


*Para Paxita y Alexandra*

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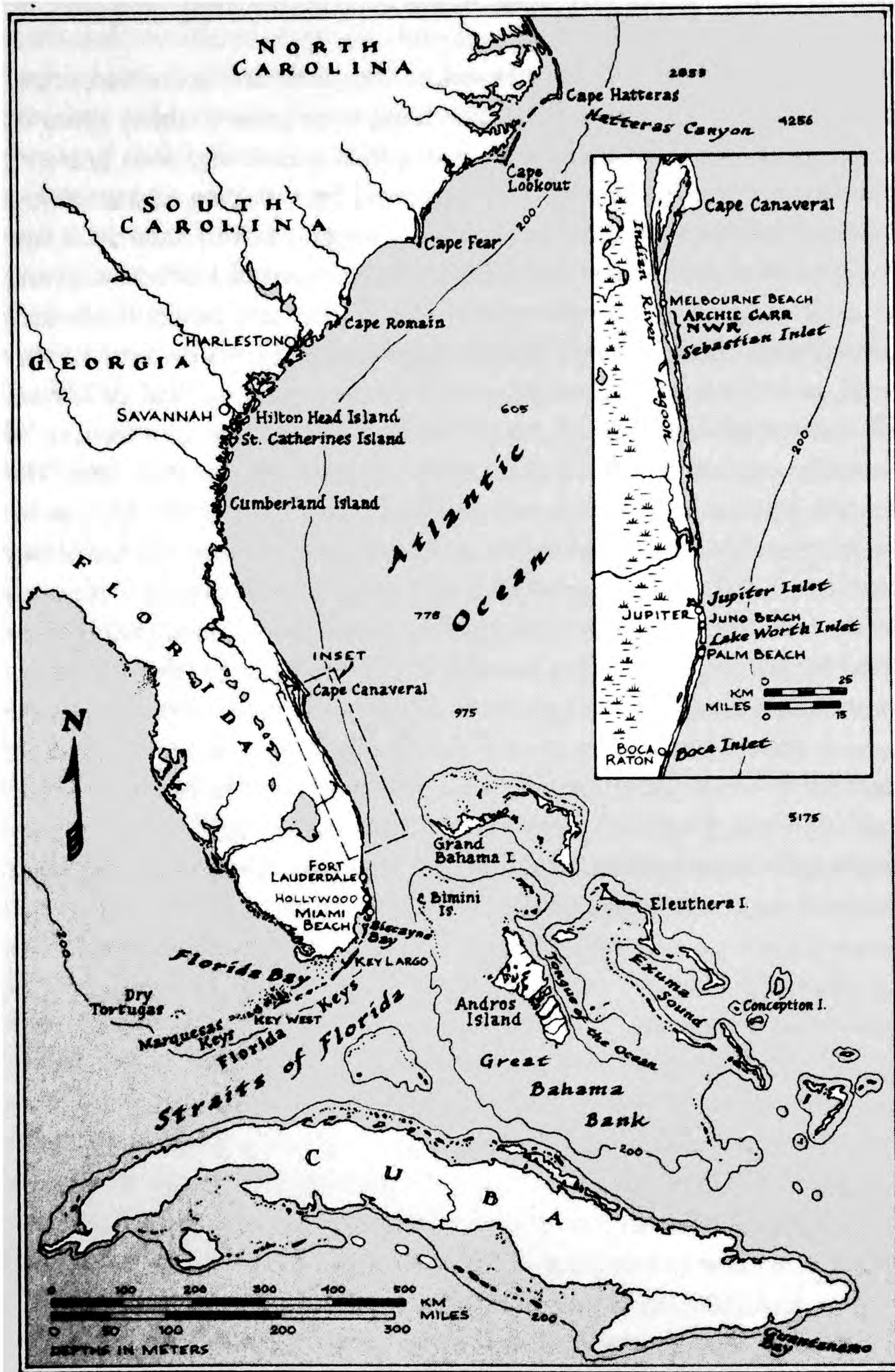
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## CONTENTS

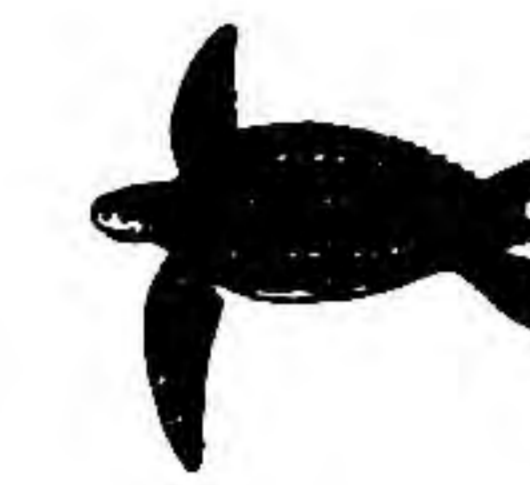
Gratitudes	<i>xiii</i>
Setting Course	1
<b>PART I: ATLANTIC</b>	
Angels of Eden— <i>Trinidad</i>	9
Weight of the World	38
Moonlight in the Sunshine State— <i>Florida</i>	45
Leatherbacks and Cannonballs— <i>South Carolina</i>	73
On the Edge— <i>Georges Bank</i>	117
Animal Magnetism	148
Northeast of Summer— <i>Cape Breton Island</i>	152
<b>PART II: BETWEEN OCEANS</b>	
The View from Turtle Island	187
<b>PART III: PACIFIC</b>	
The Great Beach— <i>Costa Rica</i>	213
Flying Turtles— <i>Mexico</i>	242
Baja	259
The Other Grand Canyon— <i>Monterey Bay</i>	284
Jamursba <i>Belimbings</i> — <i>New Guinea</i>	317
Chant for the Enchanted	341
Appendix: A Few Places to See Nesting Sea Turtles	350
References	352
Index	369





## MOONLIGHT IN THE SUNSHINE STATE

*Florida*



Juno Beach, Florida, with its oceanfront high-rise condos and hotels, is a very different seascape from Trinidad’s jungled beaches. But the street signs picture turtles, and the parks and shopping malls are named after sea turtles. Loggerhead, Green, and Leatherback Turtles still use the beach. Juno Beach is, in fact, Leatherback Central in Florida.

But nesting’s been slow. “It hasn’t felt like summer yet,” says Kelly Stewart. “We’re averaging under one Leatherback a night.” Kelly’s many sleepless nights searching for Florida Leatherbacks will earn her a Ph.D. at Duke University—if more turtles start showing. Dark-haired and energetic, Kelly says, “There’s increased nesting in Florida. We want to know how many Leatherbacks are coming, how many clutches they’re each laying, how often, what’s the hatching rate. We want to track where they’re going between nestings, what kind of habitat they’re hanging out in, and migration routes. And genetic relationships to others in the Caribbean. That’s all maybe ambitious, but”—she smiles a little shyly—“those are sort of our main objectives.”

Kelly continues: “In the early 1990s there were about two hundred nests in the whole state. Suddenly it spiked up to four hundred, five hundred, a thousand. It’s been hovering around five hundred to eight hundred. It seems to be going on throughout the Caribbean, numbers spiking.”

At sundown we fuel an all-terrain vehicle and Kelly puts a small red flashlight around her neck. Kelly and her colleague Chris Johnson will be running the beach between Jupiter Inlet and Lake Worth Inlet at Port of Palm Beach. About twenty-four kilometers, fifteen miles or so.

First priority: place your bet. Where will a Leatherback show up? I say, “Two A.M. on the north end.”



Chris is going north. Kelly takes the south half and me. We carry tags, pliers for said tags, tape measure, Betadine and blood-sampling equipment, ice for blood samples, a GPS unit, a cell phone in a waterproof bag, a camera, extra fuel.

I'm sitting on our ATV's equipment rack as we approach the beach. Kelly kills the headlight because turtles dig darkness. The night is warm with breeze enough to banish bugs. We turn south in the night, running the dark sand at a restrained pace. As she drives Kelly often stands—for miles at a time—alert and on the lookout. Constant vigilance pays; Kelly's never hit a turtle.

The first several miles of beach are quite dark, because we're riding alongside MacArthur State Park. Southward, the dark visages of distant beachfront high-rises ascend a sky backlit by human ingenuity. Kelly says there are two reasons the buildings look dark: half the inhabitants are snowbirds now flown north for the summer, and ordinances require keeping lights out for the turtles.

