you recognize what it is—a tarantula. As big around from leg to opposite leg as your fist, this much-feared spider with long glistening hairs moves gracefully, even elegantly, along the litter of the forest floor. Not an aggressive or easily provoked creature, this spider is a reminder of how we often misunderstand and unfairly characterize our nonhuman neighbors.

Hunched down close to the ground, you also notice a moving line of green. Upon closer inspection you see small leaf clippings moving single file in a long

line on a well-worn highway cleared of leaves, twigs, and other debris. Carrying these clippings are leaf-cutter ants. These industrious ants are engaged in a massive gardening project, for contrary to expectation, they do not eat the leaves. Rather, they cut and carry the clippings to their underground nests, where they chew the leaves and defecate on the organic mulch before placing it on an already growing fungal bed. Once planted, the ants weed their garden of other fungi and use body secretions to suppress bacterial growth. Hence the leaf-cutter ant's other name: fungus garden ant.

This symbiotic relationship is fascinating. The ants disperse and plant the fungus, they cultivate and protect it from competing species, they supply the fungus with necessary amino acids, and they furnish the plant medium with enzymes to produce additional nitrogen. When a new queen, after twenty years or so, migrates to found a new colony, she stuffs a small bit of the precious fungus into her mouth in order to start a new garden. In short, "the ants are the expert gardeners of the insect world." The fungus, for its part, digests cellulose, an energy source that is indigestible to the ants, and so "by eating the fungus, ants can tap into the immense abundance of energy in rain forest leaves." This fungus (*Basidiomycetes*) is the ants' only food, and these ants (genus *Atta*) are the only cultivator of this fungus. Thus both ants and fungi "are totally dependent on each other."[34] A more perfect example of obligate mutualism—a relationship in which each organism is completely reliant on the other to survive—would be difficult to find.[35]

Examples of mutualism and commensalism should not mislead. Not all is sweetness and light in the rain forest. There is ample evidence of the three *p*'s: predation, parasites, and pathogens. Aggressive and poisonous pit vipers such as the fer-de-lance. Hunting wasps that lay eggs on wolf spiders, leaving the eggs to hatch into larvae, which eat the spiders alive. The inch-long bullet ant, which packs a mighty sting. Debilitating diseases such as yellow fever, malaria, and hepatitis. Internal parasites such as blood flukes and hookworms. Ingenious insects such as the botfly.[36] The forest is a complicated mix of different kinds and patterns of interrelationship.

If you are fortunate on your rain forest hike, you might glimpse some of the larger animals that live there. Perhaps a band of agoutis by day or pacas by night—both members of the rodent order. Maybe a herd of collared peccaries—fifty- to sixty-pound wild pigs with bristly black and gray hair and a musky smell. Or perhaps an anteater or armadillo. If you are very fortunate, you may see the relative of the rhino—the tapir or mountain cow. The national animal of Belize, this stout-bodied, short-legged, herbivorous creature is, despite its appearance, shy and unaggressive. If you are very, very fortunate, a wild cat may briefly show its face—perhaps a big-eared ocelot, or the weasel-like jaguarundi, or, least likely but best of all, the secretive jaguar. At six feet and three hundred pounds, the solitary and noctural *Felis onca* reigns at the top of the food chain. The black-on-tan spotted jaguar—meaning "he who kills with one leap" in the

language of the peoples native to this place—is, though rarely seen, a constant reminder that life in the rain forest is precarious. It also reminds us that some things to this day remain, as they should, forever wild.

After some time spent exploring the rain forest, the overwhelming impression you get is of the sumptuous luxuriance of living things. This place—a lowland rain forest in Blue Hole National Park in central Belize—teems with life. Indeed, scientific studies confirm your casual observations: species richness, the number of different species in a given area, is staggering. Approximately 3,300 different species of birds—367 species of tyrant flycatchers alone—live in the neotropics. There are over 100 species of bats, compared to 40 in the entire United States. In Costa Rica alone, one researcher identified 550 butterfly species. In a Peruvian rain forest, Harvard biologist E. O. Wilson once counted 43 species of ant on a single tree, an amount equal to all ant species found in the British Isles.[37] A typical four-square-mile patch of rain forest contains 125 mammal species, 400 bird species, 100 reptile species, 60 amphibian species, and 150 different kinds of butterflies.[38] In all three ways—within a given habitat, between different habitats, and over the entire region—tropical forests are incredibly diverse.[39] The biological exuberance of the neotropical rain forest is simply astounding, as are the incredibly complex patterns of adaptation and interdependence.

