A Place With No Edge

Organizing Nature in the Mississippi River Delta, 1700-2012

By

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Abstract

The Mississippi River Delta emerged out of the Gulf of Mexico over the last 8,000 years as the river mouth meandered along an ancient inland coast, depositing sediments that eventually accumulated into more or less solid terrain. This place—spanning much of southern Louisiana—embodies some of the youngest, most dynamic, and persistently soggy land in North America, a place where the boundaries between land and water have often been porous and uncertain.

Euro-Americans arrived in this vast watery environment in the early 1700s, and soon after began a centuries-long struggle to bring order to the sodden landscape. Those efforts almost always backfired. Using levees, canals, roads, property lines, and much, much more, people struggled to impose physical and conceptual boundaries on the landscape. But although these boundaries were intended to clarify and stabilize the distinctions between land and water, they routinely proved unstable and provisional: levees crevassed, canals clogged, roads sank, property lines faded from view. Perhaps most tragically, attempts to carve stable territory from the delta often resulted in even more pronounced instability. For example: since the 1930s, almost 2,000 square miles of Louisiana wetlands have eroded into the Gulf. Those wetlands disappeared largely thanks to canals originally intended to fix the arrangement of water and land along the coast.

But while coastal land loss is an increasingly visible problem afflicting the Mississippi River Delta, it is not the only important story that has emerged from three centuries of Euro-American boundary-making in the region. Beginning with European arrival and continuing through the years following Hurricane Katrina, this dissertation follows the work of sugar and rice planters, cypress lumbermen, petroleum producers, petrochemical manufacturers, and coastal restoration professionals to show that people's efforts to organize nature in the delta were almost always far more provisional and precarious than they imagined. Bounding nature in the Mississippi River Delta left people mired in unintended consequences.

Acknowledgements

It takes a village. . . . Like all dissertations, this one wouldn't have been possible without the ideas, hard work, and friendship of more people than I can possibly name. But here goes:

My adviser and mentor Bill Cronon taught me more than and I could have ever imagined. Thank you, Bill, you're a mensch.

My dissertation committee—Craig Colten, Nancy Langston, Erika Marin-Spiotta, Paul Robbins, and Matthew Turner—offered fantastic advice and support along the way, but nowhere more so than in my defense. Thanks to all of you for making that such a great conversation. Several of my colleagues read (or listened to) parts of this manuscript—often many times over—as it evolved from the seeds of conference talks to penultimate drafts: Jake Fleming, Mark Cooper, Anna Zeide, Richard Donohue, Chris Limburg, the rotating cast of Bill's breakfast discussion group, and members of both the Human-Environment Research Discussion group (HERD) and UW-Madison's Center for Culture, History, and Environment.

My research for chapter one was limping along on intuition alone until Rich Campanella confirmed that I was on the right track. Without his encouragement, I might not have persevered to finally find all that material on rice flumes. Chapter three owes an enormous debt to Jason Theriot and both his pioneering research and generous comments. Much of chapter five, meanwhile, depended on invaluable conversations with Bob Marshall, Bren Haase, Karim Belhadjali, David Waggonner, Derek Hoeferlin, Jeff Carney, and Scott Eustis. A fantastic week of hanging out with Rob Holmes, Brett Milligan, and Tim Maly of the Dredge Research Collaborative also influenced my thinking for parts of this project.

Keli Rylance invited me to housesit in New Orleans on more than one occasion, and also passed along articles and contacts of interest. Special thanks goes to Richard Misrach for allowing me to reprint one of his stunning photographs (see p. 261—unfortunately, the size of this reproduction doesn't do it justice).

Finally, I can't express enough gratitude for the archives (and archivists!) that carefully preserved, tended to, and organized the documents at the heart of this project:

- Louisiana State University's Louisiana & Lower Mississippi Valley Collection
- Tulane University's Louisiana Research Collection
- Southeastern Louisiana University's Center for Southeast Louisiana Studies
- The Louisiana State Museum
- The Historic New Orleans Collection
- The Morgan City Archives
- University of Houston's Houston Oral History Project
- The Texaco Archives, housed at Chevron's Corporate Archive in Concord, California
- The Forest History Society's photographic collections

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All errors in this work are my own. Its insights and contributions belong to many.

— Adam Mandelman, June 2016, Madison, WI

Introduction: A Place With No Edge

To enter water is, of course, to cross a border. You pass the lake's edge, the sea's shore, the river's brink—and in so doing you arrive at a different realm, in which you are differently minded because differently bodied.
—Robert Macfarlane, *Landmarks* (London: Hamish Hamilton, 2015)

In the first decades of the twenty-first century, two deluges struck the United States. Hurricane Katrina in 2005 and "Superstorm" Sandy almost a decade later together unleashed floods of an intensity that the nation had not seen for almost a century. Though these years were fraught with public debate around the realities of climate change, both storms suggested for many that a warming planet had at last begun to blur the boundaries of the nation's coastlines.[1] Indeed, Sandy's 2012 devastation across the northeastern United States spurred renewed concern over a "new normal" in which ever more powerful storms and rising seas would invade the nation's shores. In Sandy's aftermath, a spate of watery visualizations gripped the US imagination. Interactive maps from the *New York Times* and *National Geographic* depicted drowning coastal cities and the unrecognizable outlines of continents subdued by melting ice caps.[2] The Twitter hashtag #DrownYourTown offered users on-demand visualizations of fantastical rises in sea level.[3] Other artists and designers produced maps, views, and portraits of

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[1] After Katrina, scientists communicating with the public were careful to distinguish between weather and climate and urged caution in attributing any individual storm to a warming planet. The image of a hurricane emerging ominously from a smokestack nonetheless promoted Al Gore's 2006 documentary, *An Inconvenient Truth*, directed by Davis Guggenheim (2006; Hollywood, CA: Paramount Studios). Arguably, Gore's film provoked a massive public relations and disinformation campaign from industry and other climate skeptics; see: Frontline, *Climate of Doubt*, PBS, 2012.

[2] Baden Copeland, Josh Keller, and Bill Marsh, "What Could Disappear," *New York Times*, November 24, 2012, accessed January 26, 2015, http://www.nytimes.com/interactive/2012/11/24/opinion/sunday/what-could-disappear.html; Jason Treat et al., "If All The Ice Melted," *National Geographic*, September, 2013, accessed January 26, 2015, http://ngm.nationalgeographic.com/2013/09/rising-seas/if-ice-melted-map.

[3] Andrew David Thaler, "#DrownYourTown: Exploring Sea Level Rise Through Real-Time, Interactive, GIS Modeling," *Southern Fried Science*, October 16, 2013, accessed January 16, 2015, http://www.southernfriedscience.com/?p=15665.

the nation overcome by doomsday tides.[4] J.G. Ballard's classic 1962 climate-fiction novel *The Drowned World* no longer seemed quite such a stretch of the imagination.[5]

But while Sandy captured the spotlight as a harbinger of future inundation, Hurricane Katrina's storm surge was the symptom of a far more immediate crisis. Perhaps nowhere else in the United States is apocalyptic flood more a present-day reality than in the Mississippi River Delta (Figure 0-1). Spread across southern Louisiana, the Mississippi River Delta is a region where the boundaries between land and water are already a good deal more porous and uncertain than in most places.[6] Here, warm, rising seas and invigorated Atlantic hurricanes encounter a predominantly wetland environment that is both subsiding and eroding into the Gulf of Mexico. Since the 1930s, almost 2,000 square miles of the Louisiana coast have sunk and crumbled into open water, leaving New Orleans and other regional communities increasingly vulnerable to catastrophic inundation. This subsidence and erosion also poses enormous threats to fisheries, energy infrastructure, and shipping concerns on which the entire nation depends.[7] In 2012, director of the USGS National Wetlands Research Center Phil Turnipseed called Louisiana's coastal land loss "the greatest environmental, economic and cultural tragedy on the North

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[4] Florida Center for Environmental Studies at Florida Atlantic University, "Sea Level Rise in Our Lifetime," accessed January 26, 2015, http://www.ces.fau.edu/SLR2013/gallery.php; Nickolay Lamm, "Sea Level Rise in Real Life," April 4, 2013, accessed January 26, 2015, http://nickolaylamm.com/art-for-clients/sea-level-rise-in-real-life/; Jeffrey Linn, "Sea Level Rise Maps," accessed January 26, 2015, http://spatialities.com/category/sea-level-rise-maps/.

[5] J. G. Ballard, *The Drowned World* (New York: Doubleday, 1962). Note that Ballard's *The Drowned World* is about solar radiation warming the planet, not carbon dioxide.

[6] For the purposes of this project, I am defining the Mississippi River Delta to include not just the active "bird's foot" delta at the southeastern tip of Louisiana, but the entire 3-million acre deltaic plain that stretches from Vermillion Bay in the west, to the Chandeleur Islands in the east, and to the north beyond Baton Rouge.

[7] State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Baton Rouge, LA: Coastal Protection and Restoration Authority of Louisiana, 2012).

American continent." If nothing is done to arrest that tragedy, an additional 1,750 square miles of coast could convert to open water by the middle of the twenty-first century.[8]

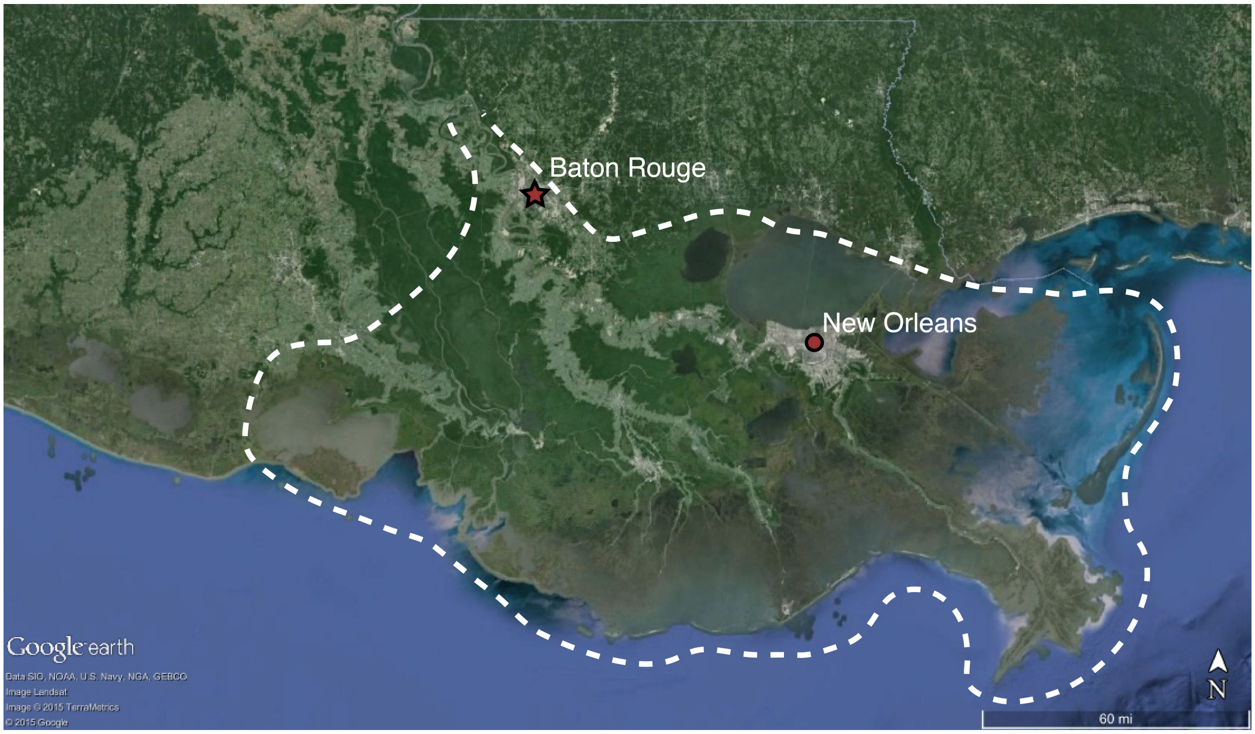

Figure 0-1: A rough outline of the Mississippi River Delta. Satellite image from Google Earth, 2015. Map by author.

