

“Henderson has a novelist’s knack for getting into the hearts and minds of her characters, and she makes complex science not only clear but exciting.”

—DAVID LASKIN, author of *The Family* and *The Children’s Blizzard*

THE NEXT



TSUNAMI

Living on a Restless Coast

BONNIE HENDERSON

The Next Tsunami

The Next Tsunami

Coming of Age on an Unsettled Coast

Bonnie Henderson

OREGON STATE UNIVERSITY PRESS • CORVALLIS

The paper in this book meets the guidelines for permanence and durability of the Committee on Production Guidelines for Book Longevity of the Council on Library Resources and the minimum requirements of the American National Standard for Permanence of Paper for Printed Library Materials Z39.48-1984.

Library of Congress Cataloging-in-Publication Data

Henderson, Bonnie, author.

The next tsunami : coming of age on an unsettled coast / Bonnie Henderson.

pages cm

Includes bibliographical references and index.

ISBN 978-0-87071-732-1 (alk. paper) -- ISBN 978-0-87071-733-8 (e-book)

1. Tsunamis--Pacific Coast (America) 2. Tsunami hazard zones--Pacific Coast (America) I. Title.

GC220.4.P37.H46 2014

363.34'940979509146--dc23

2013040039

© 2014 Bonnie Henderson

All rights reserved.

First published in 2014 by Oregon State University Press

Printed in the United States of America



Oregon State University Press

121 The Valley Library

Corvallis OR 97331-4501

541-737-3166 • fax 541-737-3170

www.osupress.oregonstate.edu

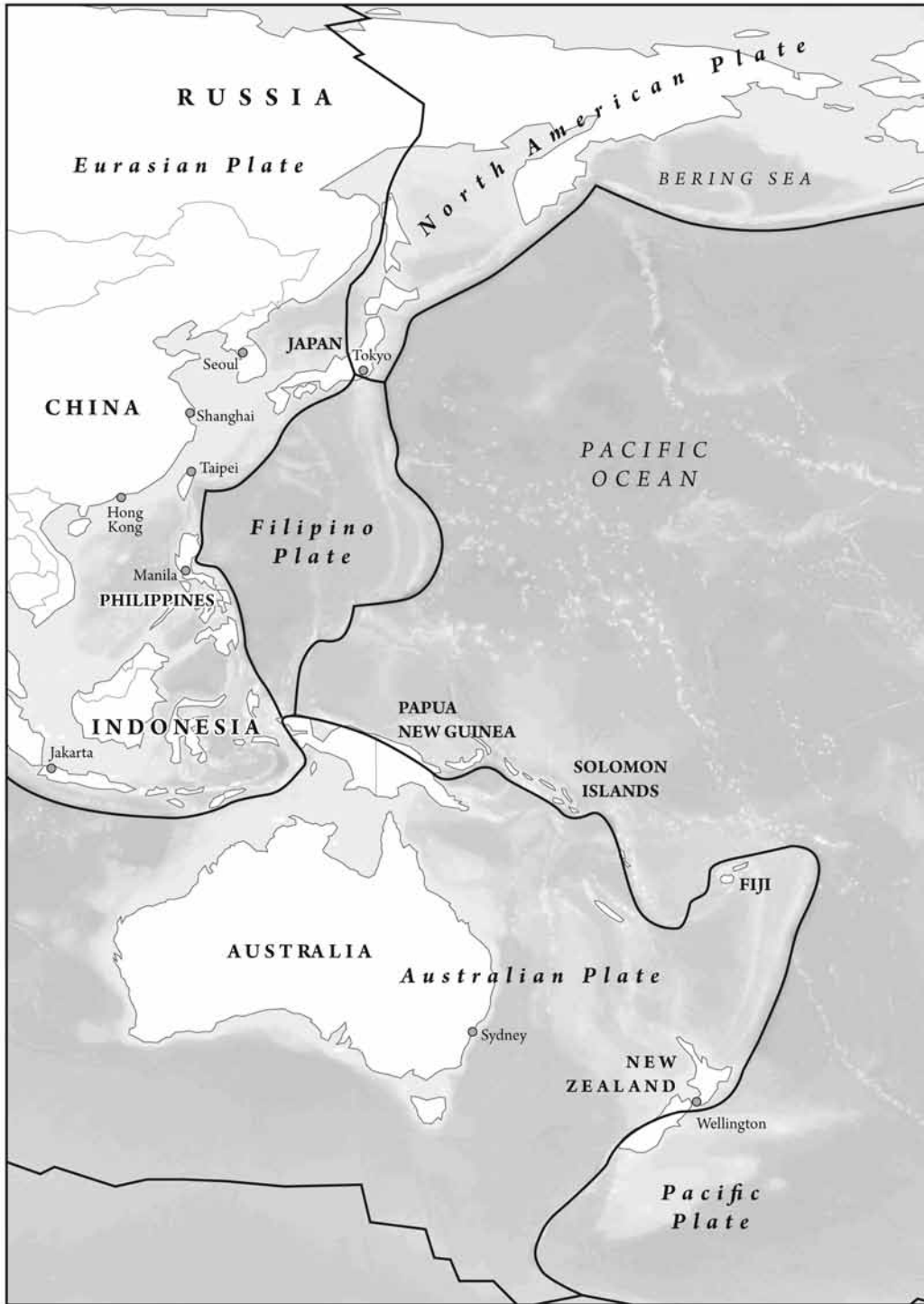
This is a work of nonfiction. Conversations not witnessed by the author have been reconstructed with the collaboration and approval of those participants still living.

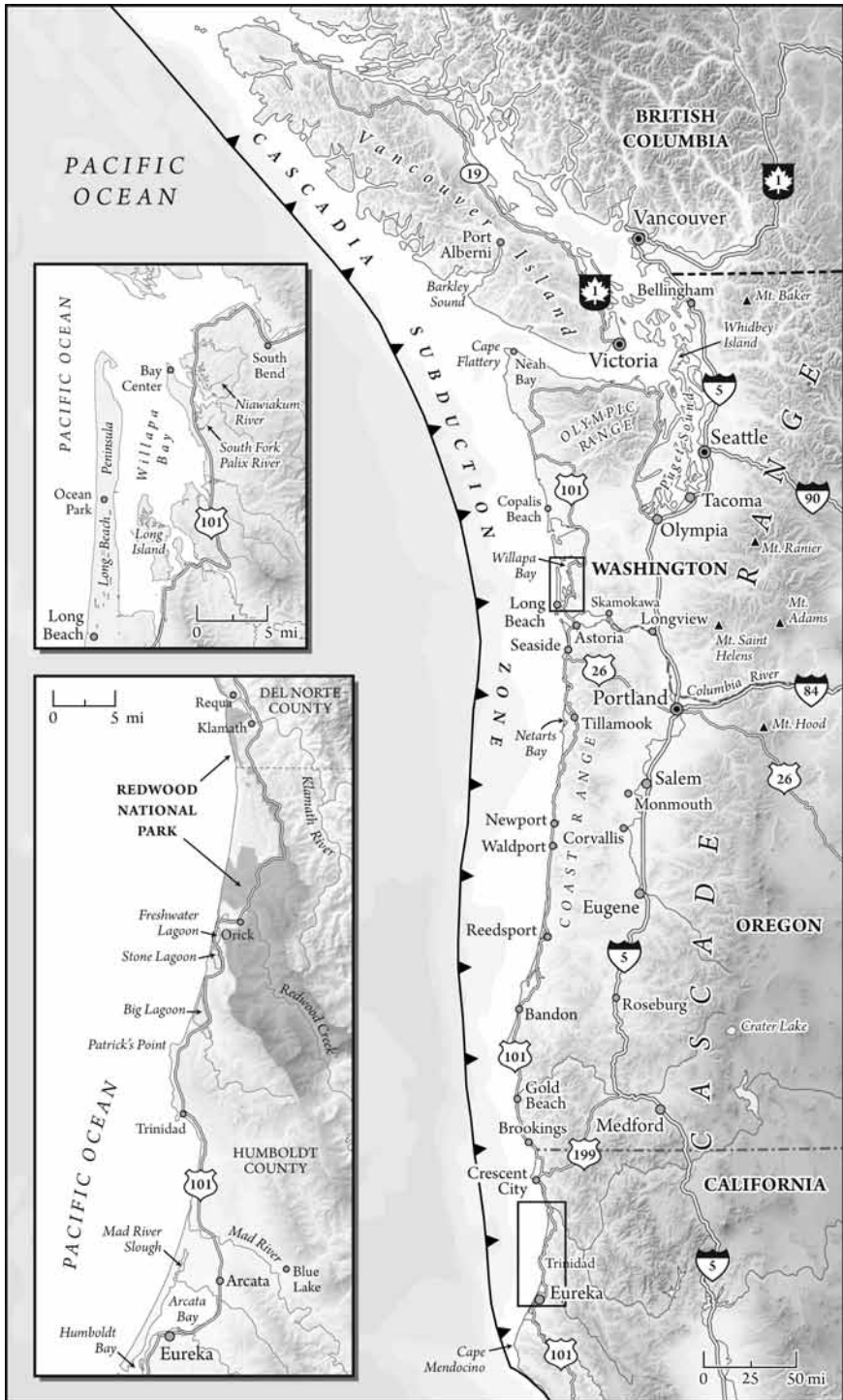
Seismologists use a variety of scales to characterize the relative size of an earthquake, including the local magnitude or Richter scale, developed in the 1930s, and the surface wave magnitude scale. The United States Geological Society now uses the moment magnitude scale, developed in the 1970s, to estimate all modern large earthquakes. Unless noted, mention of earthquake magnitude in this work is based on the moment magnitude scale.