Mountain

In many ways, the contrast between the mountains of California and the rain forest of Belize could not be more striking. The air around you is cool and dry. Compared to the hot and humid climate of the rain forest, this alpine air is bracing. You see what some would call a stark, austere landscape. Mountain pinnacles and peaks, like spires on a medieval cathedral, shoot high into the azure sky. Everywhere you look there are granite slabs, polished to a high gloss by ancient glaciers and water of more recent times. Large boulders, called glacial erratics, are strewn haphazardly hither and yon. Snow in the cracks and crevices, even in August, is melting and cascading its way into an interlaced chain of deep blue-turquoise lakes, whose surfaces mirror the crags above. All in all, a stunningly beautiful scene.

The air is bracing for yet another reason. At 11,407 feet above sea level, the oxygen is scarce. Just walking from campsite to stream to fetch water can leave you winded. And you have carried a forty-pound pack up steep mountain trails—the only way to get to this piece of God's good earth. To the north, as the sun nears its diurnal circuit, you can barely make out Forester Pass—a small notch in the Kings-Kern Divide, sandwiched between Cal Tech Peak on the left and Diamond Mesa on the right. At 13,200 feet, this pass is higher than most mountains in the continental United States. To the west, into the red-orange glow of the setting sun, you see the magnificent Great Western Divide—a long

series of 13,000-foot peaks forming the north-south boundary between the Kern River and Kaweah River watersheds. To the south is a precipitous drop-off. In the valley over 3,000 feet below where you stand is the Kern River, flowing icy cold and clear from its snowy origins above. And to the east, on fire with the burning light of alpenglow, is the magnificent Sierra crest—Tyndall, Versteeg, Barnard, Russell, Whitney, Muir. As you gaze, transfixed, at the rugged peaks now pierced by this ethereal light, you recall something written by the most famous of the persons immortalized on that list of mountains. John Muir, writing some twenty-five years after his first experience hiking and living in the Sierra Nevada of central California, penned these now famous words:

> Then it seemed to me the Sierra should be called not the Nevada, or Snowy Range, but the Range of Light. And after ten years spent in the heart of it, rejoicing and wondering, bathing in its glorious floods of light, seeing the sunbursts of morning among the icy peaks, the noonday radiance on the trees and rocks and snow, the flush of alpenglow, and a thousand dashing waterfalls with their marvelous abundance of irised spray, it still seems to me above all others the Range of Light, the most divinely beautiful of all the mountain-chains I have ever seen.[40]

From your vantage point on Bighorn Plateau, smack dab in the middle of north-central Sequoia National Park, the contrast with life-teeming Belize could not be more clear. In this the Hudsonian or subalpine zone, little life is immediately visible. But first impressions to the contrary, you are on no moonscape. On a closer look you notice life virtually everywhere. Most immediately evident are the trees, for at this elevation—at timberline—the trees are eye-catching to say the least. Near you is a copse of rugged survivors—foxtail pines. With bleached yellow-brown trunks three to four feet in diameter and gnarled beyond description, upper branches helter-skelter to the sky, these thirty- to forty-foot-tall drought-resistant trees possess spreading root systems that penetrate deeply into the well-drained rocky soil. Their name comes from needles that clothe branchlets in a manner resembling a fox's tail—needles that may persist seventeen years, much longer than on any other pine. Native only to California, foxtails often live, despite the harsh climate, for one thousand years. Sentinels evoking an almost mystical allure, the foxtail would be right at home in any C. S. Lewis novel or Harry Potter adventure.

Nearby is a clump of battered white-bark pines—the foxtail's comrade in high altitude living. A smaller, more shrublike tree, the sprawling white-bark also lives on the very frontier of arboreal existence. Found only between ten thousand and twelve thousand feet in the southern Sierra, it can grow as a tiny wind-pruned shrub huddled in the lee of rocks extending up into the alpine zone. Unlike most pines, its purple thick-scaled cones disintegrate on the tree when the seeds are ripe. White-barks provide essential food and shelter for

native inhabitants of the high country, such as chickarees, chipmunks, and blue grouse.

In a nearby white-bark you see a Clark's nutcracker—pale gray-white body with black wings and big as a crow. Taking a break from its work to check out your unexpected arrival, he soon resumes his appointed task of dismantling a pinecone, extracting and eating the seeds. You hear, not too far away, the telltale call of the mountain chickadee: "chick-a-dee-dee-dee." With its familiar call this hardy avian—with black throat, black crown, and white over the eyes and on cheeks and breast—welcomes you to this high country perch. Though lacking the species richness of the rain forest, the Sierra high country nevertheless exhibits its own intricate web of life.

