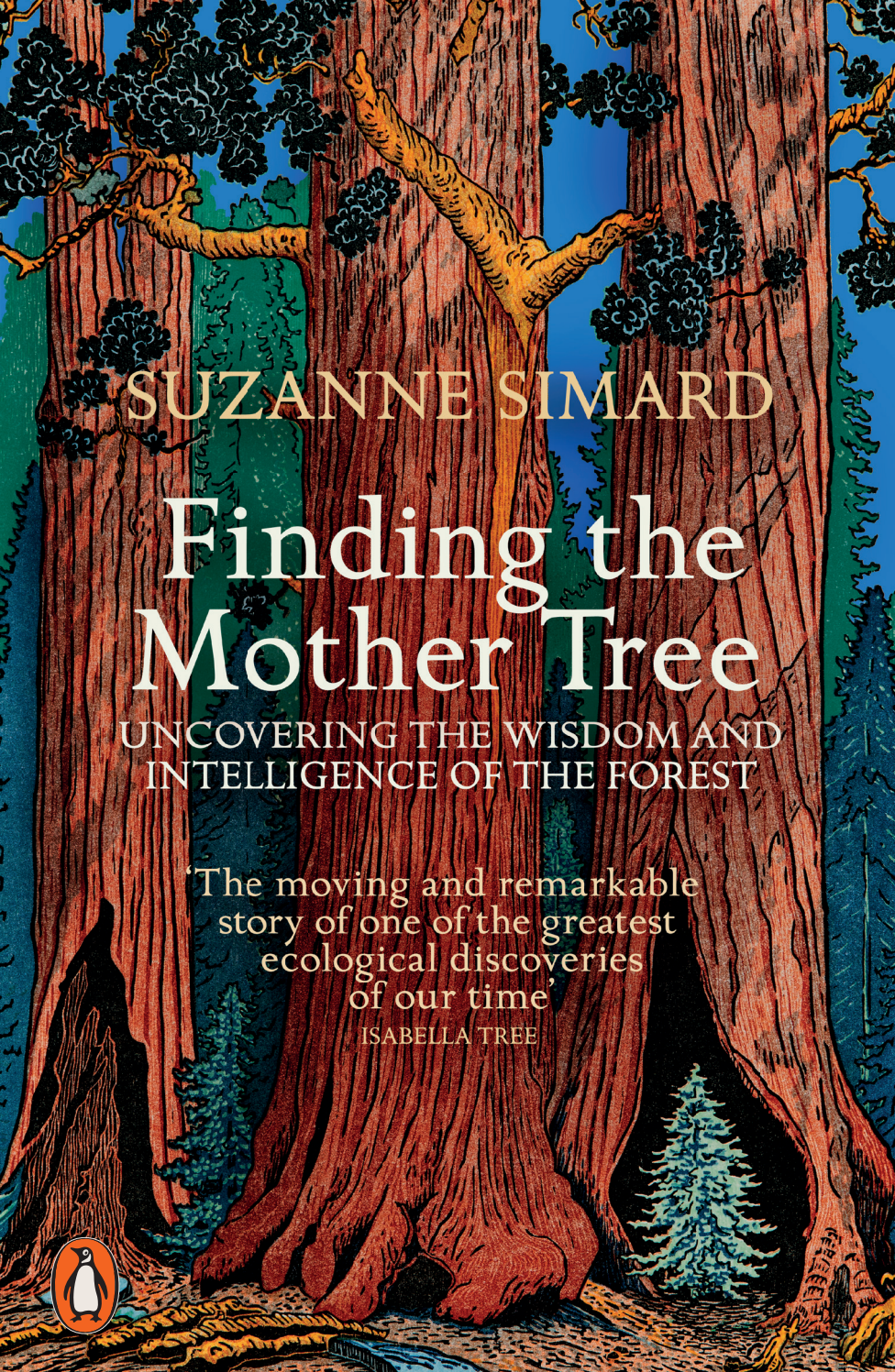

SUZANNE SIMARD
Finding the Mother Tree
UNCOVERING THE WISDOM AND INTELLIGENCE OF THE FOREST
'The moving and remarkable story of one of the greatest ecological discoveries of our time'
ISABELLA TREE

PENGUIN BOOKS

Finding the Mother Tree

Dr Suzanne Simard was raised in the Monashee Mountains of British Columbia. She is Professor of Forest Ecology in the University of British Columbia's Faculty of Forestry, and has earned a global reputation for her research on tree connectivity and communication and its impact on the health and biodiversity of forests.

FINDING THE MOTHER TREE

Uncovering the Wisdom and Intelligence of the Forest

Suzanne Simard

PENGUIN BOOKS

PENGUIN BOOKS

UK | USA | Canada | Ireland | Australia
India | New Zealand | South Africa

Penguin Books is part of the Penguin Random House group of companies whose addresses can be found at global.penguinrandomhouse.com.

First published in the United States of America by Alfred A. Knopf,
a division of Penguin Random House LLC 2021
First published in Great Britain by Allen Lane 2021
Published in Penguin Books 2022
001

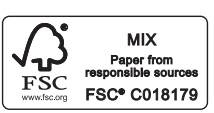
Printed and bound in Great Britain by Clays Ltd, Elcograf S.p.A.

