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The Gulf Between

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The Gulf Between

A Thesis

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in
Creative Writing
Nonfiction

by

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Note

In the manuscript that follows, I have forgone footnotes and parenthetical citations. All sources can be found at the end in the "Notes" section, ordered by chapter and page, so as to free the manuscript from minuscule, distracting numbers.

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Abstract

Great swaths of Southeastern Louisiana are drowning, land giving way to water at an alarming rate. Since the 1920s, Louisiana has lost more than 1,800 square miles of wetlands to open water, an area about the size of the state of Delaware. In the same amount of time it takes to watch an episode of Breaking Bad, our state loses the equivalent of a football field's-worth of solid ground to the rising seas. My thesis is the first part of an accessible creative nonfiction book that tells the story of what's happening in my home state. To what extent is it feasible to engineer ourselves out of harm's way? What communities get relocated, and on whose terms? Most centrally, how will we address the troubling gulf between what we know to be true about our changing climate and what we are willing to do about it?

Keywords: climate, Louisiana, restoration, environment

But we have only begun
to love the earth.

We have only begun
to imagine the fulness of life…

Surely, our river
cannot already be hastening
into the sea of nonbeing?

Surely it cannot
drag, in the silt,
all that is innocent?
Not yet, not yet—

…So much is unfolding that must
complete its gesture,

so much is in bud.

- Denise Levertov, “Beginners”

1. The End of Ourselves

I am the tree that trembles and trembles.
- Muriel Rukeyser, “The Speed of Darkness”

Just ten miles southwest of New Orleans, a forest of old trees is drowning. The box elders, red maples and oaks in this wood are nestled in the northeast corner of the Barataria Nature Preserve, which itself lies at the heart of the Barataria Basin, a wedge of land in southeast Louisiana about the same size as the state of Rhode Island. Bordered to the east by the banks of the Mississippi River, to the west by its hundred-mile-long distributary, Bayou Lafourche, and to the south by the Gulf of Mexico, the Basin itself is among the youngest places on earth. Its soil was laid down by the Mississippi a mere three thousand years ago as the great river built up the delta all around it. Some of the live oaks that grow in this soil, however, have been drinking in the sun well before my grandparents were born. They’ve withstood hurricane-force winds, persisted despite centuries of logging and oilfield development. The trees in this wood have survived it all only to find themselves dying in the twenty-first century, suddenly forced to do something that few of their species do very well: swim.

Scientists have combed this forest for data over the decades, but likely none of them know their way around this particular plot of trees as well as Dr. Julie Whitbeck does. An ecologist with the National Park Service, Whitbeck has been tromping out into this patch of woodlands for more than twenty years. When she began monitoring things in the nineties, the trees were relatively healthy. The forest flooded a couple of times a year, but that is par for the course for this part of southeastern Louisiana. The standing water would always eventually drain down.

In a mere twenty years, though, all that has changed.

Whitbeck explained all this to me over her shoulder one morning as we sped south on Highway 45 towards the Preserve in her little two-door car.

"The forest has fallen apart," she said. Approaching fifty, Whitbeck has dark eyes and wears her tawny greying hair loose. It's long, hangs about halfway to her waist when she stands and sways with her as she moves. The day that Whitbeck took me out to the Preserve, she wore it under her olive-green park service cap.

I'd first contacted Whitbeck after sitting in on a presentation she'd given weeks earlier in one of my courses at the University of New Orleans, where I was enrolled in a graduate writing program. I also worked as a teaching assistant there, guiding freshmen through their required intro-level English composition classes. Many of my students had grown up in and around Barataria Basin, I learned, and their essays about the place and its environmental issues captured my curiosity. One student, in particular, cited the ever-rising waters encroaching on her hometown as the primary reason she'd decided to move away for good. Haunted by my students' strangely pragmatic attitudes towards such a surreal phenomenon, I'd launched myself into further research on the topic.

After a short jog south towards the Preserve on Highway 45, Dr. Whitbeck pulled to a stop in a gravel lot just outside the concrete flood gates that mark the northernmost edge of the park. It was a chilly spring morning, the sky bright and cloudless and the air smelling crisp and rinsed from a heavy rain the night before. Two Tulane University students had come along with us, and the three of us stood around the trunk of the car as Whitbeck dug around in it, fishing out a pair of ankle-tight knee-high rubber boots for each of us. She advised that we cinch them up at the top. After all the rain yesterday, she said, we were almost guaranteed to flood our boots in the wettest section of the plot.

"And watch out for snakes," she added. Water moccasins and other poisonous vipers love this part of the forest, and should one of us get bitten off the trail, calling for help would be tricky.

The three of us had come out to assist Whitbeck in collecting what she called "litterfall," bits of twigs and sticks and fallen leaves, acorns and flowers and seedpods, the canopy's dry rain of dead plant matter. Throughout her plot, Whitbeck had scattered two-foot-square "traps," low-tech affairs fashioned out of PVC pipe with hand-sewn nylon screens stretched across the top to approximate a kind of shallow basket. The baskets caught the litterfall, and every two weeks, Whitbeck traipsed from trap to trap collecting it. She weighed it, then tracked that weight over the months, weeks and years. Higher amounts of litterfall was linked, she said, to higher amounts of "ephemeral aboveground productivity." In other words, the more seedpods and acorns and flowers the trees *shed*, the more seedpods and acorns and flowers they'd *produced.* High productivity was, in this way, associated with a healthy forest.

Whitbeck had designed the study in order to investigate in what ways the increasingly prolonged flooding she'd been seeing in this part of the Preserve since the nineties was affecting the trees. "Trees need to breathe," she said. Like humans, they are aerobic organisms. She hypothesized that more flooding meant less productivity. The rapid shift from a terrestrial environment to an aquatic one, she posited, would not bode well for the trees.

She set about to test her hypothesis by sectioning off the study plot into three transects. Moving from west to east, each section of forest got progressively wetter. The easternmost section, she said, had been flooded around the clock for years now.

After securing our rubber boots, the four of us set off from the gravel lot towards the forest. The Tulane students, biology undergraduates both, were both quiet and shy in their navy

university sweatshirts. Whitbeck explained to us that we'd start in the driest, westernmost section of the plot and work our way east. We skirted through an opening in the ten-foot flood wall, then down a small mowed grassy embankment to the edge of the woods. We stepped into the Preserve on a soggy trail beneath a canopy of water oaks and ash, sweetgum and hawthorn and elm. From above came the *chit-chit* of chickadees and kinglets and yellow-rumped warblers. In between the silvery, lichen-splotched trunks, giant spiny palmetto fronds dominated the understory. Shaped like the crimped paper of a Spanish hand fan, most were six or seven feet high, their round leaves almost a yard wide from edge to edge. Clumps of wood fern curled about our boots on the edge of the footpath.

A few minutes after entering the forest, Whitbeck directed us to follow her off the trail towards her first litter-fall trap. Ducking low to avoid the sharp edges of the palmetto fronds, we crashed into the forest, the mud slick and shifting under our feet. We spent about twenty minutes slogging together from trap to trap, collecting the soggy seedpods and dead leaves that had fallen into the mesh baskets and depositing them into labeled brown paper bags. There wasn't much to see. Most of the traps were nearly empty.

Whitbeck had prepared us for as much. The entire plot, she said, had borne out her hypothesis, becoming steadily less productive over the last two decades. The most dramatic declines were in the wettest part of the plot, where the stress of year-long flooding had begun to kill many of the trees.

As I watched Whitbeck scrape a couple of wet twigs into a paper bag with the side of her hand, I found myself ruminating on something Marc Reisner had written in his book, *Cadillac Desert.* "Trees," he said, "because of their moisture requirements, are our physiological counterparts in the kingdom of plants." He went on to suggest that, in areas of the West where

trees could not grow—in drought-plagued deserts, for instance—people also struggled to live. "One does not really conquer a place like this," he wrote. "One inhabits it like an occupying army and makes, at best, an uneasy truce with it." Obviously, Reisner had been considering an extreme environment on the opposite end of the hydrological spectrum from where I was now standing. Still, I thought, it was a useful benchmark: if trees can't survive here, people probably can't for long, either.

The plight of the trees in Dr. Whitbeck's plot, however dramatic, is not unique. Great swaths of southeastern Louisiana are drowning, land giving way to water at an alarming rate. Since the 1920s, Louisiana has lost more than 1,800 square miles of wetlands to open water, an area about the size of the state of Delaware. In the same amount of time it takes to watch an episode of *Breaking Bad*, our state loses the equivalent of a football field's-worth of solid ground. In just under a century, coastal Louisiana has shrunk; it's about a quarter smaller than it was in 1930.

I first learned about Louisiana's sinking, shrinking coast at the dining room table of Pulitzer-Prize-winning environmental journalist Bob Marshall. A few university classmates and I had joined him in his home in Uptown New Orleans, a neighborhood known for its stately colonnade of street-side oaks and the buckling, pock-marked and sink-holed asphalt of its narrow-paved roads. Marshall himself is tall, genial, and charismatic, his thick hair going white and his low voice a little gravelly—a passable stunt-double to the late Anthony Bourdain, with square wire-rimmed glasses perched on the bridge of his nose. His friendly demeanor is pocked through here and there with a kind of dark, bone-dry sarcasm that betrays the many years he's spent reporting on what he calls "the greatest ongoing environmental disaster in the country."

He introduced us to his wife, the co-founder of Lost Lands Tours, as we got settled around the table, and identified himself as our educator for the day and her slave for life. Against

the far wall of the dining room hung a large flatscreen, and from his perch behind a laptop at the head of the table, Marshall projected a map of the state of Louisiana onto it.

This place, he explained, took more than 7,000 years to form. The land we now know as southern Louisiana accreted over centuries, rising up out of the Gulf of Mexico as the Mississippi River slowed and dropped sediment “like a rain of sand and dust,” said Marshall. “And that’s how deltas are built.”

My wife once explained this to me with her forearm, which she held up before her to represent the river. She snaked it back and forth, like a garden hose left gushing unattended on the grass. The river fanned out like that, she told me, undulating across the hundred-mile expanse of the Delta over thousands of years, sweeping back and forth. Every springtime, like clockwork, the river swelled with melted snow and precipitation. This flooding was a boon to the surrounding landscape, since the river water brought dirt and sand and clay with it. Over thousands of years, these trace amounts of sediment settled out around the banks of the river and all its branched-off distributaries. The soil compacted and the muddy, spongy earth grew slowly taller and more solid. Eventually, it accumulated into the boot-shaped land mass we now know as Louisiana.

Maps that chart this slow land-building progression over time lop the southern part of the state off into five major lobes, grouped according to when and for how long the river ran through them. Sale-Cypremont, Teche, St. Bernard, LaFourche, and Plaquemines:

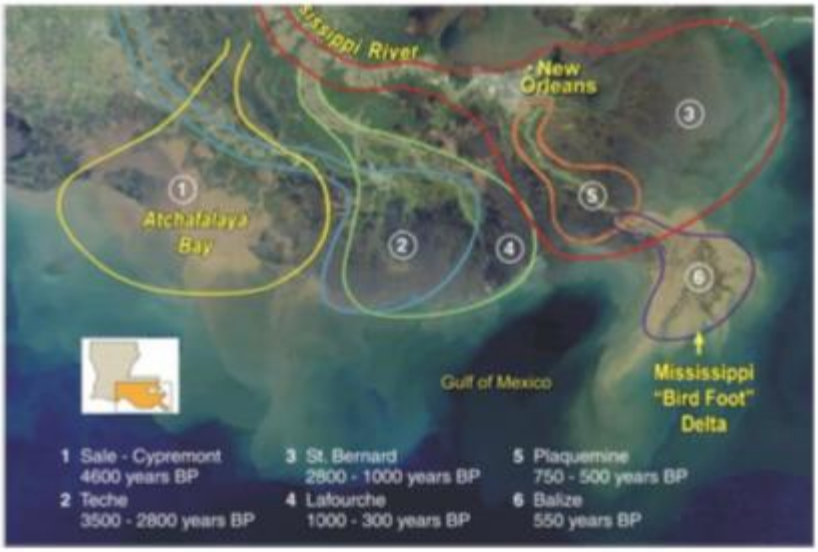


Fig. 4-2. Historical evolution of lobes in the Mississippi River Delta complex. Source: Day et al., (2007) and refs therein.

Each sizable section of the state once hosted the great river in its core for a few thousand years. Eventually, when the land grew too high and firm for the Mississippi to rush freely into the Gulf, it swung out to chart a different course, following gravity and the path of least resistance out into the sea.

Understanding how deltas are built, Marshall explained, is crucial to understanding why ours is unravelling—and fast. He told us that, after the Great Mississippi Flood of 1927 displaced nearly 700,000 people alongside the river as far north as Illinois, the federal government called for the construction of thousands of miles of protective levees. These structures, for the uninitiated, are high walls or mounds of earth or concrete, designed to keep high water from overtopping the banks of the river.

“When you put a levee on a delta,” said Marshall, “things happen.”

Aided by computer graphics, Marshall explained how seasonal over-bank flooding is crucial to maintaining land mass in the wetlands. Historically, when the Mississippi and all of its

distributaries swelled with melted ice and rainwater from the north in the springtime, floods breached the riverbanks and spilled out into the wetlands. This natural phenomenon allowed suspended sediment carried in the waterways to spread out, and continue the process of building up the land, replenishing whatever earth was lost during autumn's storm surges and hurricanes. Unfortunately, this seasonal flooding was blocked by the Army Corps of Engineers' new levee system, which essentially put the river in a straight-jacket. The protective concrete and earthen hillocks worked to shield communities from floodwaters, but at the cost of preventing new sediments from being laid down.

To add to the dilemma, more and more cities and towns cropped up in the shadow of these levees, "putting huge amounts of weight on this muddy sponge," said Marshall. "And it's pressing down, cutting off resupply of moisture from groundwater. So you've got subsidence."

Subsidence: the sinking of the land beneath our feet. The reason so many parts of New Orleans are in fact *under* sea level, the concave bottom of a rounded, earthen bowl.

"You can go to any levee anywhere in South Louisiana," said Marshall, "especially the ones built at the edge of land they wanted to drain to build a subdivision. And you can stand on the top of that levee and look on the wetlands side, and it won't be far down. But if you turn and look at the protected side, you gotta look down five, six, seven, eight, nine, ten feet."

Such are the problems inherent to urban development on the top of what amounts to a wet, muddy sponge.

"When the sponge dries out," said Marshall, "it shrinks. That's why New Orleans streets are like roller coaster rides. That's why houses tilt. Cracks show up. Doors stick."

Add to this the problem of global warming and the resultant ever-rising seas, and the scale of the environmental crisis Marshall mentioned at the beginning of his talk becomes clear.

"According to the National Climate Assessment," he told us, "that you *might* still be able to find online on the EPA's website—"

My classmates and I twittered and frowned.

"According to them, the Gulf and East Coast are looking at anywhere from two-and-a-half to three-point-two feet eustatic warming sea level rise by the end of the century." Scientists use the term "eustatic" to refer to *global* sea level rise, calculated using the center of the earth itself as a point of measure, as opposed to "relative" sea level rise, which pertains to how high the surface of the sea is in different geographic locations. Marshall explained that, by and large, unchecked emissions from burning fossil fuels were to blame for the planet's temperature shifts and the overall rise of the sea across the world.

Marshall turned to the flat screen, upon which an image of the lower half of Louisiana's boot was projected.

"Here's a two foot rise," he said. He clicked. The map filled with blue. "Here's a meter." He clicked again. The blue subsumed the hospital where my wife was born, the house where my father-in-law currently lives, and about half of my freshmen writing students' hometowns.

"That's just from warming," Marshall said. "That's without adding our sinking."

The room became deadly silent.

Marshall gave us all a bright smile. "But hey," he said, "you've only got a couple more years of college here, so…"

Back in the forest with Whitbeck, we slogged eastward, ducking beneath the undergrowth, making a wide arc around an ancient-looking live oak, its craggy trunk as wide as the bed of a pickup truck and twisted like sinew. Wrist-thick vines of trumpet creeper wrapped all the way up

to its canopy, which was festooned with soot-colored beards of Spanish moss. Despite the presence of this powerful oak, it was clear that the younger trees in this part of the plot were struggling. The canopy overhead grew steadily thinner as we plunged deeper into this mid-section of the woods. The water, now, was halfway up our calves.

The students and I followed Whitbeck to half a dozen more traps, paused at one or two to replace old mesh baskets with new ones. Occasional stiff gusts of wind blew through the leaves overhead, sometimes loosening a dead tree branch somewhere, and we'd all stop to listen to the brittle crash of its fall. One trap, in fact, had been knocked askew by the trunk of a dead tree about six-inches in diameter that had likely blown over in the rainstorm the night before. After repositioning the trap, Dr. Whitbeck frowned, shrugged, then placed a sample of the desiccated wood into one of her brown paper bags.

Less tree cover overhead meant that more sun played off the water. Little ripples of light reflected off its surface back up onto the crimped green undersides of the palmetto fronds. Undisturbed, the water itself was the color of diluted iodine, a translucent amber-brown. We high-stepped through it and stirred up clouds of sediment in our wake.

Watching the thick muddy particles swirl up around my boots, I thought about an event called "Wine for the Wetlands" that I'd gone to months before in Belle Chasse, a small town about five or six miles east of the Preserve. My father-in-law, a longtime biologist with the federally-funded Louisiana SeaGrant program, had suggested that I attend after learning of my interest in the state's environmental crisis. Many of the "big players" in coastal restoration would be there, he said.

So I'd decided to drop in. The event was a fundraiser for RESTORE the Mississippi River Delta, a coalition of local and national environmental nonprofit organizations. Held at The

Cypress Bar off Highway 23, it was cozy inside, with exposed wooden rafters and a couple of swirling daiquiri machines. A black-and-gold New Orleans Saints pennant hung by the cash register. By the time I arrived, the place was full of people—mostly older white guys—milling about in business casual. Spread across a couple of tables near the front door were stacks of pamphlets, volunteer sign-up sheets, and a handful of tri-fold informational boards. I peered at them over the rim of my plastic cup of rum punch.

Restoring Louisiana's Coast, they said. *Protecting Our People.* Most of the boards and a few of the pamphlets included large maps of the Gulf Coast of the state, criss-crossed with dotted lines and little white icons to indicate various restoration projects, both proposed and underway. I was impressed by the high quality of the literature, everything full-color and glossy. The tagline *Multiple Lines of Defense* ran in bold-face type along the top of the handouts. The militaristic language made me think again of Reisner, of our increasingly untenable human presence here in the fast-flooding landscape all around us.

The projects detailed in the pamphlets were all a part of the state's 2017 Master Plan for a Sustainable Coast. According to the 90-page document, the state had set "an ambitious path to respond to the loss of our coastal land and the threats from storm surge events." The plan outlines 124 different projects, ranging from marsh creation to barrier island restoration, from dredging up mud to diverting Mississippi River water, from levees to flood walls to pumping stations.

The price tag for such a vast strategy is about $50 billion. For this reason, the Master Plan is more like a wish list than a plan, per se, and priority projects stand to be among the first funded, designed and executed based on their potential to mitigate further loss to the coastline.

One of those projects was called the Mid-Barataria Sediment Diversion.

If the Army Corps of Engineers had put the river in a straightjacket back in the ‘30s, then the Mid-Barataria Sediment Diversion might be best understood as an attempt to loosen one of its buckles.

So named for its proposed location about midway up the easternmost edge of the Barataria Basin, the massive engineered structure would begin its life as little more than a wide, shallow channel near the levee on the west bank of the Mississippi. Gradually, work crews would hollow out an expanse of grass between the edge of this channel and the riverbank, pouring out a flat concrete sill and sinking thick, 125-foot piles into the soft marshy earth to stabilize the foundation. From the base of the sill, four smooth, forty-foot-tall fins would rise. Running parallel to each other and perpendicular to the river, the fins would be gradually extended in the direction of the levee. At this point, water would be pumped in to partially submerge the concrete structure. Finally, the levee would be methodically lowered until the river at last overtook its western threshold and filled the concrete culvert beyond.

Barges would then work to extend the four fins about one or two hundred feet out into the river. Between their walls, three deep troughs of water would begin to take shape. The most crucial aspect of the diversion’s design, these three long concrete “inlet channels” would eventually reach out into the river and catch great quantities dirt, clay and sediment as it passed along in the swift current. Once snagged, the diversion would siphon this freshwater slurry westward through the trinity of long concrete chutes and, at last, release it into the outlet channel towards Barataria Basin.

The conceptual drawings of the diversion that I saw that night in RESTORE’s promotional literature were sleek, the low concrete fins rendered in white. The whole thing

looked like a mysterious, half-submerged mega-church built out into the river by a modernist architect, perhaps one inspired by Frank Lloyd Wright's Pennsylvania Fallingwater home.

Its minimalist look notwithstanding, were the Mid-Barataria Diversion a church, it could house a seriously large congregation. From end-to-end—from the tip of Mississippi inlet channels all the way through to the basin outlet bay—the structure would be longer than a dozen Boeing 737's parked nose-to-tail, longer than the Empire State Building lying on its side. It's poured concrete control structure, over which a railroad and a raised highway would pass, would be about as wide as the end zone on a football field.

Even more impressive than the proposed size of the thing, however, is the amount of water it could move at peak flow—75,000 cubic feet per second, to be exact. To get a sense of this immense volume of water, imagine standing at the base of Niagara Falls in May, when the waterfall cascades at 100,000 cubic feet per second. Then take three-quarters of that deluge and shoot it through the concrete bays of the diversion every second for the six- to eight-week flood seasons in the winter and spring.