On some rocks near your campsite you spy a pika, or coney, scurrying from rock to rock. A pale-gray animal the size of a small rabbit, the pika has rabbitlike nose and teeth (four upper teeth rather than two) and a rabbitlike hop—hence its other name, the rock rabbit. Heard more often than seen, with its sharp whistle call of alarm, the pika feeds on green vegetation, putting away enough to last through the entire winter, for unlike many of its high-altitude neighbors, he does not hibernate. As might be expected in this land of short summers and long, brutal winters, "the pika's link to snow and cold is an ancient one, for they are among the creatures known as glacial relicts. Widely distributed during the Ice Age, they now occur only where the climate is still similar to Ice Age type, hence are scattered disjunctively in the far North and on mountains in North America and Eurasia."[41] Evolutionary adaptation and habitat fit are as evident in this climatic zone as in the tropical rain forest.

The rock-loving pika is not to be confused with that other common high-altitude mammal, the marmot. As you look for a place to pitch your tent, you spot a fat yellow-bellied marmot basking in the sun on a nearby rock. The relative of the woodchuck or groundhog, this charming creature forages in the alpine meadows, eating to put on sufficient fat for his long winter hibernation. With a sharp whistle to warn its comrades, the marmot goes into hiding, only to emerge when the coast is clear. Your quiet patience in waiting out the marmot is rewarded when he peeks his blackish-brown whiskered face out at you from only a few feet away.

Despite the harsh climate, there is no dearth of things for these vegetarian, rock-hugging mammals to eat, for interspersed among all the rock gardens are gardens of a different sort—lush meadows sporting a variety of grasses and wildflowers. Even above timberline in the alpine zone at the very edge of subsistence, plants with fitting names such as rockfringe and prickly phlox and yellow alpine columbine manage to survive. Against the onslaught of wind and heat and cold, these highest of all Sierra flora hug the ground, put down deep and wide roots, and preserve moisture by hook and by crook. In so doing, they provide a powerful testimony to the tenacity of life.

Perhaps the prime example of the tenacity of life lies not high up in the alpine zone but farther down, in the transition zone between 5,000 and 7,500 feet. In your hike up to Bighorn Plateau you passed through many forests of large trees—sugar pine, Douglas fir, Ponderosa pine, mountain hemlock—but no tree was as breathtaking as the giant sequoia. This famous sequoia—*Sequoiadendron giganteum*, not to be confused with the taller though slimmer coastal redwood, *Sequoia sempervirens*—grows to an enormous size. For example, the famous General Sherman tree stands at a height of 275 feet and has a basal diameter of 36 feet. The biggest living thing on earth, its trunk totals over 50,000 cubic feet in volume.[42] One of its branches, 130 feet off the ground, measures almost 7 feet across and is 140 feet long—bigger than most entire trees in the forests of the eastern United States.[43] And at 2,700 years old, the General is still growing at the same pace as when he was a mere adolescent.[44] Only the bristlecone pine, one estimated at 4,500 years of age, is older than this giant.

The giant sequoia is a particularly fine example of ecological adaptation. Limited to about 75 small groves within a 250-mile stretch of the Sierra Nevada, the tree has very specific needs. Above 7,500 feet the temperature is too cold and the growing season too short. Below 5,000 feet there is too little moisture. The sun-loving sequoia flourishes in the relatively mild, sheltered basins on the western slopes of the Sierra. In the thin soil, the sequoia sends its roots far and wide in search of water, with a root base that can extend for hundreds of feet.

Due to lightning storms, fire is common in this forest zone, and prior to human arrival and the ubiquity of Smokey Bear, any given area would experience a fire at least once every five to ten years. The giant sequoia defends itself in a variety of ways. Its cinnamon-colored bark is two feet thick and very resistant to fire. The soft and spongy bark also offers insulation against the heat. And even when the bark burns and forms a scar, new bark creeps over the wound until the breach is covered and the tree is again protected. But the giant sequoia has not only adapted to survive fires; it has also learned to take advantage of them. Each tiny sequoia cone—only one to one and a half inches long—contains one hundred to three hundred seeds, each seed so small that it takes ninety-one thousand of them to weigh one pound. Unlike other trees in the conifer forest, the giant sequoia retains its cones, rather than dropping them when they reach maturity. As a ground fire sweeps through the forest, the updrafts cause the old cones to dry and open, and within a week or two they release a cascade of seeds onto the forest floor. In addition to providing the heat necessary for the cones to release their seeds, fire clears away underbrush and purifies the soil, thus preparing the floor for the coming rain of seeds. In short, fire is crucial to the life cycle of the giant sequoia.