The authorized representative in the EEA is Penguin Random House Ireland,
Morrison Chambers, 32 Nassau Street, Dublin D02 YH68

A CIP catalogue record for this book is available from the British Library

ISBN: 978–0–141–99028–6

www.greenpenguin.co.uk



Penguin Random House is committed to a sustainable future for our business, our readers and our planet. This book is made from Forest Stewardship Council® certified paper.

For my daughters,

HANNAH AND NAVA

But man is a part of nature, and his war against nature is inevitably a war against himself.

—RACHEL CARSON

CONTENTS

A FEW NOTES FROM THE AUTHOR

I use the British spelling "mycorrhizas" as the plural of "mycorrhiza" because it comes more naturally to me and may be easier for readers to recall or say. However, "mycorrhizae" is also frequently employed, especially in North America. Either plural is correct usage.

For names of species, I have used a mixture of Latin and common names throughout. For trees and plants, I usually refer to the common name at the species level, but for fungi I generally only provide the name of the genus.

I have changed the names of some people to protect their identity.

FINDING THE MOTHER TREE

INTRODUCTION

CONNECTIONS

For generations, my family has made its living cutting down forests. Our survival has depended on this humble trade.

It is my legacy.

I have cut down my fair share of trees as well.

But nothing lives on our planet without death and decay. From this springs new life, and from this birth will come new death. This spiral of living taught me to become a sower of seeds too, a planter of seedlings, a keeper of saplings, a part of the cycle. The forest itself is part of much larger cycles, the building of soil and migration of species and circulation of oceans. The source of clean air and pure water and good food. There is a necessary wisdom in the give-and-take of nature—its quiet agreements and search for balance.

There is an extraordinary generosity.

Working to solve the mysteries of what made the forests tick, and how they are linked to the earth and fire and water, made me a scientist. I watched the forest, and I listened. I followed where my curiosity led me, I listened to the stories of my family and people, and I learned from the scholars. Step-by-step—puzzle by puzzle—I poured everything I had into becoming a sleuth of what it takes to heal the natural world.

I was lucky to become one of the first in the new generation of women in the logging industry, but what I found was not what I had grown up to understand. Instead I discovered vast landscapes cleared

of trees, soils stripped of nature's complexity, a persistent harshness of elements, communities devoid of old trees, leaving the young ones vulnerable, and an industrial order that felt hugely, terribly misguided. The industry had declared war on those parts of the ecosystem—the leafy plants and broadleaf trees, the nibblers and gleaners and infesters—that were seen as competitors and parasites on cash crops but that I was discovering were necessary for healing the earth. The whole forest—central to my being and sense of the universe—was suffering from this disruption, and because of that, all else suffered too.

I set out on scientific expeditions to figure out where we had gone so very wrong and to unlock the mysteries of why the land mended itself when left to its own devices—as I'd seen happen when my ancestors logged with a lighter touch. Along the way, it became uncanny, almost eerie, the way my work unfolded in lockstep with my personal life, entwined as intimately as the parts of the ecosystem I was studying.

The trees soon revealed startling secrets. I discovered that they are in a web of interdependence, linked by a system of underground channels, where they perceive and connect and relate with an ancient intricacy and wisdom that can no longer be denied. I conducted hundreds of experiments, with one discovery leading to the next, and through this quest I uncovered the lessons of tree-to-tree communication, of the relationships that create a forest society. The evidence was at first highly controversial, but the science is now known to be rigorous, peer-reviewed, and widely published. It is no fairy tale, no flight of fancy, no magical unicorn, and no fiction in a Hollywood movie.

These discoveries are challenging many of the management practices that threaten the survival of our forests, especially as nature struggles to adapt to a warming world.

My queries started from a place of solemn concern for the future of our forests but grew into an intense curiosity, one clue leading to another, about how the forest was more than just a collection of trees.

In this search for the truth, the trees have shown me their perceptiveness and responsiveness, connections and conversations. What started as a legacy, and then a place of childhood home, solace, and adventure in western Canada, has grown into a fuller understanding

of the intelligence of the forest and, further, an exploration of how we can regain our respect for this wisdom and heal our relationship with nature.

One of the first clues came while I was tapping into the messages that the trees were relaying back and forth through a cryptic underground fungal network. When I followed the clandestine path of the conversations, I learned that this network is pervasive through the *entire* forest floor, connecting all the trees in a constellation of tree hubs and fungal links. A crude map revealed, stunningly, that the biggest, oldest timbers are the sources of fungal connections to regenerating seedlings. Not only that, they connect to all neighbors, young and old, serving as the linchpins for a jungle of threads and synapses and nodes. I'll take you through the journey that revealed the most shocking aspect of this pattern—that it has similarities with our own human brains. In it, the old and young are perceiving, communicating, and responding to one another by emitting chemical signals. *Chemicals identical to our own neurotransmitters. Signals created by ions cascading across fungal membranes.*

The older trees are able to discern which seedlings are their own kin.

The old trees nurture the young ones and provide them food and water just as we do with our own children. It is enough to make one pause, take a deep breath, and contemplate the social nature of the forest and how this is critical for evolution. The fungal network appears to wire the trees for fitness. And more. These old trees are mothering their children.

The Mother Trees.