Table of Contents

| | |
|-------------------------|-----|
| <i>Introduction</i> | I |
| <i>Prologue: Litany</i> | 3 |
| 1. The First Tsunami | 11 |
| 2. Barnacles Never Lie | 30 |
| 3. Silver Dollar | 42 |
| 4. A Flexible Worldview | 45 |
| 5. Mad Rise | 57 |
| 6. Live Land | 64 |
| 7. Pay Dirt | 68 |
| 8. Our Turbulent Earth | 75 |
| 9. Wave of the Future | 78 |
| 10. Epidote Dreams | 81 |
| 11. The Core Locker | 87 |
| 12. A Prepared Mind | 94 |
| 13. A Fresh Sandbox | 103 |
| 14. Last Glance | 111 |
| 15. Mad River Slough | 116 |
| 16. Stumped | 119 |
| 17. Ataspaca Prospect | 132 |
| 18. Thirty Minutes | 136 |
| 19. Home | 146 |

| | |
|----------------------------|-----|
| 20. Freak Accidents | 153 |
| 21. Wanted | 164 |
| 22. Reunion | 176 |
| 23. Drawing the Line | 180 |
| 24. Wanted II | 184 |
| 25. Test-ch'as | 189 |
| 26. Wisdom of the Elders | 210 |
| 27. Thirteen | 219 |
| 28. Star of the Sea | 225 |
| 29. Penrose | 231 |
| 30. Sumatra | 236 |
| 31. Higher Ground | 240 |
| 32. Aftershock | 252 |
| 33. S-XXL | 261 |
| 34. 3/II | 271 |
| 35. Strategic Investment | 286 |
| 36. Perpetuity | 294 |
| <i>Epilogue</i> | 303 |
| <i>Selected References</i> | 305 |
| <i>Acknowledgements</i> | 309 |
| <i>Index</i> | 311 |





Introduction

I FIRST MET TOM HORNING IN 2008 on a visit with my brother in Gearhart, Oregon. We had stopped for coffee and muffins at Pacific Way Bakery. In one corner a tall man stood, reclining against the wall, long arms clasped over his chest, holding forth good-naturedly on a range of topics, from the floodlights that shone on the beach and inhibited viewing of the night sky (an apparent pet peeve) to the pros and cons of a proposal in neighboring Cannon Beach to rebuild city hall as a tsunami evacuation building.

Randall waved Tom over to our table and we introduced ourselves. By the time we left the bakery, my head was swimming with the story I'd heard: of a man who, as a ten-year-old boy in Seaside, Oregon, had narrowly escaped being swept to sea when a tsunami rushed into the mouth of the river where he lived, a man who now parlayed his bona fides as a professional geologist and hometown boy to stir up interest in preparing for the much larger tsunami threatening the town, all the while continuing to live at what amounted to, in Seaside, Tsunami Ground Zero: the mouth of the river.

I began poking around, educating myself in the history of plate tectonics theory and the 1964 tsunami from Alaska. I was astonished at the pace of change that had occurred in the earth sciences in just the past half-century. Satellites were being launched into space well before humans had a clear understanding of what processes actually formed the valleys and mountains, the rifts, ranges, and deep ocean trenches of our own home planet, what caused it to periodically tremble and convulse, its seas to catastrophically overflow. I was also struck by the synchronicity of the science and by the almost uncanny correspondence between the course of Tom's life and the development of what we know of earthquake and tsunami risk on the Pacific Northwest coast. Not that he did the research himself, but he seemed to know everyone who did. (Just weeks before we met, Tom later told me with chagrin, he had accidentally broken the bow seat in Brian Atwater's aluminum canoe during a field trip with the esteemed geologist.)

Seaside, Tom's hometown, is just one of many communities from Vancouver Island to northern California threatened by a major tsunami from an earthquake at what scientists call the Cascadia Subduction Zone. But it is arguably the town most at risk, due to the size of its population

and the lay of the land. Shortly before I met Tom, the U.S. Geological Survey published a paper rating the tsunami vulnerability of towns on the Oregon coast. In chart after chart, the bar for Seaside stretched the longest, with neighboring Cannon Beach and Gearhart generally close behind and sometimes slightly ahead. Most acreage and percentage of developed land in the tsunami inundation zone? Seaside. Highest number of people living in the inundation zone? Seaside. Greatest number of schools, and child care centers, and clinics, and hotels, and churches in the tsunami zone? Seaside, Seaside, Seaside. In fact, Seaside's vulnerability to every category of tsunami mayhem was so high it made the city, statistically speaking, an outlier. Similar USGS reports for Washington and California followed. The Washington coast, like the west coast of Vancouver Island, is much less developed than the Oregon coast; except for Aberdeen, Washington's most vulnerable towns are very small, and Aberdeen has accessible high ground to run to. That state's most vulnerable shoreline state parks are on the Strait of Juan de Fuca, far east of the fault line, giving vacationers an hour to evacuate rather than, as on the outer coast, fifteen or twenty or thirty minutes. Crescent City, California, is about the same size as Seaside, but most of its residents live on high ground, as do most citizens of Eureka and smaller towns on Humboldt Bay.

"How can you write a book about a disaster that hasn't happened yet?" a friend had asked me. Fair question, and one I couldn't answer at the outset. But the world continues to turn, and the tectonic plates under us to shift and grow, about as fast as your fingernails grow: slowly, in human terms, but not imperceptibly so. Ultimately Acts of God (and, apparently, of small-town arsonists) provided the book's denouement.

From the start of my research, I knew this story wasn't really about a future disaster. It was about the quest to understand the geologic history of the Earth, and of one corner of the Earth in particular, a place Tom Horning refers to with love and irony as Tsunamitopia. And it is about how we choose to deal with that knowledge, and that uncertainty, as a society and as human beings with competing priorities and limited imaginations. Humans like Tom Horning, going to sleep and waking up in a beautiful place steeped in childhood memories and knitted together with lifelong relationships. A place he couldn't think of leaving.

Prologue

Litany

MARCH 10, 2011

IT WAS PAST 10 P.M. WHEN THE CHIME SOUNDED on the computer speakers in Tom Horning's office, which he hoped to lock up and leave well before midnight. The next meeting of the board of the North Coast Land Conservancy was scheduled for the following afternoon, and as secretary, Tom was expected to show up with minutes from the previous month's meeting. An e-mail at 10 p.m.? Probably spam, or chunnings from a fellow night owl. Nothing urgent, certainly, but one can't help but wonder. Curiosity overcame him.

He relaxed. The sender was "USGS ENS," the Earthquake Notification System of the United States Geological Survey. The subject: "(M 7.9) NEAR EAST COAST OF HONSHU, JAPAN." So not spam, but nothing urgent. Still, they were always interesting, these alerts that arrived almost daily, sometimes several in one day: constant reminders of the disquietude of the Earth. Tom had set his notification parameters so he would be alerted only by earthquakes in the Pacific Ocean region, minimum magnitude 7.5. Across the earth there are more than one hundred detectable earthquakes every day, some days more than two hundred, one place or another, most of them too small to be felt by humans. Tom knew it generally takes an underwater earthquake of at least magnitude 7.5 or so to generate a tsunami. And tsunami-generating earthquakes were the only kind Tom was really interested in.

Magnitude 7.9? It might be enough to trigger a tsunami, but not much of one. He clicked to open the message and scanned the stats. "Depth: 24 km"—*shallow focus, right at the leading edge of the subduction zone.* "Local standard time in your area: 21:46:23"—*just a half-hour ago. Mid-afternoon in Japan, March 11.* "Location with respect to nearby cities: 81 miles E of Sendai, Honshu, Japan." *Good thing it was just magnitude 7.9, or those poor people would be underwater by now.*

Tom had anticipated a late night when he arrived at his office after 8:30 that evening. Such are the dues of procrastination and passion and,

perhaps, over-commitment in the affairs of a small town. Tom's approach to preparing the meeting minutes was characteristically thorough, painstaking even; they were practically a transcript of the meeting, captured on a digital recorder, leaving nothing to chance. He leaned back in his heavy oak office chair, springs squeaking, to peer out his west-facing office window.

The headquarters of Horning Geosciences consisted of a single cluttered room on the ground floor of a small, two-story office building—just right for a one-man operation—off U.S. Highway 101 at the north end of Seaside, a dozen miles south of the Columbia River on the northern Oregon coast. Across the highway, beyond a slice of ebony water where Neawanna Creek emptied into the wide Necanicum River estuary, he could see a light on in the kitchen of his own small white house, gray in the moonless night and hunched just above the waterline at the end of the peninsula south of the estuary. No light escaped the living room windows, but the wooden blinds were probably closed. This time of night his wife, Kirsten, and father-in-law, Mike, were almost certainly in that room, watching television.

Some evenings Kirsten worked at her printmaking, gouging grooves in blocks of wood, chipping away the negative space between what would become, once the block was inked and pressed onto paper, a shore pine's needles or the vanes on a kingfisher's wing. But at the end of a day spent working at the community college in Astoria, television in the living room was her after-dinner default. TV is what usually occupied Mike, except when Kirsten or Tom got him out of the house for a drive or a meal at a restaurant. He didn't remember anything of what he saw on TV, but he seemed to enjoy the parade of images.