The ecological web is even more intricate, however. Also helping the giant sequoia prosper are squirrels and beetles, which munch on mature cones and thus spread seeds during the times between fires. And while the moist and mild climate of the transition zone forest provides an excellent habitat for fungi, the

giant sequoia has developed certain internal chemical compounds that render it unpalatable to fungi and to many insects. Thus "large sequoias are highly resistant to the ravages of insects even though more than a hundred species are known to inhabit them."[45] An impressive witness not only to the interrelatedness of the natural world but to the vast physical and temporal scale of living things, the giant sequoia evokes in us a proper humility. Verna Johnston states it well: "Throughout the fires and storms of centuries, through the rise and fall of Rome, the Mayan empire, Spain, through Magna Carta, the Renaissance, 1776, the birth of the United Nations, this statesman has heralded each sunrise anew for nearly three millennia."[46]

As with the description of the Belizean rain forest, this sketch of the mountains of central California is merely the tip of the proverbial iceberg. Much, much more could and should be said. But the spirit of the Sierra Nevada is perhaps best captured in the ringing words of John Muir:

> The snow on the high mountains is melting fast, and the streams are singing bank-full, swaying softly through the level meadows and bogs, quivering with sun-spangles, swirling in pot-holes, resting in deep pools, leaping, shouting in wild, exulting energy over rough boulder dams, joyful, beautiful in all their forms. No Sierra landscape that I have ever seen holds anything truly dead or dull, or any trace of what in manufactories is called rubbish or waste; everything is perfectly clean and pure and full of divine lessons. This quick, inevitable interest attaching to everything seems marvelous until the hand of God becomes visible; then it seems reasonable that what interests Him may well interest us. When we try to pick out anything by itself, we find it hitched to everything else in the universe.[47]

Lake

Water and trees. Blue and green as far as the eye can see. A land of forest, lake, and stream. Such is the third and last place I will briefly describe. A labyrinth of water on this the water planet is the Quetico-Superior wilderness of northeastern Minnesota and western Ontario. A canoe paddler's paradise, this two-million-acre expanse of enchanted lakes, meandering rivers, and dense forest contains some of the oldest exposed rock on earth. With outcrops dated to three billion years ago, this ancient Precambrian bedrock, called the Canadian Shield, stretches in a vast arc from the Atlantic to the Arctic Sea across the upper part of North America. Walking on rock so old prompts you to marvel at the temporal scale of the natural world. We humans are such latecomers to this aged earth.

You notice that the forest floor where you stand has very little topsoil. Scoured by glaciers two miles thick at least four times in the last two million years, most recently a mere ten thousand years ago, the soil around you is seldom more than ten inches deep, and often it is much less.[48] No thick taproots probe this earth. The lay of the land before you, you quickly deduce, is in large measure the legacy

of the glacier. On an exposed rock to your right you notice splotches of orange and brown. A closer look reveals, clinging to the rock, that most marvelous of plants—the lichen. A combination of two primitive plants, fungi and algae, lichens often grow in places too harsh for other plants. After the glacier receded, these strong and hardy creatures were the first to colonize the barren landscape. Over aeons, by slowly breaking down the rock, the lichens helped produce the humus necessary for other plants to grow. The fungi provide moisture for the algae while the algae furnish sugars, produced from the light of the sun, for the fungi. Thus, the fungi and algae live symbiotically, each benefiting the other and playing an integral part in the development of the forest ecosystem.

Nearby is a large pond. On one end you see a dam, built by a colony of beavers. A marvel of engineering prowess, with sticks and logs and mud every which way, the dam is able to bear your weight and then some, as well as hold back the water.[49] Not far from the dam you notice a large dome-shaped lodge. Twelve feet across and six feet high above the water, with two underwater entrances and walls four feet thick—to keep the inner chamber free from predators such as the lynx and bobcat, as well as above freezing even in the coldest winter—the lodge is a snug and safe haven. As you quietly approach the lodge, you spot a beaver—black and brown fur glistening, long whiskers on dark nose, wide and flat tail—just before it dives underwater. Weighing in at up to sixty pounds, the beaver is the second largest rodent in the world, after the South American capybara, and ranks second only to humans in its ability to deliberately alter its environment.[50] With large front teeth that are, due to timber cutting, constantly resharpened, the beaver is able to down a two- to three-inch-diameter aspen in thirty seconds and has been known to fell trees one hundred feet long and twelve inches thick.[51]