Much of the beach has long steplike sand escarpments three to six feet high, where waves have taken out swaths of sand. These are hazardous to any ATV driver inattentive in the small hours. Kelly says that most years, at this season, the beach is flatter, the water calmer. But this year, higher winds wrought erosion later into the season. Three years ago engineers pumped extra sand onto a three-mile stretch of this beach; this "scarpiness" may be the ocean yet carving away sand pumped along the tide line.

At ten P.M. we almost zoom past a Loggerhead obscured in a wrack line marbled with the shadowed camouflage of cast-up seaweed. Kelly stops in the turtle's track and checks: "Yeah, she's laying." But Kelly is studying only Leatherbacks. We continue.

The beach seems devoid of other human life. Yet the sand bears sufficient footprints from the daylight hours that Genghis Khan's hordes might well have swept through carrying beach balls and boogie boards, leaving the beach as pitted as the surface of a golf ball.

MacArthur Park ends at a complex of three seventeen-story condos, followed by a gated community with a few hundred homes. With their drapes closed and outside lights off, all the buildings look so dark they seem almost empty. This is "lights out for turtles."

I ask Kelly if it's brighter when it's not turtle season.

"*Ohhh* yeah. You could play volleyball all night all the way up this beach. Those condos look like they're expecting an invasion by sea, with

security lights shining on the beach all night long. You go out there in November—*huge* lights. But when the turtles do invade, it gets pretty dark."

Lights discourage mama turtles from coming onto the beach, and they confuse hatchlings. When proliferating beachfront high-rises began shining huge floodlights on the beach in the 1980s, new residents found hatchlings in their bushes and elsewhere hatchlings shouldn't be, and little turtles by the hundreds were getting squashed in lit parking lots. Troubled, residents sought an ordinance. Now residents expect to extinguish their outdoor lights from June through October. There is no state law, but twenty counties and forty-six municipalities have lighting laws, encompassing 95 percent of Florida's Loggerhead and Green Turtle nesting areas. The ordinances say, basically, Because artificial light harms sea turtles, you should shield, lower, turn off, change, or redirect lights so they're not visible from the beach during sea turtle nesting season. It's pretty much that simple.

A while along, a middleweight Loggerhead is covering her nest. Her track proves that a sea turtle can climb a five-foot bluff of loose sand. We wait and watch her half-plummet, half-ski back down that loose scarp to the lapping lip of sea.

At midnight, as I run another year up the flagpole, Kelly sings a heartfelt if perfunctory "Happy Birthday." I request a matched set of Leatherbacks, no gift wrapping necessary. Kelly responds, "*Two Leatherbacks!* That's a tall order, considering we've been averaging fewer than one a night."

We pass a series of well-darkened ten- to twelve-story buildings stretching more than a mile. Sited right on the beach, their concrete footings stand in some cases not more than sixty feet from the high-tide line. I'm thinking, "With big-time money like this invested, you can bet they'll take the beach before the beach takes them."

And sure enough, several of the buildings are fronted by large cement aprons—essentially a concrete beach, impervious to human footprint and turtle flipper alike.

Here a Loggerhead has just turned away after hitting a different barrier: beach chairs. Prime nesting habitat is prime sunbathing habitat. And though there's a light ordinance, ain't no beach-chair ordinance. Chairs block about 20 percent of the beach here. Kelly says the hotels and condos are unwilling to move the chairs back even fifteen or twenty feet. On



the Greek Island of Zákynthos, where hundreds of thousands of tourists annually enjoy all-night beach parties, resort owners so resolutely resist accommodating the turtles that the European Court of Justice has found Greece negligent in its stewardship of nesting sea turtles. One creature has no choice and no voice; the other chooses to act deaf and say no.

At two A.M. we motor past two standing women gazing seaward, wrapped only in the breeze. Kelly yells back to me, "They're crazy. I'm freezing."

At the south end of the beach, right at the inlet, a major hotel corporation is erecting a five-building condo complex. What are they thinking? How can they keep their basements from continually flooding? What about hurricanes?

At two-thirty Kelly's cell phone rings. Chris has a Leatherback. He's way up on the north part of the beach, about twelve miles from us. I win the bet. Kelly says, "Ready to zoom?" We slow only once, to avoid an armadillo.

When we arrive at the dark, still-digging turtle, Chris greets us with the words "It's Beatrice." Serial numbers are fine, but Kelly and Chris give their turtles names.

Kelly says, "Last time we saw Beatrice"—she knows this off the top of her head—"was April twenty-ninth. That's when we first flipper-tagged her. We haven't seen her since. The timing means between then and now, she's nested twice, somewhere."

Tonight Beatrice will get a permanent identity via a tiny internal tag, plus a satellite transmitter. The internal tag is a glass microchip the size of a grain of rice; it reacts to an electronic stimulus by reporting its individual serial number. It's called a Passive Integrated Transponder, or PIT, tag, and it stays for life.

Kelly and Chris have tracked several other Leatherbacks by satellite, and Kelly says, "Aires went to Canaveral, Charleston, Hatteras, then in September she went east. She spent the winter and the whole next year wandering around the northern part of the North Atlantic Gyre. Then in January, February, she looped around, then started coming down." Her last transmission: off Charleston. "We're hoping she's coming back to nest. So far *all* our transmitted turtles went north and stayed coastal till they got to Hatteras, then hung out there for a couple of months, presumably eating Cannonball Jellies. A couple headed out into the central Atlantic; one ended up off the west coast of Africa. Others went to Canada, to the Grand Banks."

...

I continue north with Chris. The road rubs right along this northern stretch, with public parking along its length.

In our first mile we find two Loggerheads. Chris is monitoring them and he notes their tag numbers, then asks me if I've ever felt a Loggerhead's nose. "They're soft and squishy," he says. He's right! Chris expects about fifty Loggerhead Turtles tonight. By season's end, this five-and-a-half-mile stretch of beach will get perhaps a thousand Green Turtle nests, five thousand Loggerhead Turtle nests, and maybe seventy Leatherback nests. Chris enthuses, "It's become a thousand-nest-per-mile beach—pretty cool."

Our progress gets abruptly halted by a hundred-yard-wide seawall. With the tide high, the Atlantic meets the twelve-foot wall directly, waves slapping concrete. No beach. We have to drive up onto the road and around the building. Turtles can't drive. When the tide is lower Chris often finds turtles stopped by the wall. This kind of "armoring" is used where erosion poses acute threat to buildings. It's how turtles and even the public can get squeezed out between real estate and the sea.

Chris is scanning with a nightscope, hoping one of these nights he'll catch a poacher who recently dug up three nests.

"We see some amusing things," Chris says.

I can imagine.

In the scope's ghostly green image we detect only one stroller and two fishermen, and watch one Loggerhead emerging. Chris's scope imparts an air of clandestine activity. We're not just watching this turtle, we are *spying*.

Chris remarks that all the Leatherbacks and Greens look the same to him but the Loggerheads all look different. "Different kinds of things growing on the shell, different barnacle patterns; some have a head that's extra-wide—huge." Suddenly Kelly's voice crackles from the radio, calling from the south with a Leatherback ascending.

"Happy Birthday," says Kelly. "You got your matched set." A big fresh track goes only up the beach. We follow to a dark mountain of muscle, settled in and digging.

Kelly says, "Carl, meet Georgia. She's a big girl." Georgia's the most massive turtle ever on this beach. Kelly's Leatherbacks' shell lengths average 151 centimeters; the curve of Georgia's back spans 168 centimeters, five and a half feet (not counting head, neck, or tail).



The only thing short about Georgia is the last third or so of her right front flipper. It's missing. I'm thinking shark bite, until I notice two pink scars at her other wrist—line tangling.

Her intact flipper is 125 centimeters long, over four feet. Georgia finishes and begins moving from her nest. Though it's her right limb that's shortened, she tends to veer left when crawling, as if accustomed to compensating for her abbreviated flipper.

Kelly knows her turtles well enough to anticipate, on any night, who's due to return to lay their next clutch. Tonight Georgia was on her mind, and Kelly's also on the lookout for Hydra, who's a couple of days overdue. "We met Hydra two years ago. But when I saw her a week and a half ago, she had raw, bleeding wounds with thick white tissue, her head was badly scraped, and the top of her shell was shaved off. Her shoulder had an oozing wound with so much dead tissue she really stank."

Watching Georgia maneuver on her disfigured limb, listening to Kelly, I'm already getting sad on my birthday, though it hasn't even dawned yet.

Kelly speculates, "Maybe there was a hook or something caught up in Hydra's shoulder, with line trailing. Maybe every time she raised her flipper the line would abrade across. Every time she went like *this*"—Kelly raises one shoulder—"it would abrade more, shaving off little bits."