Lights from other living rooms and kitchens shone like sparks in the otherwise dark neighborhood, but no moonlight penetrated the clouds that night to sheen the estuary or frost the ocean breakers beyond. Poking the bridge of his glasses with a finger, Tom swiveled back to the monitor. *Well, no time like the present*, Tom thought—maybe even said out loud to himself, as he sometimes did, alone in the office. Two hours, he figured. Three, max.

Tom had moved his office out of the back bedroom of his house and into this small business complex just a few years earlier. It was where he tended to do his volunteer work as well as his *work* work—geologic hazard assessments, mostly, for homeowners and prospective homeowners and business owners and sometimes governmental bodies seeking to avoid landslides, slumping, or other unpleasant surprises. Everything he needed was here, and here

everything fit him: the office chair, the large oak desk with its legs raised on blocks, the bookshelves stretching almost to the ceiling, the side tables within comfortable reach of his long arms. At six feet, four inches, Tom was a tall man, solidly built. All was arranged for his convenience, in heaps mostly, strategically placed: the parks and recreation district's business in one clump (he was a member of that board too), city documents in a couple of other piles (he chaired the city's planning commission), his books and journals and maps, his computer-monitor-printer-fax assemblage, buttes of unshelved reports, a drift of unfiled memos at their angle of repose. The door and walls were plastered with posters advertising recent nature walks with the land conservancy, some led by Tom, and brightly colored geological maps, one nearly as tall as Tom himself. Those maps revealed at a glance—if you knew what you were looking at—the story of uplift and subsidence and tension and compression across North America from the collision of tectonic plates and related forces of nature across millions of years. A very old story, one as clear to Tom as the nightly news; nearly as predictable, eminently more sensible. Working at night, alone in his office, Tom not only had access to all the resources he might conceivably need, but he was subject to a minimum of distractions. So when the phone rang ten minutes later, he was momentarily startled.

“Tom, it's Al”—Al Smiles, director of the Seaside Chamber of Commerce, his voice strained with urgency. The introduction was unnecessary. No one else with that crisp Welch accent would be calling Tom at that time of night, or maybe ever. “There's just been a big earthquake in Japan, and they're expecting a tsunami. I'm watching CNN. It sounds pretty serious.”

“Oh, yeah, I just saw that,” Tom replied laconically. People worry so much, he thought. They don't realize how many earthquakes go off every day, all over the globe. Devastating for the people on the ground, of course. All a part of life on Earth.

“Are you watching the television?”

“I'm in my office, Al,” Tom replied, patiently, almost teacherly. “No TV here. A tsunami, huh? Well, I don't expect it will be much of one. The quake wasn't particularly big.”

“Well, we'll see. Let's hope not.”

Odd, Tom thought, hanging up and turning back to the computer to refocus on the meeting minutes. Al Smiles had spent twenty-three years in the British army, fifteen of them in special ops. He had been the personal

security advisor for a dot-com billionaire before following his fiancée to Seaside, Oregon. Now, when he wasn't figuring how to lure more tourists and retirees and businesses to Seaside, he volunteered with Clatsop County Search and Rescue, rappelling down sea cliffs to reach injured surfers or clueless hikers stranded by the incoming tide. *Takes a lot to rattle Smiles.*

Not ten minutes later the phone rang again.

"Tom, you'd never guess." It was Smiles again, his voice even more urgent. "I'm watching it on CNN. They were saying, 'We're expecting a tsumami,' and then they cut to this scene of a port full of boats, and then this wave arrived and the boats were all getting pushed under this big bridge, and there were cars driving along the waterline getting picked up ..."

"So they've had a little local wave action there in Japan?" Tom asked, humoring Al, meanwhile checking the computer for updates. Nothing—just a preliminary magnitude 7.9 earthquake off Japan. It was a good spot for a bad earthquake, certainly. Right on the Japan Trench, where the northwestern edge of the Pacific tectonic plate collides with an arm of the North American Plate—the Okhotsk Microplate, some geologists called it. *Fifty years of plate tectonics*, he mused, *and we still know less about how our own Earth works than about the locations of dwarf galaxies 200,000 light years away.* But Tom had faith in the numbers—and more confidence in himself than in news reports from the other side of the globe. Whatever Al thought he was seeing, it couldn't be that bad, not from a magnitude 7.9 quake.

"Oh my God, Tom, you're not going to believe this," Al continued, "it's just absolute devastation, they're showing this wave going up this big flat-bottomed valley and it's taking everything out with it, houses and cars, pushing this debris—my God, there's a building on fire floating on top of the water, I've never seen anything like it, it's just complete devastation ..."

"Oh, really?" Not that Al was prone to exaggeration, but magnitude 7.9? That was hardly big enough to produce even a small tsunami. "I'll have to watch it later at home."

"I wish you could see this, Tom. You wouldn't believe it, oh my God ..."

"Well, I'll be up for a while, Al. Call anytime."

Tom checked the clock in the corner of the monitor: past 11 p.m. He'd barely made a dent in the land trust minutes. *Might not get home by midnight after all.*

Not until about 11:30 did the phone ring again.

“Hey, Tom, you should see this footage they’ve been showing on the news.” It was Kirsten. “It’s pretty startling.”

“Yeah, well, it can’t be too bad. It wasn’t much of an earthquake, all things considered.”

“It looks pretty big on TV. The video shows some pretty big shaking, stuff falling off buildings, and now this tsunami pouring over seawalls and picking up cars and houses ...”

“I’ll check it out. I’ve just got to finish these minutes, then I’ll be home. Might be after midnight, at this point.”

“What do you think? Should we be worried here?”

“I can’t see why. I haven’t seen anything yet to indicate we’ll get a tsunami here. But I’ll keep an eye on it.”

“OK. I may stay up.”

“Don’t wait up for me.”

She stifled a laugh. “I won’t.”

Tom turned back to the computer, but clicked away from the land trust minutes and over to the Internet, where he started opening familiar websites: the USGS, the National Oceanic and Atmospheric Administration, and its West Coast and Alaska Tsunami Warning Center. There it was, unchanged: preliminary magnitude 7.9, accompanied by a “Tsunami Information Statement” for California, Oregon, Washington, British Columbia, and Alaska—*information* being NOAA-speak for the lowest level of alert, really no alert at all. “NO tsunami warning, watch, or advisory is in effect for these areas,” it read. *Pretty emphatic “no,”* he thought. *Good thing, that emphasis. People do tend to overreact.*

A *distant* tsunami—that’s the possibility NOAA was referring to, and the term coined for it. The tsunami Japan was apparently experiencing, if there really was a tsunami, would be a *local* tsunami, kicked up by an earthquake off Japan’s own shore. The greatest damage from a tsunami like that would be to the nearby shore: to Japan itself. But tsunamis are also long-distance travelers. They cross entire oceans at the speed of a jet plane, losing power incrementally but—depending on the severity of the quake and other factors—maintaining the capacity to do damage thousands of miles from where they started. At Seaside, Oregon, for instance, and the rest of the west coast of North America. Especially Seaside, and places like it: Crescent City, California, and Vancouver Island’s Clayquot Sound and Alberni Inlet—flat coastal plains, and bays and fjords where an incoming

tsunami, distant or local, gets squeezed and its effects get magnified. If this quake in Japan did stir up a tsunami big enough to cross the Pacific Ocean to Oregon, it wouldn't be the first time. Seaside's fire chief and police chief and city manager were probably huddling right now, Tom figured, assess the danger and figuring whether or when to activate the city's new, improved tsunami warning sirens scattered around town.

But magnitude 7.9? It was possible geologists had initially underestimated the magnitude of this thing, he mused. He opened a screen listing the coordinates of the fault zone off Sendai, Japan. If the quake *were* big enough to generate a significant tsunami, it would already have begun crossing more than 4,000 miles of Pacific Ocean, headed east-southeast toward California and Mexico, he calculated from the angle of the trench. Not aimed directly at Seaside. But Seaside might catch the edge.

Then a new e-mail popped up, this one from the community organizer hired by the state's Department of Geology and Mineral Industries to boost tsunami awareness and preparedness in Clatsop County. The e-mail added nothing to what Tom already knew and seemed, to Tom, to be jumping the gun a bit: "FYI everyone. Biq earthquake and tsunamis in Japan right now. No official watch or warning for our area yet, but I am certainly texting my Warrenton, Gearhart, etc., friends."

Tom turned back to the land trust notes. He managed to focus for another ten minutes or so before until another chime sounded, from the same community organizer. The subject line: "FW: TSUNAMI WATCH ISSUED."

Tom knew the language. *Watch* was NOAA's official term for "danger level not yet known; stay alert, and was just one step above *Information* ("minor waves at most; no action suggested"). *Watch* was followed, in order of urgency, by *Advisory* ("strong currents likely; stay away from the shore"). At the top of the hierarchy was *Warning*: "inundating waves possible; full evacuation suggested."

The land trust minutes could wait. Tom clicked away from that screen to the NOAA website—they were still calling it a magnitude 7.9 quake, which was genuinely odd—then opened the CNN streaming live footage from Japan. Al was right; this was no minor tsunami. Then shortly after 12:30 a.m., he checked NOAA's West Coast and Alaska Tsunami Warning Center site again.