When Mother Trees—the majestic hubs at the center of forest communication, protection, and sentience—die, they pass their wisdom to their kin, generation after generation, sharing the knowledge of what helps and what harms, who is friend or foe, and how to adapt and survive in an ever-changing landscape. It's what all parents do.

How is it possible for them to send warning signals, recognition messages, and safety dispatches as rapidly as telephone calls? How do they help one another through distress and sickness? Why do they have human-like behaviors, and why do they work like civil societies?

After a lifetime as a forest detective, my perception of the woods

has been turned upside down. With each new revelation, I am more deeply embedded in the forest. The scientific evidence is impossible to ignore: the forest is wired for wisdom, sentience, and healing.

This is not a book about how we can save the trees.

This is a book about how the trees might save us.

1

GHOSTS IN THE FOREST

I was alone in grizzly country, freezing in the June snow. Twenty years old and green, I was working a seasonal job for a logging company in the rugged Lillooet Mountain Range of western Canada.

The forest was shadowed and deathly quiet. And from where I stood, full of ghosts. One was floating straight toward me. I opened my mouth to scream, but no sound emerged. My heart lodged in my throat as I tried to summon my rationality—and then I laughed.

The ghost was just heavy fog rolling through, its tendrils encircling the tree trunks. No apparitions, only the solid timbers of my industry. The trees were *just trees*. And yet Canadian forests always felt haunted to me, especially by my ancestors, the ones who'd defended the land or conquered it, who came to cut, burn, and farm the trees.

It seems the forest always remembers.

Even when we'd like it to forget our transgressions.

It was midafternoon already. Mist crept through the clusters of subalpine firs, coating them with a sheen. Light-refracting droplets held entire worlds. Branches burst with emerald new growth over a fleece of jade needles. Such a marvel, the tenacity of the buds to surge with life every spring, to greet the lengthening days and warming weather with exuberance, no matter what hardships were brought by winter. Buds encoded to unfold with primordial leaves in tune with the fairness of previous summers. I touched some feathery needles, comforted by their softness. Their stomata—the tiny holes that draw in carbon

dioxide to join with water to make sugar and pure oxygen—pumped fresh air for me to gulp.

Nestled against the towering, hardworking elders were teenaged saplings, and leaning into them were even younger seedlings, all huddling as families do in the cold. The spires of the wrinkled old firs stretched skyward, sheltering the rest. The way my mother and father, grandmothers and grandfathers protected me. Goodness knows, I'd needed as much care as a seedling, given that I was always getting into trouble. When I was twelve, I'd crawled along a sweeper tree leaning over the Shuswap River to see how far out I could go. I tried to retreat but slipped and fell into the current. Grampa Henry jumped into his hand-built riverboat and grabbed my shirt collar right before I would have disappeared into the rapids.

Snow lay deeper than a grave nine months of the year here in the mountains. The trees far outmatched me, their DNA forged so they'd thrive despite the extremes of an inland climate that would chew me up and spit me out. I tapped a limb of an elder to show gratitude for its hovering over vulnerable offspring and nestled a fallen cone in the crook of a branch.

I pulled my hat over my ears while stepping off the logging road and waded deeper into the forest through the snow. Despite it being only a few hours before darkness, I paused at a log, a casualty of saws that had cleared the road right-of-way. The pale round face of its cut end showed age rings as fine as eyelashes. The blond-colored earlywood, the spring cells plump with water, were edged by dark-brown cells of latewood formed in August when the sun is high and drought settles in. I counted the rings, marking each decade with a pencil—the tree was a couple hundred years old. Over twice the number of years my own family had lived in these forests. How had the trees weathered the changing cycles of growth and dormancy, and how did this compare to the joys and hardships my family had endured in a fraction of the time? Some rings were wider, having grown plenty in rainy years, or perhaps in sunny years after a neighboring tree blew over, and others were almost too narrow to see, having grown slowly during a drought, a cold summer, or some other stress. These trees persisted through climatic upheavals, suffocating competition, and ravaging fire, insect, or wind disruptions, far eclipsing the colonialism, world wars, and the

Camping at Shuswap Lake near Sicamous, British Columbia, 1966. Left to right: Kelly, three; Robyn, seven; and Mum, Ellen June, twenty-nine; I'm five. We arrived in our 1962 Ford Meteor after barely escaping a rockslide on the Trans-Canada Highway; rocks flew down the mountain straight through the car window and landed on Mum's lap.

dozen or so prime ministers my family had lived through. They were ancestors to my ancestors.

A chattering squirrel ran along the log, warning me away from his cache of seeds at the base of the stump. I was the first woman to work for the logging company, an outfit that was part of a rough, dangerous business starting to open its doors to the occasional female student. The first day on the job, a few weeks back, I'd visited a clear-cut—a complete felling of trees in a thirty-hectare patch—with my boss, Ted, to check that some new seedlings had been planted according to government rules. He knew how a tree should and should not be planted, and his low-key approach kept workers going through their exhaustion. Ted had been patient with my embarrassment at not knowing a

Temperate rain forest typical of Mum's and Dad's childhood homes in British Columbia

J-root from a deep plug, but I'd watched and listened. Soon enough, I was entrusted with the job of assessing established plantations—seedlings put in to replace harvested trees. I wasn't about to screw up.