Prevailing explanations of Louisiana's coastal crisis suggest that land loss is the unintended consequence of technological ingenuity. Since arriving in the region at the beginning of the eighteenth century, Europeans and their descendants engaged in an increasingly pervasive effort to improve the delta's flood-prone and persistently sodden environment, rendering it one of the most extensively engineered landscapes in the nation. A sprawling network of levees, canals, and reclaimed land ensured that no part of southern Louisiana went untouched by human

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[8] Turnipseed quoted in Gabrielle Bodin and Jennifer LaVista, "USGS Flyover Shows Storm Damage and Marsh Dieback," USGS News, September 11, 2012, accessed January 26, 2015, http://www.usgs.gov/newsroom/article_pf.asp?ID=3398. Projections for future land loss come from: State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan*.

artifice. All of this plumbing, however, eventually undermined the integrity of the delta, leaving the region vulnerable to subsidence and erosion.[9]

Louisiana is also not alone in this watery crisis. Countless places around the globe similarly occupy the muddy ground of estuaries and deltas and have likewise witnessed development that increased the risk of inundation, particularly in our present era of rising oceans.[10] From the Mekong and Niger Deltas to much of the Netherlands, from almost the whole of Bangladesh to the Narragansett, Mumbai, and Thames Estuaries, hundreds of millions of people inhabit deltaic and estuarine environments in which past human efforts to reclaim land from water—or vice versa—are no longer as stable as they once seemed.[11] Two dozen major river deltas in the world—to say nothing of estuarine communities like London and Venice—are sinking into their respective oceans, putting not only their populations at risk, but also threatening profound cultural, economic, and environmental consequences.[12]

But it would be a mistake to understand Louisiana's coastal land loss and these other crises around the world as solely—or even mostly—the failures of misguided engineering. After

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[9] Mike Tidwell, *Bayou Farewell: The Rich Life and Tragic Death of Louisiana's Cajun Coast* (New York: Pantheon Books, 2003); Richard Campanella, *Bienville's Dilemma: A Historical Geography of New Orleans* (Lafayette, LA: University of Louisiana at Lafayette, 2008); Jason P. Theriot, *American Energy, Imperiled Coast: Oil and Gas Development in Louisiana's Wetlands* (Baton Rouge: LSU Press, 2014). Bob Marshall, Brian Jacobs, and Al Shaw, "Losing Ground," *ProPublica*, accessed January 29, 2015, http://projects.propublica.org/louisiana/.

[10] For discussion of 33 eroding and subsiding river deltas, see: James Syvitski et al., "Sinking Deltas due to Human Activities," *Nature Geoscience* vol. 2, no. 10 (2009): 681-686.

[11] For histories and explorations of other deltaic and estuarine environments, see: David Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta* (Seattle: University of Washington Press, 2010); Matthew Booker, *Down By the Bay: San Francisco's History Between The Tides* (Berkeley: University of California Press, 2013); Salvatore Ciriacono, *Building on Water: Venice, Holland, and the Construction of the European Landscape in Early Modern Times* (New York: Berghahn Books, 2006); Craig Colten, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge: Louisiana State University Press, 2006); Matthew Gandy, "Fears, Fantasies, and Floods: The Inundation of London," in *The Fabric of Space: Water, Modernity, and the Urban Imagination* (Cambridge, MA: MIT Press, 2014); Anuradha Mathur and Dilip da Cunha, *Soak: Mumbai in an Estuary* (New Delhi: Rupa & Co., 2009); Christopher Pastore, *Between Land and Sea: The Atlantic Coast and the Transformation of New England* (Cambridge, MA: Harvard University Press, 2014).

[12] On the populations at risk in deltaic environments, see: James Syvitski, "Deltas at Risk," *Sustainability Science* vol. 3 (2008): 23-32.

all, subsidence, erosion, and flood all threaten these places despite some very different histories of reclamation. Poldering—or enclosing agricultural land from the sea with dikes—developed in the Netherlands over a very different period and under very different circumstances from the rectilinear dredging that created farmland in French Indochina.[13] The colonial settlement of Narragansett Bay's muddy estuarine margins unfolded in ways that would look quite unfamiliar to eighteenth-century Louisianans attempting to tame the Mississippi River.[14] And yet despite the very different technologies and strategies employed to reorganize nature in the world's deltas and estuaries, these muddy environments have witnessed some very similar consequences. Whether high water today threatens Ho Chi Minh City, Dhaka, London, or any number of other deltaic and estuarine cities, these sites have more in common than a disparate collection of failing strategies to reclaim land from water, or water from land.[15]

Something in addition to misguided engineering has been at work in the Mississippi River Delta. Understanding land loss in southern Louisiana (and other crises like it), is not just a matter of understanding ill-conceived coastal development or the unintended consequences of the technologies and practices that have allowed communities to—for at least a few centuries—thrive in watery environments. Rather, I propose that these failed efforts at the control of nature are also in part unified by a much deeper underlying phenomenon: the interplay of rigid, often taken-for-granted human categories on the one hand, and watery nature that is inherently

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[13] Ciriacono, *Building on Water*; Erik van der Vleuten and Cornelis Disco, "Water Wizards: Reshaping Wet Nature and Society," *History and Technology* vol. 20, no. 3 (2004): 291-309; Biggs, *Quagmire*.

[14] Pastore, *Between Land and Sea*. On the efforts of eighteenth-century Louisianans to tame the delta, see: chapter 1.

[15] These other sinking landscapes never reappear at the center of this project, but they still permeate its margins. The diverse geographies and histories of other deltas and estuaries at risk have helped suggest to me that perhaps there is more to their stories besides the unforeseen consequences of technological and engineering.

dynamic, in-between, and resistant to categorization on the other.[16] Ultimately I argue that without understanding the values and concepts that have animated people's technological and engineering interventions in watery landscapes, we cannot fully understand the consequences of those interventions. But before I elaborate these claims, we must take a brief tour of both the Mississippi River Delta and the places that watery landscapes have occupied in the human imagination.

Amphibious Terrain

Geologically speaking, the vast majority of southern Louisiana is not at all well suited to permanent settlement, agriculture, or industry. The region emerged out of the Gulf of Mexico beginning about seven or eight thousand years ago thanks to sediments collected from across more than a million square miles of North America, including thirty-one US states and two Canadian provinces. As sediments accumulated and extended Louisiana's ancient Gulf shoreline, the mouth of the Mississippi would meander across the landscape in search of the steepest, quickest route to the sea. In this way, the river created at least six major delta lobes that, depositing layers of porous sands and imporous clays, built up most of southern Louisiana's landscape (Figure 0-2).[17] Fundamentally dependent on flood to take form, deltas are

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[16] On the control of nature more generally and the unintended consequences that often result see: Nancy Langston, *Forest Dreams, Forest Nightmares: The Paradox of Old Growth in the Inland West* (Seattle: University of Washington Press, 1995); John McPhee, *The Control of Nature* (New York: Farrar, Strauss & Giroux, 1989). McPhee's classic essay "Atchafalaya" is especially pertinent here. James Scott discusses the ways large-scale projects to organize nature have been deeply misguided features of modern states: *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

[17] Chapter four examines some of the unimagined complications these sands and clays have posed for hazardous waste disposal in the deltaic landscape. For more on the formation of the delta, including each of the Mississippi's six deltaic lobes see: Harry H. Roberts, "Dynamic Changes of the Holocene Mississippi River Delta Plain: The Delta Cycle," *Journal of Coastal Research* 13, no. 3 (1997): 605-627.

continuously accreting, eroding, and accreting again.[18] Save for the obvious exception of volcanic landscapes, deltaic environments boast some of the youngest and most dynamic terrain in the entire world.

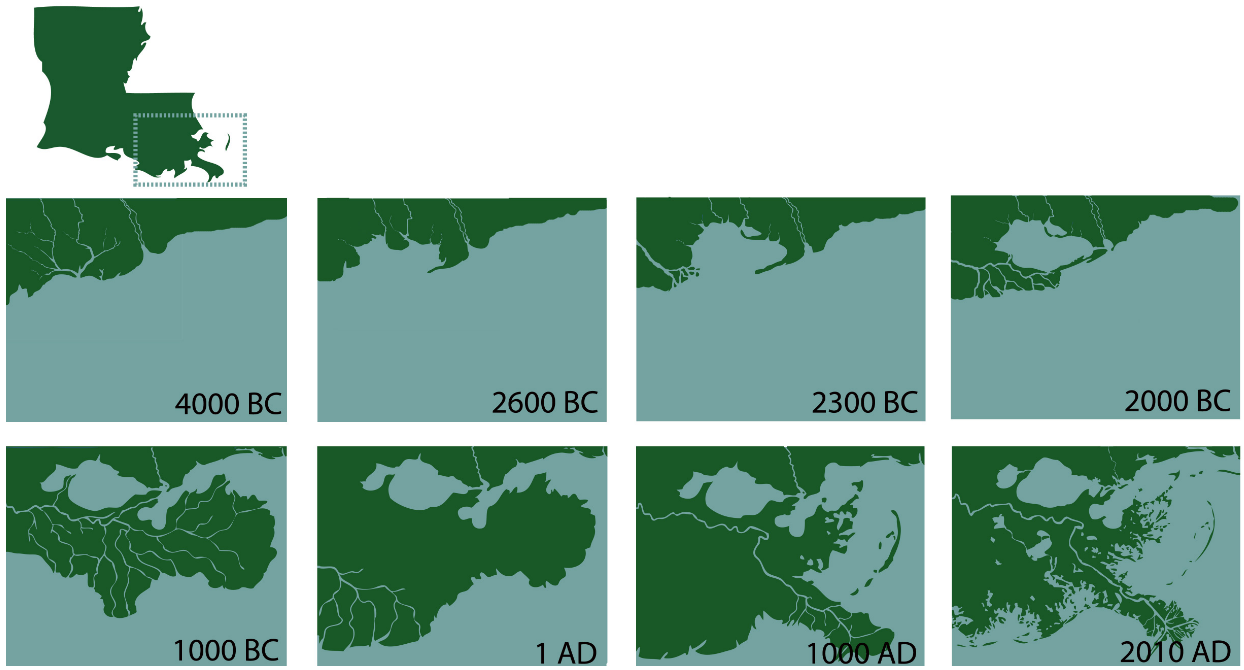

Figure 0-2: Development of southern Louisiana over the last 6,000 years. Image courtesy of Wikimedia Commons. See: Roberts, "Dynamic Changes of the Holocene Mississippi River Delta Plain."

One testimony to that youth and dynamism is the fact that New Orleans occupies a region of the Mississippi's deltaic plain that first emerged out of the Gulf just four or five thousand years ago. The historical geographer Richard Campanella observes that, since its foundation in 1718, the city has existed for about six percent of the lifetime of its underlying geology. By comparison, New York City has only existed for less than 0.00001 percent of the lifetime of its underlying geology.[19] The youth of southern Louisiana's terrain suggests its geological instability. Defined by sediment, muck, ooze, and flood it is a fundamentally dynamic place of

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[18] Chapters one and three together suggest the troubling consequences of leveeing a deltaic environment against the sediments that sustain it. Kazuaki Hori and Yoshiki Saito, "Classification, Architecture, and Evolution of Large-River Deltas," in *Large Rivers: Geomorphology and Management*, ed. Avijit Gupta (Hoboken, NJ: Wiley, 2008), 75-96.