Bingo. There it was, the update he by now expected: magnitude 8.9, an entirely different ball game. Not just one-eighth bigger than a magnitude 7.9, but—according to the logarithmic scale used to quantify earthquakes’ energy and potential for mayhem—thirty-two times bigger. An *enormous* quake, one of the biggest on record anywhere in the world, if this new magnitude estimate held, just shy of the 2004 Indian Ocean earthquake, which spawned a tsunami that killed more than 230,000 people and wreaked havoc along coastlines throughout southeast Asia. This quake off northern Japan was, by any standards, a Big One. Big enough to kill a lot of people in Japan. Big enough, probably, to send some kind of measurable wave to North America. Possibly even to Seaside.

It would be an interesting night, and morning, and that thought made Tom smile. There would almost certainly be TV reporters calling him from Portland, and live interviews with reporters who would be, even now, scrambling to gather a crew and make the hour-plus drive to the coast to film the action and get commentary from Tom Horning, Local Geologist and Tsunami Expert. If he could unearth his old camcorder from under the piles of papers and miscellany in his office, he’d be able to videotape the wave himself, documenting its entrance into the Necanicum River from his favorite tsunami-watching spot: the rise at the end of Twenty-Sixth Avenue, two blocks from his house and directly east of the bay mouth. Distant tsunamis don’t hit Seaside every day, not even once a decade, on average, at least according to official reports. These distant tsunamis were always exciting: another opportunity to add data points to his on-going, lifelong study of tsunami behavior in Seaside, Oregon.

Exciting, but not alarming. This was not the tsunami Tom spent at least part of every day thinking about, ranting to the city manager or planning director about, e-mailing politicians and fellow geologists and members of Seaside’s Tsunami Advisory Group about. A distant tsunami like this was a double-edged sword, he figured: it got people in Seaside thinking about tsunamis, and that was a good thing. But it got people thinking the wrong way, thinking that they’re no big deal, that if you buy new warning sirens, you’re done, you’ve finished the job.

The tsunami Tom did worry about would make warning sirens irrelevant. Minutes before that tsunami hit, the sirens would probably be silenced by the force of the earthquake, which he fully expected would cut the electricity

even as it manufactured a tsunami the likes of which no one has witnessed in North America for hundreds of years.

Three hundred and eleven years, to be exact. And two months.

He hoped he wouldn't miss it, frankly—felt, in a way, that he was entitled to witness it, given the nearly twenty years he had spent learning about it and preparing for it and trying to engage others in Seaside to prepare for it. He was fairly confident he and Kirsten would survive it, suspected that his father-in-law and many of his neighbors would not. He already knew what he would say to the TV reporters when they started calling, any moment now: "... a distant tsunami, not the same as a local tsunami, really not dangerous as long as you stay off the beaches and out of harbors ...” Knew what he wished he could say, to them and to every city official who kept pushing tsunami readiness to the bottom of the to-do list.

The land is talking to you all the time! he would tell them. *It's an interesting language. If God talks to us, he does it through natural forces. And this litany of stuff that we're living through, the earthquake in Chile, and now in Japan? It's telling us that we're going to have one here pretty soon, and you better be ready. Really, what the hell is wrong with you that you can't hear these messages?*

Tom swiveled the heavy chair to take another look out the window, at the point of light that, despite the reflections cluttering the window's surface, shone like a tiny beacon across the highway, beyond the black estuary: the light in his own kitchen window.

I've never had God really talk to me except through geology, Tom mused—maybe even spoke the words, to no one but himself.

It's loud and clear. I wish other people would listen.

1

The First Tsunami

TOM, 1964

IT WAS CALLED GOOD FRIDAY, but to a ten-year-old boy living at the mouth of the Necanicum River on Oregon's north coast, every Friday was good. It took Tom Horning fewer than ten minutes to pedal home from Central School in downtown Seaside to the Venice Park neighborhood where he lived, across the bay from the outlet of Neacoxie Creek. He would have at least three hours to play outside until dinnertime. After dinner there would be TV in the living room with the family, maybe even *The Twilight Zone* if his mom was in an expansive mood, and then the whole weekend lay ahead. This day—March 27, 1964—could actually be characterized as a great Friday. For one thing, the weather was perfect: sunny, shirtsleeve warm, not much wind. Not at all typical for late March in Seaside, where early spring was often drizzly at best or, at worst, lashed with sou'westers that pummeled the shoreline with huge waves and littered yards with the downed limbs of Sitka spruce and shore pine. But not this weekend. The forecast called for more fair weather, at least through Saturday, which meant a dry Easter egg hunt at the city park.

It was a fairly straight shot north up Holladay Drive, along the east bank of the river, past the old wooden Fourth Avenue Bridge (condemned to cars but a handy shortcut for kids on bikes) and the bridge at Twelfth Avenue, past the high school and its playing fields, then across Twenty-Fourth Avenue, where Tom veered onto Oregon Street. The houses here were modest, the yards neat with blooming daffodils and spike-leafed crocosmia or strewn with Japanese glass floats and other beachcombing treasures, the vacant lots bristling with a tangle of salal and blackberry and spruce. Two blocks farther, at Twenty-Sixth Avenue, he turned right and pedaled the last block to his house at the corner of Twenty-Sixth and Pine. He ditched his bike in the garage, picked up his new Tonka dump truck, and headed back outside.

The truck was perfect: bright yellow cab with real windows, a yellow hinged dump box just like a real dump truck, black wheels and grill and bumpers, and not a scratch on it. Tom had had it only nine days, since his

tenth birthday. He grabbed the truck and started walking west, up Twenty-Sixth Avenue toward the broken lines of ocean breakers he could see over the top of the bluff, two blocks away. He was headed toward his favorite spot in the world: the edge of the bay where the Necanicum River mingled with the waters of Neawanna and Neacoxie creeks before dumping into the Pacific Ocean. At the top of the bank he resumed excavation operations, using sticks and his hands to dig in the hard, cemented sand layer just below the top of the bank, where the brushy shoreline vegetation ended and the sandy riverbank began.

Tom sat cross-legged, leaning into the bank and squinting in concentration, his mouth set slightly open with a sense of expectancy. He was a stocky, gap-toothed boy already as tall as many adults, his brown hair cut short and ragged by his mother's scissors. Most of his friends already had Tonka trucks, many since the first grade. He had yearned to have what the other boys had. That desire had gnawed at him, had led him finally to beg his mother for it. And this year she'd given in. Maybe the cancer had overridden her usual frugality—cancer and weeks of absence in Seattle, recovering from surgery. Bobbie Horning wasn't the most demonstrative of moms, not big on hugs. She had other ways of showing her affection. A truck, for instance.

Now that he had it, he didn't know quite what to do with it. Another boy might have put the yellow dump truck to work transporting sand from one locale to another. Tom had at his disposal an unlimited inventory of soft river sand just steps away, a whole bay full of it. Beyond lay Oregon's widest ocean beach, composed of sand transported over millennia from the Cascade Range to the ocean via the broad Columbia River, which met the Pacific some fifteen miles to the north. But the firm upper riverbank was what drew him: a place not so much to work the truck as to park it. The compact sand here had just the right structural integrity for single-truck garages, hollowed-out sand caves whose walls, he wagered, wouldn't easily collapse in wind or rain.

The Hornings' house was one of a small collection of houses that made up the north Seaside neighborhood of Venice Park—aptly named, with water on three sides. Tom's house was the last one on Pine Street, at the very end of the peninsula formed where Neawanna Creek, running north, curved west and met the broad estuary at the mouth of the Necanicum River, also running north. Ocean, river, creek. Water in one form or another defined Seaside. The wide ocean beach was what drew the tourists and turned the

town crazy in summer, easily doubling its population of 4,000. Spring break was even wilder, keeping the police busy corralling partying college students. But tourism was what had put Seaside on the map almost a century earlier, with its holiday hotels and tent camps by the seashore, and tourists of all stripes were what kept it going in 1964 as well. The motels and restaurants and chowder cafés and bars. The souvenir shops with their T-shirts and salt water taffy. The arcades and bumper cars and Ferris wheel. The aquarium with its octopus and jellyfish and harbor seals, performing for the tourists and applauding their own antics with slick gray pectoral fins.