Such prodigious tree-cutting ability is a necessity when not only your shelter but your food is at stake, for the beaver is entirely vegetarian, preferring the bark of aspen and birch, as well as twigs and leaves. Though able to move (albeit slowly) on land, the beaver vastly prefers the water, and so its industrious dam building serves to make available trees and vegetation otherwise inaccessible. By flooding large areas, the average colony can more easily forage a large expanse for food—six to ten acres of water and up to four hundred yards from the water's edge.[52]

The effects of the beaver's dam building are profound, for over time the forest itself will change. From a stand of aspen and birch comes "a rushy, sedge-grown, semi-aquatic world, part swamp, part lake. The shallow slow-moving waters attract a host of living things—from algae and plankton to fish and crustaceans. These creatures in turn have their own parasites and predators—from mosquitoes to hawks."[53] Eventually, these beavers will consume all the food within their reach and have to abandon this pond for a more promising home elsewhere. In so doing they set the stage for the death of the pond, for the dam will slowly disintegrate and release its impounded water, the aquatic

creatures will no longer be able to live there, and the pond will eventually dry out—only to be succeeded by a meadow. After a few decades the meadow will be inhabited by colonizing trees such as aspen and birch, and if the stream does not dry up altogether, another group of hungry beavers will begin the story all over again. Such is one of the many cycles of the northwoods forest.

While wading in the pond your eye catches the zigzag pattern of water striders skittering over the surface of the water. Buzzing just above the water is a dragonfly, its long body powered by two pairs of veined wings. Exiting the pond you shake your feet in the water to rinse off the mud—except one piece of mud does not rinse off your left big toe. You reach down—and, behold, it's a leech. Four inches long and a half inch wide, with a gray-brown body, this wormlike bloodsucker evokes a near universal disdain. But leeches are an important part of the food web, providing nourishment for fish such as northern pike and walleye and also breaking down dead organic matter, thereby making crucial nutrients available to plants and all manner of aquatic organisms. Even the lowly leech has its role—its niche[54]—in the functioning of the pond ecosystem.

As expected this time of year, a small cloud of blackflies hovers around your blue bandana. Seemingly omnipresent in the Quetico-Superior area during May and June, the pinhead-sized female blackfly, like the mosquito, needs blood to provide protein for her developing eggs. However, despite their sometimes annoying presence and welt-producing bite, the blackfly's penchant for blue serves an important ecological function, since they are an important pollinator of the tiny white flowers that later become wild blueberries. The presence of blackflies "also indicates excellent water quality, since nearly any pollution will kill off the larva."[55] Like the leech, the dreaded blackfly has its utility.

On your leisurely walk from pond back to lakeshore campsite, you travel through a forest of balsam fir and white spruce, with some northern white cedar near the water's edge. No birches or aspens stand among these conifers, for the forest through which you walk is a fine example of a boreal forest.[56] Sometimes nicknamed "the spruce-moose forest," the boreal forest circumnavigates the earth, for it is found not only in the northern climes of North America but also in Finland, the Ukraine, and northern China. As one naturalist astutely states, "the globe wears the boreal forest around its head like a spruce-studded crown."[57] As you walk you see many balsam fir, with their famously fragrant needles, as well as pyramidal, Christmas-tree-like spruce here and there. Near the shore is the ubiquitous white cedar, with its scaly needles and peeling bark. You wonder why all the cedar branches are the same height and then remember that deer browse on the cedar in the winter. The lowest level of these branches represents the highest reach of the hungry deer.

So-called natural disasters are an integral part of this forest community. Windfall, insect attack, and fire all contribute to the continuation of this spruce-fir forest. This forest, in other words, "depends on continuing disturbance to maintain

itself."[58] Put differently, succession—"the natural change in the plant life of an area that involves the gradual, continuous replacement of one group of species by another"[59]—in this case involves maintenance through disturbance. This beautiful conifer forest would not be what it is without periodic disruption.