"Are there others?"

"Sedna has a mass in her shoulder that feels like a hook, with the eye on its shank and everything." Delphinia had terrible deep wounds and abrasions as though from ropes or fishing gear; she returned healed, though heavily scarred. "Pesca came once, last year. When we got close, we realized she was tangled in heavy longline monofilament, attached to a large hook embedded in her shoulder. She'd swallowed a lot of the line, and—this was horrible—the line went all the way through her and was sticking out of her cloaca, which was, at that moment, dropping eggs into her nest. We cut lots of line and removed the hook. We hoped that the rest of the line would work its way through her body and be expelled." They equipped her with a satellite transmitter and monitored her travels for several months, only to lose her signal east of Canada's Grand Banks, where there's intense longline fishing.

The momentary silence between us begins to unspool into a wordless lament. Kelly adds, "About one out of every four or five of our Leatherbacks has line scars from fishing gear."

This disfiguring and wounding, so unnatural and frequent, so unjust to innocent animals, tangles my mind in their suffering. And many turtles

also swallow plastic, mistaking it for food. In one study, nearly half of adult Leatherbacks had plastic in their guts. Of Leatherbacks found dead here and autopsied at Juno's Marinelife Center, 70 percent have digestive tracts blocked by stuff like Mylar balloons and trash bags. One arrived ashore with a sheet of plastic emerging from her; only after someone pulled and pulled, and finally yanked a trash bag out of her, could she lay eggs. Is this the only thing we give generously and abundantly to nature, such pain?

The curl of dawn is just pinking the sky when, spent, we quit the beach. In an earlier dawn in the late 1960s, I had headed offshore from a marina in Brooklyn, New York, on a fine fall day. I was fourteen and in awe of the seafaring skills and oceanic knowledge of my uncles Sai and Tony, but actually we ventured only a few miles into the Atlantic; you didn't have to go far to catch Bluefin Tuna in those days. We were bobbing at anchor within easy sight of Highlands, New Jersey, steadily tossing pieces of fish into the current astern, and I was wound with anticipation of a heavy fishing rod suddenly bending under the frightening power of a great fish. I was gazing with a child's eyes into the infinity beneath us when suddenly, as though conjured by my sense of the ocean's limitless possibilities, a strange sea beast appeared at the surface about fifty yards off our stern. It was a creature sufficiently large to break the sea into whitecaps across its back. I was thinking it looked like a Volkswagen floating just under the surface when it raised a surreally huge head, drank a deep breath of air, and withdrew. I was still frozen in disbelief when one of our rods dipped and strained. But it was no speeding tuna. The line slowly arced across our stern and my eyes widened as I witnessed a turtle of impossible proportions. Our line was wrapped around its long, waving flipper, and as it began to angle away my uncle Tony screwed the reel's drag tight enough to part our heavy line. Thus ended my first awestruck encounter with the greatest turtle on Earth, the Leatherback, tangled in fishing gear.

Is this really the same beach? It's Saturday morning, and Kelly and I can't find a parking space at Jupiter Inlet Park. This beach beloved by turtles at night is by day a different beast, populated north to south, inlet to inlet, by people from condos, hotels, and private residences local and afar. Everyone—we're on the beach now with *hundreds* of people—wants a piece of beach to love. In this same sand that now bears the weight of innumerable oiled sun worshippers lie turtle nests, also incubating by the



hundreds. It's hard to tell what's more improbable: that so many people live with turtles or that so many turtles live with people. I ask why this trampling is not catastrophic for turtles, and Kelly responds thus: "Well—I don't know." She adds, "There doesn't seem to be any real problem from beach blankets and chairs and people walking, except—the spikes from beach umbrellas would not be good in a nest."

IN THE BIBLICAL GENESIS, GOD'S FIRST UTTERANCE CREATED LIGHT. That's how fundamental light is—to people. Before light, more fundamentally, was dark. Our great-grandparents saw nights vastly different from what we see. For billions of electrified people, the light with which we flood each tide of darkness is drowning the stars.

Just past sundown I'm standing among two dozen Girl Scout Brownies on the beach in Boca Raton, Florida. We're here to release a dozen hatchlings earlier found disoriented and dropped off at the Gumbo Limbo Environmental Complex's "sea turtle hatchling box."

Impresario Dr. Kirt Rusenko is a tall, wiry, mustachioed scientist in his early fifties. With a Ph.D. in protein biochemistry but tired of lab work, he started volunteering at the Marinelifelife Center of Juno Beach, then landed a job here monitoring sea turtles' nesting and people's compliance with lighting ordinances. Government-granted authority makes him the turtles' ambassador to landlords, a statesman of the art of light.

Kirt gazes upon the Brownies and me, assessing our readiness. The girls, little hatchlings in their own right, are eager. We are facing the ocean waves. As the girls stop giggling, we begin.

Kirt reaches into his bucket and places three hatchlings on the sand. They head not straight seaward, but southeast. One must even be restarted.

Their misorientation was immediate and predictable. Kirt comments, "Better than usual."

A little girl chirps, "I saw them go in th' *ocean*."

Kirt produces the next hatchling, asking, "Are you gonna name this one?" and letting the girls admire the baby turtle cupped in his palm.

One mother sardonically advises, "Don't get attached."

Kirt releases hatchlings three or four at a time until they're no more—all gone. The delighted girls and mommies thank him, leaving Kirt and me.

Of the hatchlings' imperfect performance, Kirt says, "It's unbelievable how strong their attraction to light is." Why hatchlings go to light is well known: the lightest area of a natural beach is usually the horizon over

the ocean, the darkest the dunes or jungle. So going toward the light should get you quickly to the water. "When we do releases," Kirt adds, "they sometimes crawl toward white sneakers, white pants, or if we have a white bucket—." Kirt has seen a photo of three hundred turtle hatchlings charred in the ashes of a bonfire.

Monthly, Kirt monitors the night lighting here—porches, windows, landscaping and street lighting. The next day he calls people, reviewing their lightscape, sometimes bulb by bulb. Kirt adds, "It's not a matter of sea turtles versus safety and comfort. You can light your path; just make sure turtles can't see it."

Until the last instant in biological time, human-generated light amounted to scarcely a spark in the dark, merely a way to peer into each other's smudged faces. Moths to flames notwithstanding, wildlife didn't notice much of anything. Not until electricity, in just the last few generations, did we find a way to banish the night and light up Broadway. Now, more than two-thirds of the population of the United States and half the population of the European Union cannot see the Milky Way. In many cities, lights mask all but the very brightest stars.

Tonight as we begin traveling Boca's beach in Kirt's four-wheel-drive golf cart-like vehicle, waterfront condominiums stand dutifully darkened. One high-rise building, strikingly dark, shades the beach from night's brightness. Its paint is nonreflective, its windows tinted, and most of its drapes are drawn. "It's been a good condo," Kirt says, in a tone usually reserved for praising a worthy dog. "That's how we like to see them. It's the only big building on the beach that has never had disoriented hatchlings in front of it—and it's had lots of nests."

Farther along, in contrast, another high-rise has a light glaring as though left on absentmindedly. Brightness comes so easily that it takes effort and forethought simply to allow midnight its darkness. Now night itself has trouble falling.

At the next building, Kirt notes, "That new fluorescent at the end has to go." He explains, "A lot of people don't realize it's not the *light* that's the problem, it's the *wavelength* of light that matters. Turtles' perception of light gets really bad at wavelengths beyond five hundred and fifty nanometers. That's yellowish into red. We can see it, but most turtles basically can't." Or, at least, they don't respond to it. Hatchlings are least attracted to yellow or red light sources—such as might misleadingly come



from a rising or setting moon or sun. Simply, then: artificial light visible to a person on a beach will cause problems to turtles unless it's red or yellow.

There's an efficiency question too. Only 10 percent of the energy used by an incandescent bulb produces light; the rest is lost as heat. Light is sometimes measured in lumens. Per watt of electricity, incandescent bulbs produce 20 lumens, mercury-vapor bulbs give off 60, fluorescents produce 100, high-pressure sodium puts out 140, and low-pressure sodium bulbs shine with 200 lumens. With these other bulbs you can get the same brightness while using much less electricity.

Kirt points. "That doorway light there? Those fixtures have turtle-friendly shields, but to save energy they put in a fluorescent bulb that sticks out, so I've gotta ask them to use a compact fluorescent that won't show." Kirt adds, "Luckily, I have no problem talking with condo managers. They're friendly. They know there are fines, but it's not a confrontational thing."