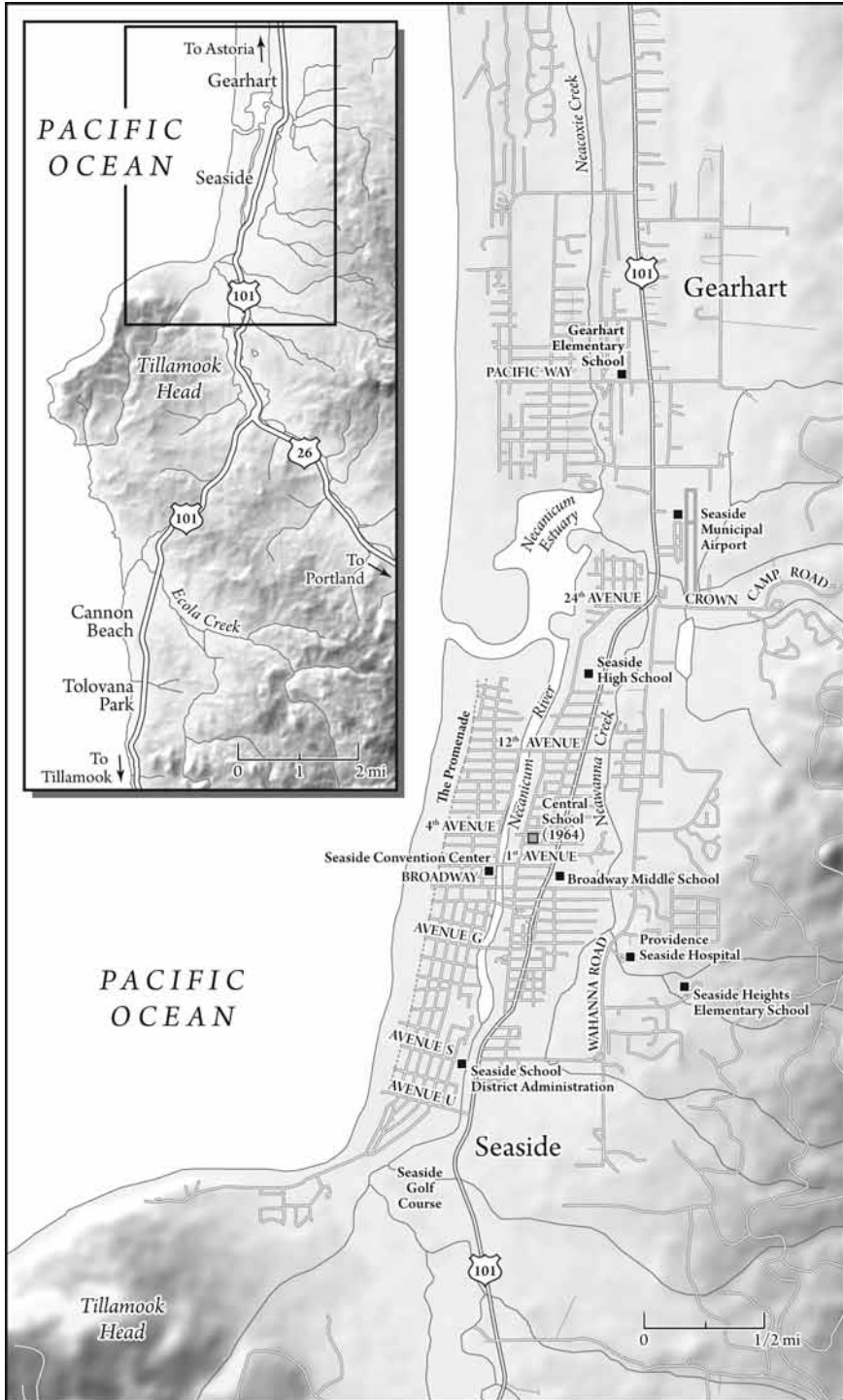
To get to the beach from the highway running through town, you first had to cross one of a half-dozen bridges over the Necanicum River, which bisected downtown. The Necanicum tumbles west out of the Coast Range, calming to a slow meander when it reaches the coastal plain, veering north when it hits the base of 1,150-foot-tall Tillamook Head, the mountain of basalt defining the south end of town, then meeting the creeks and swinging west a scant hundred yards to join the sea. You hardly noticed the river running through town, for all the restaurants and shops crowding its banks, until you needed to go east or west through downtown and had to find a bridge. Neawanna Creek flows parallel to the Necanicum just a few blocks to the east, more or less defining the city's eastern edge. It serves to separate the town from the rolling patchwork of growing trees and clear-cut forest that dominate the view to the east, forest nurtured by the rain that drizzles, or showers, or drips, or dumps much of the winter and spring.

Tom and his four siblings—two older sisters, an older and a younger brother—had moved with their mother to the house at the edge of the bay five years earlier, after their father had died. Tom had been born at Seaside Hospital and spent his first five years at Crown Camp, a logging camp and company town in the forest three miles east of Seaside. John Horning—educated in architecture but lacking a degree—worked as a purchasing agent and sometimes as facilities designer for Crown Zellerbach, the biggest player in the leading industry in Clatsop County, which was cutting down trees and turning them into lumber and paper products. Crown Camp was a little company town of about twenty houses and offices clustered on three lanes set deep in the woods where the Coast Range runs down to meet the Clatsop Plains. Tom and his three older siblings had had the run of the place. Identical white frame houses with little yards and laundry lines and sandboxes. A jungle gym and a baseball diamond. Gravel roads with

logging trucks grumbling incessantly by. Surrounding Crown Camp were deep woods where massive trees grew out of the hulking stumps of other, older trees, and the ground was a sponge of moss overlain with knobby tree roots, and red-legged frogs hid at the edges of muddy seeps shaded by salal and huckleberry. Everyone knew everyone else at Crown Camp. There were drunken fathers and sober fathers. Suspended fathers with muddy hardhats carrying chain saws with grimy hands, and fathers in white shirts and clean hardhats carrying blueprints. There were mothers with crossed arms and defeated faces. Mothers with open doors, and sometimes cookies. Bobbie Horning was different from most of the other mothers at Crown Camp, mothers who wouldn't allow their children to leave the yard on their own or to venture past the last house or beyond the ball field, lest they get lost in the woods or run over by a log truck. *I took the laissez-faire approach*, she would tell people with a laugh. *I figured with five kids, I could afford to lose one or two.* And everyone would laugh with her when she said it, even her own kids, because they all knew it wasn't true.

In the summer of 1959, just after Tom had turned five, his father had been transferred to Crown Zellerbach's office in downtown Portland, and Tom and his four siblings—baby David had been born the previous October—traded Crown Camp and the infinite forest for a house in the Portland suburb of Milwaukie. Just three months later, Tom's father entered the hospital with a bleeding ulcer on his esophagus and didn't come home. John Horning, whose hemophilia ruled out rough work outdoors, who couldn't risk cutting his finger, started to bleed inside. Doctors transfused him again and again, a special blood drive was held, 265 pints of strangers' blood was pumped into his veins and was filtered through his kidneys before bleeding back out. It took nearly a week for him to die. Eventually his blood started to clot, but by then, his kidneys had worn out.

There wasn't much outward grieving. Bobbie had suddenly become a widow with five children ages ten and under. The kids tucked their grief and confusion inside, and Bobbie focused on moving forward. There was never any question about where they would live; all of their friends were back in Seaside, either at Crown Camp or in town. Bobbie's first task was to find a job there. She had trained as a registered nurse, though most of the nursing she'd done was with her own kids. She started asking around and found that Dr. Russell Parcher, the general practitioner who had delivered both Tom and David, was looking for an office nurse, and he hired her. Next,



she needed a house for the six of them. Bobbie found one for sale on the Necanicum River in the middle of town, just blocks from Dr. Parcher's office and Central School, a convenient location. Then she heard about another house several blocks north, at Twenty-Sixth and Pine. It was farther from downtown but just a short walk from the high school, which the kids would all eventually attend. And as at Crown Camp, there was plenty of room for children to run and play outdoors, minus the log trucks.

Tom would never forget the details of their return to Seaside that day in September 1959. By the time Bobbie had packed the last box and loaded baby David and five-year-old Tom into the station wagon and left Portland it was already late afternoon. She had barely pulled into the driveway when Tom jumped out of the car and ran to catch up with his older siblings, who had arrived earlier with family friends. They had already been under the house and inside the old detached garage and across the yard to the little two-story cottage and out onto the river beach, beyond the white plank fence that scribed the boundary between the bay and the lawn surrounding the house. The tide was rising, hissing quietly as its leading edges crept over the hard white sand flats. Tom could see his sisters standing on a dock built on pilings over the river at the edge of the property, and he ran over to join them. He walked to the end of the dock and stood there, surveying his new realm. To the west was the broad estuary, swelling with the tide that carried lopsided clumps of sea foam the color of buttermilk, and beyond them the white breakers marking the river's meeting with the Pacific Ocean. To the north, past the flat expanse of tidewater and salt marsh where narrow Neacoxie Creek slipped southward into the bay, he could see lights starting to twinkle in the houses above Little Beach, in the community of Gearhart. His eyes traced the curve of Neawanna Creek eastward, upstream, where the creek narrowed, flowing lazily alongside the highway.

By now his sisters were lying face-down, peeking through cracks in the dock to watch the water below, and he joined them, flattening his face against the damp, splintery planks. The water that evening was crystal-clear, and as his eyes adjusted, he began to see schools of silvery shiner perch flashing in the water. Below the perch, milling along the bay's sandy bottom, were the dark brown bodies and fleshy whiskers of bullheads.

"Look!" Lynne whispered, nudging him. Through the clear water, they could see a jumble of old logs, discarded metal tanks, and a broken boat rudder, all submerged by the tide and colonized by clumps of white

barnacles. In the fading light, Tom could make out feathery appendages emerging from the little fortress-like barnacle shells: wispy fingers, urgently raking the water with rhythmic intensity. “See! You can see them gathering in food!” she said.

Tom had never seen anything like it.