[19] The rocks under New York are around five hundred million years old. Campanella, *Bienville's Dilemma*, 78.

shifting boundaries and porous, uncertain edges. Built up from the deposition of sediment by several millennia of annual floods, the land would not exist if not for the kind of hydrological disturbances that most people experience as disasters.[20] Deltas are profoundly unpredictable slices of the earth.

They are also incredibly flat. In times of flood, heavier, larger sediments fall out of the water column first and are deposited closest to the main channel, while smaller sediments get deposited further from the river. When rivers create land in this way, what little topography exists follows the riverbank in the form of natural levees. Unlike a river valley, then, a delta's terrain gets lower and muckier the *further* you move from the river, becoming the "backswamps" and marshes where only certain kinds of vegetation—like bald cypress (*Taxodium distichum*)—are at home.[21] Also unlike a river valley, any waterways found in the delta that are branching off of the Mississippi are no longer feeding the main channel of the river. Here, tributaries have become *dis*tributaries. Instead of gathering rainfall and sediment these smaller, more sluggish streams—called "bayous" in Louisiana—distribute Mississippi water, sediment, and muck across the region. "High ground" is thus relative here in the delta. Few might call something submerged in six inches of water in some years a ridge, but in a landscape where a few inches of elevation can make all the difference, a ridge it certainly is.[22]

Given this incredibly dynamic, flood-prone, flat and mucky landscape, why did people even bother settling it? Curiously, despite the obvious challenges of environments that are

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[20] Chapter one examines nineteenth-century agricultural struggles over how best to negotiate the risk (and benefits) of flood in Louisiana.

[21] Chapter two examines the strenuous efforts of Euro-American settlers to transform *Taxodium distichum* into an industrial-scale commodity.

[22] This observation about ridges in deltaic landscapes is based on an anecdote in Ervin Mancil, "An Historical Geography of Industrial Cypress Lumbering in Louisiana" (PhD diss., Louisiana State University, 1972), 12, n. 3.

neither fully land, nor fully water, regions like the Mississippi River Delta have long attracted human exploration and inhabitation. Deltas and estuaries have witnessed human occupation practically since their beginnings when sea levels more or less stabilized following the last ice age.[23] Within just one thousand years of deltaic landscapes redeveloping at coastal river mouths all over the world, communities began to take hold in these new environments built from water and silt. In some cases, such as the Nile and Yangtze deltas, people began expanding onto new land within just five hundred years of its initial formation.[24] Similarly, in Louisiana, humans have occupied the deltaic plain of the Mississippi River for as many as four thousand years.[25] Archaeologists and physical anthropologists suggest that people have been drawn to these places because the confluence of nutrient-rich rivers and shallow marine waters foster some of the most productive ecosystems in the world.[26]

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[23] A curious fact of deltaic geomorphology is that *all* coastal river deltas in the world are roughly the same age. When the last ice age began to end around 18,000 years ago, global sea levels rose significantly across the planet, pushing shorelines several miles inland from where they had once been. When those rising seas stabilized around 7-10,000 years ago, river deltas around the globe began simultaneously prograding into their respective oceans. Hori and Saito, "Classification, Architecture, and Evolution of Large-River Deltas"; Sampat Tandon and Rajiv Sinha, "Geology of Large River Systems," in *Large Rivers: Geomorphology and Management*, ed. Avijit Gupta (Hoboken, NJ: Wiley, 2008), 7-28;

[24] On the long history of deltaic habitation see: J. Budel, "Deltas: Basis of Culture and Civilization," in *Scientific Problems of the Humid Tropical Zone Deltas and Their Implications* (Paris: UNESCO, 1966), 295–300; J. W. Day et al., "Emergence of Complex Societies after Sea Level Stabilized," *Eos, Transactions, American Geophysical Union* vol. 88, no. 15 (2007): 169–70; Douglas J. Kennett and James P. Kennett, "Early State Formation in Southern Mesopotamia: Sea Levels, Shorelines, and Climate Change," *Journal of Island and Coastal Archaeology* vol. 1, no. 1 (2006): 67–99; Daniel J. Stanley and Andrew G. Warne, "Holocene Sea-Level Change and Early Human Utilization of Deltas," *Geological Society of America Today* vol. 7, no. 12 (1997): 1–7.

[25] Mark A. Rees, *Archaeology of Louisiana* (Baton Rouge: LSU Press, 2010); Tristram R. Kidder, "Making the City Inevitable: Native Americans and the Geography of New Orleans," in *Transforming New Orleans and Its Environs: Centuries of Change* (Pittsburgh: University of Pittsburgh Press, 2001), 9–21.

[26] Budel, "Deltas: Basis of Culture and Civilization"; Day et al., "Emergence of Complex Societies after Sea Level Stabilized"; Kennett and Kennett, "Early State Formation in Southern Mesopotamia"; Stanley and Warne, "Holocene Sea-Level Change and Early Human Utilization of Deltas."

Figure 0-3: Indian settlements—“Sitimachas” and “Tchaoumachas”—are depicted in some of the lowest, muckiest reaches of the Mississippi River Delta in Guillaume de Lisle’s 1718 map, “Carte de la Louisiane et du Cours du Mississipi.” Image courtesy of the David Rumsey Collection.

But a tradeoff accompanies the rich abundance of deltaic and estuarine environments. Anthropologist Hugh Raffles would call such watery landscapes *terra anfíbia*, or amphibious terrain.[27] Writing about the lower reaches of the Amazon basin, Raffles described a sodden, “amphibious universe,” in which the boundaries between land and water are shifting, porous, and continually being remade. Those shifting, porous boundaries might foster rich ecosystems full of valuable nutrients and biomass that human communities can harvest, but they are also deeply threatening for many forms of social organization, particularly when it comes to marking property, building extensive permanent settlements, or conducting large-scale agriculture and natural-resource extraction.[28]

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[27] Hugh Raffles, *In Amazonia: A Natural History* (Princeton, NJ: Princeton University Press, 2002).

[28] For examples, see: Biggs, *Quagmire*; Ciriacono, *Building on Water*; Colten, *An Unnatural Metropolis*; Pastore, *Between Land and Sea*. For similar struggles in watery places that are not deltas or estuaries, see: David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W. W. Norton & Co., 2006); Laura Ogden, *Swamplife: People, Gators, and Mangroves Entangled in the Everglades* (Minneapolis:

As such, for the past several centuries (if not longer), wetlands have existed in many cultures as exemplars of in-betweenness, transition, and uncertainty.[29] Not infrequently, such uncertainty has been greeted with hostility. In the Old English epic, *Beowulf*, the monster Grendel is monstrous at least in part because of the watery "marches" that he inhabits, a marshland etymologically entangled with the notion of borderlands.[30] For many people in recent history—although by no means all—the borderland geographies of watery environments have been places of disease, disorder, and danger, places where particularly unsettling creatures swarm and crawl their way through ooze and muck.[31] Watery landscapes and their inhabitants do

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University of Minnesota Press, 2011); Nancy Langston, *Where Land & Water Meet: A Western Landscape Transformed* (Seattle: University of Washington Press, 2003); Megan K. Nelson, *Trembling Earth: A Cultural History Of The Okefenokee Swamp* (Athens: University of Georgia Press, 2005); Hugh C. Prince, *Wetlands of the American Midwest: A Historical Geography of Changing Attitudes* (Chicago: The University of Chicago Press, 1997); Ann Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands* (Washington, D.C: Island Press, 1997); Robert Wilson, *Seeking Refuge: Birds and Landscapes of the Pacific Flyway* (Seattle: University of Washington Press, 2010); Christopher Morris, *The Big Muddy: An Environmental History of the Mississippi and Its Peoples, from Hernando De Soto to Hurricane Katrina* (New York: Oxford University Press, 2012). On the challenges of creating property in nature more generally, see: Theodore Steinberg, *Slide Mountain, Or, The Folly of Owning Nature* (Berkeley: University of California Press, 1995).

[29] Rodney J. Giblett, *Postmodern Wetlands: Culture, History, Ecology* (Edinburgh: Edinburgh University Press, 1996); William Howarth, "Imagined Territory: The Writing of Wetlands," *New Literary History* 30 (1999): 509–39; Barbara Hurd, *Stirring the Mud: On Swamps, Bogs, and Human Imagination*, (Boston, Mass: Houghton Mifflin, 2003); Robert Van de Noort and Aidan O'Sullivan, *Rethinking Wetland Archaeology* (London: Duckworth, 2006); Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands*. Compare wetlands with the transition zones and liminal spaces of beaches and shores: Greg Dening, *Beach Crossings: Voyaging Across Times, Cultures, and Self* (University of Pennsylvania Press, 2004); John R. Gillis, *The Human Shore: Seacoasts in History* (Chicago: The University of Chicago Press, 2012); Russell Fielding, "The Liminal Coastline in the Life of a Whale: Transition, Identity, and Food-Production in the Eastern Caribbean," *Geoforum* vol. 54 (2014): 10–16.

[30] Charlotte Ball, "Monstrous Landscapes: The Interdependence of Meaning between Monster and Landscape in Beowulf," *Hortulus: The Online Graduate Journal of Medieval Studies*, accessed January 27, 2015, http://hortulus-journal.com/journal/volume-5-number-1-2009/ball/.

[31] On wetlands as disordered spaces: Tristan Sipley, "The Revenge of 'Swamp Thing': Wetlands, Industrial Capitalism, and the Ecological Contradiction of Great Expectations," *The Journal of Ecocriticism* vol. 3 (2011): 17–28. For a sprawling exploration of the notion of wetlands as borderland spaces in literature, see: Giblett, *Postmodern Wetlands*. Again, contrary to the moral universe depicted in *Beowulf*, it is important to note that these attitude and encounters are not, in fact, universal. It would be a mistake to overstate the essential otherworldliness of watery places and presume that humans have always and everywhere brought to them a troubled history. The *crannog* settlements of the British Isles and the floating markets of Vietnam offer two other examples of communities content to live with watery uncertainty. James Scott has also gestured at various peoples whose intimate relationships with watery landscapes facilitated resistance to colonization and incorporation: James C. Scott, *The Art of Not Being Governed: An Anarchist History of Upland Southeast Asia* (New Haven: Yale University Press, 2009).

not easily conform to human categories; they are environments where, for many people, matter has often felt strangely "out of place," unmoored from the more familiar taxa of ecosystems that are more definitively either terrestrial or aquatic, rather than some indeterminate mixture of the two.[32] While exceptions exist throughout history, including Iraq's "marsh Arabs," some Amazonian communities, and wetland Louisiana's own Cajuns, most modern human settlers seem to have grown markedly uncomfortable with inhabiting amphibious terrain.

This, of course, holds true for the Mississippi River Delta. Take, for example, the iconography of Louisiana's official boundaries. The state's highly recognizable outline appears on paper maps, highway signs, bumper stickers, and other memorabilia; it has become so pervasive as to appear indisputable. Yet that outline radically differs from the shifting and fragmented watery topography found on the "ground" along the Gulf. Although the deltaic coast has always and forever been a zone of shifting margins, Louisiana's coast exists in the minds of most of its residents as hard, distinct edges.[33] In fact, in 1981, the United States Supreme Court decided that Louisiana's coast was not an "ambulatory line," but a fixed boundary.[34] The

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[32] "Matter out of place" comes from: Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Praeger, 1966). For broader debates on borderlands in Geography, see: Reese Jones, "Categories, Borders and Boundaries," *Progress in Human Geography* vol. 33, no. 2 (2008): 174–89; Anssi Paasi, "Border Studies Reanimated: Going beyond the Territorial/relational Divide," *Environment and Planning A* vol. 44, no. 10 (2012): 2303–9; Hillary Cunningham, "Permeabilities, Ecology and Geopolitical Boundaries," in *A Companion to Border Studies*, edited by Thomas M. Wilson and Hastings Donnan (Malden, MA: Blackwell, 2012), 371–86. On borderlands in US Western History, see: Pekka Haemaelaeinen and Samuel Truett, "On Borderlands," *Journal of American History* vol. 98, no. 2 (2011): 338–61; Jeremy Adelman and Stephen Aron, "From Borderlands to Borders: Empires, Nation-States, and the Peoples in Between in North American History," *The American Historical Review* vol. 104, no. 3 (1999): 814–41; Samuel Truett, "The Ghosts of Frontiers Past: Making and Unmaking Space in the Borderlands," *Journal of the Southwest* vol. 46, no. 2 (2004): 309–50.