Farther along, Kirt says, "This building's good. All those are energy-saving yellow bug lights. In the past we had hatchlings going to their lights, but turtles really can't see this type very well."

Several adjacent buildings are dark from within, but because they're *angled*, their walls reflect lights from the streets behind them. Kirt comments, "Just because of this reflected light, there's almost no nesting here." To a female turtle, illuminated sand looks more like an ocean horizon than like land. She wants a dark dune with a darkly broken sky behind it, as it looks on a natural beach backed by jungle. Even a little light inhibits females from emerging. Even reflected light constitutes the unbearable lightness of buildings.

Nowadays, most of Florida's sea turtle nesting action happens at four beaches between Boca Raton and Cape Canaveral that differ from adjacent sites only by being dark. The east coast of Florida is the world's most important nesting ground for the Loggerhead Turtle, so merely doing nothing about the light of night on this populous coast would devastate one of the world's most important turtle shores.

Anyone planning alterations or construction on the beachfront must get Kirt's comment on whether it's up to ordinance standards for turtles. Options abound: install timers and motion-detector switches, turn lights off, reduce their number, lower their wattage, hide them, shield them, recess them, lower them, aim them down so you can't see them from the beach, or change their color. "It's nice to be ahead of things," Kirt

comments. "I can say, 'If you do it this way, there won't be a problem.' I don't have to count dead turtles first. The condo owners now call and say, 'We're gonna do such-and-such; what kinds of bulbs should we use?' To me, that shows it's finally working."

Morning. We're returning to document last night's nesting and hatching by reading the tracks in the sand. We make the rounds as in a maternity ward. An adult Green Turtle's track indicates a new nest. Raccoon tracks are all over it and though they drilled a few test holes, they failed to find the eggs. That's why turtles are messy while covering; it conceals the exact location of their treasure chamber. Kirt surprises me by saying Raccoons are concentrated in unnaturally high numbers in the parks—where garbage bins keep their numbers subsidized. In the condos the garbage is all locked away. In terms of shadows and densities, the "natural" parks are less natural than the high-rises.

Kirt sprinkles powder on this nest, saying, "This habañero pepper is the hottest thing going." How hot? Peppery hotness is described in Scoville units, a measure of capsaicin, the chemical that activates pain receptors and makes peppers taste "hot." Tabasco sauce rates 5,000 Scoville units. Kirt's habañero pepper powder burns in at 250,000 Scoville units. "It's really good stuff—except when it's windy and you get it in your eyes. Even if you're digging up a nest much later, sometimes your forearms will start to burn. It really deters mammals, but it doesn't seem to bother turtles at all."

Another nest has fire ants penetrating the egg chamber. They don't chew through eggshells, but when a hatchling makes a hole in the shell, the ants invade, stinging, biting, and devouring the baby turtle, leaving little turtle skeletons. Kirt has just the potion: on the ants' busy trail he sprinkles a poison that they'll take back to their nest. They immediately begin picking up the dooming hors d'oeuvres. These nests contain the Red Imported Fire Ant—the "ant from hell" (*Solenopsis invicta*, for "invincible"). Having invaded the United States from Brazil before World War II and spread mainly in shipments of suburban nursery plants and sod, red fire ants occupy most of the southern United States, where they cause \$1 billion in damage annually. A queen may produce fifteen hundred to five thousand eggs per day. Freed from the parasitic fly that keeps them in check back home—that's one reason invading species often get out of control—in the States they achieve densities ten to fifteen times higher than in their natural range. They're aggressive in extremis,



and their stings form blistering sores. Not only are they hell on nestling turtles and birds, they attack crops, kill young livestock, attack farm-workers, and *protect* pests such as scale insects, mealy bugs, and aphids, which produce a sweet excretion called honeydew that the ants use for food; the ants then transport such “ant cows” to new feeding sites. They even damage irrigation systems, air conditioners, traffic signal boxes, telephone junctions, airport landing lights, and electric pumps for oil and water wells, wherein they chew electrical insulation or cause short circuits. They’ve spread to Puerto Rico, New Zealand, and Australia. *Invicta* was intercepted at California agricultural inspection stations about once every three days between 1990 and 1996. In 1998, it finally got a piece of the Golden State. Persistence pays. Next stop: Hawaii.

Kirt has marked each nest with stakes and colored tape, so an easy glance reveals the whole season’s nest locations. Here’s what I’m noticing: more nests lie in front of the condos than in the park. Let me repeat that: more turtles have laid eggs in front of the condos than in the parks.

“That’s testament to the lighting ordinances. Like I said: they’re working.” Boca has the highest turtle-nesting density of any urban area in the country. The parks used to be the best place for turtles. Now the parks, with their long stretches of low dune vegetation and the glow of the city behind them, are becoming some of the worst places for light. Compared to low dunes, the dark shadows of brooding condominium complexes do a better job of shading the beach and blocking light. So a lot of turtles are nesting in the shadows of individual condos. “To me,” Kirt says, “that’s the first step in losing them entirely. First, the parks will get too bright, then, with urban sprawl expanding northward...”

We see where a brood of hatchlings emerged, but instead of dashing to the sea, the tracks from this nest lead landward. Kirt puts his cheek on the sand right at the nest stake. The nest is situated line of sight to a sea-wall with two fluorescent lights. Kirt mutters, “Earlier in the season we asked them to turn them off and they did.” But now, despite the morning sun, we can see that those lights are on.

Under the lights turn the curlicue tracks of several hatchlings. “This stinks,” Kirt says bluntly. “Well—I’ll call the manager again.”

Other tracks from the same nest lead toward a bright light from a building across the street. The tracks take a one-way trip, vanishing into the grass. It’s distressing. But Kirt says, “This is uncommon now because of the ordinances.” He straightens and adds, “Fixing this is as

easy as asking someone to change a light bulb. I’d rather deal with this anytime.”

I’m about to see what he’s alluding to. On a flat area are lots of little turtle tracks so loopy and directionless that even Kirt cannot find the nest whence they came.

“This,” Kirt comments ominously, “is sky-glow.” In the past, if there was a problem all the tracks went straight to a light source, like we just saw. They wouldn’t wander around in circles. Kirt mutters, “This is a whole new ball game. It’s chaos.”

When a hatchling turtle emerges at the surface, its eyes are half an inch above the sand and its most immediate cue is the overhead sky. And when the sky is sending mixed messages, it confuses hatchlings about the single, simple question a questing hatchling must correctly answer: Where’s the sea?

At night on the beach here, if you squint and scan slowly around the compass, north, south, east, and west—a blur of the world as I imagine a baby turtle might see—it’s not the ocean horizon that seems brightest but the glow from town, lighting up the clouds. When the beachfront lighting ordinances were designed, no one thought lights in town could trouble nesting turtles.

Kirt illuminates the problem: “Just a couple of years ago, that glow was not as wide, certainly dimmer. High-pressure sodium was the main kind of bulb for city lighting. You could look south toward Miami and see an orangey glow in the sky. That wasn’t too bad. Now the city glow is getting whiter.” Boca put in several blocks’ worth of 170-watt metal halide lights. “You’ll see it; it’s bright enough to take the paint off your car.”

I saw it. On the streets of Boca Raton, each pole bears three brand-new fixtures. Some shine light upward as well as downward, illuminating buildings as well as streets. It’s a nice effect—if you’re not concerned about turtles or stars. Or sleeping; they’re shielded on the sides that face buildings, so as not to flood people’s bedrooms. But enough escapes skyward that it sets the clouds aglow, easily visible from the beach.

Kirt says, “That glow in the sky is why most hatchlings head not straight east into the ocean but instead begin crawling in different directions.”

When I’d noticed that the north sky seemed particularly bright, Kirt had answered, “That’s a whole strip of car dealers, a couple of miles up the highway.”

Once you look, escaped light is inescapable. Light emanating from Boca Raton’s streets, stores, and homes, and all the way down to Fort



Lauderdale (about twenty miles south), erases the shadow of night from the bellies of clouds, turning them into reflectors of the busyness below.

The glowing sky is the ever-advancing halo of humanity. About a third of all outdoor lighting is wasted by illuminating the atmosphere, costing more than \$1 billion annually in the United States alone, according to the International Dark-Sky Association, whose motto is "*Carpe Noctem*"—Seize the Night. Wasted with the electricity is the six million tons of burned coal used to generate that electricity. The consequences include everything from global warming to wandering turtles.