Never—not even at Crown Camp—had he been in a place quite so magical, and so alive. With every shift of the tide, every minute even, something changed, something new revealed itself. Even the bay itself was constantly changing, its channels and pools continuously reshaped by storm and tide. In the summer he would join the other neighborhood boys skinny-dipping on the ebbing tide, bathing in the sun-warmed freshwater pools until someone would shout *ocean water*, meaning the tide had turned and the cold Pacific—55 degrees at best—had started streaming in. Then they would make their way to shore and pull on their clothes and haul the rowboat off the lawn and go crabbing, combing the sandy bottom with garden rakes until a big Dungeness crab would grab the tines with muscular pincers, clinging all the way into the boat. Alone or with Pat, his best friend, Tom spent his fair-weather days outdoors, crabbing and fishing, watching the waves spilling onto the bay shore or soldiering up the river with the tide. They built driftwood forts and dug in the sand to build sand castles, sand volcanoes, sand moats, digging, designing, compacting, destroying, until his mother called him inside for dinner. And sometimes, spring through fall when the days were long, he’d be back outside even after dinner.

This night, however—Good Friday 1964—he stayed in. *International Showtime* had started at 7 p.m., and the whole family was watching TV—everyone but five-year-old David, who was already in bed, and Bobbie, who was around the corner in the kitchen, doing the last of the dinner dishes. Lynne, a freshman at Seaside High, and her boyfriend, Lyle, a junior and a football player, were snuggling in an armchair; they’d just come in from a romantic float in the family’s rowboat, riding the incoming tide under the full moon. Judy, Chris, and Tom filled the sofa in the compact living room, with Muffin, the family shepherd mix, curled at their feet. On the TV, tigers were jumping through flaming hoops at a circus, urged on by a tall ringmaster in tails and a black top hat. Now and then he’d crack a long, black whip on the ground, directing the big cats this way and that. The German audience was applauding rhythmically—*clap, clap, clap, clap, clap*,

nothing like the chaotic applause Tom was used to at, say, football games or school assemblies. It was strange, the mechanical clapping. Tom reached down to scratch Muffin's back.

Then the circus scene vanished and a newscaster's head and shoulders appeared. "We interrupt this program to bring you a special bulletin," Chet Huntley intoned. "A massive earthquake struck the state of Alaska approximately 45 minutes ago, at 5:37 p.m. Alaska Standard Time. At least five people are known dead, and property damage is extensive. The main street in Anchorage has been completely flattened, and the city is in darkness. Tidal waves have reportedly struck several coastal towns, but few details are available, as communication with the region has been almost entirely cut off. Civil defense authorities are warning coastal communities to the south to prepare for a possible seismic sea wave."

The image on the screen switched from Huntley's face to a map of the wide northern Pacific Ocean. Alaska hunched in the upper right, looking a little like an elephant's head with the chain of Aleutian Islands its trunk, stretching west in a broad arc. Down the left side of the TV screen were the islands of Japan, and on the right side, the west coast of North America. Concentric curves—the presumed path of the tidal wave—were depicted fanning out across the Pacific, marching southward from Anchorage. The right tip of one curve ended in a scattering of islands off the Alaska panhandle. Another, south of it, touched cigar-shaped Vancouver Island. And one touched the Oregon coast just below the indentation indicating the mouth of the Columbia River, at a bump on the map that Tom knew well, the place where the long, straight coastline was abruptly broken by the jutting bulk of Tillamook Head.

Tidal wave? Tom looked around. None of his siblings seemed to be the least bit alarmed. *Tidal wave, here?* Well, Tom *was* a little alarmed. Someone should tell Mom at least. He got out of his chair and scrambled into the kitchen. "Mom? There's going to be a tidal wave," he told her matter-of-factly, standing next to her at the sink, looking up at her face in profile.

Bobbie didn't respond, not right away. She continued to work at the dishes, running a soapy sponge around a greasy plate rim, turning the plate under a stream of water from the faucet, lodging it in the dish drainer to drip, reaching for another plate. Finally, eyes still on the sink full of dishes, she spoke. "Why don't you go to bed," she said. "Chris too."

Her response struck him as odd—and patently unfair. It wasn't even bedtime yet, not even weekday bedtime, and here it was Friday night. Tom turned, a little puzzled, a little defeated—and a little relieved. He had done his duty. He had alerted his mother about the life-threatening disaster that Chet Huntley himself said was, at that very moment, bearing down on them. But if she wasn't concerned, why should he be? There had been many tidal wave warnings in Seaside in recent years. Sometimes they even blew the siren at the fire station. Nothing ever came of these warnings. He'd never actually seen a tidal wave. Nobody had, not in Seaside. And Tom recognized his mother's tone. There was no point in arguing with her about bedtime, early or late, tidal wave or no tidal wave.

He headed to the bathroom to brush his teeth, jostling with eleven-year-old Chris for room at the sink, then followed Chris out the back door and a dozen steps across the dark yard. Since the previous summer, both boys had slept upstairs in the little cottage between the house and the river, freeing up space in the main house, which was getting more crowded with two teenage girls in the family. Their Grandfather Baker—their mother's father—had visited from California for a few weeks the previous summer and had taken it upon himself to update the cottage and make it habitable. It had been built back in the 1930s, probably as a summer rental. There were entrances on both the river and the house side—porches that a previous owner had enclosed to shut out the often-harsh coastal weather. A little half-bath occupied part of the south entrance, closest to the house, the entrance the boys generally used. Grandfather had taken out the decrepit old toilet and replaced it with a new one. He had also installed a shower, and he had hooked up toilet and shower to the city sewer system, which had only recently reached the houses in Venice Park. He had also run an underground electrical line out to the cottage so the boys could have heat in their bedroom. As for the north-side porch, the Horning kids themselves had turned it into what they called the “hamsterium,” a little room where their half-dozen pet hamsters (and one rabbit) could run free. They'd shoved an old steamer trunk against the inside of the north entrance; people could step over it, but it kept the animals from escaping when the kids came in and out through that door.

Tom could hear the rustling sounds of hamsters nibbling their sunflower seeds and burrowing under the linoleum floor as he passed the hamsterium and headed up the wooden staircase in the dark, could smell the familiar

smells: the perfume of cedar shavings mingling with the sour ammonia odor of rodent pee. At the top of the stairs, he could see the estuary through the north window, black water streaked with a sheen of moonlight, and the dark void of spruce forest bordering Neacoxie Creek on the other side of the bay. Now and then the twin spots of headlights appeared at the forest's edge and moved down the highway that followed the bayside. He pulled off his shoes and socks and pants and sweatshirt and crawled between the familiar cold sheets, curling into a ball, feeling the weight of the blankets and waiting for his own body heat to warm the bed.

Tom, Tom, wake up, Tom. It was a man's voice. He felt a hand on his shoulder, shaking him awake in the dark, reeling him up from the soft, muffled depths. It was Lyle, Lynne's boyfriend, his big hand rough, and urgent.

"Hey, Tom, wake up. There's been a tidal wave," he was saying. "Come on, let's go. There's been a tidal wave. Let's go to the house."

Tom bolted upright. "I knew it! I knew it!" he cried, instantly awake. Across the room, Chris was sitting up and rubbing his eyes. "Let's go, boys," Lyle reiterated, moving toward the stairs in the dark.

The three of them started down at a trot, Tom and Chris still in their T-shirts and underpants. The wooden stairs were cool on Tom's bare feet. Two steps above the landing where the staircase made a turn, Tom first felt dampness underfoot. From there to the landing and down the final three steps everything was wet. When he reached the bottom, his feet felt not the slick of the cottage's linoleum floor but the grainy burr of wet sand, a thick layer of it. Lyle led the way out over the sand-covered floor, through the open inner door, and stepped over a white board that was now inexplicably plastered across the bottom of the outside entrance at a slight angle, clinging with nails driven into the siding at either side. It looked like one of the planks from the fence at the edge of yard, above the river. Tom followed Lyle over the rail and onto the lawn.

But there was no lawn. What he saw instead was like something from a dream: familiar and eerily unfamiliar at the same time. Every inch of what had been green grass was now covered with dark, wet sand. The sand was strewn with debris. Some of it was the same stuff Tom was accustomed to seeing in the wrack line on the beach after a storm: clumps of seaweed and grasses and driftwood of all sizes. But there was more. Thick, lustrous

yellow foam clumped in piles a foot or more thick all over the sand, and more of it piled deeper against the house and cottage. And fish: flounders and perch and bullheads, lying still and scattered all over the yard. And little waxy, translucent pink shrimp the length of Tom's pinky finger, thousands of them, everywhere.

Tom took a few steps, then stopped and stared, surveying the known world. The house was there, and the old, two-story detached garage, but the concrete block patio wall on the north side of the house had collapsed. The fence was gone, its posts still standing but the flat white planks all missing—all but the one that had apparently fastened itself across the cottage entrance. The dock, too, had vanished. So had the rowboat that Lynne and Lyle had left upside down on the lawn after their moonlight float a few hours earlier. An outdoor rabbit hutch that had stood along the west wall of the cottage now staked a claim in the middle of the yard. The chicken coop, too, had drifted west but was still upright, the chickens apparently still alive, judging from the low rustling sounds that came from within. East of the cottage, drift logs lay scattered on the yard, huge logs, one as wide as Tom was tall. Beyond the north edge of the yard, past the shore pines, the river was running out fast and full like a winter flood tide, laden with dark, angular, moon-washed objects—more logs and other floating debris Tom couldn't quite make out. Across the short expanse of sand-covered yard between the cottage and the house, he could see his mother standing outside the back door, watching them, her arms crossed over her chest in the cool of midnight, hugging herself. His brothers and sisters were all out wandering on their new backyard beach too, smiling and laughing as if a little drunk on it all. And there was Mr. Jensen, their bachelor neighbor, in his long white nightshirt and white nightcap, his bare legs thrust into leather work boots, a quizzical expression on his face as he went about poking the toe of his boot into piles of debris. There was a tang in the air, a briny smell like low tide, fresh and pungent, mixed with the faint odor of rotten eggs.