[33] On margins and zones as opposed to edges, see: Pastore, *Between Land and Sea*.

[34] I first heard about the Supreme Court's fixing of Louisiana's "ambulatory" coastline in Brett Anderson, "Louisiana Loses Its Boot," *Matter*, September 8, 2014, https://medium.com/matter/louisiana-loses-its-boot-b55b3bd52d1e. Note that the issue was decided more in terms of state versus federal sovereignty over natural resources than cartographic boundaries. For some legal history and a guide to the relevant litigation, see: Aaron Louis Shalowitz, *Shore and Sea Boundaries: With Special Reference to the Interpretation and Use of Coast and Geodetic Survey Data*, vol. 3 (Washington, DC: United States Government Printing Office, 2000). On the challenges of mapping spatially and temporally variable landscapes, see: Giblett, *Postmodern Wetlands*, 66.

certainty and consistency people have come to depend upon for organizing territory obviously leave no room for ambulatory lines and amphibious terrain. Jeff Carney, director of Louisiana State University's Coastal Sustainability Studio, commented on this very phenomenon: "How do you represent a place with no edge?" Carney asked. "We don't have a shoreline. We're not Florida. It's not like you're on solid ground and then you step into water. . . . [That] unclear edge creates problems with land ownership, insurance, all of these things. We don't deal with ambiguity very well."[35]

Therein lies the problem at the heart of this research.

The Place With Porous Edges

"The place with no edge" suggests a landscape completely void of categories and order—a landscape primed to receive whatever form of organization humans might be able to muster amidst uncertainty. That is precisely what most Euro-Americans reconfiguring southern Louisiana's environment seem to have imagined. Aside from the Cajuns who later settled the coastal marshes, the majority of Europeans (and later, Americans) to arrive in watery southern Louisiana could not abide by its amphibious uncertainties. For these Euro-Americans, the undifferentiated morass of swamp and marsh embodied an environment in which some core values of modernity—order, stability, property—were regularly thwarted. This was a landscape in which the fragmented, porous boundaries between land and water resulted in muddy categories. The river seemed even more unwilling to remain within its banks than most. Swamps and marsh appeared to shift (or even come and go) with the seasons. What seemed arable fertile land one day might be drowned in miasmatic muck the next. Though it seemed valuable

[35] Carney quoted in: Anderson, "Louisiana Loses Its Boot."

resources might be hidden amidst the delta's flooded landscapes, there was deep uncertainty about not only the nature and extent of those resources, but also how one would go about extracting them. What ensued, then, was a struggle to reform and rationalize the seeming chaos of amphibious terrain with a new set of more rigid, clearly defined boundaries. And what is crucial to understand about these transformations—these boundary-making efforts in the watery environment—is that as much as they depended on technology and engineering to succeed, they also depended on vision and values. By taxonomizing, reimagining, and reconfiguring nature in the Mississippi River Delta, Euro-Americans hoped to eliminate the unpredictability and confusion of the water-logged landscape—of what appeared to be a place with no edge.

But ambiguity and uncertainty is not always necessarily equivalent to chaos. For as much as most people—particularly in our modern era—have difficulty inhabiting environmental uncertainty, the Mississippi River Delta was not (and is not) at all a place with no edge. Though watery environments are perhaps shifting places that thwart most human categories, they are also comparatively transient landscapes that persist only through the dynamic interaction of land and water. Amphibious terrain has its own muddy and fluid order. And when people have tried to impose their own, far more brittle order on amphibious terrain, they (ironically) invited *actual* disorder.[36] Whether for settlement, agriculture, natural resource extraction, or industry, carving

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[36] That human boundaries are often quite brittle and full of unnoticed fractures or porosities is a central theme of this dissertation. Anthropologist Tanya Luhrmann observes that prototypes—"land" and "water," for example—are fast, convenient ways of categorizing the world. Unfortunately, they also produce "prototype effects" that make it increasingly difficult for people to account for the exceptions (the hybrids and monsters, if you will). Unable to acknowledge the uncertain boundaries of the categories that they are deploying, people grow committed to increasingly rigid ways of organizing the world. Applying such rigid organization to wild nature, particularly the wild nature of amphibious terrain, is only to invite rupture. T. M. Luhrmann, *Of Two Minds: An Anthropologist Looks at American Psychiatry* (New York: Vintage Books, 2001), 41. Luhrmann's observations were inspired by, among others: George Lakoff, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind* (Chicago: University of Chicago Press, 1987). Also see: Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999). Bruno Latour has famously argued that one particularly brittle boundary—that dividing society from nature—lies at the foundation of modernity. Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993). For discussion of what in

clear distinctions into deltaic nature often resulted in deep social conflict, enormous expenditures of labor and capital, and dangerous unforeseen consequences. While it was perhaps easy to misread dynamic, porous, and shifting boundaries for their complete absence, doing so was often actually a grave mistake.[37]

The first efforts to tame the uncertainties and perceived disorder of the Mississippi River Delta began as soon as the French arrived in the region in the early eighteenth century. These new settlers struggled to erect embankments against the Mississippi's annual floods, hoping to create some semblance of a rigid divide between the swollen river and already sodden agricultural land. By the early decades of the nineteenth century, those efforts had begun to succeed and an extensive, if largely uncoordinated, to sever the flooding Mississippi from the delta was well underway.

Beginning in the mid-1800s, a rising chorus of dissenting "river rice" planters began to contest these boundaries, calling for both perforations in the levees and floods on their plantations. River rice agriculture depended on inserting openings—called flumes—into river embankments at a time when many other residents were adamant that only unbroken, unyielding

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reality are the very porous boundaries between nature and society, see: William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (New York: W. W. Norton & Co., 1995); Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999); Richard White, *The Organic Machine* (New York: Hill and Wang, 1996); Michael Pollan, *Second Nature: A Gardener's Education* (New York: Laurel, 1992); Jennifer Price, *Flight Maps: Adventures with Nature in Modern America* (New York: Basic Books, 1999); Gregg Mitman, *Breathing Space: How Allergies Shape Our Lives and Landscapes* (New Haven: Yale University Press, 2007); Daniel Schneider, *Hybrid Nature: Sewage Treatment and the Contradictions of the Industrial Ecosystem* (Cambridge, MA: MIT Press, 2011); Sarah Whatmore, *Hybrid Geographies: Natures, Cultures, Spaces* (London: SAGE, 2002).

[37] And that misreading remains an easy mistake. Just moments after describing "a place with no edge," Jeff Carney asserted that there are in fact edges in the Mississippi River Delta, just "unclear" ones. Indeed, as director of LSU's Coastal Sustainability Studio, Carney certainly knows the region is not an edgeless, amorphous environment waiting for humans to rationalize it. Carney's comments should be taken as evidence that even when we know otherwise, humans are tempted to confuse dynamism with disorder.

levees could guarantee regional prosperity. Levees on the riverfront and at the swampy rear of plantations had served as part of an engineering and policy discourse separating "waste" waterlogged lands from productive farmland and untamed nature from reclaimed civilization. But between the late 1840s and 1890s, river rice planters intentionally altered levees to flood their fields, creating a genus of Louisiana plantation that was made expressly permeable to the rising Mississippi. Engineers, politicians, and sugar planters denounced this work as backward, dangerous, and even deranged.

The ensuing social conflicts over perforated levees and permeable plantations reverberated through nineteenth-century Louisiana society. Struggles over porosity and permeability entailed immense stakes, shaping ideas of nature, health, progress, and even freedom. These conflicts even had implications for the physical integrity of the delta; the late-nineteenth century consolidation of rigid and impermeable flood control set the stage for land loss by definitively severing the delta from the river that had built it. Nonetheless, a handful of flumes—the traces of a largely forgotten embrace of permeability and porous boundaries in the delta—remained buried in the region's archaeological landscapes through the 1980s. These traces of Louisiana's nineteenth-century conflict over porosity and permeability remind us that current efforts to redefine the place of water in New Orleans and the region may not be as unprecedented as they first appear.

Not all boundary-making in the region has been as obvious and literal as leveeing, however. Evolving since the early eighteenth century, Louisiana's bald cypress lumber industry required a whole suite of bounding practices that—through strenuous labor and enormous expense—both figuratively and materially re-configured the muddy terrain of the region's forested backswamps.

Before Louisiana's cypress lumber trade could even begin, Euro-Americans had to redefine a wetland organism (*Taxodium distichum*) entangled within a web of watery ecological relations into a commodity (bald cypress). The ensuing expansion of a cypress frontier throughout the region's swamps then required decades of classificatory labor over the first half of the 1800s to transform enormous swathes of "waste" wetlands into carefully enclosed resource territories. By abstracting a wetland organism from the watery ecosystem to which it had adapted, lumbering interests had transformed wasteland into territory and created a new industrial commodity, expanding the range of Louisiana landscapes in which capital could take root. Later, as river-rice agriculture dwindled out of existence in the 1890s, steam mechanized the cypress industry, resulting in a series of technological adaptations to, and transformation of, the soggy environment. These new bald cypress lumbering operations pushed an industrial-scale resource frontier into a watery landscape formerly dominated by subsistence and smaller-scale extraction. Ultimately, this expansion and mechanization of the industry attempted to reconfigure the swampy landscape into discrete segments of either open water or (somewhat) drier land, rather than a bewilderingly inconsistent mixture of the two. In their efforts to industrialize the extraction process, cypress lumber companies etched enormous hub-and-spoke patterns into the wetland environment that remain visible today.

The processes of categorizing a natural resource, delineating a resource territory, and finally dividing water and land from the watery landscape were laborious and expensive. Imposing the hard, rigid boundaries of an industrial resource frontier on watery wilderness required arduous conceptual and physical work, as well as significant stores of capital. If struggles over levees and rice flumes suggest the extraordinary stakes of reorganizing and stabilizing watery nature, Louisiana's bald cypress industry reveals the enormous physical, conceptual, and monetary expenditures that such reorganization and stabilization could require.

When exhausted cypress forests began suggesting bankruptcy for logging operations in the 1920s, a new industrial resource frontier began to emerge further toward Louisiana's still more watery coastal margins. Developments in petroleum geology in the first decades of the twentieth century had begun to suggest the featureless, seemingly undifferentiated wetlands of the Mississippi River Delta might hold vast mineral wealth. Much like the efforts of the cypress industry, oil and gas interests would expend considerable labor to carve stable categories out of the muck of Louisiana's coastal wetlands.

First, geophysical teams had to trace the contours of petroleum resources hidden below the floating marshes and choked waterways of the coast. Once apprehended as a resource, however, petroleum also had to be reliably and consistently extracted from this relentlessly shifting and in-between environment. Where the cypress industry swiftly clear-cut many of Louisiana's cypress swamps, oil and gas companies needed to maintain lasting, stable connections between wetland oilfields and voracious consumers. From the late 1920s through the 1960s and beyond, the industry explored for and extracted petroleum in this landscape, perforating Louisiana's coastal wetlands with a sprawling network of canals and pipelines that reorganized deltaic nature into a form of hard, durable infrastructure. These new, fixed porosities in the Mississippi River Delta subjected the landscape to intense stress, drowning marshes and allowing saltwater to intrude into and devour Louisiana's coastal wetlands from the inside. Imagining they were stabilizing the deltaic environment, oil and gas companies were in fact profoundly destabilizing it.