Kirt, looking down and shaking his head, says, "This is the year of wandering. The increase in this kind of disorientation is so sudden—. It's good you got to see this. This is all actually pretty new to me, and I'm still a little confused by it myself."

We finally locate the nest; it's just twenty feet from the tide line—nearer the water than almost any other on the beach. At this proximity the hatchlings should have reached the sea in half a minute. Instead, the little tracks strike out in all directions, their perfect navigation system jammed by a few sparse photons, their sure-flipped ability disfigured into mere blundering, their legendary innate certainty frayed into confusion. It's heartbreaking to see such finely tuned instincts so disrupted by something so insubstantial as a diffuse glow.

We count the tracks emerging, then walk the tide line, tallying how many crossed it and got in, and how many are missing in traction.

With eyes to ground and notepad in hand, Kirt comments, "A lot are missing."

Some of these brave little tracks head directly away from the water, into the dunes. Others, further burdened with unearned penalty, pointlessly parallel the shore for a long trudge through dry sand—rather than simply turning into the nearby sea.

"This paralleling is something we see more and more; I guess the natural ocean-horizon light is counterbalanced by the town's glow, and they're just going down the middle, torn between two opposing forces."

We ourselves consequently wander among the spaghetti trails that should have been short, straight, seaward. Normally, in their brief rush to water, hatchlings traveling together would prevent a predator from picking off too many of the brood. Safety in numbers. Not here. Separated, lost hatchlings afford a predator leisure for a thorough meal. Night heron footprints amid the confusion suggest the first and final fate of some.

One set of little tracks crosses a set of fox prints, then, having avoided the fox by luck of timing, it gets rutted in a wheel track. Eventually wandering to the dune grass it loops, turns seaward, loops again.

"When they start circling, trying to get oriented," notes Kirt, "it's because the closer to the dune and vegetation the hatchling gets, the more into the shadows it goes, where it can sense the ocean. But once back out on the open beach, under the glowing sky, they get 're-disoriented,' going in circles."

The tiny track we're following finally makes a long sweep across the beach, angling slowly seaward. Another wandering hatchling track intersects this one just a few paces from the high-tide line. Here both could have turned handily into the water, but merely drifted toward the surf.

Hope: once dawn stirs, the sun emerging from the ocean reasserts itself as still the brightest thing in the sky. Hatchlings surviving a night of wandering this beach will—if they have enough energy left—turn toward the sea. Despair: by then gulls are patrolling, pelicans' bellies are growling, fish can better see.

Finally, this track is obliterated by the smoothness of high tide. Our hatchling reached water. If it survives the next two decades, it may return here, searching for a dark reach of beach.

Kirt checks his GPS: point of entry was fully 225 yards from the nest. Hatchlings have a certain amount of fuel to get them out past the surf and into the ocean and to the Gulf Stream. They also emerge dehydrated and needing water. "At least," Kirt comments, "this one went in." A few other tracks are still plugging and plowing along through the dry sand.

Several hundred feet farther, three more cross the high-tide line into the wave zone. Glancing up, Kirt explains, "Now, see, this building right here is nice and dark at night. When these hatchlings got in its shadow they quickly oriented."

Where the last hatchling finds the sea, Dr. Kirt announces, "Nine hundred and seventy feet." That's how far this little guy trudged from a nest only a few paces from the water—wandering all this way just to find darkness on a summer night.

Walking back to the nest, we cross other sets of tracks that took between sixty and two hundred yards to reach the water, rather than the twenty feet required.

Think of an adult turtle lucky enough to have lived decades, undertaking arduous migration, laboring up the beach and perfectly exerting all



efforts necessary for nesting; her nest survived raccoons, foxes, ants, and weather, and then the hatchlings struggled up, emerged on cue in cover of what should be darkness—only to get all screwed up because now clouds glow.

“Yeah, well,” Kirt says deflatedly, “this isn’t even a bad one. Most of these made it to the water eventually.”

Farther north, at Red Reef Park, Boca’s densest turtle-nesting area, nests are packed into the sand at the rate of one every few steps, marked by Kirt’s stakes and flagging. This park has a thirty-foot-high dune, with tall Australian Pines that darken the background and shadow the foreground. Mother turtles like this spot.

We see two fresh Green Turtle crawls, leading to new nests. We also find two new Green hatch-outs. I’m bracing for more heartache, but here all the turtle tracks scramble straight to the water as if on a tight little raceway—just like they’re supposed to.

Kirt explains, “That really high dune, those big Australian Pines break up the skyline and cast shadows. So it’s almost like a condo—.”

The park beach is almost as good as if it had a *condo*! I’ve lived to see high-rise apartment buildings become the standard for habitat quality.

“Plus, they haven’t pumped any new sand on it recently, so it’s a narrow beach. Almost like natural.”

It’s nice to think something is almost like natural in an era of artificial beaches, artificial lighting, alien trees, and dazzled turtles.

In one park, six years ago sand was pumped ashore to make the beach about three hundred yards wider. That made the streetlights visible from the beach, above the vegetation. Nest density dropped from sixty nests to eleven. The next year more turtles nested, but sixteen hundred hatchlings became disoriented. Seventy-five percent never found the ocean. The following year the power company adjusted the lights’ angle; disorientations dropped to twelve hundred hatchlings, and 25 percent died. Then Florida’s transportation department removed the light poles and installed light-emitting diodes embedded in the road, wholly invisible from the beach. Kirt takes me up to the road to look at them. They’re flat lights in the road itself, like aisle lights in a movie theatre. A sign says, **SEA TURTLE LIGHTING PROJECT AREA**. Kirt informs me, “After they installed these, hatchling misorientations dropped to zero.”

We stop to check a Loggerhead nest, hatched from the foot of the dune. To me, the tracks look perfect. With the expertise of a true aficionado,

Kirt appraises them: “Still a little wider apart than they should be, but very good, pretty straight into the water.”

We ramble homeward. Dr. Kirt Rusenko sees darkness simply: “It’s so easy to fix. And cheap. For one hundred million years, that area over the ocean horizon was the brightest part of their sky. We just have to do a few things to help these animals. Most people are interested, and they’re nice about working on the lighting. People wave to us on the beach. We used to see nests where *all* the hatchlings went directly inland because of glaring lights. We rarely see that anymore. It’s a lot nicer than it was ten years ago. I’m happy about it.”

AN ENDANGERED FLORIDA SCRUB JAY LANDS ON A MAN’S HAND, TAKES the offered peanut, and carries away its prize. The generous hand belongs to Llew Ehrhart, professor emeritus of the University of Central Florida. Around here, everyone calls Llew “Doc.” Doc has a broad face, a kindly manner, and speaks with the thoughtfulness of professional science and the patience of a committed teacher.

Florida’s coastline from Melbourne Beach to Wabasso Beach is a crucial habitat for Loggerhead, Green, and Leatherback Turtles. More Loggerheads nest in Florida than probably anywhere in the world, and more Loggerheads nest in this stretch than any other beach in Florida. Since 1980 Loggerhead Turtle numbers have roughly doubled. On this stretch they lay about fifteen thousand to twenty thousand clutches annually. Each year about a million hatchlings leave this shore. And Florida’s Greens skyrocketed from three hundred nests in 1982 to more than twenty-five hundred in 2002. Most Leatherbacks nest farther south, but they began arriving here regularly in 1994. The last five years set records for Leatherbacks locally. This stretch now accounts for about 10 percent of the state’s total.

Although Loggerhead nest numbers have declined for the last few years, Doc says the turtle numbers overall show the beginning of recovery. And for nesting Leatherbacks and Green Turtles, there’s been “unsustainable increase; the growth is exponential.”

It might or might not be coincidental that this stretch includes the Archie Carr National Wildlife Refuge. In the 1950s Carr almost single-handedly invented modern sea turtle biology and conservation, and turned the tide for Atlantic Green Turtles from the path to extinction to



the road to recovery. His books remain classics, and his students are leading scientists. Decades after his death, Archie Carr remains the sea turtles' patron saint. In the 1980s the federal government began patching together undeveloped land here, and the resulting twenty-mile quilt constitutes the Archie Carr National Wildlife Refuge.

It's an odd sort of wildlife refuge, interspersed with houses and small businesses, certainly not a wilderness. The main road along the beach is two lanes, heavily trafficked, strip-mauled, dotted with motels and expensive homes whose mailboxes are held at the curb by gaudy plastic turtles. Among all this are open areas running a quarter or a half mile or more, as if to remind us what an island looks like. Here the scrubscape looks as some might say God meant it to be—and others would say it's their God-given right to improve. A string of very large identical beachfront homes, still under construction, exemplifies the latter. As you go south from here, you'll find more development, more people. And each year development and people creep northward. Everyone knew getting this refuge together was a race against time.