Today's plantation awaited me beyond this old forest. The company had chopped down a large parcel of velvety old subalpine firs and planted prickly needled spruce seedlings this last spring. My task was to check the progress of those new growths. I hadn't been able to

take the logging road into the clear-cut because it had been washed out—a gift, since I could detour past these mist-wrapped beauties, but I stopped at a massive pile of fresh grizzly scat.

Fog still draped the trees, and I could have sworn something was sliding along in the distance. I looked harder. It was the pale green trusses of the lichen called old man's beard because of the way it sways from branches. Old lichen that particularly thrived on old trees. I plunged the button on my air horn to warn off the specter of bears. I'd inherited my fear of them from my mother, who was a child when her grandfather, my great-grampa Charles Ferguson, shot and killed one that was inches from mauling her on the porch. Great-Grampa Charles was a turn-of-the-twentieth-century pioneer in Edgewood, an outpost in the Inonoaklin Valley along the Arrow Lakes of the Columbia basin in British Columbia. With axes and horses, he and his wife, Ellen, cleared the Sinixt Nation land they had homesteaded to grow hay and tend cattle. Charles was known to wrestle with bears and shoot wolves that tried to kill his chickens. He and Ellen raised three children: Ivis, Gerald, and my grandmother Winnie.

I crawled over logs covered with moss and mushrooms, inhaling the evergreen mist. One had a river of tiny *Mycena* mushrooms flowing along the cracks down its length before fanning along a splay of tree roots that dwindled to rotten spindles. I'd been puzzling over what roots and fungi had to do with the health of forests—the harmony of things large and small, including concealed and overlooked elements. My fascination with tree roots had started from my growing up amazed at the irrepressible power of the cottonwoods and willows my parents had planted in our backyard when their massive roots cracked the foundation of our basement, tilted over the doghouse, and heaved up our sidewalk. Mum and Dad fell into worried discussions of what to do with the problem they'd unwittingly created in our little plot of land in trying to reconstruct the feel of trees surrounding their own childhood homes. I'd watched in awe each spring as a multitude of germinants emerged from cottony seeds amid halos of mushrooms fanning around the base of the trees, and I'd become horrified, at eleven, when the city ran a pipeline spewing foamy water into the river beside my house, where the effluent killed the cottonwoods along the shore. First the tops of the crowns thinned, then

black cankers appeared around the furrowed trunks, and by the next spring the great trees were dead. No new germinants got established among the yellow outflow. I wrote to the mayor, and my letter went unanswered.

I picked one of the tiny mushrooms. The bell-shaped elf caps of the *Mycena* were dark brown at the apex and faded into translucent yellow at the margins, revealing gills underneath and a fragile stem. The stipes—stems—were rooted in the furrows of the bark, helping the log decay. These mushrooms were so delicate it seemed impossible they could decompose a whole log. But I knew they could. Those dead cottonwoods along the riverbank in my childhood had fallen and sprouted mushrooms along their thin, cracking skin. Within a few years, the spongy fibers of decayed wood had completely disappeared into the ground. These fungi had evolved a way to break down wood by exuding acids and enzymes and using their cells to absorb the wood's energy and nutrients. I launched off the log, landed with my caulk spikes in the duff, and grabbed clumps of fir saplings to leverage myself up the slope. The saplings had found a spot to capture a balance between the light of the sun and the wetness of the snowmelt.

A *Suillus* mushroom—tucked near a seedling that had established a few years back—was wearing a scaly brown pancake cap over a yellow porous underbelly and a fleshy stem that disappeared into the ground.

Pancake mushrooms (*Suillus lakei*)

In a burst of rain, the mushroom had sprung out of the dense network of branching fungal threads running deep through the forest floor. Like a strawberry fruiting from its vast, intricate system of roots and runners. With a boost of energy from the earthen threads, the fungal cap had unfurled like an umbrella, leaving traces of a lacy veil hugging the brown-spotted stem about halfway up. I picked the mushroom, this fruit of the fungus that otherwise lived mainly belowground. The cap's underside was like a sundial of radiating pores. Each oval-shaped opening housed minuscule stalks built to discharge spores like sparks from a firecracker. Spores are the "seeds" of fungi, full of DNA that binds, recombines, and mutates to produce novel genetic material that is diverse and adapted for changing environmental conditions. Sprinkled around the colorful cavity left by the picking was a halo of cinnamon-brown spores. Other spores would have caught an updraft, latched on to the legs of a flying insect, or become the dinner of a squirrel.

Extending downward in the tiny crater still holding the remains of the mushroom's stem were fine yellow threads, the strands braiding into an intricately branching veil of fungal *mycelium,* the network that blankets the billions of organic and mineral particles making up the soil. The stem bore broken threads that had been part of this web before I ungraciously ripped it from its moorings. The mushroom is the visible tip of something deep and elaborate, like a thick lace tablecloth knitted into the forest floor. The threads left behind were fanning through the litter—fallen needles, buds, twigs—searching for, entwining with, and absorbing mineral riches. I wondered whether this *Suillus* mushroom might be a type of decay fungus like the *Mycenas,* a rotter of wood and litter, or if it had some other role. I stuck it into my pocket along with the *Mycena.*