Establishing brittle human boundaries on amphibious terrain can thus entail not only fierce social conflict, strenuous labor, and great expense, but also disastrous consequences. In July of 2013, the Southeast Louisiana Flood Protection Authority-East (SLFPA-E) named almost 100 oil and gas companies in a lawsuit seeking damages for eighty years of accelerated land loss in the Mississippi River Delta. Remarking on the rapid, anthropogenic deterioration of the environment, the suit's authors wrote, "This protective buffer took 6,000 years to form. Yet . . . it has been brought to the brink of destruction over the course of a single human lifetime." Ultimately, by carving a new form of rigid organization into amphibious terrain, the petroleum industry also seemingly ruptured not just the fabric of the delta, but also the layering of time. On the Gulf coast, processes typically occurring over geologic timescales—from epochs to millennia—have now become acutely sensed, tangible events unfolding over a human lifetime.

Although land loss is perhaps the biggest tragedy afflicting Louisiana, it is not the only form of risk that has emerged as people constructed imposed brittle boundaries on dynamic nature—particularly dynamic *watery* nature. After World War II, an increasing quantity of the resources harvested from Louisiana's wetland petroleum frontier were diverted to an emerging industrial corridor along the Mississippi River between Baton Rouge and New Orleans. Petrochemical facilities took root here in part thanks to the river, which provided water resources, a waste sink, and a wide-ranging transportation network.

As the petrochemical corridor developed atop the deltaic environment, the porosities built into the industry—by which inputs and outputs through flow chemical facilities—seemed increasingly out of control. Accidents and explosions combined with the daily flows of waste emitted by unstable petrochemical infrastructure to spread hazardous substances throughout the environment. In occupying the delta, industry was also leaking into air, water, and soils that together conspired to amplify the spread circulation of petrochemicals throughout the region.

But Louisiana's riparian petrochemical facilities are not without neighbors. One of the most heavily industrialized regions in the United States, the chemical corridor developed not just because of the amenities offered by the Mississippi, but also because relict sugar plantations had offered large parcels of available land adjacent to the river. Often these parcels were adjacent to historic all-black communities, creating a very particular geography of raced communities along petrochemical facility fence lines. Inhabited by permeable human bodies, the industrial corridor came to be known by the late 1980s as "Cancer Alley." The overlooked porosities of factory, environment, and body in Cancer Alley combined to produce a place saturated with toxic risk and uncertainty. Here, water surged from the river through facility intakes and back out into the air, soil, wetlands, and streams as contaminated liquid or steam. This poisoned water—whether liquid or vapor—then passed through the skin and mucous membranes of predominantly African American bodies, entangling inequality with exposure.

Appearing to have little resemblance with the tragedy of land loss unfolding along Louisiana's coast, the permeable bodies of Cancer Alley reveal an entirely different set of troubling consequences emerging from the interplay of brittle human boundaries and dynamic watery nature. Inextricably entangled with the physical landscape, meanwhile, these permeable bodies also suggest the ways human beings are bound to watersheds as tiny tributaries and distributaries. If humans are intimately connected with the flows of water and mud pouring through vast landscapes, then perhaps we must also reassess the scale and boundaries of the human body, both in time, as well as space.

Almost two decades after activists first coined the name “Cancer Alley,” Hurricane Katrina ripped through the Gulf Coast. Unleashing watery devastation all along the Gulf Coast, but disproportionately inundating the poor and people of color, Katrina marks an important coda to this exploration of encounters between brittle human boundaries and dynamic watery nature. Since the hurricane, Louisiana has moved to the front lines of an effort to redefine the place of water in human landscapes, a project also underway in the Netherlands, the United Kingdom, and, most recently, in the northeastern United States after Sandy. Engineers, landscape architects, planners, and other experts have begun to embrace various forms of permeability both in New Orleans and across the coast.

Rejecting rigid, unyielding forms of “hard” infrastructure—such as levees and seawalls—in favor of “soft” infrastructure defined by resilience and permeability, new designs for Louisiana’s future attempt to fend off deluge in a world of rising seas and unstable weather. In Louisiana, “living with water”—a phrase trademarked by Waggoner & Ball Architects—involves creating intentionally porous boundaries through wetland restoration, intentionally circulating water through urban environments, and more. As new visions for inhabiting the Mississippi River Delta, these proposals attempt to incorporate the dynamism of watery landscapes into daily life, potentially entailing an ethical re-evaluation of human relationships to amphibious terrain.

But while these projects describe a new—or, considering the work of nineteenth-century rice planters, perhaps remembered—vision for living with water, they remain fraught with challenges. Without attending to the troubled, often unnoticed human work of categorizing, bounding, and stabilizing wild nature, this embrace of permeability may, in the end, only be superficial. Without understanding how even human-engineered porosity can be rigid and inflexible in the face of amphibiousness, efforts at living with water may simply build new uncompromising structures in a dynamic environment.

The Mississippi River Delta—with its shifting mixtures of land and water—provides a striking canvas for revealing the brittleness of some human attempts to divide, organize, and rationalize dynamic, watery nature. Such *terra anfíbia*—amphibious terrain—offers, in the words of Hugh Raffles, the "opportunity to reflect on both the insubstantiality of the categories and on the work they accomplish: on the instrumental logic that holds apart the everyday from the historical, the natural from the artificial, the local from the global, the human from the non-human."[38] The Euro-American history of the Mississippi River Delta—like the more recent histories of many such environments—is full of people's rigid attempts to reorganize indeterminacy, to put matter back in place and to rationalize the seemingly disordered environment.[39] Often, however, that sense of control and mastery has proven illusory, for whether constrained or ignored, permeable nature has a way of creeping around, through, and between human culture's rigid categories and structures. Suffusing the environment, water

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[38] Raffles, *In Amazonia*, 42.

[39] The tensions between brittle human categories and unpredictable wild nature are not limited to people's encounters with amphibious terrain. The fences, legal codes, and taxonomies that facilitate property ownership, natural resource management, or even state sovereignty can be thwarted by a meandering river, confused by the accretion of new land, or undermined by mobile organisms like weeds and migratory birds. On the challenges of categorizing nature as property (including the particular challenges of using a meandering river as a boundary), see: Steinberg, *Slide Mountain* and Paul Kramer, "A Border Crosses," *The New Yorker*, September 21, 2014, http://www.newyorker.com/news/news-desk/moving-mexican-border. On the ways mobile nature thwarts human categories and boundaries, see: Mark Fiege, "The Weedy West: Mobile Nature, Boundaries, and Common Space in the Montana Landscape," *The Western Historical Quarterly* vol. 35, no. 1 (2005): 22–47; Wilson, *Seeking Refuge*; Cunningham, "Permeabilities, Ecology and Geopolitical Boundaries"; Paul Robbins, "Fixed Categories in a Portable Landscape: The Causes and Consequences of Land Cover Categorization," in *Political Ecology: An Integrative Approach to Geography and Environment-Development Studies*, ed. Karl Zimmerer and Thomas Bassett (New York: The Guilford Press, 2003), 181–200; and Paul Robbins, "Tracking Invasives in India, or Why Our Landscapes Have Never Been Modern," *Annals of the Association of American Geographers* vol. 91, no. 4 (2001): 637–59. For more on people's responses to the unclassifiable, see: Jones, "Categories, Borders and Boundaries"; Harriet Ritvo, *The Platypus and the Mermaid and Other Figments of the Classifying Imagination* (Cambridge, MA: Harvard University Press, 1997); Eviatar Zerubavel, *The Fine Line* (Chicago: University of Chicago Press, 1993).

muddies human efforts, both conceptual and physical, to organize the world, whether those efforts are as intangible as defining natural resources and mapping territory, or as material as levees and canals.

The struggle to impose categories on these watery landscapes—of taxonomizing and reordering the environment—has been at the core of modern efforts to inhabit, develop, and profit from places like the Mississippi River Delta. Frequent irreconcilable differences between the stable human order and the shifting deltaic order, however, meant that those efforts have often invited disaster, creating the conditions for long-term failure. The paradox of developing southern Louisiana is that those very efforts of development—whether for flood protection, natural resource extraction, or industry—exacerbated the risks of inhabiting amphibious terrain. In reality, the Mississippi River Delta, though a deeply unstable place, is not in fact without its own, though admittedly dynamic, boundaries and structures. In imagining chaos and edgelessness, people sought to impose categories on the environment that were at odds with the biophysical fabric of the landscape. And in so doing, they not only introduced further instability into the system, but they also overlooked the fundamentally unstable nature of their own values.

This is a history of human categories, both as ideas and as material structures in the world. Tracing that history bears witness to social conflict over porous levees and permeable plantations, the extraordinary (and unusual) labors that went into logging bald cypress, the disastrous consequences of turning muddy wetlands into stable canals, and the vulnerabilities that developed when people have overlooked the permeability of both landscapes and human bodies. I argue that the plumbing that caused catastrophic land loss along Louisiana's coast emerged from a deeper encounter between brittle human boundaries and uncertain, amphibious terrain. But it was not the only trouble to arise from that encounter. In the shoring up and subsequent breaching of people's efforts to reorganize nature in the delta, we witness a universe of values and culture accompanying the technologies and engineering that were meant to bring order to amphibious terrain. By noticing this deeper underlying cause of land loss in Louisiana, phenomena that once appeared independent of erosion and subsidence are revealed as deeply related. Levees broke, cypress swamps were denuded, and bodies were exposed to poisons according to the very same values and logics that ultimately fragmented the coast.

Chapter 1: The Permeable Plantation

From the very first moments of colonization in the early eighteenth century, European occupation of southern Louisiana involved an ecological struggle in which energetic newcomers, upon encountering an unfamiliar wetland environment, sought to make the landscape sensible, manageable, and profitable.[40] Situated on the deltaic plain of the Mississippi River, southern Louisiana is a dynamic landscape defined by water, sediment, and muck. The Mississippi, its distributary bayous, and the delta's backswamps are the dominant features of an unstable environment in which, until the last few hundred years, floods routinely overcame the high ground of the region's natural levees. Europeans began reorganizing this landscape almost immediately upon arrival, but efforts to extract dependable livelihoods from this uncertain, watery environment would dramatically intensify at the turn of the nineteenth century. Louisiana policymakers, engineers, and planters worked to more definitively segregate dry land from the region's seasonally overflowing waterways and wetlands, creating stable territory for development. Expanding and perfecting the levee system lining the river and its bayous would better guarantee the promise of dry, firm terrain and the wealth that would flow from it.[41] Although the Civil War interrupted this process of drainage and embankment, many residents increasingly viewed the Mississippi and the region's wetlands as disordered nature to be

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[40] Such struggles are by no means unique to Louisiana. For a very diverse set of examples, see: Hugh Raffles, *In Amazonia: A Natural History* (Princeton, NJ: Princeton University Press, 2002); Nancy Langston, *Where Land and Water Meet: A Western Landscape Transformed* (Seattle: University of Washington Press, 2003); Megan K. Nelson, *Trembling Earth: A Cultural History Of The Okefenokee Swamp* (Athens: University of Georgia Press, 2005); David Blackbourn, *The Conquest of Nature: Water, Landscape, and the Making of Modern Germany* (New York: W. W. Norton & Co., 2006); David A Biggs, *Quagmire: Nation-Building and Nature in the Mekong Delta* (Seattle: University of Washington Press, 2010).