The state body responsible for carrying out this huge project, the Coastal Protection and Restoration Agency, cautions that the diversion would not run at this tremendous capacity very often. Within each bay, a 53-foot control gate will be installed. This barrier will be mechanically manipulated, partially raised or lowered as needed, in order to produce the desired outflow of water and sediment into the basin. Ultimately, CPRA hopes to move some 150 tons of mud out over the atrophied basin in the next fifty years. These sand, clay, and dirt particles would settle, the same as they did for the past 7,000 years. Plants would put their roots down into the new earth. If the plan works, the rate of land loss in the basin would gradually decrease. Freshwater

marsh would begin to re-appear where, before, the landscape had been pocked through with open water and crisscrossed with man-made canals.

At least, this is the hope. No one is completely sure how the Mid-Barataria Sediment Diversion will work, because a diversion of its ostentatiously outsized scale has never been built anywhere else on the planet. Not on the Nile, not on the Ganges, not even upstream on our own river. We have huge locks and giant dams and multi-storied control structures built into the banks and across the spans of the Mississippi. We even have a couple of smaller-sized river diversions near New Orleans. But with this project, the state of Louisiana intends to effect something far more Biblical in scope than merely stopping, slowing, or re-directing water. No—like Christ turning water into wine, our state will perform a miracle of transfiguration, and by the power of concrete, turn water into land.

It might have been the rum punch, which by then had stained my lips a garish cherry color, but something about looking at all those glossy, streamlined CAD images of the diversion was having a very salutary effect on me. It was comforting to think that something so large and authoritative was on the way to our rescue. The whole thing inspired confidence. In truth, the project seemed an elegant solution to a daunting problem: allow the river to do what it was naturally inclined to, loosen up a buckle on its man-made straightjacket, and within my lifetime, some of the damage done to our coast could be reversed.

"Return the river to the marsh," went the motto, and no one that night said it more emphatically than RESTORE's Outreach Coordinator, Richie Blink. He looked to be somewhere in his thirties, with a round, clean-shaven face and blue eyes. He struck me at once as both extremely likable and very tense. He'd grown up wearing rubber boots in Empire, a small fishing town tucked off the Mississippi about thirty miles north of river's mouth. He'd come of age

tooling his bike around shipyards and helping his father haul up shrimp. Blink himself has an intimate knowledge of the labyrinthine bays and bayous that sprawl out in every direction around his hometown, having grown up navigating them "like the hallways in your house," he said. After shaking my hand and listening carefully as I described my interest RESTORE's work, he penned my name onto a little pad he had opened before him. *Get coffee,* he wrote next to it, in a shaky print that might have had something to do with whatever was making him so anxious. After this, I was quickly shunted off to the side. A receiving line of sorts had formed behind me. Blink was in demand.

Maybe twenty minutes later, just as I'd begun to chat with a red-headed guy who was working on some kind of fish-tracking smartphone app, Blink stepped up to the center of the floor and cleared his throat. Behind him were a couple blown-up aerial shots of the marsh and a computer-generated drawing of the Mid-Barataria Sediment Diversion.

After expressing general thanks to everyone for coming out, Blink gestured to the diversion pictured behind him. It was the coalition's flagship project, he said. Blink went on to explain that RESTORE hoped to help the state in any way they could so the project might be permitted, constructed and put into operation as quickly as possible. Our situation was dire. We needed to act fast.

"Return the river to the marsh," Blink said, and I found myself nodding along. It seemed like common sense to me.

At around this point in his fundraising pitch, a fisherman spoke up. I can't remember what he looked like, or what his name was. What I do remember is the confrontational quality of his voice as he told Blink, point-blank, that their diversion was gonna drive all of the fish away.

Folks in the room went stiff. For a full three minutes, the fisherman recriminated Blink, who nodded in a tight, diplomatic way as the guy explained that when you loosed a whole mess of fresh water into a brackish swamp, it changed the composition of the fishery. Plus, the Mississippi was clogged with pollutants and fertilizers and other chemical wastes. What was everyone like him supposed to do, he wondered aloud, when the diversion opened up and all of the oysters died, all of the fish swam away?

For a moment, nobody said a word. Blink had a grave look on his face. His jaw muscles twitched. Then, another man stood up in the back of the room and responded to the fisherman in Blink's stead. The gist of his counterargument went something like, well, if we don't do anything to rebuild new wetlands habitat, juvenile fish will have no nursery in fifty years, anyway.

"Your fishing spot's gonna change," the man said, and the fisherman stood down ever so slightly.

Blink picked it back up at that point. He spoke gently, saying that without these diversion projects, *everything* would be gone in fifty years. The fish, the people, and the land beneath our feet.

That seemed to bring everyone to a prickly ceasefire. Blink said a few more words of thanks, asked that we give as we were able in the envelopes at the entry tables, and stepped down from the improvised stage.

I tried to wrap my head around the heated conflict I'd just witnessed, around the idea of a skyscraper-sized concrete hydrological structure being sunk into the riverbank, but mostly around the craziness of the land beneath my feet disappearing by the time I was eighty years old.

The guy I'd been speaking with before Blink's presentation broke me from my bewildered trance to ask me what I was studying at the University of New Orleans. "Nonfiction writing," I said.

He nodded and smiled a wry smile. "Well," he said. "That's good. Cause this isn't fiction."

At last, I waded with Whitbeck into the wettest part of the forest, crossing over an old footpath and into an environment vastly unlike the one we'd gotten started in. Here, the water easily overtopped my knee-high boots. No longer translucent, the surface was covered with a thin scrim of tiny aquatic plants, their floating leaf-pads no larger than the head of a thumbtack, colored the brilliant chartreuse of a cockatoo's tail.

Dr. Whitbeck explained that marsh vegetation like this could thrive here because the treetop leaf-cover had so thoroughly disintegrated. Sure enough, when I looked up, the vibrant green ceiling of oak and red maple and hawthorn leaves we'd walked in under had vanished. All around us, long-dead sun-bleached tree snags thrust upward into the sky. Their bark hung down around them, peeled off in long strips, their naked trunks pocked with tiny holes from woodpeckers. The palmettos looked sickly, too. Many of their fans were yellowed, or dried, or blotched with black fungus. Their iconic cylindrical bases, composed of a cross-hatch of old broken-off fronds, crumbled at the touch.

We all stopped. "It's like a tree graveyard," I said.

Dr. Whitbeck nodded. Weeks earlier, in an interview at the Visitor's Center, she told me that the park was totally behind the proposed Mid-Barataria Sediment Diversion Project, seeing it "as a net positive thing, because we anticipate that the marsh will establish, that the surface

will emerge from underneath the water, the plants will colonize it, other biota will establish there, and that this will all be additional friction from ocean forces that are one of the major threats for us here."

However, she also alluded to a lack of scientific consensus around the structure. "There's dispute," said Whitbeck. "This big polarized debate between two LSU graybeards." She explained that Dr. John Day, an ecosystem ecologist in Louisiana State University's Department of Oceanography & Coastal Sciences, was very pro-diversions. "He did some research here that illustrated greater levels of productivity and accretion of the organic substrate in the marsh surface [traceable to the diversion]," Whitbeck said.

"But Dr. Eugene Turner," she added, referring to Day's departmental colleague at LSU, "looked at changes in edge and actual wetland areas." His findings indicated that smaller, existing freshwater diversions built off the Mississippi had *not* led to an increase in land surface. Turner's research also raised questions about some of the things the fisherman had brought up that night at the fundraiser: namely, the polluted quality of water in the Mississippi River and its effect on plants' ability to establish healthy root systems.

"I haven't read as many of Turner's papers," Whitbeck admitted. "I'm more a 'Day' kind of person."

Standing beside Whitbeck that morning in the tree graveyard, though, I felt troubled. I didn't know what kind of person I was—a Day-person or a Turner-person, a RESTORE-person or a fired-up-fisherman-person. What I knew for sure was that, as a species, both humans and trees were coming up against an environmental situation to which we were poorly adapted. Humankind, of course, has weathered tremendous upheavals and crisis of continuation in our time on the planet: the black plague in Europe, smallpox in the Americas.Yet, we have always

survived these times of seeming apocalypse—as a species, at least, if not as culturally coherent communities. Now, though, the environment confronts us with something else entirely. The planet is heating up and its oceans are rising at a pace that people have never encountered before. Whole ecosystems are transforming from terrestrial to aquatic in a matter of decades. The psychic burden of even *accepting* this threat to our collective survival, let alone coming up with any sort of solution to it, may well be beyond us. In a way that is, perhaps, more profound than any other time since we climbed down out of the trees and began to walk around upright, humans are being asked to do something that none of our species do very well: imagine the end of ourselves.

In a worried haze, I looked up at the bare arms of the trees against the sky, and reached out towards a curl of papery bark a couple of feet away to stabilize myself on the mud. Just then I heard a buzz, almost inaudible, as from a bumblebee. Instinctively, I froze. There, coiled up on the dry bark, was a charcoal-colored viper with a diamond-shaped head.

A water moccasin, Whitbeck confirmed, just trying to stay dry like the rest of us. For a moment, the snake and I regarded one another with equal wariness. A breeze rushed through the exposed architecture of the dying forest all around me, and I took a couple of steps backward in the mud, giving the snake a wide berth. I was in a dangerous place about which I knew relatively little, I realized, and would need to keep my wits about me if I wanted to wade any further into the morass.

2. A Higher Truth

> There are a thousand hacking at the branches of evil to one who is striking at the root.
>
> - Henry David Thoreau, *Walden*

The first thing I noticed about Dr. Eugene Turner upon meeting him was that he had no beard, gray or otherwise, despite my having been somewhat prepared for one by Dr. Whitbeck's characterization weeks earlier. The second thing I noticed, however, were his exquisitely tufty eyebrows. Unruly, coarse and white, they made up for his lack of a long gray wizard's beard in conferring to him the distinct look of slight pre-occupation, eccentricity and sagacity that I've come to expect from scientists of a certain age. So great were Turner's eyebrows that they almost upstaged his large intelligent eyes, which were dark in color and a little bit swimmy all the time.

We first met on a bright, clear Saturday morning in April just outside of the Lakefront Airport in New Orleans, an art-deco-style building with a couple of small charter airlines housed inside the terminal. Turner had invited me to join him and another writer named Brian Czech on a plane ride over some of the marshes he'd studied to the south and west of the city. That day, Turner wore a short-sleeved sport shirt printed with palm fronds under a burgundy knit vest, a sort of nerdy-Dad-at-the-beach look I'd eventually come to know as his go-to weekend outfit. After introductions were made all around, I followed him up a small flight of stone steps into the building.

Fifteen minutes later, we were a thousand feet up in the sky, banking over Lake Pontchartrain, a wide body of water that separates the Crescent City from Mandeville, its small-town neighbor to the north. The aircraft itself was an alarmingly tiny four-seat prop plane, and despite the time I'd spent studying our flight path on the maps Turner had provided beforehand, I

became immediately disoriented. Up front, the pilot sat beside Czech, and I squished in the backseat beside Turner. Peering down through the small window to my right, I searched for a landmark. Within minutes, though, we'd reversed course to glide southward, leaving the airport behind. The marsh slid past beneath us, a flat expanse of deep blue water splotched with patches of yellow-green vegetation.

My headset crackled and Turner piped onto our shared passenger communication line to tell me and Czech more about the land and water directly below us, which he identified as the Caenarvon Diversion Outfall Area.

The Caernarvon Diversion project had been completed in 1991, and had originally been constructed to address runaway saltwater intrusion in the marshy region just southeast of New Orleans. The move had mostly to do with improving habitat for oysters. The tasty bivalves, which are harvested to the tune of $317 million every year in Louisiana waters, are a finicky species. They flourish only within water of a very particular salinity gradient—anywhere from 5 to 35 parts salt per every thousand parts freshwater. By the nineties, saltwater had intruded into the Breton Sound estuaries due to the carving of shipping canals.

So the state built the Caenarvon Freshwater River Diversion, designed to siphon freshwater off of the east bank of the Mississippi River and sheet it out over the marsh. How much water, exactly, varies according to the season, but over the first 11 years of its operation it averaged about 1,250 cubic feet per second, a flow rate you could also achieve by filling the beds of about twenty pickup trucks with river water, then instructing them to release their cargo out over Breton Sound every second, ad infinitum, for eleven years. It's important to note that, however large this amount of water might seem at first, it's nothing the river would miss. The Mississippi can move more than 800 times as much per second between its banks.

Still, this relatively small amount of fresh water shook things up in Big Mar, the lake nearest to the diversion site. Alligators flocked to the area, increasing an astounding 243% from before the diversion began operating. Waterfowl and freshwater-loving fish like black bass also increased in abundance. The most surprising outcome of Caenarvon, however, had nothing to do with wildlife and everything to do with dirt. Tiny bits of clay and earth and sand, suspended in the murky river water, fell out and slowly accumulated in Big Mar. These sediments built up new, tentative landmasses in the middle of the lake. Vegetation appeared, springing upward with alacrity. Suddenly, acres of marshland existed where before there'd been only water.

In a state suffering from unprecedented land *loss,* land gain—unintended or otherwise—always makes the news. So although it was not designed to build land per se, the Caernarvon Diversion project quickly became the poster child for future coastal restoration projects throughout southeastern Louisiana.

However, there was a problem. Over the chop of the rotors, Turner explained that, in 2005, two powerful hurricanes blew through the area, first Katrina, then Rita right on her heels. The storms decimated the area below. They ripped up whole mats of vegetation. In some cases, high winds rolled up these detached patches of turf into long tubes as easily as you'd roll up a rug.

Curious about this devastating turn of events, Turner conducted a study with two other scientists. They examined vegetation growth inside Big Mar before and after it began receiving water diverted from the Mississippi River using more than twenty years-worth of Landsat satellite imagery data, cross-referenced with aerial photography. By analyzing this massive set of images, the three researchers hoped to determine "whether changes occurred in vegetative cover after diversion operations began."

The first thing that Turner and his colleagues discovered was that, although the highest percentages of cover in the study area appeared nearest to the diversion inlet, this was not necessarily indicative of new land. “This phenomenon,” they write, “is mostly a response to algae and floating vegetation in the open water areas, rather than to the presence of deeply-rooted marsh vegetation.” In other words: floating swamp plants created the initial *appearance* of land gain when, in fact, they were merely growing on the water’s surface rather than rooted into sturdy earth below. The researchers note that such growth is a merely a “nominal indicator of vegetation vigor.”

In the airplane, Turner directed my attention out the window and downward. At first glance, much of what I saw appeared to be solid marshland, thickly blanketed in vibrant green plant life. But then Turner told me to look closer. Because it was a clear day, the sunlight reflected back up at me from what should have been patches of land, the glare betraying the presence of water just below. Much of that greenery, Dr. Turner informed me, was actually just floating islands of algae and annual plants like the water hyacinth.

After Hurricanes Katrina and Rita, plant life in the Caernarvon study area dropped more than 30%. The highest rates of cover lost were found in zones closest to the diversion, despite the fact that these areas were further away from the hurricanes’ path than more southeastern portions of the marsh.

To explain this, Turner and his colleagues posited that chemicals suspended in the Mississippi River, mostly fertilizer and agricultural runoff from farms as far north as Minnesota, were to blame. Some scientists believe that the addition of these chemicals, called “nutrients,” impair wetland plants’ ability to develop resilient root systems.

“Fertilizers give you fruit, not roots,” said Turner.

Without sturdy roots to help hold it in place, then, whatever new land might be built by a freshwater diversion like the one at Caernarvon would be vulnerable to high winds and storm surge. “Ultimately,” Turner and Keaney write in the conclusion of their paper, “the scientific basis for river diversions needs to be more convincing before embarking on a strategy that may result in marshes even less able to survive hurricanes.”

I gazed out of the back window of the plane down at the marsh passing by beneath us. A tension headache was forming between my eyes, and the bob and toss of the small-bodied plane was beginning to make me feel nauseous. I thought about the state’s plan to build the Mid-Barataria Diversion just forty miles south of here. In an interview at a later date, I asked Turner what he thought about the state’s plans in the light of his findings at Caernarvon. “So far, they have no project that has generated [land] gain from a diversion.” He raised his wild eyebrows. “So now they want to build an even bigger one.”

The Mississippi River birthed not only the state of Louisiana, but in many ways, modern delta science itself. Heavyweights like Richard Russell and H.N. Fisk—both credited with developing the lobe theory of delta formation as explained to me almost one hundred years later by my wife waving her forearm around—they cut their teeth sampling water and coring the earth in our wetlands way back in the 1920s. As one of the largest river delta systems in the world, nestled at the base of the wealthiest nation on the planet, the region has inspired a truly robust amount of research and scientific literature. Today, the Department of Oceanography and Coastal Sciences at Louisiana State University has its own building tucked back behind Tiger Stadium with a faculty of more than thirty educators, including Dr. Turner.

I visited his office a few weeks after our plane ride. Tacked to the corridor just outside of his door were a series of laminated, full-color images of roots: photos and illustrations, cross-sections and scale models. Some were clearly for younger visitors to the university: *Roots have many functions,* one poster said across the top. Another quizzed, *What is holding this wetland together? ROOTS!* Closer to the door, Turner had hung a gargantuan, life-sized photo of a clump of grass. Its roots hung down in a dry brown tangle at least seven feet below the above-ground vegetation, so long that the tall canvas print, secured at the floorboards, had to be stapled up to the ceiling.

I gawked up at it, impressed, and thought about the reading I'd been doing lately about marsh plants, their roots, and a microbial process that goes on around them called "denitrification." When humans consume organic material—say, a spinach salad or a Big Mac or something—oxygen plays a crucial role in our ability to break it down for energy. Most living things puttering about up here in the air rely on it in order to conduct the daily biological business of our lives. Oxygen molecules, turns out, act as what scientists call "electron acceptors," helping our cells to transform stuff like Big Macs and spinach salads into fuel.

But once you get down into the mud in wetland habitats, within a few millimeters of the surface, the oxygen's all gone. This is where the microbes come in. These tiny living organisms have evolved over millennia, developing the capacity to find and use other kind of molecules as electron acceptors. The most energetic alternative to O2 is nitrate.

For the uninitiated, nitrate is a *pretty big deal* in the underwater mud community. It's a charged molecule made up of three oxygen atoms glommed onto a central nitrogen, and beloved by anaerobic organisms for its ability to act as what scientists call an "electron acceptor." When nitrates diffuse down in the sediments, specialized microbes cleave off the oxygen and use it just

like free oxygen. The byproduct is nitrogen gas, which escapes harmlessly to the atmosphere, as it is in fact composed of about 80% nitrogen already.

Part of Turner's research concerns what happens to marsh plants—specifically, their roots—when you flood a wetland area with excess nutrients like nitrates. Turner's research indicates that, in these scenarios, microbes burn merrily through it all, cleaving off oxygen molecules and decomposing all kinds of important organic material in the soil while they're at it.

"Wetlands here are showing a reaction," Turner told me that day. "An enhanced decomposition or weakening of the soil."

We sat together in his office. The bookshelf behind me was stacked haphazardly with encyclopedia-sized books. So was the floor. And the desk. Turner seemed at home in the general disorder of it all, projecting an air of calm patience and groundedness—which makes sense, I guess, considering that so much of what he studies lives under the ground.

We discussed then, briefly, a study conducted on nutrient loading in a wetlands habitat many thousands of miles north of where we sat. In coastal Massachusetts, scientist Linda Deegan at Woods Hole Research Center, along with seven other researchers, added controlled amounts of nitrogen and phosphorus into the tidal water that flowed into Plum Island Estuary. Every day for nine years, nearly seven acres of previously untouched salt marsh were exposed to these nutrients.

The results, published in the journal *Nature*, raised considerable concern over the effects of nutrients on plant growth. "In only five to seven years," said one of the researchers, LSU professor emeritus John W. Fleeger, "the edge of the marsh is literally falling apart." The marsh grass initially bounded upwards with the increase in nutrients, but its roots did not mirror this growth spurt. The bright green *Spartina* cordgrasses—a species also found in Louisiana

wetlands—eventually toppled over, along with the peat banks they'd settled on, straight into the creek.

According to Deegan, "when we first started this work, it was thought that salt marshes would be able to sequester excess nutrients and neutralize them with little impact on the marsh itself, but that hasn't proven to be the case." Excessive nitrates, some scientists believe, are like steroids for plants; their initial growth is impressive, but the long-term effects are sinister. Instead of "drilling deep" into the mud to gather nutrients, plants are content to suck up the nitrates and phosphates suspended in the shallow water, using that easy energy to shoot upward instead of root down.

Turner explained why, in light of this data, structures like the proposed Mid-Barataria Diversion could in fact *exacerbate* land loss instead of combat it. "The Mississippi River now, right today, has around 1.43 milligrams of nitrogen per liter [of water]," he said. "Historically, it might have been .5. [Marsh plants] grew up under .5 milligrams per liter—grew up in the sense that they evolved to these conditions over thousands of years, the roots always scrounging for nutrients." According to Turner, if the roots no longer had to scrounge for their meals, they wouldn't. On the contrary, once the river diversion began to spoon-feed excess nitrates to marsh plants, Turner suggested that they'd gobble it all up at the surface and fail to develop the kind of deep, fibrous root systems on display in the hall just outside the office where we both sat. Without these long, grippy tendrils running through the earth, whatever mud the diversion managed to spill out over Barataria Basin would remain soupy and largely unincorporated; whatever new land the diversion built would be fragile, as easily washed away as those rolled-up mats of Big Mar turf back in 2005.

Before long, our conversation took a broad turn towards the overall causes of land loss in the state. According to Turner, the Coastal Protection and Restoration Authority (CPRA) and his colleague Dr. John Day tended to get it wrong on this account by overstating the role of the levees in the destruction of our coast. That whole "river-in-a-straightjacket" theory, he said, was not so much incorrect as it was incomplete. In his view, the lion's share of land loss in the coastal zone of our state is traceable to the vast network of man-made canals slicing through it. Some had been cut to expedite the logging of cypress trees at the beginning of the century, others for piloting cargo ships to port. However, the vast majority of the canals criss-crossing our wetlands were opened up to access our state's most lucrative natural resource: oil.