The clear-cut where the seedlings replaced the chopped-down trees was still not visible. Dark clouds were gathering, and I pulled my yellow rain jacket out of my vest. It was worn from bushwhacking and not as waterproof as it should have been. Each step farther from the truck added to an aura of danger and my foreboding that I wouldn't be on the road by nightfall. But I'd inherited an instinct for pushing through hardship from Grannie Winnie, a teenager when her mother, Ellen, succumbed to the flu in the early 1930s. The family was snowed

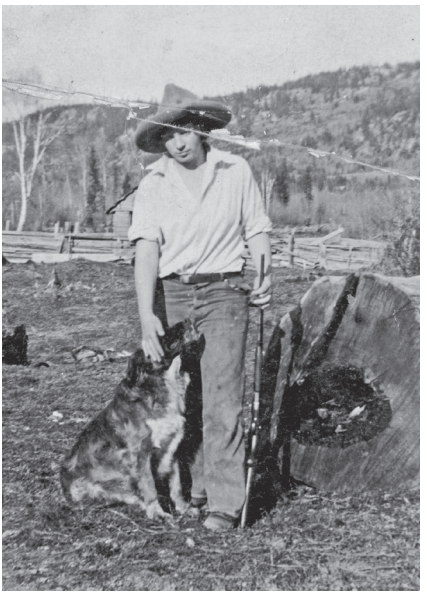
in and bedridden, with Ellen dead in her room, when the neighbors finally broke through the frozen valley and chest-deep snow to check on the Ferguson clan.

My boot slipped, and I grabbed a sapling, which came loose in my hand as I tumbled down the pitch, flattening other saplings before coming to rest against a sodden log, still clutching the octopus of jagged roots. The young tree looked to be a teenager, the whorls of lateral branches demarcating each year adding up to about fifteen. A rain cloud started to spit, soaking my jeans. Drops beaded on the oilskin of my scruffy jacket.

There was no room for weakness on this job, and I'd cultivated a tough exterior in a boy's world for as long as I could remember. I wanted to be as good as my younger brother, Kelly, and the ones who had Québécois names like Leblanc and Gagnon and Tremblay, so I learned to play street ice hockey with the neighborhood gang when the temperature was minus twenty. I played goalie, the least coveted position. They took hard shots at my knees, but I kept my black-and-blue legs concealed under my jeans. The way Grannie Winnie kept on as best she could, resuming her job of galloping her horse through the Inonoaklin Valley, delivering mail and flour to the homesteads, soon after her mother died.

I stared at the clump of roots in my fist. Clinging to them was glistening humus that reminded me of chicken manure. Humus is the greasy black rot in the forest floor sandwiched between the fresh litter from fallen needles and dying plants above and the mineral soil weathered from bedrock below. Humus is the product of plant decay. It's where the dead plants and bugs and voles are buried. Nature's compost. Trees love to root in the humus, not so much above or below it, because there they can access the bounty of nutrients.

But these root tips were glowing yellow, like lights on a Christmas tree, and they ended in a gossamer of mycelium of the same color. The threads of this streaming mycelium looked close to the same color as those radiating into the soil from the stems of the *Suillus* mushrooms, and from my pocket I took out the one I'd picked. I held the clump of root tips with its cascading yellow gossamer in one hand and the *Suillus* mushroom with its broken mycelium in the other. I studied them closely, but I could not tell them apart.



Winnifred Beatrice Ferguson (Grannie Winnie) at the Ferguson farm in Edgewood, British Columbia, ca. 1934, when she was twenty years old, shortly after her mum died. Winn carried on raising the chickens, milking the cows, and pitching the hay. She rode her horse like the wind and shot a bear out of the apple tree. Grannie rarely spoke of her mum, but on my last walk with her along the waterfront of Nakusp, when she was eighty-six years old, she cried to me, "I miss my mum."

Maybe *Suillus* was a friend of the roots, not a decomposer of dead things as *Mycena* was? My instinct has always been to listen to what living things are saying. We think that most important clues are large, but the world loves to remind us that they can be beautifully small. I began to dig into the forest floor. The yellow mycelium seemed to coat every minuscule particle of soil. Hundreds of miles of threads running under my palms. No matter the lifestyle, these fungal branching filaments, called *hyphae*—along with the mushroom fruit they spawned—appeared to be only a smattering of the vast mycelium in the soil.

My water bottle was in the back zipped pocket of my vest, and I washed the soil crumbs from the rest of the root tips. I'd never seen such a rich bouquet of fungus—certainly not this brilliant a yellow, plus white and pink too—each color wrapped around a separate tip, bearded with gossamer. Roots need to reach far and in awkward spaces for nutrients. But why were so many fungal threads not only sprouting from the root tips but blazing with a palette like this? Was each color a different fungal species? Did each do a different job in the soil?

I was in love with this work. The rush of excitement climbing through this majestic glade was far more intense than my fear of bears or ghosts. I set the roots of my ripped-out seedling, with their vivid netting of fungus, near a guardian tree. The seedlings had shown me the textures and tones of the forest's underworld. Yellows and whites and shades of dusty pink that reminded me of the wild roses I grew up with. The soil where they had found purchase was like a book, one colorful page layered on the next, each unfolding the story of how everything was nourished.