[41] The word "levee" comes from the French past participle, "*levee*," which means "raised." Levees are simply embankments of soil or other material raised along a river bank to prevent flooding.

rationalized and subdued. By the end of the century, it seemed a consensus had formed. The soggy floodplain and oozing swamps would be wrung out to produce a landscape conducive to both profitable agriculture and permanent settlement.[42]

What had thus emerged in nineteenth-century Louisiana was a kind of impermeable society in which political power, capital, and environmental values converged toward reforming the watery chaos of the delta through rigidly distinguishing water from land.[43] Flood control and wetland reclamation would bring stability and certainty to the dynamic environment. And, much as in other places where people have undertaken large-scale projects to reorganize the flow of water through the landscape, the work of this flourishing impermeable society gained a kind of momentum.[44] Leveeing and drainage begat more leveeing and drainage, initiating an impermeability treadmill as sugar planters and other inhabitants increasingly took for granted the drier ecologies they had created. Indeed, for those stabilizing the watery environment, this treadmill turned the wheels of progress; impermeability was akin to modernity.

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[42] For the broad strokes of this history, see: Richard Campanella, *Bienville's Dilemma: A Historical Geography of New Orleans* (Lafayette, LA: University of Louisiana, 2008); Christopher Morris, *The Big Muddy: An Environmental History of the Mississippi and Its Peoples, from Hernando De Soto to Hurricane Katrina* (New York: Oxford University Press, 2012); George Pabis, "Subduing Nature through Engineering: Caleb G. Forshey and the Levees-only Policy, 1851-1881," in *Transforming New Orleans and Its Environs: Centuries of Change*, ed. Craig Colten (Pittsburgh: University of Pittsburgh Press, 2000), 64-83; Cynthia Poe, "Reconstructing the Levees: The Politics of Flooding in Nineteenth-Century Louisiana" (Ph.D. diss., University of Wisconsin-Madison, 2006).

[43] "Impermeable society" is inspired by Karl Wittfogel's notion of "hydraulic societies": *Oriental Despotism: A Comparative Study of Total Power* (New Haven: Yale University Press, 1957). Wittfogel argued that wherever the project of water management—usually for irrigation—required significant and centralized control, political power would concentrate to form despotic governments. Today, his scholarship often raises eyebrows, since his model tended toward sweeping claims and troubling ethnocentrisms. Despite Wittfogel's shortcomings, environmental historians like Donald Worster and Mart Stewart have reassessed the sociologist's work to make important arguments about the ways human societies transform landscapes, and the ways those transformations in turn reshape society, politics, and values. Worster discusses Wittfogel's work and offers a taxonomy of several studies it inspired in: *Rivers of Empire: Water, Aridity, and the Growth of the American West* (Oxford: Oxford University Press, 1985), 17-60. Mart Stewart led me to Worster's discussion and the usefulness of reconsidering the phrase "hydraulic society" in: "Rice, Water, and Power: Landscapes of Domination and Resistance in the Lowcountry, 1790-1880," *Environmental History Review* 15 (1991): 47-64.

[44] Stewart's "Rice, Water, And Power" also remarks on the momentum of hydraulic interventions, insights that were inspired by another student of Wittfogel, Marvin Harris, and his work on the "hydraulic trap" in: *Cannibals and Kings* (New York: Random House, 1977), 233-250.

Reordering and stabilizing this sodden, dynamic place into an impermeable landscape was fundamentally a process of value-laden boundary-making. Distinguishing wet from dry, swollen river from settled deltaic plain, and waste swamp from valuable plantations was the work of cleaving improved landscapes from unruly nature.[45] This process unfolded not just out of economic calculus, nor only through the physical effort of drainage and embankment. Rather, imagination and morals were at work here as well. Impermeability in Louisiana hinged as much on prevailing Euro-American distaste for muddy wetland environments as it did on the political and financial institutions embracing both sugar agriculture and permanent settlement.[46]

But despite the seemingly inexorable process of draining and barricading Louisiana's sugar plantations and growing settlements, disastrous flooding due to crevasses (or levee breaches) continued to mark the latter 1800s. While many of these crevasses were simply the result of a levee failing in high water, a significant number of breaches were also associated with "river rice." This largely forgotten agricultural practice reveals an alternate set of watery values in nineteenth century Louisiana, values that suggested a different imaginary for bounding and organizing the environment, as well as a competing vision of progress for the region.

Embracing porous levees, these rice planters sought to avoid completely rigid distinctions between river and plantation, seeking instead to carefully manage—rather than totally obstruct—the flow of water through the landscape. This permeable vision for agricultural development in

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[45] A number of writers have influenced my thinking on modernity, boundary-making, and the epistemological rift between culture and nature, but none moreso than Bruno Latour in: *We Have Never Been Modern* (Cambridge: Harvard University Press, 1993). For more literature on the permeable boundaries between nature and society, see the introduction. For this subject as it relates to New Orleans in particular, see: Ari Kelman, "Boundary Issues: Clarifying New Orleans's Murky Edges," *Journal of American History* 94 (2007): 605-703; Craig Colten, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge: LSU Press, 2006).

[46] On the history of Euro-American antipathy toward wetlands, see: Ann Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands* (Washington, D.C: Island Press, 1997). Louisiana's marsh and swamp-dwelling Cajun communities offer an important counterfactual for said antipathy, but note that these were primarily subsistence-oriented communities operating largely in contrast with late nineteenth-century modernity.

southern Louisiana suggests that the choices people ultimately made in stabilizing the delta were not inevitable. Rather, for a time in the nineteenth century, there existed another set of ideas about how best to negotiate uncertainty, improve nature, and promote human flourishing in the flood-prone landscape.

The ensuing conflicts between rice planters on one side, and a host of sugar planters, engineers, and lawmakers on the other, reveal the enormous stakes of boundary-making in the delta's watery environment. The struggle over porous levees and permeable plantations reverberated through Louisiana culture and society, transforming not just the biophysical environment, but also people's ideas of nature, modernity, and well-being. As twenty-first century Louisiana struggles to restore the hydrological dynamism of an eroding, subsiding delta, this forgotten nineteenth-century ethic of permeability perhaps offers a precedent for envisioning new ways of "living with water."[47]

The Roots of Impermeability

Engineering the landscape for flood protection in southeastern Louisiana is almost as old as European occupation of the entire Gulf Coast. Before the establishment of New Orleans in 1718, the only attempt at permanent settlement in the deltaic plain began in 1700 with the French Fort de la Boulaye near the mouth of the Mississippi. Within seven years, however, that project was abandoned as annual flooding and the generally soggy terrain had made life not only miserable, but also nigh impossible for a sedentary outpost of soldier-settlers.[48] While visiting in

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[47] "Living with water" is a phrase trademarked by Waggonner & Ball Architects, a New Orleans firm at the forefront of reimagining the place of water in urbanized deltas. For more discussion of both "living with water" and Waggonner and Ball, see chapter 5.

[48] Morris, *Big Muddy*, 37-47.

mid-December of 1700, Jesuit priest Jacques Gravier observed that "the high Waters flood the place—to such an extent that the men spent four months in the water; and frequently had to wade mid-Leg deep in it outside of their Cabins."[49] Meanwhile, the crops they planted consistently failed thanks either to spring floods or ocean storm surges.

Life at the very edges of the porous boundary between land, river, and the Gulf of Mexico did not accommodate European-style permanent settlement. The native Bayogoula guide who had recommended the site had assured the French that it never flooded, but as historian Christopher Morris has observed, that conception of flooding was probably dependent on significant cultural differences.[50] The Fort de la Boulaye site might in truth never have flooded . . . during those eight or nine months of the year when one could actually settle there. Native peoples living in the delta understood seasonal relocation as a non-negotiable fact of life, while Europeans, of course, associated such seasonal migration with savagery.

When Jean Baptiste le Moyne de Bienville founded New Orleans in 1718, then, he and subsequent settlers had to contend with some very particular watery challenges. Bienville chose a site for a port that was upriver enough to minimize the watery assaults of flood and storm surge seen at Fort de la Boulaye, without being too far removed from the Gulf of Mexico. In 1976, Geographer Pierce Lewis made what has since become a classic observation about the tradeoffs Bienville negotiated: New Orleans was an "inevitable city" established on an "impossible site."[51]

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[49] Jacques Gravier, "Relation or Journal of the voyage of Father Gravier, of the Society of Jesus, in 1700, from the Country of Illinois To the Mouth of the Mississipi River," in *The Jesuit Relations and Allied Documents*, vol. 65, ed. Reuben Gold Thwaites (Cleveland: The Burrows Brothers Company), 1900, 162-163.

[50] Morris, *Big Muddy*, 37-47.

[51] Pierce F. Lewis, *New Orleans: The Making of an Urban Landscape* (Cambridge, MA: Ballinger Publishing Company, 1976), 17. In fact, after three spectacular monographs about the historical geography of New Orleans, it's become somewhat of a cliché to cite Lewis. See also: Campanella, *Bienville's Dilemma*; Craig Colten, *An Unnatural Metropolis: Wresting New Orleans From Nature* (Baton Rouge, LSU Press, 2006); Ari Kelman, *A River and Its City: The Nature of Landscape in New Orleans* (Berkeley: University of California Press, 2003).

The inevitability of the city's impossible site emerged thanks to indigenous knowledge gained over the previous eighteen years of European exploration in the delta, knowledge that revealed a topographical and geopolitical compromise. Bienville's city would occupy the slim strips of high ground on the natural levees, but even though the terrain was drier and firmer than that found at the Fort de la Boulaye, it was still vulnerable to spring flooding and surrounded by swamp. But establishing a colonial capital on the truly dry terrain near present-day Baton Rouge, or even further upriver at Natchez, however, would have meant sacrificing proximity to the Gulf. Coastal shipping might then be intercepted by some other subsequent settlement, leaving the French at risk of ceding control of the lower Mississippi watershed to either the Spanish or English. What the region's native inhabitants had revealed to the French about the future site of New Orleans was a "backdoor" waterway to the Gulf. From the banks of the Mississippi, it was only a short portage to Bayou St. John, which then led into Lake Pontchartrain, and ultimately out into the Gulf of Mexico through a narrows known today as the Rigolets. This shortcut eliminated about 100 dangerous, unpredictable river miles of navigation while also justifying settlement at least a little ways upriver. At Bienville's site, the deltaic topography, although far from ideal, revealed more distinct differences between land and water than at the Fort de la Boulaye, without trading too much in shipping distance to the Gulf of Mexico.[52]

The compromise offered by the site's portage to Bayou St. John provided huge benefits. Bienville's location for New Orleans allowed the French to maintain control over the Mississippi's gateway to its enormous watershed while reducing the chances its inhabitants would spend four months of the year wading through high water. With New Orleans established as the colonial capital of French Louisiana and control over river trade in the lower Mississippi

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[52] Campanella, *Bienville's Dilemma*, 109-114; Morris, *Big Muddy*, 70-85.

Valley secured, environmental change in the region accelerated. Settlers established themselves on the high ground afforded by the natural levees and relict banks of the river and its distributaries, making use of abundant resources present at least in part thanks to millennia of indigenous interventions in the landscape.[53]

French colonists thus began their project of modernizing the soggy landscape by raising the first levees fronting New Orleans in 1722. Within two years they measured about three feet high and six feet wide and extended for over half a mile along the riverbank. Although the levees were breached that spring, by 1727 the riparian battlements at New Orleans measured over three feet high and eighteen feet wide and protected one mile of river frontage.[54] Some of the most dramatic transformations to ever affect the deltaic landscape had begun.

The first planters began with rice cultivation, but as their leveeing and drainage efforts succeeded through the second half of the 1700s, they slowly began substituting that wetter crop for drier ones like sugar and indigo, setting off the impermeability treadmill that would characterize much of the next century. Reclamation and subsequent adoption of drier crops set off a positive feedback loop. Levees begat not only more levees, but also longer, higher, and wider levees. The more the river was contained in one area, the more it compensated by pouring its floods elsewhere, driving settlers to build even more embankments and dig even more drainage ditches. The more planters expanded their agricultural and settlement efforts away from the highest ground closest to the river, the more extensive and elaborate grew their systems of

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[53]Tristram R. Kidder, "Making the City Inevitable: Native Americans and the Geography of New Orleans," in *Transforming New Orleans and Its Environs: Centuries of Change*, ed. Craig Colten (Pittsburgh: University of Pittsburgh Press, 2000), 9-21.