Louisiana is by no means the first place in the world where human beings have compromised the land beneath their feet in the pursuit of easy energy. The Dutch, for example, have not only beaten us to the punch in universalizing healthcare, but also managed to engineer their coasts into a state of abject environmental crisis more than 600 years before we got around to it over here. Peat, the youngest of the fossil fuels and the precursor to coal, was a favorite for heating homes in the Netherlands through the 13th century. By 1500, peat mining had so decimated the low-lying landscape surrounding Amsterdam, Rotterdam and Utrecht that the North Sea threatened to drown the whole region. According to historians Raj Patel and Jason Moore, sixteenth-century Dutch wetlands looked like "Swiss cheese, with dozens of water-filled, exhausted peat bogs often separated from each other by nothing more than narrow, vulnerable strips of land on which were scattered the structures of what once had been farms."

If prop planes had been available for hire half a century ago in Amsterdam, passengers sitting in the back of them would have likely have glimpsed something very similar to what I

saw that Saturday morning next to Turner as the pilot banked west, leaving the Caernarvon Outfall Area behind us and flying out over Barataria Basin. In some places, oil and gas canals were so dense that the swamp looked like a giant's game of tic-tac-toe. The long straight waterways crossed and re-crossed, locking up pockets of the marsh between their intersections. Where the soft curves and smooth lines of a healthy swamp should have been, a bizarre geometry dominated the landscape. Everything was disconnected, diamonds and triangles and rectangles of blue-black water bounded by strips of densely-forested green.

So much of marsh health, Turner explained, has to do with water flowing freely. The wetlands are a soft, open, dynamic place. In a healthy ecosystem, shallow water sheets out over the grasses and cypress roots. It meanders in shallow winding waterways, curving around bends in complex, free-form squiggles. The unobstructed flow of water in a swamp ensures that it drains properly after a hurricane or flood, and that swimming creatures like fish, shrimp and crabs can travel safely to and from their breeding sites and feeding grounds.

When you start walling in the swamp—with mud piled up twenty feet high beside man-made canals, or with concrete bridges and flood gates—you get a phenomenon that scientists call "impoundment." Once impounded, a marsh system deteriorates in a variety of complex ways. Fish species that may have found shelter at a particular waterway's edge can no longer swim to it through the barriers, and may succumb to predation or starve. Additionally, the weight of the walls presses down on the earth and compacts it, makes it less and less permeable to the flow of water. A hurricane may blow through, causing an impounded pool of freshwater swampland to capture the salty storm surge of the Gulf. Then, instead of draining that water back out into the sea with the rain, the swamp holds it in. As the water evaporates, it becomes ever more saline, and organisms specially adapted to a freshwater environment die.

Before long, we were gliding over the Barataria Preserve. I rubbed my temples, which were now throbbing, and thought back to Dr. Whitbeck's drowning forest. She, too, had mentioned impoundment. According to her best guess, at least *part* of the cause of her plot's rapid deterioration in the past twenty years were the concrete floodgates we walked along at the north edge of the plot, plus a mile-long, fifty-foot-high concrete bridge installed nearby. Both erected in the nineties, the two structures' incredibly heavy spans of concrete press downward on the spongy soil just north of the preserve, exacerbating the already high rates of subsidence with their mass.

Not only do heavy concrete structures cause impoundment; so, too, do the piles of mud heaped up alongside channels cut into the marsh. At the time that oil was discovered under Louisiana's coast in the 1930s, no laws existed to protect wetlands, and before long the nascent oil-and-gas industry began to slice up the marsh. Dredge operators, hired to dig out access canals to and from freshly-drilled oil wells, had to put the earth they were displacing *somewhere*. The quickest and easiest thing to do was pile it into dense banks on each side of the canal, which are called "spoil levees" or "spoilbanks." These levees, sometimes ten feet high, pressed down on the wet sponge of the marsh, intensifying land subsidence the same as the levees on the banks of the Missippi did when they were installed in the 1930s.

"More than 50,000 oil wells were eventually permitted in the state," writes Bob Marshall. "[And] roughly 10,000 miles of canals were dredged to service them." 10,000 miles, if you're curious, is equivalent to the distance of a round-trip flight from New Orleans to Amsterdam. Lay down all of the spoil banks that border these 10,000 miles of canals end-to-end-to-end, and they would take you nearly all the way around the equator. In presentations on the topic, Turner likes to note that you could cross the entire state of Louisiana at its widest point back and forth eighty

times with a spoil bank as tall as he is. “This is a wetlands eco-system,” he says. “There’s no way this is not gonna have an effect.”

Different scientists quantify these adverse effects in different ways, but the complexity of wetland ecosystems make it inherently challenging to do so. Obviously, digging out a channel in a marsh is adding open water where, before, there was none. However, a host of indirect effects begin to work in tandem around the new channel, a slow domino effect that works over time to unravel the landscape all around it. Canals that cut a straight line from the heart of the freshwater wetlands into the Gulf, for instance, allow salt water to intrude into the ecosystem. Animals that had evolved to exist in a freshwater or brackish environment either relocate or die. Plants that had once held the land in place with their root systems begin to give way. Shorelines fall back. Some canals double their width in just five years. According to a study Turner conducted in 1997 with colleague Aaron Bass, “canal dredging significantly and directly related to wetland losses.” They noted that for each hectare (a little over two acres) of canal dredged, there was a corresponding net loss of 2.85 hectares of land over the 34-year time frame of the study. In plotted line graphs of this trend, the correlation is striking:

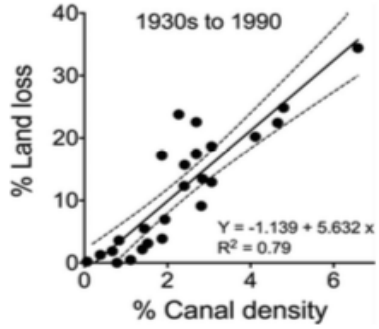


Figure 3. The relationship between canal density and land loss for the deltaic plain from the 1930s to 1990. The data shown are for 15-min quadrangle maps (roughly 664 km^2 each) for the deltaic plain, and exclude data for maps with <50% land area in the 1930s. The total area represented is 77% of the deltaic plain (12,872 km^2). The equation is for a simple linear regression of the data with a 95% confidence interval. Note the zero intercept. Adapted from data discussed in Turner, 1997.

Where there are few or no canals, there is little or no land loss. Where there are lots of canals, there's lots of land loss.

Turner doesn't mince his words about it. "Canals are the main driver of wetland loss," he told me weeks later, back in his office. According to his view, any restoration solution, like the Mid-Barataria Diversion, that doesn't proceed from this fact, is almost certain to fail.

He added that "diversions would—*if* they worked—be local. They're not gonna deal with a whole coast."

Turner sat back in his chair and opened his hands towards each other, fingers splayed out. "If you want to keep wetlands around a little longer," he said, and slid his fingers together, "you try to knit them back together the way they were torn apart."

This strategy of re-weaving the marsh back together is called "backfilling." In essence, dredge operators undo the damage done by their predecessors in the 50's, 60's and 70's by knocking spoil banks back into channels. The benefits of this strategy are twofold. First, you reduce the depth of the channel, increasing the probability that marsh plants adapted to shallow water conditions can reach the soil at the bottom and put their roots down into it. Second, by removing the height and weight of the earth piled up on each side of the canal, you can reverse the effects of impoundment. Water can come and go freely in and out of the area as it had before the channels were first dredged.

In a study with Dr. Joseph Baustian, another of Turner's departmental colleagues, Turner investigated thirty canals, each one backfilled at least twenty years prior. During the summer of 2004, Turner and Baustian collected data on soil structure, vegetation and canal depth on former spoil bank areas, as well as in the surrounding marsh for reference.

They discovered that, while restoration success varied according to their data, at least *some* marsh was restored at all thirty sites, with some areas seeing up to 95% of their area restored to previous wetland conditions. Much of the success of backfilling seemed tied to how completely the dredge operator had managed to remove the spoil banks. If they had "missed some spots" in the outer reaches of the canal, the data indicated the restoration process was incomplete twenty years later. Additionally, they found that backfilling was more successful in areas that were not already heavily impounded by oil and gas activity. Backfilling a single canal in regions like this had little effect on restoring the area as a whole due to the extensive development still in place all around it. Last, Turner and Baustian observed that backfilling was a slow process. Some canals wouldn't even begin to heal in under twenty or thirty years.

Nonetheless, Turner champions backfilling. In presentations at conferences and coastal restoration events, he hails the strategy as inexpensive and long overdue, pointing as evidence to the great number of permitted canals that are currently out of use. According to Louisiana's Department of Natural Resources, of the 35,163 canals on file with the state, more than 27,000 of them are classified as "abandoned." The cost of backfilling every single one of these abandoned canals would come out to around $335 million, about 0.67% of the $50 billion price tag on the Master Plan.

"Chump change," Turner calls it.

Still, the 2017 Master Plan includes no provisions for backfilling among its host of other sanctioned restoration strategies. When I asked Turner why he thought that was, he shrugged. "The smaller projects tend to be understood at the local level a little better than the big ones," he said. "But if you get a politician in front of something? It's gotta be big. It's gotta be huge."

In truth, there was nothing much to see when we flew together over the Preserve's two currently backfilled canals. I craned my neck out of the window, looking this way and that, but in the end, we passed over the sites without my seeing anything of note. I tried to imagine the local newspaper running a picture of our governor standing in shrimp boots on some unremarkable muddy former-spoilbank below us. "Only $335 Million!" read the caption. The whole thing just did not inspire the same degree of confidence as the huge, sleek white rendering of the diversion had at Wine for the Wetlands.

Minutes later, though, the pilot took us over one of the few areas of truly healthy marsh left in the entire basin. Undisturbed, the sprawl of wetlands below me looked smooth-surfaced and whole. The waterways were thin, doubling back over themselves in a profusion of loops and curves. If the twenty-year endgame of backfilling was anything like what I saw below me just then, it was clearly not a small-time strategy. It seemed like the kind of undertaking justified not by the short-term benefits at each individual canal, but by the long-term impact on the coast as a whole.

Gazing with me down from the window of the plane, Turner was quiet. Weeks later, in his office, he searched for the right word to describe the view. "I mean, you're a literature person," he said, "but to me it looks more, I guess… *eloquent* isn't the word…" He thought for a moment, and finally settled on *pleasing*.

Later, I consulted my thesaurus on the matter, scanning through the many synonyms for "eloquent" while also seeing in my mind's eye that patch of healthy wetlands sliding past beneath the belly of the plane. Looking down at its lithe little waterways, each one articulating itself with such ease about hairpin turns, it occurs to me that a lack of straight lines does not always indicate a lack of order, and that the wetlands obey a rigorous set of rules largely

unbeknownst to us. When left to their own devices, they fully embody this complex internal logic with a kind of graceful conviction that, I must admit, reads quite a bit like eloquence to me.

For someone who's spent more than forty years refining their authoritative expertise in the byzantine complexities of delta ecology; for someone whose wife was recently awarded a MacArthur genius grant for her groundbreaking work on the Gulf Dead Zone; for someone who routinely guides undergraduate students through dense biological concepts—for all this, Eugene Turner sometimes seems a little bit lost in the world. The very first time he arrived in Louisiana, after winning a research position at LSU via phone interview, Turner pulled up to the university on a football game day. Tens of thousands of highly compromised sports fans crowded the streets, laughing and screaming at each other across the open tailgates of their trucks. Turner took it all in, curious and bemused, patiently maneuvering around them all with a car full of all his worldly possessions. He had nowhere to stay for the night. Eventually, he found a motel with a single vacant room, only to be asked by its surly caretaker how many hours he wanted it for.

That first day we met, after masterfully directing us all (pilot included) over a vast, apparently featureless wetland landscape from a thousand feet in the air, Turner got lost on the way to the restaurant. I pulled behind him into an empty gravel lot after following him around New Orleans East for ten minutes or so. Turner rolled down his window and shrugged. Months later, at a conference, I found myself with him in the carpeted hotel lobby after being dismissed for an afternoon break. We walked along beside each other for a few moments in companionable silence. After a few moments, Turner looked about him, and said out loud, to no one in particular, "I seem to have lost my lunch."

I'm hardly in a position to poke fun, however, especially not on the topic of lunch-losing. During the last ten minutes of our flight that Saturday, after leaving the Preserve behind and setting out to cruise over the refinery town of Norco, my nausea was approaching threat level red. The pilot explained that, due to the limited amount of fuel such a small plane could carry, we'd have to begin making our way back towards the airport. Turner was a little disappointed. The last place he'd wanted to take us was north, past Lake Pontchartrain, to fly over Joyce Wetlands in Hammond. A marsh there had been the latest scientific battleground between he and Dr. Day, both of them furiously studying and publishing papers on its rapid deterioration in the past several years. The two had very different interpretations of what had happened there, and why, and while I was extremely curious to see it for myself, I felt relieved to know we'd soon be on solid ground.

Not soon enough, though. Noticing my pallor, Turner asked how I was feeling. Not so great, I told him, and he reached past me to crack open the windows in the back. Cool air rushed in over my face and neck. Below us, I could see the steel structures of a large Shell refinery, shrouded in eerie puffs of white steam, looking from this distance like a delicate, silvery, child's-sized Rube Goldberg machine. I knew, from my reading, that our state was responsible for more than 25% of the nation's refining capacity. The steam pumping out of that little silver machine below me was keeping the lights on for the rest of the country.

I also knew, however, that the Shell refinery in Dimond pumped the air full of benzene and methyl ethyl ketone, chemicals linked to the development of child leukemia. I also knew that instead of curbing their toxic emissions, Shell offered the sick and dying homeowners of the nearby Diamond neighborhood meager compensation for their small homes, based on low property values. Once in possession of the empty neighborhood, Shell leveled everything and

built three large playgrounds as a show of their corporate goodwill. I've visited them. No children ever play there.

If Shell had polluted the air, then what was preventing them from polluting the river, too, upon whose banks their giant facilities rested? I thought about all the refineries lined up and down the length of the river, all of the manufacturing companies, all of the nutrient-rich agricultural runoff from as far north as Illinois—everything pouring into the murky water of the Mississippi. Then, I imagined that water being shot out over Barataria Basin through the sleek concrete bays of the diversion.

All of a sudden, I felt hopelessly lost. The diversion had seemed practical to me weeks earlier. Now, it seemed insane. Flooding polluted river water out over an already dying marsh? With an awful, hyperbolic clarity, I imagined the entire vegetated wedge of Barataria Basin curling up at the edges, high winds rolling it all up like I'd seen men do in those cigar shops in the French Quarter. My common sense balked. And yet, there was this other esteemed scientist, Dr. John Day, who disagreed with Turner. What of his findings, what of his logic? And what was common sense, anyway, when it came to science? For years, common sense had told us that the planet was flat, that the sun circled the earth. Isn't science supposed to help us transcend our limited common senses in order to divine a higher truth?

What was the truth, here, anyway?

I dug in the little seat-back pocket before me and fished out a barf bag. It was plastic, folded neatly into a blue paper envelope. For a few moments, I held it absently in my lap, the way I might hold my purse on the subway, real casual. I looked out the window, tried to find a horizon line I could orient myself by. Beside me, Turner was looking on with obvious sympathy, as if he was somehow responsible for my motion sickness, as if a part of him felt sorry for

having invited me out here in the first place. After taking several slow, miserable breaths with no horizon in sight, I tucked my chin and lost my lunch.

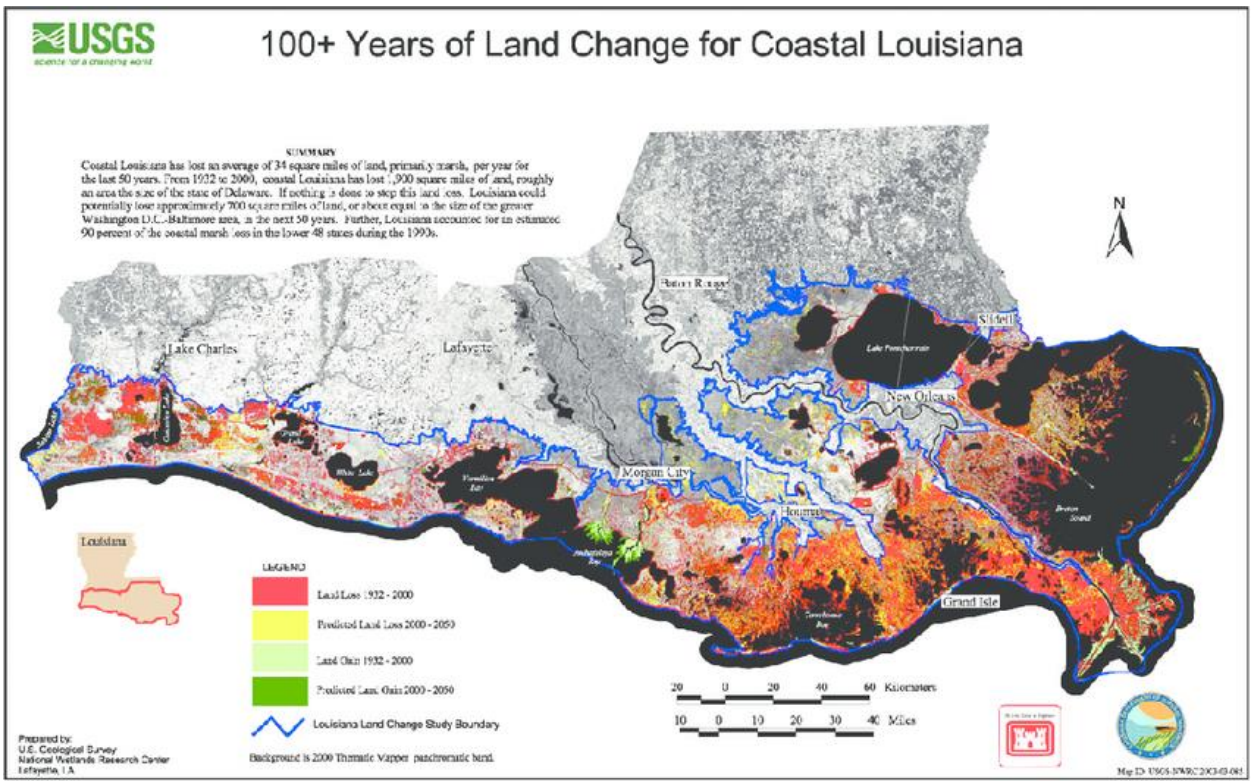
3. Four-Mile Marsh

> It is as painful perhaps to be awakened from a vision as to be born.
> - James Joyce, *Ulysses*

Despite the many charged scientific and ideological disagreements that stood between Dr. Eugene Turner and Dr. John Day, only one flight of stairs and a couple of hallways separated their respective offices in the Department of Oceanography & Coastal Sciences at LSU. Turner—being a roots-guy, after all—was on the ground floor. Day, by contrast, worked on the second floor. Unlike his downstairs colleague, Day had chosen not to curate a museum of marsh grass in the hallway outside of his office. In fact, the only picture on display was tacked up to the door itself, a little 3-by-5 glossy of two blonde girls, maybe five and eight years old, smiling up at the camera.

These, I learned, were the newest roots on the Day family tree: his grandchildren. His family has a very long history in Louisiana, with ancestors making their lives here for more than two hundred years. “You can trace it back,” he told me. “A number of lines.”

We first met in his office on a late Wednesday morning in December. Day had left his door open for me, and when I walked in, his face was turned towards the screen of his laptop, illuminated by the soft glow of James Joyce on Kindle. It was his fourth re-reading of *Ulysses,* he told me, and closed his laptop. He had a round face, with a neat white beard trimmed close and a ring of white hair around the top of his mostly-bald head. A skinny pair of frameless glasses rested on the bridge of his nose. His office, like Turner’s, was replete with textbooks and periodicals, but they were all shelved away tidily on a large bookshelf that ran the length of one wall. A blown-up image of coastal Louisiana dominated the opposite wall, the fringes of its landmass inked red where significant loss had occurred over the last century.



Day had come to LSU as a research assistant in 1971, and by 1980, was awarded full professorship. Since then he'd gone to France on a Fulbright and directed more than fifty student theses and dissertations. He was emeritus now, retired back in 2005, but more than ten years of retirement had only accelerated his scientific output. "In fact," he said, "my productivity doubled and tripled after I retired. It's just so interesting, I just keep going, you know?"

I told Day I'd come to see him after learning his name was so ubiquitous in the heated debates on coastal restoration I'd encountered in my year-long study of the subject. He was especially often cited in publications put out by CPRA in support of the Mid-Barataria River

Diversion. I pulled one of his more often-bandied-about papers from inside of my bag. It was covered in annotations and streaked with highlighter marks.

Day sat up a bit in his chair. ”You could make it through that?” he asked. “You've learned enough of the science to get the gist of what's going on?”

I smiled. As a woman who looks a solid half-decade younger than my thirty years, I am used to being underestimated. And while a part of me felt somewhat irked that Day would assume I couldn’t parse scientific literature after I’d just told him I’d been researching the topic for more than a year, another part of me recognized the opportunity to play this impression to my advantage. People, I’d learned, would say the darnedest things when they thought you were harmless and guileless and slow.

So I told Day that yes, I’d mostly managed to get the gist, but that I hoped he’d help me understand some of the thornier concepts, because I was, after all, *just* a student writer, not a scientist, and that there were limits to what I could understand.

I turned back to the publication in my lap, an article Day had published in the peer-reviewed journal *Ecological Engineering* in 2015. Like most scientific papers, it had a catchy title: “System response, nutria herbivory, and vegetation recovery of a wetland receiving secondarily-treated effluent in coastal Louisiana.” I flipped to page 128, and asked Day if he could explain to me what he meant, exactly, when he said that

> because nutrients are confounded with the floodwaters that carry them, we believe that the negative effects of excessive flooding are being inaccurately attributed to excessive nutrient loading.