When I finally made it into the clear-cut, I squinted in the glare filtering through the drizzle. I knew what to expect, but my heart still jolted. Every tree had been cut down to a stump. White bones of wood jutted out of the soil. Weathered by the wind and rain, the last scraps of bark sloughed onto the ground. I picked my way past severed limbs, feeling the pain of their neglect. I lifted a branch to uncover a young tree, just as I'd picked garbage off the flowers trying to bloom under the trash piles in the hills above the neighborhood when I was a child. I knew the importance of these gestures. Some little velvety firs had been orphaned near the stumps of their parents and were trying to recover from the shock of their loss. Their recuperation would be arduous given the slow shoot growth since the harvest. I touched the tiny terminal bud of the one closest to me.

Some white-flowered rhododendrons and huckleberry shrubs had also ducked the zip of the saw. I was a part of this harvesting of lumber, this business of chopping down trees to clear the spaces where they were free, wild, whole. My colleagues were drawing up plans for the next clear-cuts, to keep the mill going and their families fed, and I understood this need too. But the saws wouldn't stop until whole valleys were gone.

I walked toward seedlings in a crooked line amid the rhododendrons and huckleberries. The crew that had done the planting to replace the harvested elder firs had inserted prickly spruce seedlings, now ankle high. It might seem odd not to replace the subalpine firs they'd taken down with more subalpine firs. But spruce wood is more valuable. It's tightly grained, resistant to decay, and coveted for high-grade lumber. Mature subalpine-fir timber is weak and punky.

The government also encouraged planting the seedlings in garden-

like rows to ensure no patch of soil was left bare. This was because timber grown in grids of evenly spaced trees yielded more wood than scattered clumps. At least in theory. By filling in all the gaps, they figured they could grow more wood than occurred naturally. With every corner chockablock, they felt justified in bigger harvests, in anticipation of future yields. And logical rows made everything more countable. Same rationale as my Grannie Winnie planting her garden in rows, but she worked the soil and varied her crops over the years.

The first spruce seedling I checked was alive, but barely, with yellowish needles. Its spindly stem was pathetic. How was it supposed to survive this brutal terrain? I looked up the planted row. All the new seedlings were struggling—every single sad little planting. Why did they look so *awful*? Why, in contrast, did the wild firs germinating in that old-growth patch look so *brilliant*? I pulled out my field book, wiped needles off the waterproof cover, and cleaned my glasses. The replanting was supposed to heal what we'd taken, and we were failing miserably. What prescription should I write? I wanted to tell the company to start over again, but that expense would be frowned upon. I caved to my fears of a rebuttal and jotted, "Satisfactory, but replace the seedlings that have died."

I picked up a piece of bark shading a seedling and flicked it into the shrubs. Using a makeshift envelope fashioned from drafting paper, I collected the seedling's yellow needles. I was grateful to have my own desk in an alcove set off from the map tables and boisterous offices where men made deals and negotiated timber prices and logging costs; decided what patches of forest to cut next; awarded contracts like banner ribbons at a track meet. In my tiny space, I could work on the plantation problems in a secluded peace. Maybe the seedling's symptoms would be easy to find in the reference books, since yellowing can be caused by myriad problems.

I tried to find any seedlings that were healthy, but to no avail. What was triggering the sickness? Without a correct diagnosis, the replacement seedlings would likely suffer too.

I kicked myself for glossing over the problem, taking the easy way out for the company. The plantation was a mess. Ted would want to know if we were failing to meet the government requirements for reforestation at this site, because not succeeding meant a financial

loss. He was focused on meeting the basic regeneration regulations at minimal cost, but I didn't even know what to suggest. I pulled another spruce seedling from its planting hole, wondering if the answer might be in the roots, not the needles. They had been buried tightly in the granular soil, where it was still moist in late summer. Perfect planting job. The forest floor scraped away, the planting hole plunged into the damp mineral earth below. Just as instructed. By the book. I inserted the roots back into the hole and checked another seedling. And another. Every one of them packed exactly right in a slit made by a shovel and backfilled to eliminate the air gaps, but the root plugs looked embalmed, as if they'd been shoved into a tomb. Not a single root seemed to get what it was supposed to do. None was sprouting new white tips to forage in the ground. The roots were coarse, black, and plunging straight to nowhere. The seedlings shed yellow needles because they were starving for *something*. There was an utter, maddening disconnect between the roots and the soil.

By chance a healthy subalpine fir had regenerated from a seed nearby, and I uprooted it to compare. Unlike the planted spruce, which I'd plucked like a carrot out of the soil, these sprawling fir roots were anchored so tightly that I had to plant both feet on either side of the stem and pull with all my might. The roots finally ripped out of the earth and—a parting shot—sent me stumbling. The deepest root tips had refused to unglue from the soil, no doubt in protest. But I brushed the humus and loose dirt off the torn roots I'd claimed, pulled out my water bottle, and rinsed off the remaining crumbs. Some of the root ends were like the fine tips of needles.

I was amazed to see the same bright yellow fungal threads wrapped around the root tips as I'd seen in the old-growth forest, once again exactly the same color as the mycelium, the network of fungal hyphae growing out of the stems of the *Suillus* pancake mushrooms. Digging a little more around my fir excavation, I found the yellow threads infusing the organic mat that capped the soil, forming a network of mycelium that was radiating farther and farther afield.

But what exactly were these branching fungal threads, and what were they doing? They might be beneficial hyphae meandering through the soil to pick up nutrients to deliver to the seedlings in exchange for energy. Or they could be pathogens infecting and feed-

ing off the roots, causing vulnerable seedlings to turn yellow and die. The *Suillus* mushrooms might be popping out of the subterranean fabric to spread spores when times were good.