[54] On New Orleans levees, see: Campanella, *Bienville's Dilemma*, 123. Note that figures on eighteenth-century levee construction differ somewhat. See also: Donald Davis, "Historical Perspective on Crevasses, Levees, and the Mississippi River," in *Transforming New Orleans and Its Environs: Centuries of Change*, ed. Craig Colten (Pittsburgh: University of Pittsburgh Press, 2000), 84-106.

ditching and leveeing. By the 1770s, both sides of the riverbank were cleared and cultivated from Manchac (near Baton Rouge) to several dozen miles below New Orleans, suggesting over 175 miles of (not necessarily contiguous) levees along both banks of the Mississippi.[55]

The quality of those levees was surely uneven, since the colonial government only provided specifications, rather than actual levee-building services; embanking plantation lands was still the responsibility of the landowner. Nonetheless, by the end of the eighteenth century, settlers on Louisiana's deltaic plain had imposed some semblance of order and stability over the highly variable watery environment. With levees and drainage ditches separating river and swamp from high ground, settlers and planters began considering the possibility that Louisiana's ecology could be reformed enough to guarantee safe, stable, and—above all—enormously productive livelihoods, and not just in water-adapted crops like rice. Levees established at New Orleans in the 1720s were only perhaps three feet tall and eight feet wide, but over the course of the eighteenth century, the impermeability treadmill ensured that embankments would rise (and increase in size) all along the region's rivers and bayous. Once Etienne de Boré successfully granulated Louisiana sugar in 1795, cane began to push rice into commercial obscurity. Much drier and more drainage dependent, sugar took root in a landscape that, by the turn of the nineteenth century, had already been substantially engineered and reclaimed. Growing to be the dominant agricultural force in nineteenth-century Louisiana, however, sugarcane helped drive an even more concerted effort to separate wet from dry and to barricade homes, fields, markets, and towns from the unruly incursions of the Mississippi.

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[55] On leveeing through the 1770s, see: Campanella, *Bienville's Dilemma*, 195-199.

Sugar and the Impermeable Nineteenth Century

If the eighteenth century established levees as one of the most beneficial components of flood control and drainage, the nineteenth century saw settlers and their sugar plantations deploy levees across the landscape with ever more rapidity. A major flood in 1828 initiated an even more intensive round of levee-building and enlargement, with New Orleans and other local governments regulating construction and care and also creating taxes to help pay for flood protection. By the 1840s, levees extended from several miles below New Orleans all the way up to the mouth of the Ohio River, although not without gaps and inconsistencies. From this period through the end of the century, Louisiana witnessed the development among both sugar planters and engineers of a widespread flood culture of rigid impermeability.[56]

Historically, southern Louisiana has been famed for its sugar plantations and the region's agricultural past is remembered for no other crop more than sugarcane.[57] While northern Louisiana plantations looked far more like the rest of the cotton south, sugar dominated the southern reaches of the state below the confluence of the Red, Atchafalaya, and Mississippi Rivers. Some of the highest producing areas were those parishes clustered around the Mississippi and Atchafalaya rivers and bayous Teche and Lafourche. These waterways offered the promise of higher (and therefore drier) ground on natural levees, as well as the most direct access to the nineteenth century's dominant transportation medium: water. Historian John Rodrigue observes that the crop was a key feature of Louisiana's culture and economy, creating a "sugar society"

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[56] George Pabis, "Delaying the Deluge: The Engineering Debate over Flood Control on the Lower Mississippi River, 1846-1861," *Journal of Southern History* 64 (1998): 421-454, 425-6; Pabis, "Subduing Nature," 64-5.

[57] Historic plantations interpret Louisiana's sugar past, the vast majority of histories focus on the sugar economy, and even the state's major bowl sporting event is referred to as the "sugar bowl." For the history of Louisiana sugar see: John B. Rehder, *Delta Sugar: Louisiana's Vanishing Plantation Landscape* (Baltimore: Johns Hopkins University Press, 1999); Moon-Ho Jung, *Coolies and Cane: Race, Labor, and Sugar in the Age of Emancipation* (Baltimore: Johns Hopkins University Press, 2006); John Rodrigue, *Reconstruction in the Cane Fields: From Slavery to Free Labor in Louisiana's Sugar Parishes, 1862-1880* (Baton Rouge: LSU Press, 2011).

within a slave South otherwise defined by cotton.[58] From the first successful granulation of sugar in Louisiana in 1795 through the Civil War and beyond, the region became known as sugar country. Throughout the nineteenth century, Louisiana regularly produced as much as ninety percent of the nation's sugar. By 1861, Louisiana yielded a record-breaking 460,000 hogsheads (about 575 million pounds) of sugar worth $25 million. The state's industry as a whole was valued at $200 million, over half of which accrued in slave bodies.[59]

The riches sugar yielded, however, did not mean the crop was perfectly suited to the state. A tropical plant, sugarcane depended on a yearlong growing season with mild temperatures and fairly high rainfall offset by sufficient drainage. Sugarcane's shallow root system made it vulnerable to rot and the waterborne plant diseases that accompany persistent inundation or even saturation. Louisiana's subtropical climate, however, limited the growing season to nine or ten months, with the latter part of the season marked by what geographer John Rehder calls "unpredictable but devastating freezes." Those challenges of seasonality were partially overcome with the 1817 introduction of a new variety—ribbon cane—better suited to the shorter growing season and the threat of frost.[60]

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[58] Rodrigue, *Reconstruction*, 9.

[59] For sugar statistics, see: Walter Prichard, "Effects of the Civil War on the Louisiana Sugar Industry," *The Journal of Southern History* 5 (1939): 315-322; Rodrigue, *Reconstruction*, 9. A hogshead was the standard unit of measurement for sugar in nineteenth-century Louisiana. In 1870, it measured about 1250lbs., Louis Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1870-1871* (New Orleans: Bronze Pen Steam Book and job Office, 1871), xiii; Robert F. Pace, "'It Was Bedlam Let Loose': The Louisiana Sugar Country and the Civil War," *Louisiana History: The Journal of the Louisiana Historical Association* 39 (1998): 389-409, 390. $25 million in 1861 was equivalent to about $670 million in today's dollars. $200 million in 1861 is equivalent to almost $5.5 billion in today's dollars.

[60] John B. Rehder, *Delta Sugar: Louisiana's Vanishing Plantation Landscape* (Baltimore: Johns Hopkins University Press, 1999), 12-19. Despite these frosts, nowhere else in the mainland United States was better suited to growing sugarcane than Louisiana. Poorer growing conditions and a shorter season in Georgia made harvesting and processing cane with a high enough sugar content a challenge. The Florida industry only developed in earnest beginning in the 1920s—a century after its acquisition by the United States—and only because of a combination of both market forces and, importantly, environmental transformation in the Everglades. For the history of sugar agriculture in Georgia, see: Mart A. Stewart, *"What Nature Suffers to Groe": Life, Labor, and Landscape on the*

But while new varieties allowed sugar planters to largely overcome climatic challenges, the problem of drainage persisted, given this was a region essentially defined by muck and swamp and flood. Sugar could most easily be grown on the slivers of high ground afforded by the natural levees of the Mississippi River and both its distributaries and relict channels. Not only was this high ground somewhat less vulnerable to flood, it also offered planters sandier, more porous soils, which provided better drainage.[61] Even then, however, considerable labor was required to both protect the crop from inundation (through leveeing) and to maintain consistent drainage throughout the year by maintaining raised planting rows and keeping ditches free of sediment. Governor Périer's remarks in a 1731 letter suggest the deep extent to which sugar agriculture would later depend on slave labor in the 1800s:

> The lands can be drained and freed from water only by those who have negroes, since the work on levees and drainage is difficult and hard. Even though a man were not sick, no matter how good a settler he may be, in an entire year he would not put one arpent [0.84 acres] of land in condition to be planted.[62]

Louis Bouchereau pressed the point on drainage in one of his annual reports on the sugar crop: "Remember that *water* is the greatest enemy of the cane, and that to *insure* a crop you must have a sufficiency of ditches to carry off rain water at once. No money spent in ditching is thrown away, the more ditches you have the better."[63]

Maintaining adequate drainage was thus an enormous job for a sugar plantation. Any expansion of cultivated fields into low-lying areas that were less consistently dry (already a

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Georgia Coast, 1680-1920 (Athens: University of Georgia Press, 1996), 122-6. On the history of the Florida sugar industry, see: Gail M. Hollander, *Raising Cane in the 'Glades: The Global Sugar Trade and the Transformation of Florida* (Chicago: University of Chicago Press, 2008).

[61] Sam B. Hilliard, "Site Characteristics and Spatial Stability of the Louisiana Sugarcane Industry," *Agricultural History* 53 (1979): 254-269. Planters depended on river frontage not just for higher ground and better soils, but also for proximity to the river: the most important means of articulating the plantation with markets.

[62] Goveror Périer to Maurepas, quoted in Morris, *Big Muddy*, 58.

[63] Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1870-1871*, x-xi.

relative term in the soggy landscape), meanwhile, required still more reworking of the environment. Louisiana's impermeable sugarscape was thus fundamentally dependent on the development of slavery in the state. Where the slave population of the sugar-producing parishes was under 10,000 in 1810, by 1830 it had reached over 42,000. That figure more than doubled over the next 30 years such that by 1860 the sugar parishes saw slaves outnumbering whites by almost 30,000 even though the rest of the state had a small white majority at the time.[64] These figures are testimony not just to the expansion of the sugar industry as a whole, but also to the enormous amounts of labor that went into remaking the landscape in sugar's image. Slavery in Louisiana existed not just to help produce the crop, but also to remedy what historian J. Carlyle Sitterson called a "lack of complete harmony between land and product." For sugar planters, rendering the landscape impermeable to rising water was of the highest priority. Louisiana's nineteenth-century sugar society was thus also necessarily an impermeable society.[65]

Indeed, with sugar leading the way for regional prosperity, it is perhaps no surprise that impermeability also shaped the values and imaginations of Louisiana engineers and policymakers. The historians George Pabis and Martin Reuss have shown that as early as the 1840s, a debate had emerged over two main courses of action for flood control in Louisiana.[66] One side advocated a system of outlets that would allow floodwaters to spread over parts of the landscape, thereby lowering the height of the river. The other argued this was a certain path to

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[64] Slavery demographics in: Rodrigue, *Reconstruction*, 9-12. Besides reforming the landscape, sugar agriculture produced labor demands for cultivation, harvesting, and processing. In the 1870s, a typical sugarhouse needed fifteen laborers working twelve-hour shifts to produce eight hogsheads of sugar per day. Given that technological advances and developments in efficiency had likely improved production rates by the 1870s, it's safe to assume that the decades prior to the Civil War likely required even more enslaved labor to produce similar quantities. On 1870s labor requirements, see: Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1870-1871*, xiii.

[65] J. Carlyle Sitterson, *Sugar Country: The Cane Sugar Industry in the South, 1753-1950* (Lexington: University of Kentucky Press, 1953), 13, 21.

[66] Pabis, "Subduing Nature"; Pabis, "Delaying the Deluge"; Martin Reuss, *Designing the Bayous: The Control of Water in the Atchafalaya Basin* (Alexandria, VA: US Army Corps of Engineers, 1998).

future disaster. Rejecting outlets, these critics insisted that levees, and levees only, could guarantee the safety and commerce of the region. As the century unfolded, that levees-only perspective would gain a greater ideological foothold not just in Louisiana, but also federally.