Day hesitated. “This one's very complicated,” he said. “I don't know if I can explain it to you.”

I blinked. *Try me.*

Day sighed. “Well so, the question is can excessive nutrients kill marshes?”

I nodded, and Day admitted that, yes, nutrients have an impact, but that it is far more subtle than some scientists like Turner make it out to be. In the case of the rapid deterioration of the Caernarvon Diversion Outfall Area following the 2005 hurricanes, he said, prolonged flooding was more to blame than nutrients were.

“Flooding is a big deal,” Day said. “You can't flood coastal marshes all the time or they die.”

For evidence, Day pointed to a 2015 study conducted by Gregg Snedden, Kari Cretini, and Brett Patton in the Breton Sound estuary. The three researchers built what’s called a “marsh organ,” so named because its graduated “pipes” resemble those of an old-timey church organ. Essentially, the scientists lashed a series of PVC pipes together, designed to sit at different elevations from the marsh surface. As the marsh flooded due to precipitation, tidal influx, or diverted freshwater from the structure at Caernarvon, the surface of the water rose up and overtopped the PVC pipes at lower elevations, while those sitting higher off the surface of the water remained dry.

Snedden and his colleagues built four marsh organs and sunk them into the mud at two different sites in Breton Sound. They filled the PVC pipes with dirt taken from the surrounding marsh, and they planted them with two different species of cordgrass. “The elevations of each row [of pipes] were selected to achieve inundation rates of 90%, 70%, 55%, 45%, 30%, and 10%,” according to the researchers. “Thus, rows with higher elevations experienced less severe inundation regimes than those situated lower.”

The result? After eight months, the cordgrasses at both sites were more stunted the more often they'd been flooded. The species of cordgrass that dominated the Caernarvon Diversion Outfall Area, *spartina patens,* showed particularly poor root growth due to increased flooding. According to the scientists, this result "may provide an explanation for the extraordinarily high land loss rates that occurred within the Caernarvon diversion receiving area within the upper reaches of Breton Sound following the passage of Hurricane Katrina in 2005." The researchers explain that, in the five years preceding Katrina, inundation rates—times when the water level exceeded that of normal marsh elevation—were as high as 60%. According to the data from the experiment, these conditions "could have brought about a 90% reduction in belowground biomass, leading to…reduced landscape resilience to hurricanes." Because both prolonged flooding and nutrient loading seem correlated with less hardy root systems, untangling the two concepts in order to determine the real culprit is tricky.

Dr. Day added that the time of year that a marsh floods is crucial. "Over time," he said, "they were diverting more water at Caernarvon, and they were diverting it in the growing season." According to Day, if you flood a marsh in the winter when everything's dormant, that's one thing. "But if you do it during the growing season," he said, "the plants die."

I nodded slowly, beginning to understand the root of the disagreement between Turner and Day, at least in terms of why the emergent marshland in Big Mar Lake had collapsed so dramatically in 2005. One blamed nutrients, the other flooding. I gazed at the giant map of land loss on Day's wall, and he pointed at the red portions.

"If you look at those colors in there, none of that has to do with excess nutrients that you would get from a diversion," he said. "You can explain that loss mainly by flooding. Too much water and too much salt."

Okay, I said, but what about the nutrient loading study done up at Plum Island in Massachusetts? What of all those grasses toppling into the creek?

Day nodded. “I know all about it. In fact, the two people who sort of run that project—one of them is Linda Deegan, who got her PhD working with me.” He shook his head and smiled. “The people here in Louisiana who like to let the nitrates fly, they point to that study, and it is so different from what we're doing down here.”

Day sketched out a few of those differences to me. First of all, Plum Island Estuary—unlike Big Mar Lake—is subject to tidal fluctuations of as much as three meters. When the tide is out, water recedes from the carved-out channel banks of the marsh, leaving their earthen walls exposed to the air. By contrast, the Breton Sound Estuary on the receiving end of the Carnarvon Diversion sees very little tidal fluctuation, and as a result any excess nutrients in the water there spread out over the marsh instead of remaining concentrated in stream beds like they do at the Plum Island site. Thus, excess nutrients in the freshwater diverted through Caernarvon are more thoroughly distributed across the entirety of Big Mar Lake than they were in Massachusetts.

Secondly, Plum Island Estuary receives salt water during its high tides. “Seawater has essentially no nitrate in it. The concentration in the [Mississippi] river, for comparison’s sake, is one and a half to two millimeters per liter. What's in the ocean up there is much less than a tenth of a millimeter. It's almost non-detectable.”

So when Fleeger added nutrients to the estuary, they were shocking the system far more than the Caernarvon Diversion shocked Big Mar, where plants have adapted over thousands of years to conditions where nitrates are more common in the fresh and brackish water.

Finally, the researchers at Plum Island added *a lot* of nutrients to the water. “Just to give you an idea,” said Day. “The [nutrient] loading rate at Caernarvon is on the order of one to five

grams of nitrogen per square meter per year. The Plum Island Experiment was 500 to 1,000." In a review paper Day published on the topic, he notes that

> the nitrogen loading rate of incoming fertilized tidal water at [Plum Island Estuary], if spread uniformly over the creek sub-watershed, would be about 30 g N/m/yr; however, spatial variation across the landscape is significant, with [plants growing adjacent to] bare creek banks and bottoms experiencing much higher nutrient loading than the less frequently flooded [vegetation], which is inundated only about 4% of the time.

It follows logically, then, that the plants that toppled into the marsh were those that sat at the very edge of the highly fertilized banks of sea water for seven full years. Their roots were exposed to the highly nutrient-enriched tidal waters every time the tide came in. Every time it rolled out, these same roots were exposed to the air, increasingly so as accelerated denitrification processes ate away at the organic material in the soil all around them. Even a novice gardener like myself knows to press the earth down firmly over the roots of a newly potted houseplant. Roots don't like to hang out high and dry, after all.

That, however, was exactly what those creek-side roots were doing at Plum Island.

"And the other thing is," Day said, "we find that shallow, subtropical, warm estuaries with lots of wetlands are much more efficient at removing nutrients than colder systems up north."

My mind whirred to incorporate this new information. The effort must have shown on my face.

"It's enormously fascinating and complicated," said Day. "And it's involved a large part of the coastal science community for a long time, these kinds of things."

This, at least, was something I could wholeheartedly agree with: nutrients were a hot topic. If they were truly dangerous to wetlands, as scientists like Turner contended, than structures like the Mid-Barataria Diversion were potentially very dangerous to the ecosystem. If Day was right, though, CPRA could continue with their plans on his assurance that nutrients were largely no big deal. Perhaps due to the high stakes of the issue, the controversy had begun to breach the wall between the academy and the general public. There were a handful stories in the local news these days about nutrients, most of them with their crosshairs firmly trained on a contentious little patch of wetlands just north of Lake Pontchartrain called Four-Mile Marsh.

Located about twenty-five miles due north of Norco, the refinery town in whose airspace I once puked, Four-Mile Marsh lies along the northern edge of the Joyce Wildlife Management Area. A mixture of forested swampland and more grass-heavy marshes, the natural area sits immediately south of the city of Hammond, home to about 20,000 people. Most of these folks, I think it's fair to assume, avail themselves of the public sewage system at least a couple of times a day. I would wager good money, however, that a very small percentage of the citizens of Hammond are aware that the water they use to wash their hands and rinse their potatoes and flush away their bodily fluids ends up cascading out of a PVC pipe straight into a wildlife area in their own backyard.

Constructed in 2006, the Hammond Wetland Assimilation Project was meant to benefit both Four-Mile Marsh *and* the city of Hammond by invigorating the former and saving the latter a bundle of cash in sewage treatment costs. According to the Louisiana Department of Environmental Quality (LDEQ), cities that chose to release partially treated sewage out into the open wetlands could avoid incurring costs associated with performing the kind of full chemical treatments that are usually required before discharging wastewater into rivers and streams.

Wetlands, ostensibly, were not so fussy about sewage. In fact, LDEQ claims on its website that introducing "nutrient-rich wastewater to natural wetlands…stimulates productivity." While at first this concept seemed fishy to me, I reflected on all of the country houses that I'd ever visited that were old enough to still have septic tanks sunk into the earth. Inevitably, whatever stand of trees or shrubs happened to be growing above the tank were living especially vigorous lives, brighter green and taller than their less richly-fertilized neighbors.

The state of Louisiana, embracing this concept, could eschew costly wastewater treatment in favor of a more relaxed process, after which partially-treated wastewater could be piped out into the wetlands. The bull tongue, cordgrasses and cypress trees there were believed to be able to "assimilate" the excess chemical nutrients suspended in the water. The project was meant to be win-win, with a host of benefits for the wetland itself, including "erosion and flood control, saltwater intrusion control, water quality enhancement, habitat for threatened and endangered species, recreation and aesthetics."

As of 2019, there were twenty different wetlands in Louisiana with assimilation projects in operation.

For a time, it seemed like these projects were working, especially the one at Four-Mile Marsh. Plants grew to robust sizes at incredible speeds near the effluent discharge pipes. The nutrient load, for comparison's sake, was about ten times higher in Hammond's wastewater than it is currently in the Mississippi River. From all outward appearances, though, the plants seemed to love it.

But then, as with the Caernarvon Diversion, something went wrong. Less than four years after the city began to discharge wastewater into Four-Mile Marsh, upwards of 300 acres of this densely vegetated marsh turned to open water. Satellite maps of the area now show a strangely

discolored, water-pocked, semi-circular halo extending southward from the discharge pipe several hundred meters. As with the grasses at Plum Island, many of those promisingly robust juvenile cypress trees just toppled over into the water, their mud-caked, undersized roots coming up with them.

This outcome spelled disaster—not only for the city of Hammond, but also for Comite Resources, the business with whom the city had contracted to design and monitor the project. Actually, Comite was behind most of the state's assimilation wetlands projects, which were suddenly coming under fire despite many quiet years of regular operation. Before long, the founder of Comite found himself faced with a cavalcade of hard questions to answer about what had happened in Four-Mile Marsh and why.

Luckily, however, the face of Comite Resources had a lot of scientific know-how to draw from in defense his project, with forty-plus years of academic experience and more than 200 peer-reviewed publications to his name—which was, as it happened, Dr. John Day.

In April 2015, Dr. Day published an article that examined the rapid deterioration of Four-Mile Marsh in the peer-reviewed scientific journal, *Ecological Engineering*—the very same paper I'd highlighted and held on my lap in his office when we met. Alongside nine co-authors, six of whom also work for Comite, Day argues that the primary cause of land loss in the marsh after it began to receive Hammond's wastewater was not nutrients, but nutria.

Nutria are a large, beaver-like invasive species native to South America. Introduced to Louisiana in the late 19th century to bolster the muskrat fur trade, they were eventually released from farms on Avery Island out into the wild after the fur business began to decline. They reproduce rapidly and eat voraciously. A full-grown nutria's appetite extends far beyond the

mere leaves and shoots of the plants it loves; when nutria eat, they eat everything, including the stems and the root systems, too. What's more, nutria seem to prefer to snack on plants grown in nutrient-rich environments. In a 2014 study, nutria given equal opportunity to graze on both fertilized and non-fertilized species of the same plant overwhelmingly opted to eat the fertilized greens.

Day hypothesized that it was an invasion of these hungry critters, possibly drawn to the site by sniffing out its enhanced nutrient concentrations, that had spelled disaster for Four-Mile Marsh. So Day and his co-authors built ten large wire cages, each dug about half a meter into the ground and 16 meters tall. Within each wire cage, he planted nine southern cattails. He then set up ten control plots, each planted with nine cattails, but with no wire walls to keep out the nutria. He monitored the plots for three months. Nearly all of the cattails planted inside the cage survived within the study period, whereas all ten control plots were "completely destroyed" within 48 hours of planting. Additionally, the root systems—aka "belowground biomass"—were nearly 3 times higher in the protected plots than those without walls to keep nutria out. These results, Day writes, clearly demonstrate that "nutria were the dominant cause of marsh deterioration in the zone near the [effluent] discharge pipe."

In addition to testing for nutria, Day also investigated the nutrient load, testing for nitrogen concentrations on the surface of the water at different distances from the effluent outlet pipe. The further he got away from the discharge area, the lower the nitrate readings were. "Thus," he concludes, "the Hammond Assimilation Wetland is achieving one of its primary goals: that of reducing nutrient concentrations of overlying waters."

From here, in the "Results and Discussion" portion of the article, Day goes on to argue that "it is unlikely that excessive nutrient loading led directly to the marsh deterioration," citing

primarily that there is “no example that we know of where similar nutrient loading led to marsh deterioration, especially in such a short period of time.” He goes on for nearly two full pages to defend this claim, alternately by citing other studies that support his view and critiquing the methods of those that don’t. In fact, in this entire section, Day spends only about two paragraphs discussing the Four-Mile Marsh itself, preferring instead to present a litany of all the other many wetland ecosystems in Louisiana that his company has piped wastewater into without issue over the past thirty years. Often, he cites his own work as evidence of the effluent’s harmlessness.

Months before meeting Day, I asked Turner about this publication. What of Day’s measurements of the surface water? Didn’t his findings indicate that the plants were somehow “assimilating” those discharged nutrients? The further you got from the pipe, after all, the lower their concentration.

Turner didn’t skip a beat. “That’s an assumption,” he said. “You could have the dilution happening over there from rainfall. It could have nothing to do with denitrification, wetland plant take-up, or anything like that.”

Then, he sighed. “The whole thing is couched in a very narrow way, looking at only nitrate absorption. When in fact, it's also phosphorous, it's also trace metals, it's anything that goes into the sewage pipe from the city. And they don't have a way of measuring [vegetative] transformations on stuff like that.”

Turner also took issue with the brevity of Day’s study, which examined plant growth during only three months, which amounts to a single growing season. “They aren’t following it over years,” he said. In some of Turner’s published work, he suggests that nutrient-driven decomposition in plants may be delayed where there is a storage organ—aka roots. So while Day may have found increased below-ground biomass in his cattail plots near the sewage pipe,

there's no way to tell from his twelve-week experiment whether or not those roots were strong enough to survive for much longer than that.

In Turner's opinion, the state's lassitude in allowing Day's business to consult, build, and monitor the operation in Four-Mile Marsh is tantamount to letting a fox guard the henhouse. "I think it would serve the public well if they had independent analyses of this," he said. "I'm talking avoiding shell companies, and the same players coming through different avenues. I think there should be independence on this. And that's not happening, as far as I can tell."

Turner, of course, conducted a study of his own at Four-Mile Marsh. Instead of reading the nitrogen levels at the surface of the water, Turner looked into the soil. He took samples of it from a nearby marsh *not* receiving wastewater, and combined it with water samples taken straight out of the effluent discharge pipe. Back in the lab, he measured the amount of organic material in the soil that had decomposed inside of each test tube after five weeks, and compared that to control samples in which the soil was mixed with freshwater taken from the reference marsh. Turner also tested Four-Mile Marsh for cellulose decomposition by sinking lengths of cotton string into the mud at regular intervals away from the pipe. After a month, Turner took readings on the tensile strength of the strings.

The results seemed unequivocal. After only five weeks, the soil that had sat in the test tubes with wastewater experienced 52% higher organic matter loss than the earth in the control tubes. Similarly, the cotton strings that had been sunk into the ground at Four-Mile Marsh had lost, on average, about 60% of their original tensile strength by the end of a month when compared to the strings placed in a reference marsh nearby.

In light of these results, as well as those from two other methods used in the study, Turner and his fellow researchers "reject the null hypothesis that nutrient addition has no effect

on the decomposition rates of these organic soils." Further, they note that the study site used to treat Hammond's partially-treated sewage water is an "open system," contrasting this with more closely-monitored, *constructed* wastewater treatment wetlands "with walls or dikes and defined entry and exit portals." In closing, the researchers note that, despite claims that assimilation projects can help re-invigorate coastal marshes, their effect in practice seems to be the opposite. It's hard for a marsh to combat saltwater intrusion and assimilate nutrients and reverse land loss, after all, if the marsh is no longer there.

One of the first things Dr. John Day told me that day in his office, after learning that I wasn't a Louisiana native, was how "really backwards" the state was. Even with his family legacy here, he admitted that the whole region had "a long history of corruption and just selling out, and we still can't get past that." Day went on to describe how in recent years, environmental advocacy organizations like RESTORE had stopped being the watchdogs they'd once been, had stopped questioning and challenging state policies, had stopped listening to scientists. Instead, he said, they had largely "gotten into bed with the state program. It's just a bad relationship. They're blindly supporting things that aren't going to work."

I took this in with a nod and fought to keep my eyebrows down, because although I agreed with his analysis, I found myself thinking of the proverb in which the pot calls the kettle black. I thought about how, in LDEQ's 2010 Official Water Quality Management Plan, a document that outlines parameters for water quality standards in assimilation wetlands, more than half of the scientific reference papers used to justify the regulations had Day's name in their byline. If this didn't constitute getting into bed with the state, I wasn't sure what did.

The biggest problem with this conflict of interest, however, was that it went beyond mere corruption by adding to the general confusion around what causes land loss and what fixes it. Whether he was motivated by genuine scientific interest or a desire to cover his ass after deep-sixing a marsh he'd been paid to restore, Dr. John Day was helping to make the case for projects like the Mid-Barataria Diversion each and every time he published a new paper about the relative harmlessness of nutrient loading. If it wasn't nutrients but nutria that destroyed Four-Mile-Marsh, then the state need only station some salaried hunters at the outfall areas to keep the critters in check.

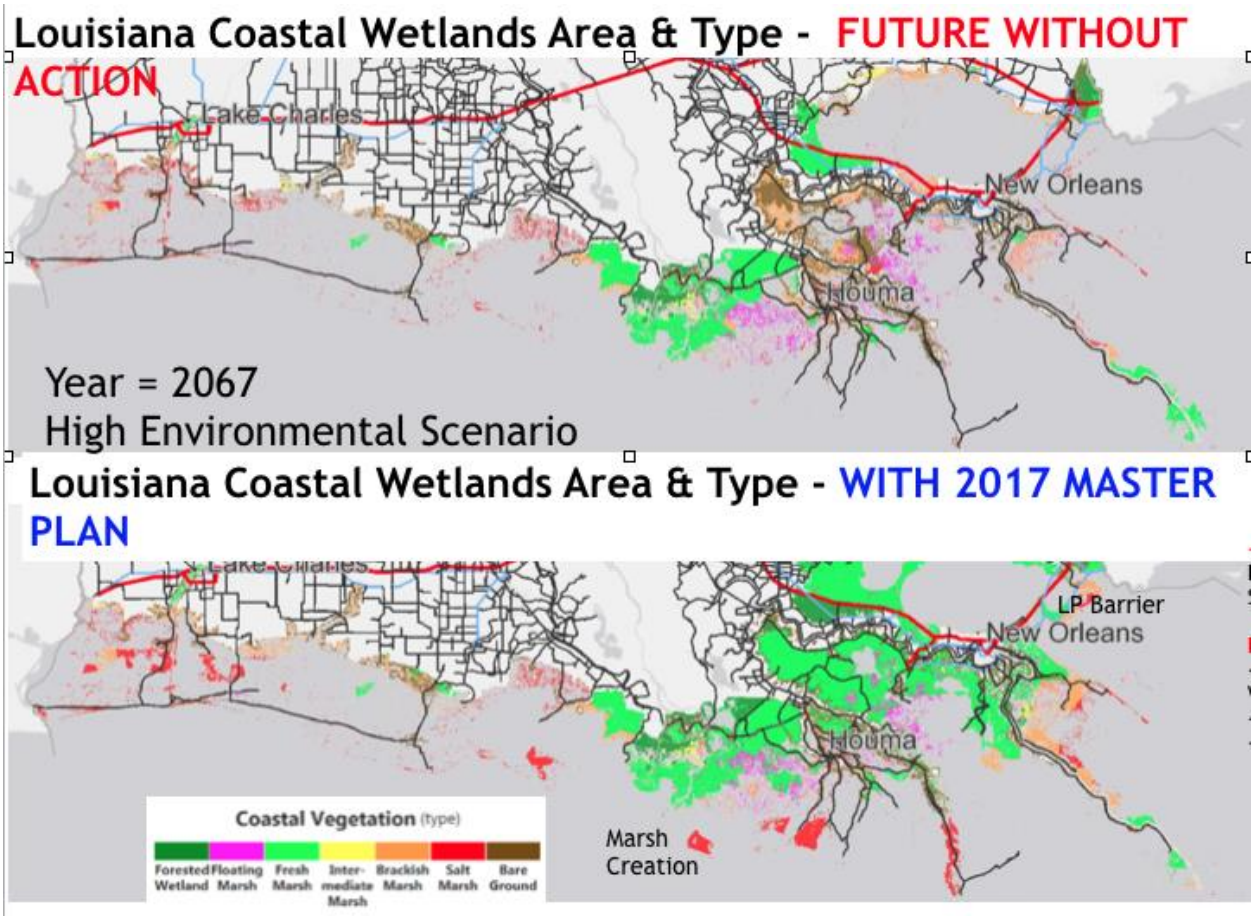
I was busy formulating a strategy to draw Day out on this topic when he surprised me by saying that, like Turner, he also didn't think the diversion project would work as planned. In fact, he thought the entirety of the Master Plan, as written, was more or less pointless. "We argue about things," he said, "but I don't know one single academic scientist that isn't directly affiliated with CPRA that believes this is going to work."