Loggerheads use more than thirty beaches in Florida, but this refuge gets about one-fourth of all their nests. Many beaches would suit for digging, yet turtles use very few. Where they nest, they often do so in heavy concentrations, yet leave adjacent miles of coast untouched. What makes some beaches attractive to turtles? One guess is that only a few beaches lie near currents that can promptly take hatchlings into good nursery feeding and hideout habitats. At all others, hatchling survival would be so low that turtle populations could not get established. Most turtles nest on or near the beach from which they hatched. They've had millions of years to figure out which areas are good, so any beach that works is important to turtles. You can't scare them away and expect them to simply settle elsewhere, like a flock of pigeons.

Doc adds, "This is the densest turtle-nesting area in North America, yet it's also very heavily used by residents, surfers, sunbathers, and fishermen. People can live with endangered species. These are the same turtles that in other parts of the world are vanishing due to people. So it can be done, and it's being done—right here. But it doesn't mean there aren't big questions on the horizon for turtles."

Perhaps better than anywhere else in Florida, Melbourne Beach exemplifies coexistence between people and sea turtles. But it's got, as they say, issues. In broad strokes, at issue is a struggle over sand and seawater. As

the world warms and sea levels rise, the beach begins adjusting. People try to freeze its contours. The face of sea-level rise is chronic erosion.

Doc understands erosion; his field station recently suffered the consequences of a breached seawall and he had to move his lab. Now the beach there has a seven-foot sheer drop where the ocean removed a chunk of sand like someone lifting a hundred-yard slice of cake from a plate.

As beaches shift and sand moves away, property owners seek to replace it. In the Orwellian speak of coastal engineers, pumping sand onto a beach is called "nourishment." To compensate for rapid washout, they pump extra sand right along the shore, making the first part of the beach higher and the rest flatter than natural.

Would a turtle care? "In the first year," Doc says, "more than half the females that emerge from the surf turn back without nesting. We think turtles are looking for a steep beach." A steep beach might indicate less chance of flooding. "In the second year the shoreline adjusts and nesting returns to about normal—if they use good sand."

Beaches here get artificially rebuilt every five years or so. Rebuilding one mile of beach requires about one million cubic yards of sand, at five to six dollars per cubic yard. U.S. beach rebuilding costs about \$150 million annually. Taxpayers pay for it, and where the houses get washed away, taxpayers pay for rebuilding houses, including some very expensive oceanfront mansions.

After repeated pumping, rock or clay remains; the seafloor runs out of sand. Lacking sand for its beach, Broward County, Florida, plans to—I'm quoting here—"set up small experimental beaches of ground-up glass bottles." For over half a million dollars two beaches will be given what officials promise will be the look and feel of sand. "No—I hate it," said a sunbather named Rosi. "I like it natural." County officials will have to deal with troublemakers like Rosi, but they acknowledged, "It may be difficult to get the public to accept ground glass as a substitute for sand." They said with enough "education" (funded by taxpayers) it could be done.

Doc adds, "As long as we're going to have jetties and storms and ocean currents, people are going to demand more sand. If you bring in *good-quality* sand, you can increase hatching success." For nesting, all sea turtles require beaches with deep, loose sand. Moisture and temperature need to be right for eggshell function and embryo development.

"But," Doc excepts, "the engineers and the county officials absolutely



refuse to talk about one indisputable fact: sea level is rising. They're trying to draw a line in the sand on beaches that continually change. Can't be done."

Just fifteen thousand years ago (practically yesterday in sea turtle history) sea level was 350 feet lower than today. Florida was thrice as big. For most of history, the shore was not where it is now. And during most of the future, the same will apply. Shift happens.

To turtles, the slow sloshing of coastline is a nonissue. If there were no houses here, it would merely be a shoreline dancing at a turtle's tempo. Nesting turtles care only that the sea meets the shore and that night means darkness. For a couple of hundred million years this humble set of requirements posed no hurdle. The recent end of such reliability, and the contests between turtle nests and human nest eggs, are nowhere more evident than here on Florida's Atlantic coast.

Global warming is accelerating the sea level's rise, the sea level's rise is accelerating erosion, erosion is intensifying calls for putting the beaches back where they just were or armoring them with walls or concrete. Llew paints some hard economic reality by saying, "Unless politicians do something about global warming, home owners wanting to try to keep those houses will be demanding sand or building seawalls—higher and higher, for generations."

The sea level is now rising at a rate of about a foot per century. But it's not quite as though the sea level will rise like water in a tub with a drippy faucet, eventually wetting the edges of, say, Manhattan and giving people time to move a few parked cars, strengthen some seawalls, and adjust. The flooding will likely first hit during storm surges, creating an enormous, expensive, deadly mess. New Orleans has had its experiment. Right now, there's one-chance-in-a-century of a ten-foot flood where I live, the Long Island and New York area. By 2090, because of sea-level rise *alone* (not counting increasing hurricane strength caused by warming waters), floods will reach those same contours once every thirty years on average, if the scientists are right. (And so far they're turning out right more frequently than the politicians and global-warming naysayers are, because they're scientists, not ideologues.) When the sea level rises a bit over three feet, lower Manhattan will flood every other year. That's three hundred years away at the recent rate, but the most extreme prediction suggests a meter-plus sea-level rise in this century. That's unlikely, but because I live on Long Island in a house eight feet above sea

level, I find this all very interesting, indeed. Things can happen sooner than predicted. In mid 2005 the New York Academy of Sciences Web site quoted the head of the U.S. Geological Survey as saying that New Orleans probably won't exist one hundred years from now. That was three months before Hurricane Katrina.

After sundown, Doc Ehrhart and I go for a walk down the beach. There's no town here, no sky-glow, and a combination of local ordinance and pride makes beachfronters keep their lights out for turtles. The turtles oblige by emerging near the houses and the silhouettes of motels.

Two shadowy figures are descending a hotel's stairs, carrying a little red light. On any night from mid-May through August, you can stroll this beach and see dinosaurs laying eggs.

Doc's abrupt "Watch out!" saves me from tripping over a Loggerhead Turtle on its way back to sea. On a beach this dark even a big turtle, its shell dusted with sand, merges with shadows. She dramatically picks up her pace, verily trotting seaward with a gait that alternates like a pond turtle's; it's not the rowing breaststroke of Green Turtles or Leatherbacks.

In Florida you can trip over Loggerheads. In most of the world they're quite rare. To find Loggerheads at similar densities, you'd have to go to the place on the Arabian Peninsula where the sun first rises, an Omani island named Masirah. In Florida, Loggerheads dig close to seventy thousand nests in a good year. Recent information suggests that Florida and Masirah account for around 70 to 90 percent of the world's Loggerhead nesting, but Masirah seems to be declining, with problems from fisheries, beach lighting, egg collecting, beach driving, and so on. The most temperate-nesting sea turtle, Loggerheads nest on certain beaches northward to the Carolinas, and on beaches scattered as far north as the Mediterranean, as well as south to South Africa. On Pacific shores, Loggerheads nest only in Australia and Japan. Their Pacific population has crashed like the Leatherback's. All this makes Florida special.

When we find a Loggerhead digging with all her heart, we halt a circum-spect distance away, because a disturbed Loggerhead may quit mid-clutch, leaving the chamber uncovered and a trail of fresh eggs in her fleeing track. It's evident that this Loggerhead is a beast different from the Leatherback. Quite unlike a Leatherback's sleek and living skin-coat, her hard, flaky shell is fuzzed with spongy growth like an old dock piling. In that wet



fuzz, a sparse galaxy of phosphorescent organisms is twinkling on and off. Extraordinary.

Over twenty-five minutes, she labors through twelve dozen eggs, nearly two dozen more than average. All the while, Doc delivers an impromptu lecture. “If your nests are subject to tropical storms, inundation, washout, you’d better evolve a way of laying a lotta eggs. Sea turtles lay a *lot* more eggs than any other reptile. This turtle will probably lay six hundred eggs this season. Land turtles don’t come close. Snapping turtles lay about a dozen eggs at a time.” While speaking, he gazes admiringly upon the turtle. “Just think of the energy it takes to make all these eggs. And in about twelve hours she’ll get another progesterone surge, and all the ova for her *next* clutch will burst from her ovary wall. Then she’s gotta yolk up another hundred-plus eggs. It’s incredible they can marshal so much nutrient-rich stuff in such a short time. I mean, yolk is pretty expensive stuff. Hard to believe she can spend such bodily resources tonight and *then* come back in just two weeks with another big, expensive clutch like this. To yolk up a hundred eggs in thirteen or fourteen days, she’s gotta just draw on her reserves like crazy.”