Or maybe these yellow threads weren't connected to *Suillus* mushrooms at all and were instead from a different fungal species. More than a million exist on earth, about six times the number of plant species, with only about 10 percent of fungal species identified. With my scant knowledge, my chances of identifying the species of these yellow threads felt like a long shot. If the threads or the mushrooms didn't hold clues, there could be other reasons why the new spruce plantings didn't flourish here.

I erased my "satisfactory" note and jotted that the plantation was a failure. A complete replanting using the same kinds of seedlings and methods—shovel planting one-year-old plug stock that is mass-produced in nurseries—felt like the cheapest way for the company to go, but not if we had to keep returning because of the same dismal result. Something different needed to be done to re-establish this forest, but what?

Plant subalpine fir? No nurseries had it available for planting, and it wasn't considered a future cash crop. We could plant spruce seedlings with bigger root systems. But the roots would still die if they couldn't sprout strong new tips. Or we could plant them so their roots touched the yellow fungal web in the soil. Maybe the yellow gossamer would keep my seedlings healthy. But the rules required that the roots be planted in the underlying granular mineral soil, not the humus—figuring that the grains of sand, silt, and clay held more water late in the summer and therefore offered a better chance of survival—and the fungus mainly lived in the humus. Water, it was thought, was the most crucial resource that soils needed to supply roots so seedlings would survive. There seemed a very low chance of a change in policy so we could plant the roots in a way that they could reach the yellow fungal threads.

I wished I had someone to talk to out here in the forest, to debate my growing sense that the fungus might be a trustworthy helper to the seedlings. Did the yellow fungus contain some secret ingredient that I—and everyone—had somehow missed?

If I didn't find an answer, I'd be haunted by turning this clear-cut

into a killing field, a graveyard of tree bones. A brush field of rhododendrons and huckleberries instead of a new forest, a burgeoning problem, one plantation dying after another. I couldn't let this happen. I had seen forests grow back naturally after my family had logged near my home and knew it was possible for a forest to recover from a harvest. Perhaps it was because my grandparents had cut only a few trees in a stand, opening gaps where nearby cedars and hemlocks and firs could readily seed in, the new plants easily connecting to the soil. I squinted to spot the timber edge, but it was too distant. These clearcuts were huge, and perhaps their size was part of the problem. If they had healthy roots, surely trees could regenerate in this expanse. So far, though, my job consisted of overseeing plantations with little chance of turning into anything resembling the towering cathedrals once here.

That's when I heard the grunt. Steps away, feeding on a shifting bank of blue, purple, and black berries, was a mother bear. The silvertipped fur on the nape of her neck declared *grizzly.* A tawny cub, as tiny as Winnie-the-Pooh but with outsized fuzzy ears, was stuck to her as if she were a glue pot. The cub looked at me with soft black eyes and a glistening nose as if he wanted to run into my arms, and I smiled. But only for a moment. Mama Bear roared, and we locked eyes, both of us surprised. She towered onto her hind legs as I stood stock-still.

I was alone in the back forty with a startled grizzly. When I blew my air horn—*aaaanw!*—she only stared harder. Was I supposed to stand tall or curl into a ball? One response was to deal with black bears, and the other was for grizzlies. Why hadn't I listened to those instructions carefully?

The mama sank onto all fours, shaking her head, her chin grazing the huckleberry bushes. She nudged her little one, and they both turned on their heels. I slowly backed up as they crashed through the shrubs. She sent her cub up a tree, scrabbling on the bark. Her instinct was to protect her child.

I raced downhill toward the old forest, leaping over seedlings and rivulets, dodging the skeleton stumps of the beheaded trees, trampling shoots of hellebore and fireweed. The plants blurred into a green wall. I couldn't hear anything but my lungs grasping oxygen as I hurdled

over the decaying logs, one after the other, before I spotted the company truck next to a tree just off the road, as if it had rolled to a crooked stop.

The vinyl seats were torn, and the stick shift was wobbly. I fired the ignition, threw the clutch into gear, and hit the gas. The wheels spun, but the truck didn't move. Throwing the gear into reverse made them dig deeper. I was wedged in a mudhole.

I got on the radio. "Suzanne calling Woodlands, over."

Nothing.

As darkness fell, I sent a last plea over the airwaves. A bear could easily break a window with one swing of its paw. For hours I tried to stay a waking witness to my demise, but I dozed on and off, and in between I thought about my mother's skill with escapes. I pretended she was tucking me under blankets as she used to do before we drove over the Monashee Mountains to my grandparents' house, setting a pot on my lap and brushing my blond bangs aside because I had a habit of getting carsick. "Robyn, Suzie, Kelly, get some sleep," she would whisper, set to wind in and out of ravines slicing the mountain pass. "We'll be at Grannie Winnie and Grampa Bert's soon." Summers meant a break from teaching school and her marriage. My brother and sister and I loved those days, roaming the woods away from the silent feuds of our parents. Disputes over money, about who was responsible for what, about us. Kelly in particular was happier on those escapes, tagging behind Grampa Bert picking huckleberries, or fishing with him from the government wharf, or driving to the dump where the bears scavenged. He'd listen wide-eyed to Grampa's stories of courting Grannie when he came to buy cream from the Ferguson ranch, of helping Charlie Ferguson with calving in early spring, and of filling gut wagons with cow and pig offal during the fall slaughter.