This seemed true enough. In his office weeks earlier, Turner had said that even if the Mid-Barataria Diversion did manage to build some land in thirty, forty, or fifty years, "by then, sea level rise is gonna be going into effect and it's not gonna make any difference." When I asked him, then, why bother even advocating for backfilling, he suggested it as a sort of palliative measure, rather than a cure. "The wetlands are going to go eventually, but maybe you have them around a little longer."

Day echoed these sentiments.

"In the end," he said, "most of the coast can't be saved. And I'm not even sure New Orleans is gonna make it. In fact, I'm pretty sure it won't. The forces taking place in this century, I think, will collapse this delta and most deltas."

Day then pulled up an image from a soon-to-be published paper for me to look at on his computer. It showed a computer-generated model of the southeastern corner of the state in 2069. The top image was labeled, “future without action.” The bottom image said, “future with the Master Plan.” At first glance, the bottom map, with all that green, seemed an improvement. But Day clarified that all of this freshwater marsh would be largely uninhabitable by humans, as well as inhospitable for many of the species that currently live in the brackish swamps and dry land it would be replacing:



“I mean, other than the green, there's no difference,” said Day. “Right?” He laughed once. “They spend $50 billion and the coast disappears.”

I stared at the two maps. Why, I asked him, had I never seen this image before in a newspaper column somewhere, under the headline “MASTER PLAN WON’T WORK ?”

“I mean,” Day said, “I talk to journalists, and they just won't write it down. They want a feel-good story.” He shook his head. “They want positive messages. I hear that over and over. Well if you want a positive message, go buy you a pack of cigarettes and start to smoke. Because it's cool and it feels good, you know?”

Later, in a more serious tone, Day pulled up a photo of his grandchildren on the computer, different than the one he had tacked onto his door.

“Much of my career as an adult,” he said, “this stuff wasn't hanging over our heads. You could live a life and not worry so much about it. But I've got two granddaughters, and when I think about it, they're going to be my age midway through the second half of this century.” He paused, and I glanced over at the giant map on the wall, the water creeping up across it, across time, devouring the boot of the state.

“This,” he said, “is going to be the defining thing of their lives.”

When it comes to saving what little of the coast we can in the next century, John Day seems to like his restoration strategies the same way he likes his books: really big and hard to understand. One method would be to have New Orleans participate in a kind of large-scale restoration Ponzi scheme, wherein investors buyout a plot of land, then have dredged river sediment systematically pumped up under it through a coordinated system of pipelines. Once the land had been raised to something like five meters above sea level, “people would come in there and pay top dollar for it. And you use that to buy up the next group [of properties].” Repeat until the city is raised. “And you plant oak trees,” added Day, "and in 100 years you have 100 year old oaks.”

“I’ve heard crazier things,” I said, and although I meant it at the time, upon reflection, I’m not really sure that I have.

Day is also an advocate of a method he calls “mega-diversions.” According to his logic, the problem with the proposed Mid-Barataria Diversion is that it would be flowing day in and day out, many years in a row. The stress that this flooding regimen would put on plants could damage the marsh in the same way that he believes it killed the cordgrasses in Caernarvon. Instead, Day says the state should “make a big diversion, and about once every five years, turn it on and let it blast away.”

Day grew excited, and explained that back in 1927, the great river broke through one of its levees near Caenarvon.

“It laid down—we published a paper on this—it laid down a layer of sediment in three months that was 130 square kilometers, and up to 40 centimeters thick. In three months! We actually went out there and cored down to it, and we could find that exact clay layer. It was pure clay. You could make pottery out of it.” He smiled. “That’s the way the delta works.”

He explained that the further you got away from that more natural, less controlled model of diversion, you “got into trouble” with chronic flooding issues for plants.

Of course, he admitted, such an extreme project would necessitate getting large numbers of people living downstream of the diversion to relocate first. “You should loose the river to the absolutely full extent as you can,” he said, “and you've got to get people out of the way.”

Later, when I thought about this approach, it occurred to me that you’d also have to be dead-sure that the nutrients suspended in all of that mega-diversion water were not going to destroy the wetlands that you loosed the river over. Of this, I was not yet convinced. Day’s

counter-arguments about the study at Plum Island were solid enough, and it *did* seem true that prolonged flooding had something to do with the destruction of Caernarvon in 2005.

Still, I had a hard time trusting the work of a scientist, no matter how impressive his curriculum vitae, who had such a clear conflict of interest when it came to the subject he was publishing papers about. To my mind, everything seemed to come down to what happened at Four-Mile Marsh. On a whim one morning after breakfast, I asked my wife if she was in the mood for a field trip, and within the hour we were speeding north along Highway 55 over Lake Pontchartrain towards Hammond.

By cross-referencing some aerial photos that Turner had given me of the marsh before our flyover with satellite images I found on Google maps, Chanel and I ended up at the end of an innocuous-looking gravel road off the highway. We parked beside an old pickup truck, presumably belonging to the guy who was fishing in the bayou just beyond. It was a gray day, early February, a chill in the air. Just past the gravel road to the east, a gated chainlink fence with a very loose length of chain holding it closed seemed to suggest that the area was not for visitors. Beyond that, an embankment rose up upon which a train track ran parallel to the road, and beyond *that*, just out of view, was Four-Mile Marsh.

No signs anywhere indicated that partially treated sewage was flowing nearby. Or (lawyers take note) that the land just beyond the poorly-locked fence was of a privately-owned nature. This whole area, according to Google Maps, was a part of a larger public wildlife area; about a mile south, a trailhead was set up with maps and informational pamphlets to guide visitors on a meandering boardwalk through the cypress swamp. I glanced at Chanel. She said that she was down if I was. I smiled, as you do in those moments when your life partner agrees to

join you in some light trespassing , and then in short order we'd both ducked under the lock through the gap in the gate. Together, we made our way over the train tracks towards the marsh.

As soon as we were clear of the embankment, this big black pipe came into view, maybe a foot and a half in diameter. It rose straight out of the earth at a low angle, and at about six feet, leveled off. A scaffold of four-by-fours supported it, extending as far as I could see into the forest of budding red maples and leafless, over-wintering cypress trees. At the base of the pipe structure, tangles of low weeds grew, their tiny flowers blossoming a glossy lemon-yellow. I knew from maps that the pipe above them was over a kilometer in length, which in the abstract, hadn't seemed that long to me. In real life, however, the structure seemed huge, giving the impression of stretching on forever as it ran down through a clearing in the trees, its terminus hidden from view.

The second thing I was struck with was the smell of the place. Rank and sulfurous, a rotten-egg stink filled the air. It wasn't chokingly dense or anything, but definitely noticeable, especially so about fifty feet past the point at which the black pipe had leveled off. Here, smaller white PVC pipes had been attached, a new one protruding out from the big pipe like a centipede leg every yard or so. From the open mouth of each one cascaded a ceaseless stream of smelly water, arcing in a four-foot free-fall before splashing into the marsh below. In some places, the continuous crash of water had scoured out the mud, leaving six-inch-wide craters in the earth around the marsh grasses and cypress seedlings. In others, scummy-looking drifts of froth spun slowly in the whorl of the water.

I wrinkled my noise and pointed out the froth out to Chanel. She, however, is cooler-tempered and more measured than I. Looking at it for a second, she reminded me that sometimes there was foam at the beach, too, and it didn't necessarily mean anything sinister was afoot. She

cautioned me not to jump to conclusions, and reminded me that, after all, it was winter, and most forests tended to look a little gloomy in winter.

So I nodded, and I tried to stay open. Gazing out southward over the Four-Mile Marsh, I noticed that some of the younger-looking cypress trees that stood in the grass were leaning perilously to the same side, as if windblown. Some were already on their backs, half-submerged, their mud-caked roots breaking the surface of the water, throwing earth-colored half-circles up against a green backdrop of marsh. But for every fallen-down tree there were ten or twelve mid-sized ones standing upright, too. Dense, healthy-looking thickets of marsh grass, bull tongue and horsetail blanketed the boggy wet ground as it stretched away to the south.

I wasn't sure what I'd expected, exactly. Some kind of fetid, open scar on the land, unidentified chemical clouds lifting up off the surface of the splotchy, ruined marsh, like a cinematic shot of a bombed-out battlefield in a movie or something. This, though—it was all so anticlimactic and inconclusive.

Perhaps if I got a bit further away from the discharge pipe, though, I could look about the marsh with a little more perspective, catch a glimpse of some damning horror I could write about. After a few minutes of walking down the length of the pipe, Chanel and I came upon a skinny wooden walkway jutting away from the structure and into the marsh, probably left by one or another team of scientists busily gauging its health a couple years ago. Who knows how long it had been since the lumber had borne anyone's weight. Chanel took one look at the unpromising, mold-slicked pair of two-by-sixes laid out over the sewer-smelling water and wished me *bon chance.*

I worked my way slowly out into Four-Mile Marsh beneath the overcast sky, both arms outstretched to keep my balance, a lone gymnast in the bog. I tested each span of planks for give

before crossing over it, and in places where the wood was slimy, I got down on my hands and knees to shimmy-crawl across. Eventually, I made it out about fifty feet from the discharge pipe. Beside me, a shrub-sized cypress tree grew up close beside the walkway. Maybe six inches below the soles of my feet, the surface of the water lay still between hardy-looking tufts of calf-high grass. High above me was a perfectly even grey sky, the sun hidden up there somewhere behind the clouds.

I turned to look back towards the pipe. Chanel, so tiny from this distance, stood framed between two parallel streams of water falling from it. We'd been talking a lot recently about starting a family in the next couple of years. We weren't sure how we'd afford it; Chanel was working as a line cook, I was bussing tables, and between us, we'd managed to accrue something like $60,000 in student loan debt. Amongst my friends, I was an outlier in my desire to parent. At least half of the 25-to-40-year-old people that I regularly socialized with evinced no interest whatsoever in parenting. Apparently, I was also an outlier amongst my generation, too. According to the Center for Disease Control, birthrates had hit an all-time low in 2017. More than a few of my non-procreating friends had said that their lack of interest in parenting had to do with the uncertainty of the future of our species on the planet. They questioned the ethics of bringing another human into the fray. These arguments checked out with me, and yet my conviction that Chanel would be the mother of my children showed no signs of abating. My desire to raise kids with her grew more and more certain within me, despite everything else that was so fuzzy about how and where and when and with what resources. *We'll figure it out* had become our mantra—which reminded me, I'd come out here to figure something *else* out.

I looked away from Chanel and did a slow three-hundred-and-sixty degree turn, but everything looked like a normal old marsh to me. What was I looking for, anyway? I felt

frustrated, and gave the shrub-sized sapling next to me a light tug, testing for the strength of its roots. It lifted a tiny bit, allowing for a small jiggle, but was that significant? I tugged again, and I could feel the suction-y resistance of the root mat. Secure enough, I guessed, but then what did I really know, what could I really glean from all this? I didn't have a PhD in science, and those who *did* seemed more likely to roll up their sleeves wrestle each other to the death in a cage match than agree on what was happening out here.

I sighed. Maybe Day was right. Maybe the marsh had recovered fully from the freak nutria chow-down a few years ago and now it couldn't be happier to suck up our sewage. But maybe Turner was right, and those jiggly roots I'd just tested were slowly weakening just as his cotton strings had. Maybe this whole place would be a garbage-smelling lake in a decade. The longer I stood there, the more confused and frustrated I felt. What was a person supposed to do, anyway, when both science *and* common sense told them opposite things about the same place? Science said that we were either killing Four-Mile Marsh or saving it. Common sense said that dumping sewage into a swamp was bad, but it also said that plants like poop.

And then, of course, there were my emotions flaring up about everything: the bad smell, the possibility of greed and underhandedness and injustice underpinning the whole endeavor, the indignity of the sawed-off cypress stump that I'd walked past on the way here, condemned by bad luck and it's naturally water-resistant properties to endure an endless buffeting of wastewater from two different PVC pipes that discharged directly onto it. These feelings—anger, disgust, sadness—they were not wholly without their authority, either. Like most, I'd heeded them many times in the past for helping in figuring out what was true, what was honest, what was real.

But now they just added to the confusion. I could feel all of my meaning-making systems straining against the complexity of the situation, everything inside of me working double-time,

searching desperately for anything certain, definite, black-and-white, good or evil—anything at all that I might press, like a salve, against the terrible fear I felt about my future as a human here on the planet these days. There is just so much that I don't know about what is going to happen to me in the next fifty years. It seems almost unconscionably punishing that, on top of this crippling uncertainty about the future, there should be so many shades of grey about the recent past. Why was it so hard to say what had happened here at Four-Mile Marsh? My mind and my heart and my soul did the math, crunched the numbers, examined the data, searched for anything conclusive, anything that might offer a glimmer of direction for me as I hurtled headlong into a world that no one has ever known before.

4. The Gulf Between

> …She has seen her world wiped clean, the cloth
> that wiped it disintegrate in mist
> or dying breath on the skin of a mirror
> She has felt her life close like a drawer
> has awoken somewhere else, bare
>
> He feels his skin as if it were mist
> as if his face would show in no mirror
> He needs some bolts he left in a vanished drawer
> crawls out into the hemlocked world with his bare
> hands, wipes his wrench on an oil-soaked cloth…
>
> - Adrienne Rich, "Behind the Motel

It was standing-room only when Captain George Ricks took the podium in the Rivertown Ballroom at the Hilton across from the old New Orleans airport in Kenner. Sponsored by a variety of seafood and oyster business organizations—the Louisiana Oyster Task Force, Louisiana Farm Bureau Federation, Louisiana Seafood Promotion & Marketing Board—the Seafood and Fishing Industry Convention included a bill full of speakers presenting on hot industry topics, specifically as they related to the state's coastal restoration plans. In the audience were more than a hundred folks, some commercial fishermen and oyster dealers, some crabbers and shrimpers, some state and parish-wide policymakers. A couple of representatives from CPRA sat behind me with paper cups of coffee. Dr. Eugene Turner was scheduled to give a twenty-minute presentation about backfilling canals. The Lieutenant Governor was also on the docket. Before him, though, Captain George Ricks had been invited to talk about diversions and their effect on the fishing industry.

Broad-shouldered, thickset, and bald, Ricks looked every bit like a man who'd spent the past forty years fighting fires and catching bass. His speaking voice was pure New Orleans, that nasally city-talk that calls Brooklyn to mind far more readily than the Deep South. The skin of

his face, especially so around his cheeks, had been colored a permanent, deep sun-roasted red from many years spent on the deck of fishing vessels. Before becoming a charter boat captain, Ricks had been an award-winning tournament angler with the Bassmaster's Classic for nearly ten years. Before that, he fought fires with the St. Bernard Parish Fire Department. Once, while on an emergency call, Ricks fell through the floor of a burning building and crashed more than ten feet down through the flames to land square on one of his knees amid a shower of incinerated floorboards.

What I'm saying is: Ricks is a fairly tough guy. For the first twenty minutes of his presentation, he admonished the state for the damages done to fisheries by the Caernarvon and Davis Pond Diversion projects over the past few decades. The PowerPoint screen behind him flashed with graphs and tables and charts, data he had researched and compiled on his own time for giving presentations like this one. There were multiple graphics that mapped the decline of commercially fished species—oysters, speckled trout, blue crabs, brown shrimp—as they related to increased flows of fresh river water from these two existent diversions. Ricks was fired-up and unapologetic and loud, the microphone before him seeming a little bit redundant after a while. The state's plans to open up the Mid-Barataria Diversion were going to destroy the state's already struggling fishermen and their families, he said. "You're talking about more than jobs here," he said. "You're talking about a culture, and a heritage."

But then his voice choked up. His eyes watered. "I'm gonna get emotional," Ricks said. "Because, there are *generations*, here. These guys fishing out there with their sons…" His voice pitched up again. "*My* son." He paused, and swallowed. "They wanna do what their fathers and their grandfathers did. And the state's gonna come in and tell you you can't do it?" He looked

squarely at the men from CPRA seated behind me. “It’s not fair.” He wiped a tear off his sun-reddened cheeks, and added quietly, “I’m sorry.”

A week later, I sat outside of the old courthouse in St. Bernard with a decidedly more composed Captain Ricks in the passenger seat of his very large, shiny black pickup truck. He’d spent the past few minutes scrolling through photos on his phone, looking for the one he was showing me now: a young girl, maybe seven, standing on the deck of a boat, hoisting up a large redfish and beaming. Beside her, a younger-looking Ricks knelt, smiling at the camera behind a handlebar mustache almost as impressive as the fish.

He liked to take groups of inexperienced fishers out the best, he told me. Especially young kids. “Sometimes, I get to be there when they catch their first fish.” More experienced fishermen, he told me, had bad habits that were hard to break, and didn’t like to take Ricks’ direction if they thought they knew better.

Ricks is one of the nearly 15,000 Louisiana residents who make their living taking tourists and sportsmen out to fish our coastal waters in charter boats. An important part of the state’s $2.4 billion fishing industry, recreational charters like Ricks’ allow fishing enthusiasts of all stripes the luxury of being led to the fish by someone who knows how to find them. “I always had a knack for saltwater fishing,” he said. “You gotta think about the time of year, the wind direction, water temperature, the tide, whether it’s incoming or outgoing. Plus, when you’re a charter captain, you have to entertain people. You gotta be likable, make jokes.”

For all his affability, though, Ricks is not afraid to get serious about the environment, which after all, has everything to do with the success of his business. Ricks spoke at length about the effect of the Caernarvon Diversion on the Breton Sound fisheries. After the Deepwater

Horizon oil spill in 2010, the state chose to open the diversion to its full capacity in an attempt to "flush out" the oil, pushing it away from the marshes and back out into the Gulf for easier cleanup.

Unfortunately, however, this deluge of freshwater affected salinities in the estuary. Speckled trout, which were at the tail-end of their spawning season when the spill occurred, were likely "flushed out" further than usual into the Gulf by the fresh water. This particular fish prefers to breed in brackish to full-strength, salty seawater. The sudden influx of river water, in Ricks's opinion, is largely to blame for the poor speckled trout season in 2011, the year after the big spill.

Ricks told me all this as we rode together in his truck down two-lane Highway 46 towards the Hopedale Docks. Just fifteen miles east and south of the mouth of the Caernarvon Diversion, Hopedale is situated within Breton Sound, which opens eastward like a megaphone, bounded to the south by the Mississippi and to the north by a large man-made shipping canal called the Mississippi River Gulf Outlet—Mr. Go, for short. A thin curve of chandelier islands forms what looks like a sound wave heading south-eastward out of the megaphone's bell and into the Gulf. The land flashing by outside of Ricks's car was low, and on the other side of the bayou that traced along at the passenger-side of the road, dead cypress trees reared up from the low green marsh vegetation, dozens and dozens of them. It reminded me of the dying forest in Whitbeck's plot in Barataria, if it were given ten or fifteen more years to deteriorate. Very few living trees interrupted the surreal, sculptural landscape of dead ones that dominated this part of the Sound.

Hurricane Katrina, Ricks said, really wiped out this area. "It was unbelievable. This—" He gestured towards an open, overgrown lot. "This used to be a hardware store. Used to be a lot

of people who lived down here, too." Not many lived down this way anymore, he said, opting to move further inland behind floodgates and levees. All that marked their former homes anymore were stands of abandoned pilings and bare concrete foundations.

As we drove, Ricks explained how important the fishing industry was to St. Bernard Parish. Unlike their neighbors in Plaquemines Parish to the east, folks in his parish couldn't rely on the oil and gas business to provide them with the majority of their jobs. "Here, we only got one, two little refineries, that's it." Instead of finding jobs there, many people fished or shrimped or crabbed or hauled up oysters for a living. Economically, they lived fairly close to or underneath the poverty line; St. Bernard has one of the lowest median income levels in the state.

That's why, Ricks said, that even on a cold winter weekday like this one, you'd see people out at Hopedale. Not as many as on a nice day, but there'd still be some activity. And sure enough, before long, my view from the passenger seat switched from dead trees to boats as we made our way through the marina-town of Yscloskey. Many, many different kinds of boats passed by outside of my window—shrimp trawlers and oyster boats and charter vessels. You could tell the shrimp boats, Ricks explained, by their long green nets, which they carried high, rigged up over mechanized booms like folded-up sails. When they went out to trawl in these wing-net boats, shrimpers would extend the paired outriggers over the surface of the water and unfurl the nets down into the water.

Due to the weather, overcast and chilly, most of the boats we drove past were either tethered up to the docks or lifted by winch up out of the water under wooden awnings. As we drove past, Ricks identified nearly every boat landing by its owner, every fisherman by name. When we arrived at Hopedale, in fact, he pulled to a stop beside a sort of pale, bespectacled, academic-looking guy in a chunky knit sweater. He was working to angle his boat, hitched up to

the back of his car, either into or out of the water, I couldn't tell. He smiled and waved at Ricks, hopped out of his car, and reached in through the open window to shake my hand.

"Well did you catch 'em?" asked Ricks.

The man laughed. "I'm just getting out."

His name was Pat, I learned, and he is a professor at Mississippi State with a PhD in meteorology, specifically focused on hurricanes and storm surge. We talked a bit about the Caernarvon Diversion, which Pat had studied a bit. "After Katrina," he told me. "I looked out at Delacroix like, *what happened? Where'd the marsh go?"* He was of a mind, like Turner, that nutrients in the river water had reduced the root strength of the grasses there.

"I'm open minded—very open minded," he said. "I try to look at all sides. But the thing about the diversion is, even if it does all it's supposed to do, in fifty to a hundred years—that is a long time. Everything else is gonna be gone by then. I think that's the thing the public doesn't understand."

Mostly, though, the two men talked about fishing, going back and forth in a jargon as specialized as any of the scientific terminology I'd had to learn thus far. Pat had turned in a major journal article yesterday, he said, and now he was out after redfish.

"I found fish in Hank's Pass a few weeks ago under similar conditions—right before a front, incoming tide."

Ricks nodded, *mm-hm.*

"There was a flat that was just loaded with reds. I'm gonna check that out."