Because all this nesting depletes her body so much, a sea turtle almost never nests two years in a row. She needs time to replenish her reserves for making those hundreds of eggs. Food scarcity—as during Pacific El Niño years, for instance—will cause breeders to defer an extra year or more. Better conditions leading to higher ocean productivity can foretell heavier nesting.

Ehrhart and a colleague, John Weishampel, have been struck by studies detecting changes in seasonal timing across North America and Europe—forests greening up earlier in spring, summers lasting longer, birds nesting two weeks prematurely and shifting their migration tempos. So they looked at Doc’s dates of turtle arrivals over a couple of decades. “And sure enough, we discovered the turtles are coming earlier,” Doc says. Local May sea temperatures have warmed about a degree and a half Fahrenheit (0.8 degrees C), and the turtles’ median nest date has shifted—fully ten days earlier.

“What it means,” Ehrhart ventures, “depends on whether turtles’ environments change in synchrony with their premature nesting.” If the males’ hormones don’t change at the same rate as the females’, egg fertilization could suffer. If the sand gets drier, it could depress hatching. Or, Llew considers, “If the sand gets hotter, or turtles nest earlier but the sand remains cool, that would affect the male-female ratio.” Like most turtles and

lizards, sea turtles don’t have sex chromosomes. Their sex is determined by temperature during the middle third of incubation. Warmer temperatures produce females. Nests in the shade of trees, or early in the season, or late, or from different latitudes produce different sex ratios. A multiday rainstorm that cools the sand can change a beach’s gender ratios. In Florida, Loggerhead nests produce about 90 to 100 percent females. South Carolina and Georgia Loggerhead nests produce 60 percent females. So even though their main population is in Florida, if the northern ones die out the whole coastwide population could lose its males and go extinct.

In a few places, sand temperatures are verging on lethal for eggs in turtle nests. According to Australia’s renowned sea turtle expert Colin Limpus, “Over thirty-three degrees Celsius [91° F], you get abnormal scale counts, spinal curvature, stunted hatchlings, impaired locomotion. And no males.” He was telling me this at a conference, and was talking mostly about his part of the world. A lot of nesting beaches there have had their beachfront shade trees removed. In Malaysia, Sarawak, and Thailand, where beaches are getting hotter, well-meaning workers compound the issue by moving eggs to save them from poachers and putting them in hatcheries sited on the hottest parts of the beach, exposed to full sun all day—producing perhaps exclusively females and lowering overall hatching rates. “When eggs fail to hatch,” Limpus notes, “the people often shrug and say they must have been infertile.”

Ignorant of the facts, the Loggerhead we’re watching finishes her task, performs her rituals, and returns.

IN MIDMORNING ANTICIPATION OF THE FLORIDA SUN, DOC EHRHART ties his hair in a kerchief under a broad-brimmed hat and we pile into pickups, pulling three boats toward Sebastian Inlet’s boat ramp. Doc’s beat-up Whaler is thirty years old and, as he proudly points out, rather ugly. We have two turtle-catcher boats and a third boat that will function as a floating field lab.

Indian River Lagoon, between Melbourne Beach and the mainland, is an expansive bay, green and breezy. Our main company is two Royal Terns whose vision pierces the glare for a glimmer of dinner. You can see houses and moving traffic along the far shore, but the major agriculture is low and invisible.

Doc has been studying juvenile turtles living in the lagoon. Before he began this study, Doc knew that people caught turtles here until they’d



nearly disappeared. In 1886 one fisherman took twenty-five hundred Green Turtles here. A few years later, he caught only sixty in a year's effort. Pressure continued for decades, until Greens almost vanished. On a whim in the 1970s, Llew decided to dunk an old turtle net he'd found. And on that day, his life took on a sweeter aroma, for, as he puts it, "If I hadn't caught that one little Green Turtle on the first day we tried it, I'd probably still be studying skunks."

We travel about four miles into the lagoon. Motoring slowly, we stream overboard our 1,500-foot-long (460-meter) turtle-catching net. A buoy every thirty feet hangs it like a curtain. The talk is all from fieldwork—the time they caught a big gator; the twelve-foot sawfish, now vanishingly rare.

Turtles need air, so at all times both catcher boats tend the net like web-walking spiders. It takes about twenty minutes to check the net's full length. On our second pass we find our web tensed taut—and the net serves a platter-sized, twenty-pound Green Turtle, flippers flapping. It has a beautiful young head and a pretty, shiny shell patterned with gorgeous starbursts. A very clean, lovely little turtle, it's about five or six years old. Turned on its back, it quiets.

Its finely serrated jaws would make good weed clippers. All turtles lack true teeth, so the cut of the jaw reflects the luck of the dietary draw. Greens are basically vegetarians. Their diet supports very slow growth, and Green Turtles first breed at around age twenty-five in some regions, as late as age forty in the western Pacific—possibly the longest time to maturity of any animal.

The other boat crew scores a Loggerhead and holds it up for my benefit. Its yellowness contrasts with our Green Turtle. They're about thirty yards away, but Doc Ehrhart says, "That turtle's about fifty-six or fifty-seven centimeters, seventy pounds."

One might reasonably assume that the lagoon's young turtles are locals. Not so. Turtles here are as likely to have hatched hundreds of miles away as just up the beach. Doc and his colleagues' genetic studies reveal that young Green Turtles here originate throughout the greater Caribbean, Mexico, Costa Rica, Suriname, Brazil, Aves Island, Ascension Island in the mid-South Atlantic, western Africa's Guinea-Bissau, and the Mediterranean Sea, as well as Florida.

Our net next arrests a Spotted Eagle Ray, of wingspread perhaps four feet across. Number of poison spines at the base of its whipping tail: five. Doc reaches for a pair of pliers and says to me almost apologetically,

"We do remove the spines—they're just too dangerous." When it's safely defused and untangled, we release the ray and garner another small Green, which flaps vigorously, slapping its shell in frantic circumvolutions. Those flat flapping flippers are a sea turtle's most striking specialization. They contain the same bones as our limbs, but the long limb bones lie shrunk and shortened, while the bones of the wrists and ankles have expanded and flattened. Fingers and toes are almost absurdly elongated, forming about half the flipper's length. The front flippers become lift- and thrust-developing propulsive wings—no longer just pond paddles. The rear, idled, merely steer. Powering the front flippers, pectoral muscles occupy more than a third of a sea turtle's internal body area, comparable to the thick breast muscle of flying birds. Like the wing of a bird or an aircraft, the foreflipper is curved on top, flat on the bottom. As molecules of the medium flow past a flipper or wing, they must spread out slightly to cover the longer distance of the curved upper surface. That creates higher density beneath, pushing upward and creating lift. In a sea turtle's downstroke, their flippers are usually twisted so that they're nearly vertical, the leading edge facing down and the "top" of the flipper facing forward like a propeller blade. As the turtle pulls its flippers down, the generated "lift" comes from behind, pushing the turtle ahead.

We locate a lemony Loggerhead whose shell is fouled like the hull of a neglected boat. Moving in its shell growth are scary-looking little praying mantis-like "skeleton shrimp"—amphipods—and other mini-monsters a-movin' and a-wigglin'. Unlike the stateliness of an old, mossy tree, this shell seems, well, it seems infested. It's creepy. Greens don't get this way. Leatherbacks certainly don't. This Loggerhead has different kinds of specialized barnacles living on its flippers, its shell, even its tongue and the roof of its mouth. Over one hundred species of small animals and plants ride Loggerheads. Some things that grow on Loggerheads have things growing on *them*; some eat other hitchhikers. No man is an island, but most Loggerheads are.

Unlike the go-along Greens, Loggerheads remain unhappy whether on belly or back. Righted, they try climbing the boat's gunwale. Doc instructs, "Don't let it get out—but don't let it bite you, either." Loggerhead Turtles' shell-crushing jaws can have a colorful effect on fingers. "Loggerheads," pronounces our professor, "are the junkyard dogs among turtles." They eat, for instance, whelks and mussels. Anything that eats shellfish finds itself competing with humans as clam boats and scallop



dredges turn the seabed into a factory floor. Along the U.S. Atlantic seaboard, Horseshoe Crabs are among Loggerheads' preferred foods. People don't eat Horseshoe Crabs, but they've been depleted for eel bait, to catch depleted eels.