As with the giant sequoia forests, fire is especially important to the boreal forest. Among other things, fire releases nutrients into the soil, burns off the acidic mat of accumulated humus, and opens the canopy, allowing more light to fall on the plants on the forest floor. After a fire in the north woods, aspen and birch and jack pine colonize, and often white or red pine if conditions are right. These pioneers endure for a generation, which may be quite a while in the case of the majestic white pine, some of which in this locale grow to be four hundred years old. But below the canopy of pines are somewhat younger white spruces and, a bit lower down, the shade-tolerant balsam fir, biding their time until the relatively short-lived aspens and birches fall.

At dusk, back at your campsite on a large island-studded lake, you hear the rhythmic "peep" of the spring peepers and the guitar-pluck "guunng" of the green frog along the water's edge. Each male sings out to demarcate and defend his territory. You also observe the erratic flight of numerous little brown bats, flying low as they scoop in up to three hundred mosquitoes and other insects in a single hour. Without the maligned mosquito, these bats would be malnourished. Though not blind, contrary to what many believe, at night the bat must rely on its acute hearing to locate its prey. Using an amazing process called echolocation, bats send out ten to twenty high-pitched calls every second.[60] Like underwater sonar, these sounds bounce off objects and return to the bat as echoes. Able to distinguish a flying beetle from a moth, the bat's sense of hearing is incredibly acute and discriminating, as it must be if it is to survive.

Your reverie in observing bats is broken by a quavering sound, one of the haunting calls of that prototypical northwoods bird, the common loon (*Gavia immer*). This vibrato laugh you hear is the tremelo, a distress call indicating danger. Another loon, this one more distant down the lake, joins in, and you are serenaded with a tremelo duet. Just then you hear another of the loon's four distinctive calls—the wail. This plaintive three-note call, long and mournful like the cry of the wolf, is a way of saying, "Where are you?" or, "Here I am." On this night you hear a third distinctive loon cry—the yodel of the male. A complex chain of three to four three-part squeals, this call is used to attract a mate and defend territory. You now know where the expression "crazy as a loon" comes from. Only the quiet "hoot" eludes your listening ears on this night.

Of all the creatures of the north woods, by common consent the most alluring is not the moose, the black bear, or the timber wolf, but rather the common loon. Large birds with a wingspan of about five feet, weighing up to fifteen pounds, and marked by a jet black head, red eyes, white plumage, and a long sharp bill, the loon is easy to recognize. Loons are fishing machines, built for diving. Their bodies are streamlined, with legs far to the rear for effective

padding, and their red eyes allow them to see more clearly underwater. Their bones are not hollow, like other birds, but solid, thus giving them a low-in-the-water look and the ability to dive to great depths. Believe it or not, loons have been taken in fishing nets 240 feet deep.[61] Able to stay underwater for up to fifteen minutes, loons swim fast enough to catch game fish such as trout and perch, spearing their prey with their beak and then, after surfacing, swallowing it whole.[62] Being built for diving makes flying more difficult, but loons are, in fact, powerful fliers. Requiring as much as one hundred yards before they can get airborne, once in wing the loon cruises at 75 miles per hour and has been clocked as fast as 108 miles per hour.[63] Loons leave the north woods every fall to winter along the south Atlantic coast from North Carolina to Florida and beyond, only to return in the spring when the ice melts off the lakes. An amazingly well-adapted creature in this land of water, the loon is an unforgettable inhabitant native to this place—a vivid reminder in this wilderness that we humans are only visitors.

Darkness settles in, like a gentle friend blanketing the land. With a new moon the stars blaze back at you brighter than you have ever seen them—Big Dipper and Little Dipper, Draco and Boötes, Cassiopeia and Cepheus, the summer triangle of Cygnus, Lyra, and Aquila, these constellations and many more in all their stellar glory. And then, out of the corner of one eye, you see a strange dancing light just over the horizon. After a few seconds you realize you are witnessing the famed aurora borealis, or northern lights. Sigurd Olson describes the indescribable as well as anyone:

> The lights of the aurora moved and shifted over the horizon. Sometimes there were shafts of yellow tinged with green, then masses of evanescence that moved from east to west and back again. Great streamers of bluish white zigzagged like a tremendous trembling curtain from one end of the sky to the other. Streaks of yellow and orange and red shimmered along the flowing borders. Never for a moment were they still, fading until they were almost completely gone, only to dance forth again in renewed splendor with infinite combinations and startling patterns of design.[64]

Caused by great solar flares that traverse the ninety-three million miles from our star to our home planet and enter the earth's magnetic field, the northern lights are perhaps the most beautiful reminder that, in the words of a poem whose author I have long forgotten, "though things near and distant are, they are connected from afar."