Ricks wanted to know if he fished on the bottom with dead shrimp.

"Yeah," he said. "I got dead shrimp." He went on a bit about some trout he'd also pulled out back in December on the way back in from the flat, but then Rick's phone rang. It was his girlfriend.

"Well alright, Pat, good to see you buddy, I gotta take this," he said. We both waved at Pat.

"Show her around!" he called.

Ricks smiled. "I sure will."

Rick's wife, turned out, had let the dog loose—not their dog, somebody else's. She'd been cleaning the house of a client, trying to be careful, and the dang thing had got out of the backyard and tore away through the neighborhood. Oh, she was distraught. Ricks listened with sympathy, told her he was sure that it would be okay, that the dog would come back. "Don't let it ruin your day, now," he said, and after he hung up, shook his head. She was a sweet woman, really, just the type that got a bit overly nervous about things sometimes.

Did I want to go meet the Campos down at Shell Beach now, he asked?

Ten minutes later we pulled up in front of a wind-worn wooden marina, a stone's-throw away from the choppy waters of Mr. Go. A bumper sticker on the front door of the marina had a stop sign on it, with the words *NO RIVER DIVERSIONS* printed below. This place was open seven days a week and going on 114 years of operation, Ricks told me, gassing up vessels, selling ice and bait. Its owners, the Campos family, were also oyster- and fishermen themselves.

Rick tapped the horn as we pulled up, and Robbie Campos, standing next to his son, looked up and waved. He looked maybe fifty, with a pair of rectangular glasses and a camouflage cap on. He was in the middle of dispatching his son to run some errand or other

when we walked up. He introduced me to him as Robbie Jr.—Carhartt sweatshirt, backwards ball cap—and we shook hands. Rob senior clapped him hard on the shoulder after that and sent him off down the road in their truck. “Don’t forget the gasket,” he yelled after him.

Campos was excited to meet me, pumped my hand with two of his. “What can I do you for?”

I asked him a bit about his business. His grandfather had taken over the marina in 1903 at the age of thirteen, he said. Back then, before Mr. Go was cut, the waters in this estuary were fresh or brackish. After the federal government put the shipping channel in, however, saltwater from the Gulf intruded. Although the seawater had a deleterious effect on much of the vegetation, the increased salinity was excellent for cultivating oysters.

“The business exploded,” said Campos. “Never had oyster-one in Lake Borgne ’til Mr. Go was cut,” he said, referring to the large body of water directly north on the other side of the shipping channel. “Lake,” however, is a bit of a misnomer, since Borgne is technically a big lagoon, opening directly out into the Gulf of Mexico. In the sixteenth century, it was bounded on all sides by wetlands, but marsh damage done by Mr. Go slowly ate away at these barrier swamps, destroying the local wetlands while creating the local economy.

In Rick’s view, since the state essentially manufactured the economy here in the first place when the cut Mr. Go, they had a responsibility to maintain it for folks like the Campos whose whole lives had been built up around fishing species that require higher salinity water to thrive.

“In my lifetime,” said Campos, “all I’ve known is the saltwater estuary. But now,” he said, alluding to the new influx of freshwater from the diversion up north, “now I’m going back to what my grandpa knew.” He laughed. “We goin’ back in time.”

Campos explained the domino-effect the changing composition of the water near Shell Beach has had on his industry. Fish like speckled trout, following the salt water, have moved further out toward the Gulf; if anglers want to catch them, they have to motor further out, too. This means spending more money on fuel. For marina owners like the Campos, this also means traveling further out to catch the bait species they sell to folks who put in at their docks.

"A man that used to be able to go fishing right here and would catch twenty-five trout," Campos said, "now has to go twenty-five miles out to catch that same speckled trout. His fuel costs probably went from five dollars to seventy-five. Plus, the price of fuel ain't what is was in the sixties and seventies, you know."

The smaller the operation, the more devastating this domino effect. "I mean, we survive," said Campos, "but it cuts into what you're gonna take home. It starts eating into your net, you know?"

This got me to thinking about what the seafood industry means to folks in Louisiana. For my wife and many of her friends who grew up here, standing together at the kitchen sink with a blunt knife working your way through a sack of Grand Isle oysters is a ritual with roots that reach all the way back to childhood. So much of the region's cultural identity seems bound up with good food and good times, *bon temps* and fried shrimp. Winter doesn't really turn the corner into spring until your fingernails are caked with red-orange from peeling boiled crawfish. So why, I wondered, weren't folks more fired up about the threat facing the seafood industry, facing folks like Ricks and Campos, if their very identities were so bound up with their fates?

I wondered this aloud, and Campos was quick to blame CPRA's decades-long campaign to promote diversions. "They bullshittin' that this river is the save-all of save-alls. And believe me, it's not. We're dealing with a river that's totally filled with pollutants from the farm belt. All

the way from Nebraska to Iowa, Missouri—it comes down in this river, it comes down to here. They wanna put that same poison water into our estuaries. And *that's* gonna save us."

He then referred to the Dead Zone in the Gulf, a New-Jersey-sized patch of toxic seawater that is, paradoxically, a direct result of our agricultural sector's pursuit of life. Farmers working upstream want their corn, soybeans, and wheat to grow—*to live!*—so they spray them with nitrogen-rich fertilizers. Rain falls, scrubbing those nitrogenous residues off of the plants and into the Mississippi. By the time the river reaches the head of passes and drains out into the Gulf, it's taken on massive amounts of nitrogen. Upwards of 1.2 million metric tons of it have emptied out of the river and into the sea every year since 1997. Before that, the annual average was more than 1.5 million tons—or, the equivalent of nearly four fully-loaded, 1000-foot-long bulk cargo freighters, each one of their shipping containers packed to the gills with nitrate.

From the moment it first empties out into the Gulf, it's only a matter of time until the algae blooms. Algae adores nitrogen just as much as the corn and soybeans and wheat plants do. It explodes to life in areas where nitrogen is heavily concentrated, a phenomena which is visible from space as a cloudy, green-brown band of seawater stretching all the way across the Louisiana coast, curving down along the edge of Texas to the Mexico border.

Once it blooms, this broad swathe of algae dies off rapidly. This decomposition process consumes great amounts of dissolved oxygen in the water, causing other aquatic creatures living in the environment to suffocate and die. According to scientists, these conditions are called "hypoxic," and some species are more susceptible than others to the low-oxygen conditions. Jellyfish, for instance, don't seem to mind the lack of oxygen and do alright in hypoxic waters. Red snapper and brown shrimp, however, have proven less able to withstand dead zone conditions in the Gulf. There is also evidence that indicates shellfish lashed onto rocks in

oxygen-depleted water are more susceptible to predation by mobile creatures like crabs, who in laboratory tests seem to opportunistically prey on the oxygen-starved clams more readily than healthy ones.

Understandably, commercial and recreational fishermen are concerned about hypoxia visiting their inland fisheries once the river is loosed out over them at the high rates proposed for the Mid-Barataria Diversion. They are also dubious about the water's land-building power.

Campos shook his head. "Freshwater don't build land," he said. "You gotta have *material* to build the land." He cited a statistic I recognized about the river's current sediment load being *lower* than that used in the state's modeling equations for the diversion.

Science backs Campos up on this. According to Ivan Gill, researcher with the University of New Orleans, and Harry Roberts, a scientist with the Coastal Studies Institute, "there is a need for more than 100 times the sediment than is presently provided by the Mississippi River" in order to "fill the empty space (the "accommodation space") produced by the rising sea-level and subsiding coastline." Similarly, researchers Michael Blum and Harry Roberts concede that "upstream dams trap ~50% of the total sediment load, and there is not enough supply to keep pace with subsidence and accelerated sea-level rise." Even if all of the dams built upstream of the delta were instantaneously removed from the Mississippi system, they write, "it would take many decades for the higher loads to return to the delta region."

For this reason, fishermen like Campos and Ricks advocate for rebuilding the land with sediment dredged up from the *bottom* of the river instead of with the limited amount of sediment that's suspended in its waters. Once dredged up, the dirt and sand and mud harvested from the riverbed can be transported via pipeline to the parts of Barataria Basin and Breton Sound that

need it. This way, all of the land-building power of the river can be harnessed without incurring nearly as much harm from freshwater and pollutants. *Dredge, don't divert,* is their rallying cry.

And although opponents of sediment delivery pipelines often argue against them on grounds of their costliness and reduced land-building potential relative to river diversions, sediment delivery pipelines have shown, in sophisticated cost-benefit analyses, to deliver more bang for the buck over the course of fifty years than projects like the Mid- Barataria River Diversion. Economist Rex Caffey, for example, ran just such an analysis, taking into account factors beyond mere land creation—things like habitat health, time, and the likelihood of socio-political resistance from folks like Campos. His study indicated that dredged sediment pipelines tended to beat out diversions in overall efficiency. "This finding," writes Caffey, "runs counter to current assertions regarding the unrivaled efficiency of diversions."

Additionally, some commercial fishermen advocate for a far broader and more ambitious solution to their problems at the dock: hold upstream agriculture accountable for the pollutants they run into the river off of their farms. Such a measure, backed by the federal government, has already been instated in the Chesapeake Bay. Local farmers, despite their protestations, were forced to abide by mandatory limits on how much nutrient pollution from their agricultural activities entered the bay. Maryland shelled out billions of dollars to achieve these ends, and as researcher Donald Boesch recently said in an interview for Iowa public radio, "we're seeing the signs of improvement. Until you have those kinds of goals and targets, it's going to be very difficult to actually achieve the agreement that the upper basin states and the federal government have to reduce the size of the dead zone in the Gulf."

Dr. Turner is also a fan of this kind of far-reaching strategy, although he admits in presentations that cleaning up the entirety of the Mississippi drainage basin is a pretty big

dream—an important one, but one that will likely require more than a single generation's-worth of work to realize. In the meantime, however, the mood down at the docks in Shell Beach is one of angry despair. At some point in our conversation, Campos' voice became low and bitter. "I mean, our business is going downhill, downhill, downhill, downhill all the time." He looked at Ricks. "I would say we got probably, what, ten years, George? Before we…"

His sentence trailed off. The two of them went back and forth, then, about the timeline before shovels hit the dirt on the state's different proposed diversion projects. My mind drifted off to something I'd seen down the street, to the spot where the road ended abruptly at an iron guardrail. Less than ten feet beyond, the waters of the defunct shipping channel stretched out towards Lake Borgne. In between the guardrail and the water, a big stone memorial stood, etched with columns of names. Ricks told me they were the names of people who'd died when hurricane Katrina blew through.

More than the diversions, more than the economic struggles, more than any other topic that we spoke about—the subject of Katrina lit Campos up. He gestured in a wide circle all around him, indicating the marina, the houses lifted up on stilts behind us, the more expensive-looking hunting and fishing camps on the other side of Ycloskey Bayou. "Everything you see out here?" he said. "This was all *since* Katrina. There was nothing left here after." He barely stopped for breath. "It was worse than Iraq," he said, "'cause Iraq, you got rubble and shit. They didn't even have rubble. This place was wiped like a slate."

Campos turned, pointed towards a little half-acre lot behind us, currently occupied by a modest-looking home on six-foot-high wooden stilts. "I had a house here," he said. "That I never found a piece of. Was a four-bedroom house—right here, born and raised in it. Never found a *piece* of that house. Not one piece of it. Not even the siding. Gone. Vanished. Disappeared."

It struck me then that Rob Campos was perhaps more well-suited than anyone else I'd met in the past year to imagine the end of our species. He'd come through to the other side of something that most of us fail at even envisioning. If he was cynical about the state's plans to wipe him and everybody he knew and loved off the map—well, it came from a place of knowing just exactly what that kind of experience was like. The shock and suffering of it had primed him, maybe more than most of us, to handle what was coming down on all of us now. The idea of our total and complete erasure from the planet—this was not something Campos had to work out like a word-problem in his head. It was not abstract or theoretical. To him, the end of human life was something he knew concretely, as intimately as the feel of the siding that once ran alongside the outside walls of his house, or the texture of the wreaths his family and friends toss out into Mr. Go every September to honor the lives of those taken by the storm.

Not only was it remarkable that Campos had lived through Katrina; but also, that he had known the kind of rootedness that he'd known before the storm had even arrived. According to a 2014 study published in the *New York Times*, nearly four out of five people born in Louisiana stay here for life, one of the highest residential retention rates in the entire country. The word "home" for folks from around here meant a particular sort of peace and purpose and legacy; a particular, esoteric knowledge of the water, fish and fowl. Through that knowledge, too, had come certain wisdoms about how to live over the years—all traceable to this place, this way of life. At the very least, to most folks from Louisiana, home is something worth digging your heels in about.

Later, on the drive back from Shell Beach, Ricks told me the story of how he got roped into doing advocacy work. In the end, he said, it all came down to this comment he'd heard straight from the mouth of a state policymaker. The guy had been asked what the folks living

down at these southernmost tips of the map should do when the big new diversions opened up and their entire way of life was irrevocably changed. “The man said—well, historically, people who’ve lived down in these areas have moved.”

Captain George Ricks—all two-hundred-plus, bass-fishing, fire-fightin’-pounds of him—stepped out of the meeting room that night and cried. Then, he began to organize.

The day after he took me down to Shell Beach, Ricks flew up to Washington DC. As president of the Save Louisiana Coalition, the advocacy organization he helped found, he’d spend a couple days there speaking with lawmakers about the situation of fishermen like him down along the Coast. In addition to advocating with Save LA, Ricks works the coastal consultancy desk with St. Bernard parish government.

Once over the phone, Ricks told me about his D.C. itinerary and laughed. “If you’d told me six years ago that I’d be going to Washington DC and talking to congressmen, and giving speeches—I’d never have dreamed it. All I wanted to do was earn a living.”

After I hung up the phone with him, I mulled over the idea of the reluctant advocate. Who wasn’t reluctant, after all, to get involved in the realities of climate change? Most of us, from what I’d encountered, anyway, were reluctant to even *acknowledge* the truth of what was happening to the planet. Just a few months before I met Ricks, I’d sat across the kitchen table from my wife and an adult friend who grew up in a fishing family, hauling up crab traps and boiling crawfish. We’d all just finished inhaling a couple dozen fresh oysters, and were working our way through cans of Miller Highlife, and the subject of my book came up, and Chanel began to mention some of the more sobering facts I’d uncovered about land loss.

Our buddy seemed tense. I looked at Chanel. “Are you sure you wanna talk about this?” I said. “It’s pretty sad.”

Our friend took a long pull from his beer and shook his head slowly. “Nope,” he said.

I laughed, said that was all right, and suggested that he just read the book when it’s published.

He didn’t skip a beat. “Not gonna read that book,” he said. After a moment, somebody changed the subject. I didn’t think about it then, but it occurs to me now that perhaps Campos was unfair to blame folks’ apathy about the plight of the fishing industry solely on CPRA. Some of our struggle to talk about it comes from something else, someplace deeper. Part of the problem, I think, has to do with living in a place that puts such a premium on good food and good times. I mean, let’s be real: climate change is a buzzkill. There’s never a good time to bring it up. But what troubles me, perhaps even more than the water creeping in between the banks of our bayous, is this ever-widening gulf between what we all know to be true and what we are willing to say about it, what we believe we value and how we actually behave, our bellies full of oysters and our minds full of high-minded convictions but our mouths stoppered, too scared to even acknowledge, out loud, that by the end of the century so much of our home will be Atlantis.

But maybe I’m being too harsh. Because although I’ve intellectually accepted the inevitable disappearance of most of our coast, I’m afraid that my heart’s less convinced. I know this only because there are moments when I feel the truth kick at my ribs. These moments surprise me: late afternoon, driving home from the gym, a cello suite comes on the radio and the setting sunlight is golden and the sky is absolutely clear and I suddenly *know* it, I suddenly feel the living presence of what’s to be lost clearly, thoroughly, physically. In those moments, I don’t think *spartina florens* or *nitrates* or anything as abstract, even, as *sea level rise* or *climate change.* I think, *no, no, no, no, no.* I feel inundated. I crave alcohol or television or junk food but

in the end I usually end up in bed beneath some blankets, crying noisily about the terminal illness of one of my favorite places in the world.

Once, when I should have been asking about nutrient loading, I confessed to Dr. Turner that I'd been feeling sad about everything. I told him that all of the acrimony and conflict and disagreement around the particulars—nutrients or flooding? Canals or levees? Dredge or divert?—all of the casting about for things to blame—it was exhausting. It reminded me, I told him, of how grieving people can sometimes act so poorly towards one another at a loved one's funeral, their suffering transforming them into enemies, into the worst versions of themselves.

Dr. Turner said he agreed with me, but only to an extent.

"Because isn't there also that moment at a funeral when everyone's at their *best,* too?" he said. "When everyone acknowledges what's been lost, and the value of it." He paused. "It's like an opening, but just for a moment."

I smiled a little, fleetingly comforted, and agreed to the truth of that, too.

5. The Elephant in the Wetlands

> the great advantage of being alive
> (instead of undying)is not so much
> that mind no more can disprove than prove
> what heart may feel and soul may touch
> —the great(my darling)happens to be
> that love are in we, that love are in we…
>
> …a billion brains may coax undeath
> from fancied fact and spaceful time—
> no heart can leap, no soul can breathe
> but by the sizeless truth of a dream
> whose sleep is the sky and the earth and the sea.
> For love are in you am in i are in we
>
> - e.e. cummings, “the great advantage of being alive”

On the same morning that I met Captain George Ricks at the Seafood Conference in Kenner, I met Chris McLindon. The vice president of the New Orleans Geological Society, McLindon is a rangy man with a long face and a grave demeanor. For more than thirty years, he’d worked as a petroleum geologist, helping oil and gas companies find and access black gold all over the state. This career had, somewhat inevitably, granted him access to a far more complete knowledge than most of what lies beneath the surface of the coast. In his view, folks who’d endeavor to restore land in the marsh ought to evince a thorough understanding of the bones that have underpinned it for millennia—the seams of earthen crust, the shallow slips in the bedrock called “surface faults,” and other geological features.

At the podium, McLindon gestured at a familiar map on the presentation screen behind him: the five lobes of southern Louisiana as they accreted into existence over the past seven thousand years. “Everyone knows that southern Louisiana was built up by a succession of deltas,” he said. Most people, he explained, understood that the wetlands had built out over the years in a steady progression, “and the land loss we’ve seen in the last century is unprecedented.

In fact," he said, "it's a highly cyclical process. Most of the historical deltas are actually submerged. What's at the surface now is what's been deposited only in the last 2000 years or so."

Then, McLindon explained a wetlands process that I'd never heard of before: accretion.

The upbeat cousin of subsidence, accretion happens whenever and wherever new sediment is put down. Accretion increases the elevation of the marsh. It is the golden calf of marsh restoration, the holy goal of the Sears-tower-sized concrete diversion that the state is currently working to get permitted down at Myrtle Grove.

According to McLindon, though, there was a fundamental problem with the diversion's design. "When we talk about mimicking nature," he said. "Nature actually sustains salt marshes through sediment accretion from the *south,* not from the north. The sediment moves inland."

I blinked slowly, flabbergasted as a new series of images flashed up onto the projector screen. They were cross-sectional illustrations of the earth at what McLindon called "surface faults." Although smaller and shallower than more well-known fault lines—the San Andreas, the Pacific Ring of Fire—these surface faults operated in much the same way. To picture it, I suggest imagining a really decadent, multi-layer, toffee-caramel brownie. This is the crust of the earth. Now, take a very sharp knife and draw it straight down through the striations of icing, toffee, caramel, and brownie. This cut-line is the fault. Now, hold the brownie up before you, lining up the toffee layer of one half with the toffee layer of the other, icing to icing, caramel to caramel, cake to cake. Finally, slide them out of alignment, letting one half slip below the icing layer of the other. According to McLindon's illustrations, the lower of the two brownie halves is called the "downthrown" side of the fault plane. The higher is the "footwall."

He explained that, as years passed, a more and more pronounced lip begins to form between the downthrown side of the fault and the footwall. Eventually, marsh plants can no longer keep up with the rate of sinking on the downthrown side, and this whole portion of the fault succumbs to open water. Importantly, however, dirt and sediment accumulate in the grooved lip that's formed between the two fault shelves, pushed up against it and held there loosely by the constant soft buffeting of incoming waves from the Gulf.

Then, crucially, hurricanes blow through, moving northward from the Gulf. The storm's elevated surges jiggle and lift all of that loose sediment that's accumulated on the downthrown lips of surface faults. The high winds and waves scatter it all northward, inland, redistributing all of that sediment out across the marshes. Studies that map this phenomena find remarkable levels of accretion in regions of marshland after hurricanes. In 2012, in fact, researchers found that

> accretion rates averaged about 2.89 cm/year from stations sampled before [Hurricane] Isaac, 4.04 cm/year during the period encompassing Isaac, and 2.38 cm/year from sites established and sampled after Isaac.

Some short-term accretion rates following hurricanes, McLindon said, could be as much as ten times higher than rates of subsidence or sea level rise.

As McLindon noted, however, the 2017 Master Plan has no measure to account for accretion that results from this geologic behavior.

"It's a big myth that we've lost our sediment supply," said McLindon. "Sediment accretion is definitely occurring." In some places on the coast, like the Biloxi Marsh Lands near Delacroix south and east of New Orleans, accretion rates are significantly *outpacing* both subsidence and sea level rise projections over the next decade. "The reality," McLindon writes in a paper prepared as an addendum to the state's Master Plan, "is that between 2008 and 2010 the

total land area of the coastal wetlands has increased by 210 square miles." In his view, based on the geologic data available about the land over the past two millennia, the higher, footwall portion of surface faults have acted as a permanent ecosystem barriers. Over thousands of years, as the river changed its course and built out new delta lobes into the Gulf, it relinquished others, which slowly submerged back underwater. However, these ancient lobes never retreated further north than the boundary of major faultiness like the Teche Shoreline and the Terrebonne Trough, even when the river had stopped replenishing them with sediment. The sediment that was keeping these areas alive was being replenished, McLindon argued, by hurricanes.