We deliver our captives to the third boat, our floating lab, which, at anchor, waits with six people ready to weigh, measure, tag, examine, document, and release the animals.

A little while along, we catch a Green Turtle presenting moderate "paps"—fibropapilloma tumors. Whitish grape-sized tumors encumber its shell margins, foreflippers, armpits, and groin. Doc's seen much worse. Cauliflower tumors often overgrow the eyes of afflicted turtles and interfere with their ability to find food. This mysterious disease, almost unknown before the 1980s, now affects various sea turtle populations in different parts of the world. It showed up in 1982. In three years, half the turtles in this lagoon had tumors.

Doc says "The only place we haven't found it is up around Port Canaveral. And—guess what—tides flush the heck out of that place. In places like here, storm water, sewage, pesticides, fertilizers, and all that agricultural crap coming down—" The more pollution, the more tumors. It's unclear why these tumors began appearing around the world during the 1980s and '90s. A pleasant surprise of the last few years is that the disease can regress in the wild. Affected turtles have later reappeared greatly improved, even recovered. Ten years ago its rapid expansion posed a great threat, yet its spread now seems to have slowed, and in many places perhaps halted. Where this disease is headed is anyone's guess.

Three slashes into the armor of its back like chain-saw cuts in tree bark indicate a serious boat-propeller strike, wounds so deep you can see the membrane of this Green Turtle's body wall moving as it inhales. The width of that membrane is how close to fatal this wound was. Doc says, "This will probably heal. They're amazingly tough animals."

Green Turtles nest upon the shores of eighty countries and swim through the waters of about 140 nations as they range the world's warm waters. Their two largest nesting grounds are Caribbean Costa Rica's Tortuguero National Park, and Australia's Raine Island, with present-day annual averages of twenty-two thousand and eighteen thousand nesting females, respectively, digging roughly one hundred thousand nests in each place during good years. People take eggs at nearly half their worldwide

nesting beaches, kill females at a quarter. Half the populations suffer accidental losses in fishing gear. Half are targeted for netting by people in various countries who eat Green Turtles. In Southeast Asia, people eat about one hundred thousand Green Turtles annually. Hunting remains significant off Nicaragua's Caribbean coast, along which you can see women on the street selling turtle stew from big steaming pots, and turtles on the decks of boats and in the backs of pickup trucks. Some poaching continues even at Tortuguero.

Doc Ehrhart says, "I don't think people realized Green Turtles were pretty close to blinking off the screen in Florida. We had only thirty-two nests one year. The commercial turtle netters were going out of business for lack of turtles when the Endangered Species Act was passed in the early 1970s." Then things turned around, he says. "By about 1990, conservation measures resulting from the Act finally gained traction. Green Turtles started recovering. They went from under a hundred nests most years to as many as twenty-five hundred nests statewide in the last few years. It's actually exponential now. What did it—in *my* opinion—was that the Act made it illegal in the U.S. to take turtles for their meat and eggs. There will always be poachers, but basically, the Endangered Species Act made people stop killing turtles on purpose. For Florida's Green Turtles, that's what did it."

Meanwhile, members of the U.S. Congress, led by California Republican Richard Pombo, have been working hard to revise the Endangered Species Act. By limiting what kinds of science can be used—no genetics or computer modeling, for example—and by putting people with commercial interests like logging and grazing and real estate on teams writing species recovery plans, and by a host of other requirements, such as mandating payments to landowners, their amendments would so change the Act that Democratic congressman Sam Farr called their bill "a gun to the head, an attack on America's great heritage." In fall of 2005, the Republican majority in the House of Representatives passed the Pombo bill.

A tiny sea horse falls from the net into the boat like an elegant living question mark. Here in Florida there is a magnificence in people's compassion that causes porch lights to go dark, giving room and consideration to ancient elders. But we are less amazed that turtles come than that turtles *still* come. In our bones we know what belongs. Buildings heightened, nights brightened, and beaches hardened are discordant. There is not on such altered shores the feel of how it always was and always can be. In our hearts

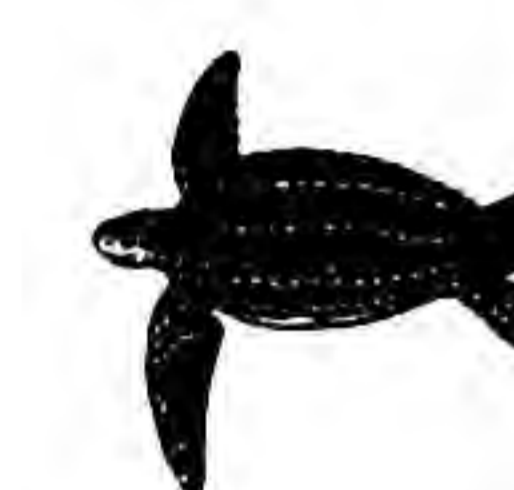


we fear what's ahead. Sense of place and deep connection yield to the magic-robbing dread familiar to those in desperate love: that the object of our affection may cease returning, may somehow—through our failure to consider or to act, or simply by time's changes—be driven away forever. Here under high-rises the palpable dread is that push may come to shove, that seawalls will come up before home owners go down, and that in any further skirmish with the colonies of strange apes so capable of loving the shore to death, turtles may lose.

There is in the tender peace here a want of assurance, a sparseness of confidence that all's right with the world. This is to say, I worry about the turtles. But so do enough others that there is some comfort. One person worrying is desperation; a worrying group sows seeds of hope. Here people keep their lights out for turtles and ride with bumper stickers announcing, *TURTLES DIG THE DARK*, and put up shopping centers named Loggerhead Plaza. It certainly could be much, much worse—and elsewhere is. True, there is something diminished about turtles amid high-rises and beach chairs. When a turtle comes ashore on a beach backed by dark jungle and a night buzzing the infinite potential of living nature, magic arises in the seamless meshing between the living thing and the setting that created it. Magic is the simplicity of rightness. Where ocean and land confront each other and dance their dance, negotiate their borders, an animal can come ashore for one hundred million years and find no disappointment. It finds the night secure in its darkness, the slope of the shore's shoulder poses the proper challenge, the very sand particles feel right; all systems living and non conspire toward the furthering of life, because the animal has been sharpened on the whetstone of this world. When a beach is yoked to a job it wasn't meant to do, or the land is forced to work, the magic ebbs. But here an accommodation is being struck, and this is the surest proof that it *is* effective: turtles come. A few years ago, the total number of Leatherback nests in Florida reached five hundred; the *next* year it was over nine hundred. At an international scientific conference Kelly Stewart and Chris Johnson recently delivered a paper titled "An Explosive Increase in Leatherback Nesting in Florida." **That counts.**

## LEATHERBACKS AND CANNONBALLS

*South Carolina*



Like sacred Egyptian icons passing below us, six White Ibises bestow on us the lofty sensation of gazing down upon birds in flight. We ourselves are wafting smooth as a swallow in the soft morning haze of a lazy South Carolina Tuesday, savoring the view afforded by small aircraft—high enough to sense the minds of birds, low enough for intimate peeks at revealing details. The cloying plumes of pulp mills are rising to our right. We hook left, putting the brown clear-cuts behind us.

Soon we're over a mosaic of wooded islands inlaid into emerald marshes, grouted with wriggling creeks, spanning expansively toward the coastal contour. The verdant sprawl of a blossoming summer, languid and luscious, stretches to the planetary curve.

Sharing her views as we speed toward the ocean is Sally Murphy, South Carolina's official "sea turtle coordinator." For two decades Sally Murphy has probably worked harder than anyone to save turtles off the U.S. Atlantic and Gulf Coasts from their largest source of human-caused mortality in the Atlantic: drowning in shrimp nets.

Today Sally and her crew are heading out over the ocean to count Leatherbacks that pool offshore here in late spring. (Kelly Stewart's Florida Leatherbacks, for example, tend northward after nesting, often stopping off South Carolina.) Sally's also done a lot of work with the Loggerheads that nest on her state's shores. Her southern voice comes through my headphones. "See there? That's Cape Romain. Still the most significant Loggerhead nesting north of Canaveral, Florida." This slightly cooler region hosts only 6 percent of the coast's nesting Loggerheads but produces most of the population's males. "Lotsa Raccoons, so we've been moving nests to hatcheries."

If the North Atlantic Ocean's turtle species are stabilizing or recovering,