Tom's mouth, which had been hanging open, now spread into a wide smile. He drew in a breath and felt his shoulders fall back, his arms reaching wide. "I knew it!" he said, over and over. "I knew it! I knew it!" He began to turn in place, and soon he was running in big circles, the balls of his feet slapping the wet sand, finding their own way among the pink shrimp, the slick, green seaweed, the buttery foam. Around and around he ran, laughing, his arms open and stretching to the very tips of his fingers, as if

to embrace it all: the glistening sand, the shrimp, the logs, the late hour, the moonlight, whoever or whatever had granted him this night, this best night of his whole life.

Like most Seasideers, Tom's family had been taken entirely by surprise, unless you count the TV news bulletin that had interrupted *International Showcase* hours earlier, a bulletin that no one in the Horning family but Tom seemed to have paid any attention to. They never heard an emergency siren. What they did hear was a sharp clanging sound coming from the basement. Judy, Lynne, and Lyle were still up, watching *Portland Wrestling*, and Bobbie was curled up with a book, keeping one eye on the teenagers, when they all heard what sounded like the metal garbage can bouncing down the basement stairs, making a terrible racket. Which made no sense, given that the garbage can was kept outside, next to the basement door. Maybe Whitey, the family's half-feral cat, had knocked it over—which still didn't make any sense. Everyone looked up at the sound. Then the lights all went out, the TV screen flickering to black. Everyone looked out the front window, their eyes drawn by the glimmer of moonlight on water, black water that now entirely surrounded the house, water where a yard and driveway should be, water already higher than the living room floor, or so it appeared.

"The boys!" Bobbie shouted, and she ran to the kitchen and out the back door and out onto the little porch, several steps above the yard. Water lapped just below the porch, an inky, swirling moat. To the north, a current was racing through a channel of water that now ran between the house and the cottage, flowing west toward the ocean like a fast-ebbing tide. "We have to get the boys!"

"Hold it!" Lyle was right behind Bobbie, and now he grabbed her—a strong woman, as tall as he—and held her to keep her from wading into the fast-moving water. "You can't go out there. Just wait. I'll go out and get them, soon as the water drops," he told her. "It's not getting any higher. The water's got to be dropping soon." She set her mouth, then nodded, irritated to be told what to do by a seventeen-year-old boy, but knowing he was right. Lyle let go, and the four of them stared at the little shingled cottage, a square, pale gray island in the stream, willing it to stay put and not get battered by logs or picked up and swept away with the debris they could see floating toward the bay mouth.

Gradually the pace of the water slowed. Gradually—it felt to Bobbie like an hour, but it was probably not more than fifteen minutes—the water level dropped and drained, and the river returned to its channel, and all that was left between the house and cottage was a wet, sandy, debris-strewn beach.

The Horning children wandered around in the moonlight for a half-hour or more, not venturing much beyond their own yard, where there was plenty to see. The family's new blue Rambler station wagon, which Bobbie had bought not six months earlier, was ruined; the flood had picked it up from its spot in front of the house and floated it about a hundred feet. Now it was resting near the end of the driveway. Beyond it, across the road, the Finnish Meeting Hall was a shambles. It had apparently floated off its foundation, swung around 45 degrees, and then collapsed in a heap, surrounded by big driftwood logs. The meeting hall, their car, their own house and cottage—every surface within two or three feet of the ground was covered with big globs of cream-colored sea foam.

Sometime after midnight Bobbie finally gathered up the kids and herded them into the house. No water had seeped into their living area; at the height of the flood, the water hadn't actually risen much above the level of the floor, despite how it had appeared through the living room window. But the force of the wave had pushed open the basement door, which sat a couple of feet lower than the main floor of the house, and water had flooded down the stairs, carrying the metal garbage can with it and filling the basement with seawater that destroyed the furnace and hot water heater. Otherwise, the house seemed to be more or less intact, and the danger over. Bobbie lit a fire in the fireplace, gathered blankets and sleeping bags, and settled all the kids together in the living room to finish out the night, much as she did when winter storms knocked out the electricity.

At first light, Tom was back outside, checking on the pets. Muffin, of course, was fine; the dog had spent the night inside curled up with the kids on the living room floor. The chickens were indeed all alive and, judging from the murmured clucking coming from their coop, apparently none the worse for their short cruise from one side of the yard to the other. Handlebars, the French lop rabbit that lived in the outside hutch, was also unharmed. But when Tom went inside the cottage to check on the residents of the hamsterium, it was another story. All the hamsters were dead. So was the indoor rabbit, which Tom found halfway under the steamer trunk, foaming at the mouth. All had apparently been electrocuted when the flood

waters had come in contact with exposed electrical wires. Both the rabbit and the hamsters had developed a bad habit of gnawing the insulation off the Romex wiring Tom's grandfather had strung along the wall during the previous summer's remodel.

Whitey the cat was nowhere to be seen.

Tom poked around in the cottage some more. The sand now covering the floor was two-and-a-half inches thick. A faint line of scum on the walls and lingering dampness on the lower stairs showed precisely how high the water had risen inside: two-and-a-half feet, nearly as high as the doorknobs, almost to Tom's waist.

Back outside, Tom and Chris started picking up the ghost shrimp that littered the sand-covered yard—their waxy pink bodies flaccid, not designed to exist outside of their sand tunnels—and throwing them back into the river, where flocks of gulls now swarmed, scavenging. Hundreds of earthworms had wriggled up through the sand as well, joining the shrimp and flounders and sole and perch scattered there. The air was ripe with the smells of life churned up in the estuary. That, and something more. The septic tank, abandoned the previous summer when the city sewer line reached Venice Park, had floated up and out of the ground like a big balloon. Now it poked through the sand, the sulphurous gasses within it seeping out and mingling with the estuarine perfume of salt and decay.

Tom's and Chris's bikes, tucked in the old detached garage, were unharmed, so the two boys grabbed them and did a slow cruise of the neighborhood, riding on the sand that now covered the neighborhood's dirt lanes and asphalt streets, past shingled houses whose bathtub rings of yellow scum clearly delineated the previous night's high-water line. They saw cars on their sides up against houses and huge logs across driveways, blocking doors and windows. The Jacksons' house, two blocks from the Hornings', sat alone at the end of the point, where north-flowing Neawanna Creek curves west to join the Necanicum River. Even before they reached the house, they could see it was a disaster site. Nearly all the landscaping around the house was gone, and the living room's west-facing picture window looked as if a bomb had hit it; the actual culprit, a drift log five feet in diameter, lay on the sand-covered yard a few feet away. They peeked inside the waterlogged living room and could see the family's baby grand piano lying on its side in front of what had been the house's east wall but was now a gaping hole. A couple of blocks to the south, the boys stopped at

the sand-covered highway and stared at what was left of the railroad bridge over the Neawanna: wooden supports dangling from iron rails.

Tom didn't venture much outside of his own neighborhood that day. It made him uneasy, somehow, all that chaos, things not being in their right places, not unlike the way he'd felt after his father died. What most interested him, anyway, was the river and the riverbank where he'd been digging the afternoon before. He headed there after lunch, half expecting to find his carefully excavated caves destroyed. But when he reached the end of Twenty-Sixth Avenue and dropped over the bank, there were the little garages he had dug, entirely intact. The tidal wave had clearly flooded his excavation site, but the riverbank and the walls of his hand-dug garages had held. That surge of water that had filled his own basement and blown open the Jacksons' house and torn up bridges had apparently flowed swiftly but sweetly past his excavation site, leaving almost no evidence of its passing.

The day was just as fair as the day before, mild and sunny. Tom plopped down on the bluff to watch the water for a while. The sand flats were bare, typical of low tide in the bay. Which made no sense; low tide should have been hours away, Tom knew. In fact, the bay should have been full of water by now, approaching high tide. Then he saw first one wave and then another roll up the river channels, waves rushing upstream cresting two or three feet high. It was the fastest incoming tide Tom had ever seen. He was mesmerized. This he had to see at close range. He began walking out across the sand flats toward the bay mouth.

He was about two hundred feet from the bank when he saw water begin to spill out of the channel and move toward him. Nothing dramatic: the water just crept across the sand flats in one long, low, relentless surge, covering them with an inch or two of dark, sand-laden water that spread ceaselessly, its leading edge jumping and popping, as if tripping over itself. Tom began walking backwards, watching and waiting for the pause between waves when the water would sink into the sand before the next wave lapped over it. But there was no pause. He picked up his pace. The water kept advancing, a dark, liquid creep. Finally he turned and scurried for the bank, running the rest of the way down Twenty-Sixth Avenue to his house.

When he got there, he found the rest of the family in the backyard, watching this new surge. Some of the debris that had floated into the estuary on the retreating wave the previous night—logs, appliances, pieces of the Fourth Avenue Bridge, which had been demolished by the tsunami—was

now rolling and tumbling on the waves, gyrating as if the bay were boiling. It was like an encore, churning up more foam and filling but not quite spilling over the banks of the river and creek.