McLindon's presentation seemed to fly in the face of everything I'd come to understand about what was happening with the environment down here. First, he seemed to be saying that sediment was laid down primarily from the south, rather than via the garden-hose, river-centric, north-to-south way that I'd come to picture it ever since that morning at Bob Marshall's house. Second—and more disruptively—McLindon argued that the recent spate of land loss we'd seen in the state was actually *slowing*, not accelerating, and was part of a completely natural phenomena.

Land loss was not primarily caused by canals, then. Or levees. Or pollution. Or flooding. The delta, he said, was just doing what deltas had always done, pulsing in and out of the Gulf, advancing and retreating but retreating only so far as certain geological thresholds. In McLindon's view, some of the state's alarmist predictions about the disappearance of places like the Biloxi Marsh in the next fifty years were bogus, in total disregard of geologic reality. These were places that had supported human inhabitation for centuries, undergirded by solid geological structures. In places like this, there was no reason to believe that we might lose so much so quickly, he said.

This line of thinking struck me as novel in conversations about coastal restoration, and I was not the only one to think so. After McLindon's presentation, all kinds of folks in the room crowded around in clusters and talked excitedly about the "cutting-edge" nature of his work. How exciting was this science, that tempered the panic-inducing sense that all was lost, that a football-field's-worth of land was going under every forty minutes or so! Things were not so bad as they had seemed. We were not quite so much to blame as we had thought.

The whole room seemed to take a collective deep breath: the coast was all right.

Despite the seeming good news of McLindon's findings, I found myself growing increasingly disturbed as days passed after the conference. My sleep became fitful. My moods ranged erratically across a spectrum of mostly negative extremes: exhausted, relieved, distrustful, angry, sad. I scheduled a meeting with McLindon at his office a week after meeting him, only to cancel it a few hours before in the midst of what felt very much like a panic attack—heart racing, breath shallow. I had begun this investigation more than a year earlier. I'd been in airplanes and flatboats and ankle-tight boots. I'd begun with a basic enough premise, one that it seemed everyone agreed on: that the coast of our state was undergoing a massive environmental crisis as it rapidly lost land to open water. How was it, then, that I'd ended up where I was now, about to sit down with a highly educated geologist who said that our state was actually *gaining* land? That it was a part of a natural process? That things were mostly fine?

Friends of mine, who'd kept up with me during my research, gently encouraged me to take each authority's view with a grain of salt. It was the nature of experts to favor their own area of specialization, after all, sometimes to the exclusion of other considerations. Of course the

ecologists pointed to plants, the geologists pointed to the earth, the fishermen pointed to the water. It was possible, these friends suggested, that *all* of them were right, in their own way.

Sure, I admitted, that was a nice way to think about it. I hadn't come to this project for a sampler-pack of nice truths, though. I'd chosen it because I'd hoped it might help me to deal with my gigantic fears about the future. From the outset, I'd always imagined myself emerging on the other side of my research feeling more secure and informed, sobered by hard truths but with a sense of direction about what to do in the coming years. I wasn't wholly naive; I knew that many of the things I was about to learn about the future of the coast, and by extension, the future of our species on the planet—I knew these things would upset me.

But I would have never guessed that a year into researching, I'd feel so much *more* confused than when I'd begun. That the pressure of standing at the intersection of all these conflicts of opinion would take such a psychological toll on me, cause my brain to fritz out from the sheer effort of grappling with everyone's vastly different stories about what was going on here.

Unbeknownst to me, I had at last become one of those aggrieved, badly-behaved mourners that I'd described to Turner in his office that day months ago. I was opinionated and strident, found myself becoming increasingly dismissive and adversarial even in my off-time when the subject of coastal restoration came up over drinks with friends. I took a kind of sadistic pleasure in tearing down their sense of the situation, countering their understanding of the issues with data from this or that competing viewpoint, wearing them out until they admitted that, okay, they didn't really know that much about the topic, after all. Despite the air of expertise I tried to project in these moments, the truth is that my friends' sense of defeated confusion largely mirrored my own.

This kind of behavior, in truth, had begun months before I even met McLindon. I remember the familiar agitation working up inside me one day almost a half a year earlier as I sat in an environmental writing class at the University of New Orleans. Our instructors had invited a science educator named Dr. Ivan Gill to share with us some of the ideas he'd written about in a paper for the *International Journal of Science in Society*. The paper was subtitled "The Elephant in the Wetlands," and concerned the limited amount of sediment suspended in the Mississippi River. He and his co-author Dr. Harry Roberts write that

> there is insufficient sediment to stabilize the entire coastline. But, there always has been. There will be winners and losers in the land-building sweepstakes: towns and communities outside of areas receiving sediment will slowly drown as sea-level rises around them.

In the paper, Gill also shares a method he'd developed for teaching a simplified version of the environmental crisis to high-schoolers.

Gill demonstrated this method to us in class. I watched as he placed a rectangular pane of clear plexiglass into a plastic Tupperware container half-full of water. The pane of plastic, he explained, would represent the subsiding coast of Louisiana. The areas that sat well outside of the water—those would be like Baton Rouge or Hammond. Little to no subsidence there, he said.

I could feel myself bristle. I knew, from reading Bob Marshall's articles about subsidence, that it was not nearly so straightforward as this sheet of plastic made it out to be. Some places far inland—in New Orleans, even—were more heavily impounded than areas far off the coast on the chandelier islands, and thus sinking far more rapidly. I watched, dubious, as Dr. Gill spooned tablespoon-fulls of sand onto the simulated plastic "coastline" to mimic the sediment contributions of a river diversion. He added milliliters of water to represent gradual sea

level rise, attempting to demonstrate how limited the diversion would be in providing sediment to build up marshes. Folks would have to be exceedingly judicious in deciding where the diversion was placed and how heavily it was allowed to flow.

Oh brother, I thought, a catalogue of critiques piling up inside my mind. By the time we got to the discussion portion of the presentation, I was ready to pop. Before long, I was grilling Gill about nutrients. The marsh, I said, was not made of plastic, and we didn't get to spoon sand into it without also spooning in a bunch of polluted river water alongside it.

Gill, understandably, got defensive. He said something about how diversions were the only real thing we had to do, even if it wasn't the best thing, it was better than nothing.

This answer did not satisfy me. I pushed him on the assertion that it was the only thing we could do. What about backfilling the canals, I asked? Or sediment pipelines?

My classmates looked on, a little tense. Dr. Gill was on the spot, and didn't seem to like it. He doubled down on the idea that, well, we had to do *something*.

Class dismissed, but I stayed talking with Dr. Gill in the middle of the floor for fifteen or twenty minutes more. When I finally left the classroom, I was silently fuming. *How reductive, illogical, stupid.* It drove me insane to think that there were folks who could follow the logic of all the arguments for and against diversions, and still come out in favor of them just to satisfy their own need to feel like they were doing something, contributing something to the problem.

I'd barely made it out of the building, though, before my anger turned a sudden, sharp corner to despair. I was so tired of all these arguments, endlessly looping around on themselves. Diversions were good, they combatted land loss—but wait, no, because what about nutrients? But actually maybe nutrients weren't a big deal, maybe it all came down to flooding, so we should just pump a bunch of mud under New Orleans and unleash a couple of megadiversion—

but wait, what about the contribution of canals? Also, even tiny diversions damaged the state's fisheries, so what we *really* should do is build sediment delivery pipelines and also cut out the massive pollution going on upstream—and all of it, *all* of it before the Antarctic Ice Sheet melts, of course, if at all possible.

I'd begun to sob. Not knowing what else to do, I fled out into the quadrangle beyond the English Department building and plopped myself down between two maples. I'd come not for the solitude; but rather, for the company of the trees, whose presence I'd always found very soothing. When I was in grade school, I used to tell my parents that the trees looked like lungs to me, all of their branches reminding me of the bronchial tubes I'd seen in my life sciences textbook.

So I sat beneath the maple trees and breathed. Some wind rushed between their leaves. I tried to make sense of my emotional reaction to Gill's presentation. The past year, I'd spent countless hours trying to understand the scientific community's maddeningly contradictory and ambivalent recommendations for restoring our coast. Now I was just arguing with its emissaries. How had I gotten here? I rubbed my eyes with the heels of my hand.

I began, then, to wonder if there weren't other kinds of people having other kinds of conversations about how to heal the coast. For the past year, I'd consulted mostly with academic authorities on the subject. Biologists, ecologists, geologists, economists—all of the 'ists you can imagine. Their expertise came from diplomas, and a lifelong commitment to serious study, and a thorough command of very specialized knowledge. They'd published papers and given talks at conferences and jumped through the many byzantine hoops required to tag honorifics to the back of their names: MS, PhD, Emeritus. It's right that folks who've given such an enormous amount of their time and energy towards accruing knowledge ought to enjoy a sense of authority in

conversations about their area of expertise. I gravitated towards these people in my research in part because it seemed irresponsible not to, and in part because the academy is a familiar world for me, one in which I've already begun to make a home for myself as a writing teacher for college students.

And yet. There are other kinds of expertise, other ways to become an authority on a subject that don't involve going to school. Some folks are authorities because they've studied a topic extensively, but many others are experts because the topic is their life. For these people and communities, our disappearing coast is not a complex thought-experiment for which their are many very interesting possible solutions. The disappearance of their way of life here is not something that might happen in the next fifty years. For fishermen, indigenous people and immigrant shrimpers, the end of the world has already happened, is happening, was this morning, is tonight. The solutions to this problem are not thought-experiments, but wrenching decisions made under duress: your childhood home is gone, not a piece of siding left, and you need somewhere to sleep tonight with your twelve-year-old son. A south wind is blowing, the water's coming up around your cousin's house, and you're twelve miles up the bayou on the wrong side of the flood protection gate. Your grandmother was too poor and frail to evacuate before the storm, you haven't heard from her in seven days, and now you have to find her in the Superdome somewhere.

Nobody's going to give anyone a diploma for solving these problems. However, given the choice, I would take the advice of someone who's lived through apocalypse over the recommendation of an academic sociologist every single time. These folks, after all, have already been enacting a myriad of solutions to the problem of their vanishing worlds, and

perhaps have gained something even more valuable than knowledge from the experience: wisdom.

These were the people, I realized, whose conversations I *did* want to tune into. At any rate, I was exhausted with the conversations I'd become privy to. Feeling a bit calmer from the sheer proximity of the trees, I laid myself back against the earth and looked up at the sky. Maybe it was cloudy. Maybe it was clear. In either case, way up there beyond me, beyond the shifting crosshatch of the leaves, was the sun; similarly, somewhere out beyond everything else that I'd managed to learn thus far, people were sharing vastly different visions of what life for our species might look like in the next hundred years. I would find them, I decided. I even had an idea where I might look. After a few moments, I closed my eyes. I couldn't see the sun, but I could feel it, somewhere out there, warming the skin of my face.

6. Someplace Loved

The first major section of the book, which you've just finished reading, is what I've been thinking of as Part One. Part Two will concern the work of anti-pipeline climate activists in Louisiana like Monique Verdin and Cherri Foytlin. It will include interviews and perspectives from Chief Ed Chreitan and Chief Albert Naquin, leaders of the Atakapas-Ishak and Biloxi-Chitimacha-Choctaw tribes, respectively. In general, I see this section grappling with the socio-cultural consequences of climate change in Southeast Louisiana, as well as tracing arguments for and against certain kinds of environmental activism. I discuss the structure of the rest of the book in further detail in the brief Afterward on p.

For the final chapter of the finished book, I will end in the small town of Jean Lafitte, the hometown of one of my former student writers, Sean [his name's been changed]. At twenty-one years old, he is the youngest person that I interviewed for this book. Actually, the second-youngest person is me. As such, the both of us have a lot at stake when it comes to how climate change will affect the course of lives. I thought it would be pertinent to end there, then, with us, just two ordinary people having a very ordinary outing together around Sean's stomping grounds, at the center of this catastrophically extraordinary situation.

Below is an excerpt from this final section of the book:

- - -

Sean didn't really write about the environment in his papers for my class. He was one of those multi-talented artistic-types—a dancer, a writer, *and* a painter. "A storyteller," he told me. If he worried about his hometown disappearing into the Gulf of Mexico, he didn't let on in his writing. Mostly he wrote about planning to leave Lafitte to pursue an artistic career in New York City. Even still, there was a dreamy quality to his renderings of Lafitte and Barataria Island,

located just a five minute drive south of the Barataria Preserve where I'd walked with Whitbeck through the tree graveyard. His "bridge town," as he called it, radiated right off the page with an almost palpable affection. He described waking to the clanking mechanical sound of tug boats in the brown bayous just outside his window, the thrill of walking over the steel swing bridge as a kid, of watching the water swirl and eddy below the rusted grating of the footpath. He had complaints, too, of course—the inconvenience of getting stranded for hours on Barataria Island when its one bridge broke down; the insularity, small-mindedness, and casual bigotry of his tiny, mostly white and very religious community. Still, even these gripes seemed to betray his attachment to the place, captured with a kind of precision that only comes from having paid careful attention to something for a very long time. In other words: from loving it.

Weeks after I'd turned in my final grades for the semester, I kept thinking about Lafitte. Once class had resumed for the spring, and Sean had officially stopped being a student of mine, I sent him an email. Would he be willing to show me around his hometown sometime for a piece I was writing?

A couple weeks later he met me in the parking lot of the Jean Lafitte Tourist Information Center. He wore basketball shorts and a t-shirt, a ball cap on his head and a shy smile on his face. The first place he took me to was Fleming Cemetery, a graveyard tucked off the main road, its grounds scattered with bone-white above-ground tombs, their sides streaked with black mold.

Sean toed his shoe into the dirt beside one of the headstones. "He was a captain," he said. "I don't recognize the name, but there's a lot of boat captains, a lot of fishermen." Sean's own family, on his mother's side at least, had been fishermen a few generations back.

We stood looking at the grave for awhile, until Sean laughed quietly. "And that's how it is," he said. "Your whole life's Lafitte."

I turned to him. “Yeah?”

“Yeah. Like, the dash?” Sean pointed toward the dash between the dates *1931* and *2013.* “All of that time was spent here.”

Next, he took me to “the handicap,” so named for reasons that have long since departed the memory of the teenagers who frequented it. It was a short wooden wharf scattered with shrimp tails, a couple of smashed beer cans and soggy newspapers. *No swimming, no diving.* I grasped that it existed as the kind of public place you could find in almost any small town, a little corner of the commons ready-made for juvenile delinquents, its parking lot perfect for scoring drugs, staging a fight or having sex inside of a car. Sean explained all this as we leaned over the wooden railing, looking out across the water as brown pelicans few past in twos and threes, skimming over the surface of the water.

After the sun went down, Sean decided to take me to the Old Road. He said that folks like him who’d grown up in Lafitte—“Lafitians,” he playfully called them—referred to Highway 45 as the “old road.” According to him, for years there had only been this one road in and out of Lafitte. “And there’d always be traffic.”

So years ago, the state built Highway 3134. The four-lane roadway, which includes a nearly mile-long, fifty-foot-high concrete bridge that swings out over the intracoastal waterway, provides Lafitte and Barataria with far easier access to Crown Point, Marrero, and New Orleans to the north. Sean thought the new road was a good choice, practically speaking.

Still, he preferred the old road. Its two blacktop lanes wound straight through the heart of Jean Lafitte National Park, bordered closely on each side by red maple, tupelo and bald cypress trees.

“If you catch it at sunset,” said Sean, “or sunrise, with the pink as a background against all these cypress trees, and the sun creeping through all the branches?” He smiled, adjusted his ball cap self-consciously. “It’s really aesthetically pleasing.”

It was now dark, though, andthrough the thick fog of that January night, there wasn’t much to see beyond a hundred feet of road and the wetland forest towering in dim outline just above our heads. Sean curved the car around a bend, and suddenly the lights of the new road behind us were gone. No street lamps, nothing but the twin headlights of Sean’s car intruded on the pitch-blackness of the swamp.

I rolled the window down as we sped ahead at forty miles an hour. Cool air rushed in over my face and neck.

We drove in silence for awhile. I kept wanting to ask Sean how he felt about the impending climate disaster threatening his hometown, if he felt angry or stressed-out or sad about it. I kept stopping short of the question, though. Some kinds of pain just aren’t fathomable, shouldn’t be probed after.

After a long quiet spell, Sean took a deep breath. “This is my jam,” he said. “I put on sad music and I’m, like, the happiest I’ve ever been.” We both laughed. “It’s a comforting road to be on by yourself.”

Outside the window, frogs peeped off and on in chorus from unseen mud puddles. I stuck my hand out, made a fin with my palm, and rode it through the humid air. I tried to imagine Sean returning to this place in his sixties. He’d have made a name for himself by then, probably; he seemed talented and driven enough to make it as a creative in some northeastern city, a choreographer or playwright or novelist. His hair would be thinner by then, more salt than pepper, maybe gone at the top. He’d have to park his rental car off the side of Highway 3134

near Marrerro, have to squint against the buffet of air as cars rushed past him on the shoulder. What had once been the Old Road would by then have become an unofficial boat launch, a curve of asphalt dipping down into water. He'd probably have to scale some overgrown fences to get to it. But he would, because it was nearing sunset and he'd been feeling melancholy and, a few weeks ago, apropos nothing, he'd found himself staring out over his desk in Chicago or New York or Boston and thinking about the way the sun used to creep through the branches on the Old Road at twilight. So he'd slip into a pair of waist-high waders, find a way to get over whatever barriers the parish had put up after the last hurricane, and slosh out a ways. He'd scan for landmarks, but not find them. All the trees he'd grown up driving under were mostly dead by now, and the water was choked with hyacinths and alligator weed and half-decayed fallen logs. Eventually, the undergrowth grew so dense, and the bottom so littered with broken bottles and other trash tossed off from the main road, that Sean would have to stop and just stand there. Instead of staring up at the sky, though, his gaze would come to rest on the surface of the thick brown water a few feet ahead. Maybe he'd recriminate himself for being sentimental, for coming out this way. Hadn't he seen enough in the news after the last hurricane? Hadn't his own family moved off the island decades ago? For a while, he would just stand there, unmoving in the alien, waterlogged landscape.

Back in 2018, though, Sean was excited to be on the Old Road. He reached for a dial on the dash. "And if you do this—"

In one swift motion, Sean flipped off the headlights, the dash-lights, everything—and away went the road and the trees and the car and our bodies. Just vanished. In an instant, the only thing real left in the world was my fear and the speed of my heartbeat, all of it hurtling forward

into the nothing that just moments ago had been something, into the dark absence that had once been somewhere loved.

Afterword; or, Goat Rodeo

> …Each life in art
> goes forth to meet dragons that rise from their bloody scales
> in cyclic rhythm: Know and forget, know and forget.
> It's not only
> the passion for getting it right (though it's that , too)
> it's the way
> radiant epiphanies recur, recur,
> consuming, pristine, unrecognized –
> and remembrance dismays you. And then, look,
> some reflection of light, some wing of shadow
> is other, unvoiced. You can, you must
> proceed.
>
> - Denise Levertov. "For Those Whom the Gods Love Less"

As the subtitle of this thesis implies, writing the first five chapters of what I intend to develop into a full-length book has been a "journey." Although I've previously written short journalistic dispatches for online news outlets, I've never attempted to write a piece of nonfiction anywhere near this size. The depth and breadth of required research challenged my limited skillset from the first. The contradictory and jargon-heavy nature of the data I uncovered, coupled with the piecemeal, haphazard way I had to conduct my research while simultaneously holding down a waitressing job four days a week—it all coalesced into a big sprawling mass of information that made questions of structure incredibly fraught. Decisions around how much and in what ways to include myself in the narrative were also difficult to make. Finally, I worked as hard as I could to include enough character and color to make the drier bits of science palatable.

Despite these many various challenges, however, the process of writing this first part of the book has strengthened my writing immensely.

In almost all of my previous journalistic work, for example, I'd been writing for online news outlets of a politically progressive bent. This is a result of two things, mostly: our

tremendously polarized Fourth Estate, and the fact that for the first three years as a freelance reporter, my beat was occupied Palestine. It's tough to get stories about that particular conflict run in publications that *aren't* outright progressive. So over the years, I ended up learning how to write articles that did two main things: dispensed information on a problem in the world, and subtly (or not so subtly) advocated for a particular solution to that problem.

This story, however, really challenged me to unlearn many of the habits of thought I'd developed writing for these news outlets. Suddenly, it was not required that I pick a side, that I paint an activist in a flattering light, or depict the machinations of some corporate or state power as despicable. This was not something I ever thought I was doing consciously in my reporting; however, much of the trouble I had writing Chapters 2 and 3 in this book are traceable to my tendency to look for a bad guy and smear them.

Before I even walked into Dr. John Day's office, for instance, I'd already decided he was my bad guy. I mean, here was a dude polluting a threatened habitat *for profit!* Turner's science seemed so airtight. It would just be a matter of pulling some damning quotes out here and there. Luckily, as a part of my interview prep, I came across some advice for young reporters in conducting interviews around polarized topics. I have since lost the article (keeping neat and functional records of my research is also a growing edge), but I remember the gist of the advice:

1. Ask yourself first what *you* believe to be true about the subject. Be honest.
2. Then, ask yourself what would prove your hypothesis right? What would prove it wrong?
3. Ask questions that get at both possibilities.

Since I'd already figured that Day was greedy, and that his conflicts of interest on the subject of nutrient loading had rendered him unable to design a fair experimental test of it, the only thing

that would prove me wrong would be to discover, over the course of the interview, a host of other scientists *without* conflicts of interest that agreed with Day.