How the World Works

From these three different places, what can we learn from and about our home planet? What can and what should we learn about how the world works? Here

are ten learnings—call them *principles of ecology*—gleaned from attending to the world around us.

First, everything is hitched to everything else, as John Muir put it. Or in the words of G. Tyler Miller, every one of us is downwind or downstream of everyone else.[65] This is the first of the "laws of ecology" for Ernest Callenbach: "All things are interconnected."[66] For Garrett Hardin, too, this is "the first law of ecology."[67] We live in an intricate web of a world in which all creatures are in some way interrelated. The cecropia tree and the biting ants. The giant sequoia and the squirrels. The beaver and the birch. Carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur recycling among all living organisms. We are all in this together. Call it *the principle of interrelatedness*.

The second follows from the first: we can never do only one thing.[68] Our actions always have many consequences, some of which we do not know and cannot predict. I flip a light switch in Holland, Michigan, and contribute to acid rain falling in the Adirondacks of upstate New York. You eat a salad whose ingredients came from your backyard organic garden and local farmers' market and end up not only boosting the local economy but also, with the scraps, providing the worms in your compost bin with supper. As when a pebble falls into a still pond, our actions ripple out far beyond their immediate spatial or temporal context. This is *the principle of multiple effects*.

Third, there is no throwing things "away." Callenbach's version is, "Everything goes somewhere."[69] We may think our garbage has gone away, but in reality we have merely moved it from one place to another. In the natural world there is no waste. The waste, including dead bodies, of one form of life is invariably the food for other forms of life. A fundamental principle of physics, this insight is called the law of the conservation of matter. We cannot create or destroy matter; matter merely changes form (which could be energy). Matter is conserved. Let's call it *the principle of matter conservation*.

Fourth, we cannot get something for nothing. It takes energy to get energy. In his third law of ecology, Callenbach puts it this way: "There's no such thing as a free lunch."[70] In physics this is the law of the conservation of energy. Often known as the first law of thermodynamics, it states that within any isolated system, we cannot create or destroy energy. Energy simply changes form (which could be matter). A further implication is that in terms of energy quality, when energy changes from one form to another, some of the useful energy is degraded or becomes less useful. This is the second law of thermodynamics: in energy conversion, entropy or disorder increases. We could call this *the principle of energy conversion*.

Fifth, everything fills a niche. Every organism has a function within its habitat. Every species has a role to play or adaptively fits a role in its ecosystem. The leaf-cutter ants cultivate a particular fungus. The ragged white-bark pines provide a home to chipmunks. The omnipresent blackfly pollinates wild blueberries. The tropical rain forest provides an especially clear example of a diverse array

of species occupying specialized niches. At every layer of the forest, from soil to canopy, many different organisms function in the trophic system. This is *the principle of fittingness*.

Sixth, things change. We live in an incredibly dynamic universe. The earth's living organisms and natural cycles are constantly changing. Gone is the view that all things reach a form of permanent homeostasis—that the world is basically static. As Daniel Botkin states, we must recognize "the dynamic rather than the static properties of the Earth and its life-support system," for "nature is a moving picture show."[71] A blowdown in the Belizean rain forest means more light reaches the forest floor and thus new plants colonize the forest. A ground fire in the Sierra Nevada causes the sequoia cones to drop their seeds. A beaver dam in the Quetico-Superior changes water flows and levels and thereby alters the landscape. On a larger scale, tectonic plates sliding and colliding rearrange the very skin of the earth. In a variety of spatial and temporal scales, the world is constantly changing. Call this *the principle of dynamic systems*.

Seventh, you adapt or die. Given the ineluctable reality of change, individual organisms, populations, and species either adapt to their surroundings or cease to exist. Bromeliads trap water or die. The pika finds sufficient vegetation to outlast the winter or it dies. Bats get good at echolocation or they die. For some organisms the tolerances of survival are thin, while for others there is much more leeway. With conditions always changing, organisms (e.g., via natural selection) and communities (e.g., via ecological succession) either adapt or go out of existence. Let's call it *the principle of adaptation*.

Eighth, the earth swims in diversity. Biodiversity has at least three forms: the genetic variety within a given species (genetic diversity), the many different individual species of organisms (species diversity), and the diversity of different kinds of natural systems (ecosystem diversity). In the three places described above, the second form of biodiversity is perhaps the most evident, and never more so than in the species-packed tropical rain forest; but diversity in all its forms is visible all over our planet. For example, there are four thousand to five thousand species of bacteria in a single gram of beech forest soil, not to mention all the beetles, centipedes, earthworms, and the like.[72] This is *the principle of diversity*.