By now tourists had begun trickling through the neighborhood, rubbernecking the damaged houses and sand-layered lawns. There were always plenty of tourists in Seaside, but they generally stayed downtown or on the beach; Tom had never before seen a tourist in his neighborhood, north of downtown and well off the highway. He watched as car after car slowly cruised down Pine Street, pointing and smiling at Tom and his siblings through car windows. Some got out of their cars to take pictures of the damage or pluck souvenirs from wreck-strewn front yards, as if collecting shells on a beach. One car came to a slow stop in front of a house that had Japanese glass floats tucked into the rose garden—precious floats the owners had themselves found on the beach years earlier, floats that, surprisingly, hadn't drifted away but had stayed put, lodged in the mud, when the previous night's tidal wave had flooded the yard. A car door opened, and a boy jumped out. He ran across the yard, snatched one of the floats, and high-tailed it back to the car to deliver it to the smiling driver, apparently the kid's father. It was odd; they didn't look like crooks. They looked like any other tourists. But what Tom saw were thieves, people stealing from his neighbors. To the east, Tom saw black vinyl records flying over the treetops; someone must have entered the Jacksons' house and was filching, or just vandalizing, their record collection. The tidal wave seemed to have suspended ordinary rules of behavior.

Not until the next day, when the *The Sunday Oregonian* newspaper arrived, did the Hornings and their neighbors get the big picture. The front page featured photos of the damage in Anchorage: exterior walls of the five-story J.C. Penney store sheared away, collapsed into a pile of rubble; stunned residents staring at the gaping hole where Fourth Avenue used to be, below a banner advertising an upcoming production of *Our Town*. President Johnson had declared the state of Alaska a major disaster area. With communication lines fractured, estimates of damage and casualties were hard to come by, but early reports suggested the death toll in Alaska could exceed fifty.

Miraculously, no one had drowned in Seaside or Cannon Beach, Oregon, or anywhere on the Washington or British Columbia coasts. The only disaster-related death in Seaside was that of Mary Eva Deis, the fifty-year-

old sister and housekeeper of one of the priests at Our Lady of Victory Catholic Church. Apparently she and Father Deis had been in the process of evacuating by car when they stopped briefly in front of the fire station, at the very moment the chief of police sounded the siren directly overhead. The sudden wail amid the panic of evacuation must have been too much for Miss Deis's heart; her head fell back, her shoulders slumped, and she was gone.

But down in Newport, one hundred miles to the south, four children camping with their parents on the beach had drowned when the arriving wave engulfed the driftwood shelter they were sleeping in, sparing the parents but sweeping all four children out to sea. Worst hit of all, outside of Alaska, was Crescent City, on the northern California coast. Eleven people had been killed and thirty blocks of homes and businesses flooded. Waves had flipped cars around, piling them up, driving them into and under buildings. Houses had been picked up and dropped on the highway. Some of the victims had been enjoying an evening out and had been trapped in waterfront restaurants and bars by the surge. A number of fishermen, upon hearing the belated warning, had begun motoring out of the harbor in an effort to evacuate to deep water, but the gathering wave had sucked so much water out of the harbor that it grounded their boats and forced the fleeing fishermen to dash on foot across the exposed harbor bottom. Another boat on the bay had overturned, tossing seven people into the churning water. One man clung to his house as he watched the water carry his wife away. Homeless residents huddled at the county fairgrounds where families had hunted Easter eggs the day before. South of Crescent City the tidal wave lost most of its punch; it wasn't big enough to do any damage by the time it reached San Francisco and San Diego, where thousands of people had flocked to the beaches and shoreline viewpoints to see it, ignoring pleas by police to get to high ground. Tide gauges as far as Japan and Chile and even the Palmer Peninsula in Antarctica registered the seismic sea wave's arrival.

There was a silver lining, for Seaside, at least: scientists had no reason to believe that a tsunami had ever before struck the Oregon coast, nor had they any reason to think that another would strike again any time soon. "Wall of Water First for State," declared the headline in *The Sunday Oregonian*. "The U.S. Coast Guard reported Sunday night that its records showed no previous tidal waves in Oregon or Washington. Threats? Yes. Tidal waves? No."

As residents of Venice Park began the job of cleaning up—ripping out waterlogged carpets and replacing furnaces and hosing sand off floors—the Hornings and their neighbors began to realize how lucky they'd been. Or how unlucky, depending on how you looked at it. If the tsunami had struck Seaside three or four hours earlier, at low tide, Tom's neighborhood wouldn't have flooded at all. The tidal wave might have manifested as nothing more than a series of surges up the main channel of the Necanicum, a cresting bore similar to the one that muscled up the river after the massive 1960 earthquake in Chile, nothing more than that. They might not have called it a tidal wave at all.

If, on the other hand, the weather had been stormy, as it often is in March, the story might have been quite different. Had the surf been a few feet higher than the mild, two- to three-foot surf that Good Friday evening, waves wouldn't have merely splashed over the oceanfront Promenade and leaked through its vents. Waves five or six or even eight feet high would have crashed onto the Prom, sending logs through the houses all along on the oceanfront, the way the log did crash through the Jacksons' front window, washing torrents of seawater down every street downtown. Water may have risen not just two or three feet in Tom's neighborhood but four or five feet or more, filling dozens of houses to the ceiling as it had the Jackson's house and just a few others at the bend in the Neawanna. Had just one or two factors been different, the hospital's ground floor, which had been dampened by the wave, and perhaps a school or two would have been inundated. A lot of people would likely have drowned. A couple more feet of water, and the little cottage Tom and Chris had been sleeping in would certainly have been wrenched free from the pilings it was anchored to, would have been swept up in the tsunami's retreat and floated out to sea.

Could Oregon have an earthquake of the size that had struck Alaska? It's unlikely anyone in Seaside even dwelt on that possibility. Alaska was rife with earthquakes; in Oregon, earthquakes were rare. And Seasideers were far too busy pointing fingers about the last tsunami from afar to worry about an earthquake closer to home. "Something must be done to provide authentic warnings on tidal waves," read an editorial two weeks after the fact, as new information about the town's lack of warning came to light.

The clean-up was the most immediate concern, especially for residents of the inundated neighborhoods. Debris lay strewn throughout Venice Park and between the oceanfront houses lining the Prom: drift logs, appliances,

propane tanks, bridge parts, lawn furniture. Thick foam clung to the lower walls of buildings, begging to be scrubbed, and a layer of ocean sand had settled on lawns and roads, everywhere the tsunami had reached before withdrawing.

The owners of the Twelfth Avenue Grocery lent Bobbie their delivery car to use for a couple of weeks until she was able to buy a new one. Members of the Hornings' church pitched in to help with the clean-up at Tom's house, shoveling out the basement and hosing the sand out the door of the cottage and scrubbing its floors. While the adults worked, Tom played outside, using a hose to carve moats and gullies and canals in the layer of tsunami sand covering the lawn.

Whitey the cat never reappeared. Tom had a hard time believing he'd drowned. He liked to think that Whitey had been swept upstream in the surge and had found a new house to live under, a new family to adopt. Whitey was a tough old boy.

At least it was over. In an editorial immediately following the tsunami, the *Seaside Signal* captured the sense of relief that dominated the community's mood following the only such waves ever known to have struck Seaside, causing the biggest disaster in local memory. Clearly someone had "slipped badly" in failing to warn Seaside and other Northwest coastal communities of the approaching tsunami, the editorial writer acknowledged, but there was no need to be overly concerned about the future. "This thing will probably never happen again in our lifetime."

“Brilliantly written... The depth of reportage is impressive.”

—WILLIAM DIETRICH, *New York Times* bestselling author of *The Barbed Crown* and *The Emerald Storm*

“That the West Coast of the U.S. is ill-prepared to deal with a major earthquake and tsunami comes through loud and clear.” —*Publishers Weekly*

On a March evening in 1964, ten-year-old Tom Horning awoke near midnight to find his yard transformed. A tsunami triggered by Alaska’s momentous Good Friday earthquake had wreaked havoc in his Seaside, Oregon, neighborhood. It was, as far as anyone knew, the Pacific Northwest coast’s first-ever tsunami.

More than twenty years passed before geologists discovered that it was neither Oregon’s first nor worst tsunami. In fact, massive tsunamis strike the Pacific coast every few hundred years, triggered not by distant temblors but by huge quakes less than one hundred miles off the Northwest coast. Not until the late 1990s did scientists fix the date, hour, and magnitude of the Pacific Northwest coast’s last megathrust earthquake: 9 p.m., January 26, 1700, magnitude 9.0—one of the largest quakes the world has known. When the next one strikes—this year or hundreds of years from now—the tsunami it will generate is likely to be the most devastating natural disaster in the history of the United States.

Illuminating the charged intersection of science, human nature, and public policy, *The Next Tsunami* describes how scientists came to understand the Cascadia Subduction Zone—a fault line capable of producing earthquakes even larger than the 2011 Tohoku quake in Japan—and how ordinary people cope with that knowledge. The story begins and ends with Tom Horning, who grew up to be a geologist and returned to his family home in Seaside—arguably the Northwest community with the most to lose from what scientists predict will be an “apocalyptic” disaster. No one in Seaside understands earthquake and tsunami science—and the politics and psychology of living in a tsunami zone—better than Horning.

BONNIE HENDERSON is the author of three books, including *Strand: An Odyssey of Pacific Ocean Debris*. She divides her time between the Oregon Coast and her home in Eugene, Oregon.

Cover photograph by Bonnie Henderson

Cover design by David Drummond

Oregon State University Press

ISBN 978-0-87071-732-1