When the time came for the interview, I forced myself to be open to this possibility. I told him what scientists I'd already read, and asked him if he recommended anyone else's work on nutrient loading. Before I knew it, he'd dropped half a dozen unfamiliar names and filled up my USB drive with papers I'd never heard of, all concluding that nutrients were not quite so harmful as Turner had implied. He neatly and roundly answered back to the Plum Island study. What's more, he seemed like a fairly nice guy in general, and upon leaving his office, I found myself genuinely unenthused at the prospect of smearing him.

Probably my biggest mistake in conducting that interview with Day was not asking him directly about Comite Enterprises. For the first time in my life, I found myself interviewing someone that I was not intending to glorify in some way, someone who may, in fact, come across as less-than-flattering in the story I was telling. I balked at the tension in the room, which was present throughout. Day asked me very early on if I had talked to other scientists, and sensing that he was asking about Turner, I lied and said I had not. My conflict-aversion denied him the opportunity to directly answer back to Turner's critiques of his work. Turner, on the other hand, was able to wax poetic about everything wrong with Dr. Day. For this reason, I feel this current draft of the book skews unfairly in Turner's direction. In revision, I'd like to revisit Dr. Day's office and ask him more questions about his business: when it was founded, why, what he has to say about claims of conflict of interest. Since the company designs sewage projects for the public, I think it's in the public's interest to have answers to these hard questions—hard, because they are likely to put Day on the defensive, and no matter how seasoned, very few journalists love sitting a room with someone who's riled up about the question you just asked. However, my

hope is that, next time, I'll be skilled enough and fair enough and brave enough to just ask them anyway.

More than anything else I learned in the process of writing this manuscript, however, I felt *most* grateful to have learned the phrase "goat rodeo.". According to an online urban dictionary, it means "a chaotic situation, often one that involves several people, each with a different agenda/vision/perception of what's going on; a situation that is very difficult, despite energy and efforts, to instill any sense or order into."

Just take a second to let that perfection of that sink in.

It became clear to me, early on, that no ordinary structure was going to be able to pen in all these, er, goats. I consulted John McPhee on the matter. In his piece on structuring nonfiction pieces for *The New Yorker*, he describes working on a similar project, one that was in some senses a "journey" like mine, but

> not exactly a journey in the Amundsen sense. There was no vestige of a beginning, no prospect of an end. If ever there was a journey piece in which a chronological structure was pointless, this was it. In fact, a chronological structure would be misleading. Things happened, that's all—anywhere and everywhere. And they happened in themes, each of which could have its own title at the head of a section, chronology ignored.

Taking McPhee's cue, I decided to organize the story around themes. More precisely: I organized it around the different, competing "agendas/visions/perceptions" of the issue of land loss. The more I looked at what I'd learned, the more it became clear to me that the central question at the heart of it all was: *what is an ordinary person supposed to do about the environmental crisis when the relevant authorities can't even agree on its causes, and there's a problem with every proposed solution?*

My structural decisions all followed from this central question. I myself would play the role of the "ordinary person," stepping in from time to time with all my human feelings and impressions. I would begin the book with the most widely-known explanation of the environmental crisis and it's causes, and from there, spiral inward in a daisy-chain of counter-arguments and counter-explanations. Once the scientific explanations ran themselves out, I'd toggle in to track the explanations and solutions proffered by climate activists and the like. I tried to be mindful, throughout, about keeping readers appraised of the time and place of scenes I described; however, I didn't let chronology dictate where and how I incorporated something in the flow of the story.

Finally, I made a visual outline of all of this for myself. I wrote with it tacked up next to the computer at all times, my only working map of the goat rodeo:

Notes

The End of Ourselves

2 *the Basin itself is among the youngest places on earth* For more on the formation of the Louisiana coast, see p.19 of "The Impacts of the Mississippi River and its Delta on the Oceanography, Ecology and Economy of the Gulf of Mexico Large Marine Ecosystem," by Alex S. Kolker et. al., 2018, prepared for RESTORE at *mississippiriverdelta.org*. The publication is promotional in nature but the graphic above, taken from p.19, is derived from research by Dr. John Day (more on him in Chapter 3), which *itself* is derived from the work of Kolb and Van Lopik, 1958, a widely-accepted seminal source on the topic of the delta's formation.

5 *something Marc Reisner had written in his book,* Cadillac Desert, New York, Penguin, 1993. p. 4.

6 *Since the 1920s, Louisiana has lost more than 1,800 square miles of wetlands* All statistics in this paragraph taken from: Marshall, Bob et al. "Losing Ground." *Pro Publica*, The Lens, 18 Aug. 2014, www.projects.propublica.org/louisiana/.

8 *Sale-Cypremont, Teche, St. Bernard, LaFourche, and Plaquemines* Day, J. W., D. F. Boesch, et al. 2007. "Restoration of the Mississippi Delta: Lessons from Hurricanes Katrina and Rita." *Science* 315 (5819): 1679–84.

8 *the great Mississippi Flood of 1927* For more on the flood, see John Barry's exceedingly thorough account of it in his book, *Rising Tide: The Great Mississippi Flood and How it Changed America,* New York, Simon & Schuster, 1997.

10 *"According to [the National Climate Assessment], the Gulf and East Coast are looking at anywhere from two-and-a-half to three-point-two feet eustatic warming sea level rise by the end of the century."* Predictions regarding sea-level rise are continue to change. However, the NCA released an updated report in 2018, predicting anywhere from one- to 4.3-feet of sea level rise by 2100. If the Antarctic Ice Sheet melts, however, authors of the study note that this number could be as high as eight feet. See more at https://nca2018.globalchange.gov/ .

10 *by and large, unchecked emissions from burning fossil fuels were to blame* For more on other causes of climate change, I recommend the "highlights" section of the very user-friendly 2014 NCA report, available online at https://nca2014.globalchange.gov/highlights

13 *sinking thick, 125-foot piles into the soft marshy earth to stabilize the foundation.* All dimensions for proposed diversion taken from a document prepared for CPRA by engineering firm, HDR Engineering, titled *Mid Barataria Sediment Diversion, Alternative 1, Base Design Report, 30% of Base Design*, July 2014, available online at coastal.la.gov/wp.../2016/07/MBSD_Alt_1_Base_Design_Report_30_July_2014.pdf

14 *150 tons of mud* There are lots of different numbers thrown about re: how much sediment the diversion will move. On CPRA's website, the claim is that diversions will move "between 2-3 million cubic yards of sediment a year," a number that I confess I can't really wrap my head around. The 150-tons-in-fifty-years claim comes from a document prepared by the National Fish and Wildlife Foundation for CPRA, as notice of a $102.3 million grant awarded to them through the NFWF's Gulf Environmental Benefit Fund Program in November, 2016.

15 *We even have a couple of smaller-sized river diversions* Most notably, the Caernarvon Diversion and the Davis Pond Diversion. More on these, specifically Caernarvon, in Chapter 2.

20 *I heard a buzz* Some threatened snakes make noises very similar to growling; some rub their scales together to make a rasping sound; still others make percussive warning sounds by forcefully pushing air out of vents towards their tails. That said, it is possible that the sound I heard came from an insect nearby, or something else entirely. For more on cool snake sounds, check out this Mental Floss article: http://mentalfloss.com/article/68816/6-sssecrets-snake-sound-scientissst

A Higher Truth

22 *The Caernarvon Diversion project had been completed in 1991* Masson, Todd. "Caernarvon Diversion moving fish and killing marsh, anglers say." *Nola.com*, March 2013, https://www.nola.com/outdoors/2013/03/caernarvon_diversion_moving_fi.html.

22 *anywhere from 5 to 35 parts salt per every thousand parts freshwater.* Hagedorn, David. "The Saltiness of Oysters." *The Washington Post*, 25 Oct. 2011, https://www.washingtonpost.com/lifestyle/food/the-saltiness-of-oysters/2011/10/21/gIQAhFN3FM_story.html?noredirect=on&utm_term=.44717eb43092.

22 *By the nineties, saltwater had intruded* Shaffer, Gary P., et al. "The MRGO Navigation Project: A Massive Human-Induced Environmental, Economic, and Storm Disaster." *Journal of Coastal Research*, 2009, pp. 212–213. JSTOR, www.jstor.org/stable/25737481.

22 *averaged about 1,250 cubic feet per second* Louisiana Department of Natural Resources, "Caernarvon Freshwater Diversion Project 2002 Annual Report. Prepared September 2003, p. 2, https://lacoast.gov/reports/project/3890870~1.pdf

22 *The Mississippi can move more than 800 times as much per second* Around one million cubic feet per second at the Baton Rouge gauging station as of February 2019. For more on Mississippi River flow rates, visit the interactive website below, produced by the United States Geological Survey (USGS), from which I took the number above: https://waterdata.usgs.gov/usa/nwis/uv?site_no=07374000

23 *Alligators flocked to the area…waterfowl…black bass* Louisiana Department of Natural Resources, "Caernarvon Freshwater Diversion Project 2002 Annual Report. Prepared September 2003, p. 4-8, https://lacoast.gov/reports/project/3890870~1.pdf

23 *Suddenly, acres of marshland existed* This fact—at least, the nuances around it—is hotly contested by Dr. Turner, which the remainder of this chapter will deal with. The existence of newly created marshland to which I refer, however, comes from the LDNR report cited above, p. 8.

23 *the Caernarvon Diversion project quickly became the poster child* Prime example of this online at RESTORE's blog: Henkel, Theryn. "What can the Caernarvon Diversion and Bohemia Spillway teach us about coastal restoration?" *Restore the Mississippi River Delta*, Delta Dispatches, 23 Dec. 2014, http://mississippiriverdelta.org/what-can-the-caernarvon-diversion-and-bohemia-spillway-teach-us-about-coastal-restoration/

23 *Turner conducted a study with two other scientists* Kearney, Michael S, et al. "Freshwater River Diversions for Marsh Restoration in Louisiana: Twenty-Six Years of Changing Vegetative Cover and Marsh Area." *AGU Journal*, Aug. 2011, agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2011GL047847.

24 *"This phenomenon…vegetation vigor."* See above, pp. 2-4.

24 *plant life in the Caernarvon study area dropped more than 30%* See above, p. 5.

25 *"Ultimately, the scientific basis for river diversions needs to be more convincing…"* See above, pp. 5-6.

26 *a microbial process that goes on around them called "denitrification."* The highly simplified breakdown of the denitrification process on pp. 25-26 is taken from an explanation given to me in person by ecologist Dr. John Day in an interview in December, 2018. More on Day's work in Chapter 3.

27 *a study conducted on nutrient loading in a wetlands habitat* Deegan, Linda A, et al. "Coastal Eutrophication as a Driver of Salt Marsh Loss." *Nature:* International Journal of Science, 18 Oct. 2012, pp. 388–392, www.nature.com/articles/nature11533?page=4.

29 *By 1500, peat mining had decimated the low-lying landscape* Patel, Raj and Jason W. Moore. *A History of the World in Seven Cheap Things: A Guide to Capitalism, Nature, and the Future of the Planet.* U of California P, Oakland, 2017, pp. 167-68.

31 *in the 1930s, no laws existed to protect wetlands:* "There were no laws protecting wetlands…Free to choose the cheapest, most direct way to reach drilling sites, oil companies dredged canals off natural waterways to transport rigs and work crews." From Marshall, Bob et al. "Losing Ground." *Pro Publica*, The Lens, 18 Aug. 2014, www.projects.propublica.org/louisiana/.

31 *"More than 50,000 wells were eventually permitted in the state," writes Bob Marshall* in the same article cited above.

32 *a study Turner conducted in 1997 with colleague Aaron Bass* : Bass, Aaron and R. Eugene Turner. "Relationships between Salt Marsh Loss and Dredged Canals in Three Louisiana Estuaries." *Journal of Coastal Research,* 13.3, Summer 1997, pp. 895-903.

32 *In plotted line graphs of this trend, the correlation is striking* My favorite such graph is included in the text, taken from p. 1332 of the following: Turner, R. Eugene. "Discussion of: Olea, R.A. and Coleman, J.L., Jr., 2014. A Synoptic Examination of Causes of Land Loss in Southern Louisiana as Related to the Exploitation of Subsurface Geological Resources. *Journal of Coastal Research,* 30.6, Nov. 2014.

33 *In a study with Dr. Joseph Baustian :* Baustian, Joseph J. and R. Eugene Turner. "Restoration Success of Backfilling Canals in Coastal Louisiana Marshes." *Restoration Ecology*, 14.4, 2006, pp. 636-644.

34 *35,163 canals on file with the state, more than 27,000 of them are classified as "abandoned." The cost…would come out to around $335 million* Data taken from presentation Turner gave at Louisiana Seafood Industry Convention, Saturday, Jan. 19, 2019.

37 *our state was responsible for more than 25% of the nation's refining capacity* Rich, Nathaniel. "The Most Ambitious Environmental Lawsuit Ever." *The New York Times Magazine*, 14 Oct. 2014, www.nytimes.com/interactive/2014/10/02/magazine/mag-oil-lawsuit.html.

37 *linked to the development of child leukemia* Doyle, Kathryn. "Benzene in traffic emissions tied to childhood leukemia." *Reuters,* 6 Oct. 2016, https://www.reuters.com/article/us-health-airpollution-kids-leukemia/benzene-in-traffic-emissions-tied-to-childhood-leukemia-idUSKCN0S02Q520151006.

37 *meager compensation for their small homes* Hasselle, Della. "Shell plant at Norco stirred controversy decades before Clean Air Act allegations." 19 Feb. 2018. https://www.theadvocate.com/new_orleans/news/environment/article_56d74596-15c4-11e8-9df3-4b1ef551c1aa.html.

Four-Mile Marsh

41 *the giant map of land loss* Most likely it was a blown-up version of this map, taken from: Couvillion, B.R., et al. "Land area change in coastal Louisiana 1932 to 2016: U.S. Geological Survey Scientific Investigations Map 3381," doi.org/10.3133/sim3381.

42 *the publication in my lap* Shaffer, Gary P. et al. "System response, nutria herbivory, and vegetation recovery of a wetland receiving secondarily-treated effluent in coastal Louisiana." *Ecological Engineering,* vol. 79, June 2015, pp. 120-131, doi.org/10.1016/j.ecoleng.2015.04.001.

43 *a 2015 study conducted by Gregg Snedden, Kari Cretini, and Brett Patton* Snedden, Gregg A. et al. "Inundation and salinity impacts to above- and belowground productivity in Spartina patens and Spartina alterniflora in the Mississippi River deltaic plain: Implications for using river diversions as restoration tools." *Ecological Engineering,* vol. 81, pp. 133-139, 2015. doi.org/10.1016/j.ecoleng.2015.04.035 .

46 *in a review paper Day published on the topic* Day, John W. et al. "Can denitrification explain coastal wetland loss: A review of case studies in the Mississippi Delta and New England." *Estuarine, Coastal and Shelf Science,* vol. 213, pp. 2018, doi.org/10.1016/j.ecss.2018.08.029 .

47 *a handful stories in the local news these days about nutrients* For example: Kailath, Ryan. "Can Sewage Save Wetlands? One Louisiana City Decided To Find Out." *WNNO 89.9: New Orleans Public Radio Online,* 4 Mar. 2016, www.wwno.org/post/can-sewage-save-wetlands-one-louisiana-city-decided-find-out .

48 *LDEQ claims on its website* "Wetland Assimilation." *Louisiana Department of Environmental Quality,* deq.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=wetland-assimilation.

48 *As of 2019, there were twenty different wetlands in Louisiana with assimilation projects in operation* Straudinger, Chris. "Assimilation Wetlands: Scientists are fertilizing wetlands with treated sewage." *Country Road Magazine,* 24 May 2016, www.countryroadsmagazine.com/outdoors/knowing-nature/assimilation-wetlands/.

48 *The nutrient load…was about ten times higher in Hammond's wastewater than it is currently in the Mississippi River.* Or, to be more precise, 15.7 g of nitrogen per square meter per year, according to p. 127 of the Shaffer 2019 study cited above. The comparison metric is based on current Mississippi River nutrient loads, which both Day and Turner put at around 1.5 g N per square meter per year in the interviews they gave me.

48 *300 acres of this densely vegetated marsh turned to open water* Pagones, Sara. "Projects aimed at marsh restoration draw concern from Lake Pontchartrain Basin Foundation." *The Advocate,* 13 Oct. 2017, www.theadvocate.com/new_orleans/news/environment/article_389fc81a-b060-11e7-bc2f-3f05e643aafb.html.

49 *Introduced to Louisiana in the late 19th century to bolster the muskrat fur trade* Gibbens, Sarah. "Rodents of Unusual Size Invading U.S. Wetlands." *National Geographic,* 16 Feb. 2018, news.nationalgeographic.com/2018/02/nutria-spreading-california-wetlands-louisiana-swamps-spd/.

50 *nutria seem to prefer to snack on plants grown in nutrient-rich environments.* Ialeggio, James S. and John A. Nyman. "Nutria Grazing Preference as a Function of Fertilization." *Wetlands,* vol. 34, pp. 1039–1045, 2014, doi.org/10.1007/s13157-014-0557-7 .

51 *he suggests that nutrient-driven decomposition in plants may be delayed where there is a storage organ* Bodker, James E. et al. "Nutrient-enhanced decomposition of plant biomass in a freshwater wetland." *Aquatic Botany*, vol. 127, p. 50, 2015, doi.org/10.1016/j.aquabot.2015.08.001 .

52 *Turner, of course, conducted a study of his own at Four-Mile Marsh* See citation immediately above.

53 *more than half of the scientific reference papers used to justify the regulations had Day's name in their byline* Louisiana Department of Environmental Quality. *Permitting Guidance Document for Implementing Louisiana Surface Water Quality Standards.* Vol. 3, pp.26-27, 26 Oct. 2010. deq.louisiana.gov/assets/docs/Water/IMPV35_final_110210version8.pdf .

55 *an image from a soon-to-be published paper* Dr. Day gave me a copy of this image, citation forthcoming with publication.

56 *One method would be to have New Orleans participate in a kind of large-scale restoration Ponzi scheme* This method, called "The Marais Design Strategy," is outlined in detail on pp. 171-200 in *Mississippi Delta Restoration: Pathways to a Sustainable Future,* edited by Day and Jori Erdman, *Springer Press,* 2018.

57 *we published a paper on this* Indeed they did: Day, John et al. "Large Infrequently Operated River Diversions for Mississippi Delta Restoration." *Mississippi Delta Restoration: Pathways to a Sustainable Future. Springer Press,* pp. 113-133, 2018.

61 *birthrates hit an all-time low in 2017.* Coughlin, Joseph. "Millennials Aren't Having Kids. Here's Why That's A Problem For Baby Boomer Real Estate & Retirement." *Forbes,* 11 June 2018. www.forbes.com/sites/josephcoughlin/2018/06/11/millennials-arent-having-kids-heres-why-thats-a-problem-for-baby-boomer-real-estate-retirement/#564367b12058.

The Gulf Between

66 *one of the nearly 15,000 Louisiana residents* Louisiana Department of Wildlife and Fisheries. *The Economic Benefits of Fisheries, Wildlife and Boating Resources in the State of Louisiana.* p. 14, 10 May 2008, www.wlf.louisiana.gov/pdfs/education/Southwick_2006_final_final_report_5-27-08.pdf.

66 *$2.4 billion fishing industry* "Industry Information." *Louisiana Fisheries Forward,* https://www.lafisheriesforward.org/fisheries/industry-information/ .

67 *the state chose to open the diversion to its full capacity* Schliefstein, Mark and Sheila Grissett. "State, Corps consider opening Bonnet Carre Spillway to keep Gulf oil spill at bay." *Nola.com,* May 2010, www.nola.com/news/gulf-oil-spill/2010/05/state_corps_consider_opening_b.html.

67 *the poor speckled trout season in 2011* : Taken from presentation Ricks gave at Louisiana Seafood Industry Convention, Saturday, Jan. 19, 2019. Will follow-up for more information/fact-checking.

68 *St. Bernard has one of the lowest median income levels in the state* : "Median Household Income." *Greater New Orleans Inc,* http://gnoinc.org/explore-the-region/demographics/income/.

73 *Upwards of 1.2 million metric tons of [nitrogen has] emptied out of the river and into the sea every year since 1997* : United States Environmental Protection Agency. *Mississippi River/Gulf of Mexico Watershed Nutrient Task Force Report to Congress.* p.20, 2017. https://www.epa.gov/ms-htf/hypoxia-task-force-reports-congress.

73 *some species are more susceptible than others to the low-oxygen conditions* Claims made in this paragraph taken from: Mutsert, Kim de et al. "Exploring effects of hypoxia on fish and fisheries in the northern Gulf of Mexico using a dynamic spatially explicit ecosystem model." *Ecological Modeling,* vol. 331, 2016, doi.org/10.1016/j.ecolmodel.2015.10.013.

74 *"there is a need for more than 100 times the sediment than is presently provided by the Mississippi River"* : Gill, Ivan and Harry Roberts. "Sediments, Subsidence, and Sea-Level Rise: The Elephant in the Wetlands." *The International Journal of Science in Society,* vol. 7, is. 3, 2015.

74 *"there is not enough supply to keep pace with subsidence and accelerated sea-level rise"* Blum, Michael D. and Harry Roberts. "The Mississippi Delta Region: Past, Present, and Future." *Annual Review of Earth and Planetary Sciences,* 8 Mar. 2012, doi.org/10.1146/annurev-earth-042711-105248 .

75 *Economist Rex Caffey, for example, ran just such an analysis* : Caffey, Rex H. et al. "Trajectory economics: Assessing the flow of ecosystem services from coastal restoration." *Ecological Economics,* vol. 100, pp. 74-84, 2014. doi.org/10.1016/j.ecolecon.2014.01.011 .

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