I woke with a start in the dark, neck sore, not sure where I was, the windshield opaque with my condensed breath. Wiping drizzle off the glass with the cuff of my jacket, I peered into the black for wild eyes and glanced at my watch—four a.m. Grizzlies are most active at dusk and dawn, so I checked the door locks again. Leaves rustled like a wraith creeping by. I dozed until a fierce banging on glass made me scream. A man was shouting through the foggy windshield, and I was relieved the timber company had sent Al. His border collie, Rascal,

Left to right: me, five; Mum, twenty-nine; Kelly, three; Robyn, seven; and Dad, thirty, at Grannie Winnie and Grampa Bert's house in Nakusp, ca. 1965. All of our holidays were spent either with my maternal grandparents in Nakusp or my paternal grandparents at Mabel Lake.

jumped up and scratched my door, barking. I rolled down the window to prove I was still whole.

"You okay?" Al's voice was as loud as he was marvelously tall. He was still trying to figure out how to talk with a girl forester, to do his best to include me as one of the guys. "Must have been black as molasses out here."

"It was okay," I lied.

We'd more or less succeeded in pretending it was just another night on the job, and I cracked open the door so Rascal could squeeze in for me to pet him. I loved it when Al and Rascal drove me home from work, and Al would lean out and bark at the chasing dogs, which always yelped and ran the other way, much to his delight. I found this extremely funny, which egged him on to bark even louder.

I stretched my limbs outside the truck, and Al handed me a thermos of coffee while he took a stab at driving out of the mudhole. He turned the starter, and the cold-as-a-frog engine groaned. Dew speckled the rusty hood and the pink-blossomed fireweed lined the road. Watching through the coffee's steam, I wondered if we would have to abandon the *tacot rouillé.* But the truck started on the third try. Al floored the gas pedal, and the wheels spun in place.

"Did you lock the hubs?" he asked. The hubs were dials in the middle of the front wheels, at each end of the front axle. Manually twisting them ninety degrees locked the wheels to the axle so that they, along with the back wheels, would be torqued by the engine. With all four wheels turning, the truck could plough through anything. But with the front hubs unlocked, the truck had as much traction as a cat on linoleum. I almost died when he jumped out, twisted the hubs, and drove clear of the bog. Grinning, Al handed me the keys.

"Oops," I said, banging the heel of my hand against my head.

"Don't worry, Suzanne, it happens," he said, looking down to spare me the humiliation. "It's happened to me."

I nodded. A rush of gratitude flooded through me as I followed him out of the valley.

BACK AT THE MILL, I walked rumpled and sheepish into the office, expecting to be teased, telling myself I could take it. The men glanced up, then did me the courtesy of returning immediately to chatting, enjoying the hell out of their stories of building roads, installing culverts, planning cut-blocks, cruising timber. I wondered what they thought of me, so different from the women of the town and the girls on the pinup calendar by the drafting tables, but they mostly went about their business and let me be.

I caught up with Ted a short while later, leaning against his doorjamb until he looked up. His desk was stacked with planting prescriptions and seedling orders. He had four daughters, all under the age of ten. He leaned back in his swivel chair and said with a grin, "Well, look what the cat dragged in." I knew this meant he was glad I was back safely. They'd been worried. Plus—even more crucial—our sign

advertised "216 accident-free days," and I'd never hear the end of it if I'd broken our streak. When he suggested I go home, I said I had a little work to do.

I spent the day writing up my planting reports before mailing my envelope of yellow needles to the government lab to have the nutrition levels analyzed and checking the office for reference volumes about mushrooms. There were plenty of resources about logging, but books on biology were scarce as hens' teeth. I called the town library, glad to learn there was a mushroom reference guide on their shelves. At five o'clock, Ted and the guys prepared to head out to watch the football game at the Reynolds Pub before going home to their families.

"Want to join us?" he asked. Hanging out with guffawing men was the last thing I wanted, but I appreciated the gesture. He looked relieved when I thanked him and said I needed to get to the library before it closed.

I collected the mushroom book and filed my report on the plantation but vowed to keep my observations quiet and do my homework. I often feared I'd been hired into the men's club as a token of changing times, and my goose would be cooked if I came up with a half-baked idea about how mushrooms or pink or yellow quilts of fungus on roots affected seedling growth.

Kevin, another summer student, hired to help the engineers lay roads into unspoiled valleys, appeared at my desk as I gathered up my cruiser vest. He and I had become friends at the university, and we were grateful for these bush jobs. "Let's go to the Mugs'n'Jugs," he offered. It was at the other end of town from the Reynolds, and we could avoid the older guys.

"I'd love to." Hanging out with other forestry students was easy. I lived with four of them in the company bunkhouse, where I had my own dingy room with a single mattress on the floor. None of us was good at cooking, so pub nights were common. The bar also was a welcome respite because I was still hurting from breaking up with my first real love. He had wanted me to quit school and have children, but I wanted to become *someone,* my eye on a bigger prize.

At the pub, Kevin ordered a pitcher and burgers while I hunted on the jukebox for the Eagles song about taking things easy and watched