Ninth, there is not always more. Except for our energy income from the sun, the world is finite. Numbers of individual organisms (e.g., buffalo and passenger pigeons) may seem limitless, but they are not. Species may appear to be beyond counting (e.g., beetles and flycatchers), but they are finite in number. Our life-support systems (soil, water, and air) may seem beyond abuse, but there are limits to what they can bear. Like it or not, we are finite creatures living in a finite world. Hence, *the principle of limits*.

Tenth and last, the natural world is more complex than we think. Indeed, as G. Tyler Miller Jr. reminds us, the world is more complex than we can ever possibly imagine.[73] The burgeoning field of complexity theory is but one example

that demonstrates the truth of this claim.[74] The world is not fundamentally like a machine—understandable by a dissection and cataloguing of its parts. It is, rather, an incredibly complex system whose properties cannot be fully explained by knowing its constituent components. In other words, the whole is more than the sum of its parts. In the natural world there are nonlinear systems, such as the weather, whose behavior can never be easily predicted. Hence, the butterfly effect: a butterfly flapping its wings in Tokyo affects the rainfall in Chicago. Also, in complex systems there are properties that unexpectedly emerge, such as social life among certain insects. The more we learn about the world, the stranger and more mysterious it gets. Call this *the principle of complexity*.

There are, of course, many other important things we could learn, but this short list will suffice. What would it mean to acknowledge and live by these principles? How would our world be different if we took these learnings to heart? Would this knowledge of how the world works increase our love of and care for our place?

Places of the Heart

We care for only what we love. We love only what we know. We truly know only what we experience. If we do not know our place—know it in more than a passing, cursory way, know it intimately and personally—then we are destined to use and abuse it. So we need to experience our home place firsthand. In my case, only if I see the great blue heron arch its prehistoric wings in flight, only if I hear the song sparrows and the chickadees, only if I smell the scent of skunk or wild onion, only if I feel the warm sun of spring or the brisk breeze of autumn, only, in short, if I take the opportunity to know my place will I feel motivated to care for it.

Important as it is to have a solid sense of our connectedness to the larger whole, we all live in particular places, discrete locales, specific homes. I live in southwestern Michigan, in a temperate transition zone of conifers, such as spruce and hemlock, and of hardwood deciduous trees, such as maples and beeches and oaks, above layers of sand deposited thousands of years ago by glaciers a mile high, along the shore of that great inland sea we call the Great Lakes—holder of one-fifth of all the fresh water on the surface of the earth.

More exactly, my home is the Macatawa watershed. I live in an area drained by countless creeks and streams, all flowing inexorably into the Macatawa River, which itself flows west into Lake Michigan. Sometimes called the Black River, the river comes by its alternate name honestly. The water is black, very black. With phosphorus levels four times what they should be, the lake is eutrophic: there is not enough oxygen to support the normal food chain. In addition, the turbidity is quite high. That is, the blackness of the river and its feeder streams is due in large measure to large quantities of suspended silt and organic matter

in the water. Put in layperson's language, soil is being eroded into the streams and thus contributing to the problems in the river. In short, the watershed is not in very good shape. That's the bad news.

The good news is that things are changing for the better. For example, the Macatawa Area Coordinating Council has launched a campaign to clean up the watershed. Aimed at farmers, industry, private homeowners, and local municipalities, this watershed conservation program is raising awareness of how we can and must do a better job of caring for our place by using less fertilizer, installing erosion strips on stream banks, protecting remaining wetlands, and the like. In addition, the Macatawa Greenway Partnership, a nonprofit organization whose mission is to protect and connect green spaces, streams, and natural lands, has been working to preserve remaining area along the Macatawa River and build trails for walking, running, and bicycling. Convinced that one sure way to cultivate care for the watershed is by getting people out into it, the people of the Greenway Partnership envision a series of public waterfront pathways for the enjoyment of all. These groups are merely two examples in my local community of people who know their place and are working to make it better—for humans and nonhumans alike.

So where are we? Do we know our place? If we wish to properly care for our homes—not only for ourselves but for our children and our children's children—then we, and all our fellow dwellers in our place, must love our homes. And we must love them for more than merely our own gain. And to love them we must know them—up close and personal. When asked by a questioner what he could do to stem the tide of ecological degradation and work to improve the state of our home planet, contemporary poet Gary Snyder gave this sound advice: "Settle down, get to know your place, and dig in."