Naturally, there were some dissidents. State engineers Paul Octave Hébert and Absalom D. Wooldridge expressed grave concerns about a levees-only approach to flood control. These engineers advocated a more diversified system that incorporated some porosity in the riverbanks alongside levees. They argued that successful flood control had to mimic nature by incorporating outlets and reservoirs that allowed for rivers in high water to spread over certain parts of the landscape. Swamps and distributaries absorbed, stored, and siphoned away floodwaters from the main channel. Constraining the Mississippi in between endless, unbroken, levees and indiscriminately draining the swamps of surrounding lowlands would only guarantee higher, more destructive floods in the future.[67]

Similarly, a civil engineer named Charles Ellet expressed reservations about levees-only at the federal level when he submitted a report to Congress in 1851. A year earlier, President Millard Fillmore and Secretary of War Charles Conrad had requested two parallel surveys of the lower Mississippi River. Andrew A. Humphreys, leading the Corps of Topographical Engineers (which would merge with the Army Corps of Engineers in 1863) led the first. After finally being published in 1861 as the *Report Upon the Physics and Hydraulics of the Mississippi River*, it became the most influential document advocating a levees-only policy for the Mississippi River basin.[68] In contrast, the second survey, undertaken by Ellet as a civil engineering study

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[67] Pabis, "Subduing Nature," 65; Pabis, "Delaying the Deluge," 426-428.

[68] Andrew A. Humphreys and Henry L. Abbot, *Report Upon the Physics and Hydraulics of the Mississippi River* (Philadelphia: J.B. Lippincott & Co., 1861). Although future research would reveal that it contained significant errors, *Hydraulics and Physics* presented far more data of a far higher quality over a far larger geographical area than anything that had come before. Ellet's competing and dissenting survey, by contrast, had largely been

independent of the US Army, identified the extension of the levee system as one of the four factors responsible for the increased severity and frequency of lower Mississippi floods.[69] Like Hébert and Wooldridge, Ellet advocated building upon the natural hydrological processes of the river in flood. In addition to improving its natural outlets for absorbing and retaining excess waters, Ellet suggested building a system of artificial outlets and reservoirs. Such a system could account for the increased volume of flooding that he argued was caused by deforestation, expanding cultivation, and increased swamp reclamation in the upper watershed. But although Ellet was concerned that relying solely on levees exacerbated Mississippi flooding, he still believed they were an important component of a diversified flood protection system. Ellet was not advocating that levees be abandoned altogether, but rather advocated their judicious use to protect and improve riparian development.

In submitting his report, Ellet acknowledged but did not condemn one of the most significant social factors that he argued would inevitably exacerbate flooding in the lower Mississippi: the Swamp Land Acts of 1849 and 1850.[70] Devastating floods in 1844 and 1849 drove Congress to act on the matter of flood control in the lower valley. Unwilling to pay for

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theoretical, rather than empirical, in nature. In being the definitive data source and documenting the unprecedented efficacy of military engineers in gathering data, Humphreys's report carried considerable authority. See: Pabis, "Delaying the Deluge," 425, 435, 448.

[69] Pabis, "Delaying the Deluge," 430-434. The report was later published as part of: Charles Ellet, Jr., *The Mississippi and Ohio Rivers Containing Plans for the Protection of the Delta from Inundation; and Investigations of the Practicability and Cost of Improving the Navigation of the Ohio and Other Rivers by Mean of Reservoirs* (Philadelphia: Lippincott, Grambo, and Co., 1853). The other three factors included: the expansion of agriculture throughout the watershed (the most important factor in Ellet's analysis); cutting across river meanders for navigational purposes; and the continuing natural extension of the Mississippi River into the Gulf of Mexico. Ari Kelman observes that Ellet prefigures George Perkins Marsh by over a decade in his assertions that humans were capable of large-scale environmental change and that those changes could result in dire repercussions that would cascade through a watershed: Kelman, "Boundary Issues," 699.

[70] Historian George Pabis claims that Ellet roundly condemned the Swamp Land Acts: Pabis, "Delaying the Deluge," 433. Ellet, however, was clearly a pragmatist. He wrote in his report, later published as a book in 1853, that "it is impossible to restrain the States in their career of reclamation. . . . In fact, the interest of the country, as well as that of the States in which these inundations occur, does demand the speedy reclamation of the swamps." Ellet, *The Mississippi and Ohio Rivers*, 107.

flood protection directly and believing that state levees would be a vast improvement over the ad-hoc system that existed, the US government transferred federal swamplands to Arkansas, Missouri, Mississippi, and Louisiana. The states would in turn sell these lands "subject to overflow and unfit for cultivation" to private citizens, using the revenue generated to support levee-building and wetland reclamation. Louisiana alone received over nine million acres of swampland. The process was highly dysfunctional, however. Plagued by corruption, the Acts tended to enrich speculators more than they resulted in flood protection. But while the laws failed to produce a line of uniform levees along the river, they still encouraged settlement and agricultural expansion—particularly sugarcane—and ushered in an era of state-managed reclamation and flood control.[71] Together, these processes inevitably accelerated, albeit imperfectly, the desiccation and embankment of the landscape.

The Swamp Land Acts undeniably shaped the culture and economy of mid-nineteenth-century Louisiana. The region was marked by a kind of reclamation boosterism in which the prosperity of both the state and nation were profoundly tied to wringing dry plantation land from the watery environment. State engineer Absalom Wooldridge, with his deep reservations about a levees-only approach, believed swamps played a crucial role in a diversified flood-protection system. Yet at the same time he believed there was "comparatively little swamp land in Louisiana." Rather there was a vast amount of "inundated land" which, once reclaimed, would "become the habitation of an industrious and enterprising population," rendering the state "the most wealthy and delectable region in the broad world."[72] Failure to engage in such reclamation

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[71] On the role of the Swamp Land Acts in Louisiana history, see: Cindy Poe, "Reconstructing the Levees," 88-95 and Morris, "*Big Muddy*," 141-142.

[72] Absalom D. Wooldridge, *Report on the Internal Improvements of Louisiana* (New Orleans: Hinton & Co., 1850), 32, 53-54.

efforts, meanwhile, would send investors and capital elsewhere, leaving Louisiana inundated not only with water, but also lost opportunity.

If pro-outlet engineers like Wooldridge could be swept up by the impermeable values of reclamation boosterism, then the levees-only evangelists were the perfect partners in said boosterism. George Bayley, an assistant to Louisiana's state engineering office in the early 1850s, condemned Ellet's pro-outlet views by arguing they were "contrary to the spirit of the age; to that spirit of improvement which would reclaim and cultivate, that would convert every swamp and fen into abodes of wealth, into cultivated fields."[73] Doubtless the "cultivated fields" of Bayley's vision would be planted entirely with sugarcane. Likewise, Caleb G. Forshey, one of the most "vehement" defenders of levees-only in the mid-1800s, according to George Pabis, was also a staunch advocate of reclamation as being of critical importance for the national economy.[74] Of course, levees-only would not be enshrined in any form of official policy until its adoption by the Mississippi River Commission in 1885. Nonetheless, the efforts of engineers like Forshey, William Hewson, Albert Stein, and, most famously, Andrew A. Humphreys synergized with reclamation boosterism to ensure that, even by the 1860s, this flood culture of impermeability had become dominant among Louisiana engineers.[75]

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[73] Bayley reviewing Ellet's report is quoted in Pabis, "Subduing Nature," 66.

[74] Pabis, "Subduing Nature."

[75] On other levees-only advocates, see: Pabis, "Subduing Nature," 66, 76; Reuss, *Designing the Bayous*. Not all levees-only advocates were ideological reclamationists like Bayley and Forshey. Andrew A. Humphreys's survey of the lower Mississippi, published almost a decade after Ellet's report, reached its levees-only conclusion through a process of elimination: Humphreys was not at first opposed to outlets; he just found them too expensive and ineffectual to be worth the effort. The profound influence that the *Hydraulics and Physics* would have on cementing the place of levees-only in a national flood culture had more to do with data and institutional power. Although it would ultimately serve the interests of reclamationists, any biases toward wetland reclamation were not a significant feature of the report. On Humphreys, see: John Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (New York: Simon & Schuster, 1997). Also see: Morris, *Big Muddy*, 144-163; Pabis "Delaying the Deluge." Finally, despite this increasing consensus around levees-only, nineteenth-century attitudes toward flood control were still not homogenous, particularly outside of the field of engineering. As late as 1892, several years after levees-only had become official dogma, an editorial in the *Louisiana Planter and Sugar Manufacturer*

By the time the Mississippi River Commission was created in 1879, levees-only ideology was pervasive; its adoption as federal policy in 1885 was already perhaps a fait accompli. Institutional conflicts between military and civil engineers in the 1870s, alongside politicking in amongst Army Corps leadership, resulted in even more rigid dedication to levees as the only possible solution to flooding on the Mississippi. But even decades prior to this consolidation around levees-only in the 1870s and 1880s, its values predominated among a majority of Louisiana engineers and almost all of its sugar planters. From the 1840s through the 1870s, then, Louisiana was marked by an increasingly impermeable flood culture. Attempts to render the dynamic landscape both habitable and conducive to sugar agriculture accelerated alongside the emergence of an impermeable engineering consensus around flood control. That consensus was increasingly entangled with reclamation boosterism and the hopes of guaranteeing both regional prosperity and Louisiana's economic centrality in the affairs of the nation. An impermeable sugar society had emerged in the deltaic plain of the Mississippi River.[76]

Despite the best efforts of engineers and sugar planters, however, crevasses would still tear through southern Louisiana's levees, resulting in disastrous floods through the late 1800s. Although a cultural and engineering consensus seems to have developed in the region, the unruly forces of the deltaic environment still produced frequent deluge for much of the century.

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condemned that approach to flood control and argued in favor of a diversified system including outlets: B.A. Colomb, "Levees Alone Won't Do," *Louisiana Planter and Sugar Manufacturer*, July 2, 1892, 8.

[76] John Barry wrote extensively on the clash of egos and the political and institutional developments around levees-only in the 1870s. Barry, *Rising Tide*. George Pabis adds important nuance and further historical detail to Barry's arguments in "Delaying the Deluge."

Crevasse!

With the first levees in Louisiana came the first crevasses. Wherever French settlers began erecting embankments in case of flood, water periodically—and inevitably—found a way through. As colonial Louisiana developed, riparian levees increased in size and length to protect larger and more numerous plantations, settlements, and other investments threatened by inundation. Ironically, and unbeknownst to most, those efforts also ensured that crevasses grew considerably more destructive. The more levees constrained high waters, the more catastrophic their eventual release on the landscape. Although the Mississippi had spent the last seven thousand or so years regularly breaking its natural banks, crevasses in the eighteenth and nineteenth centuries became ever more dramatic as bigger levees ensured high water in the river channel could be tens of feet above surrounding lands.[77]

In the earliest years of European settlement in and around New Orleans, overtopping was probably one of the more common sources of levee failure. Spring freshets coursing down the Mississippi watershed could pour enough water in the channel to raise a flood substantially higher than the two or three-foot high embankments erected in the 1720s. But as time went on, particularly amid the growing engineering and cultural consensus around reclamation and levees-only flood control, embankments in the region grew taller, wider, and more systematic in their construction. Overtopping grew less and less frequent and more violent crevasses—in which water burst through, rather than over the levees—became the norm instead.

As larger, more impermeable embankments increasingly contained floodwaters in the main channel of the Mississippi, the pressure and forces swirling against those levees grew

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[77] Roger T. Saucier, *Geomorphology and Quaternary Geologic History of the Lower Mississippi Valley* (Vicksburg: U.S. Army Engineer Waterways Experiment Station, 1994), 105.

correspondingly greater. No longer able to as easily flow over the top of these embankments, the Mississippi churned amidst its confines with ever-greater ferocity until a crevasse released devastation across the landscape. Roiling waters could saturate levee soils so much that they eventually lost stability, collapsing in a rush of mud and froth. Alternatively, powerful waves and currents that developed in high water could tear at the crest of the levee, weakening the structure enough for the river to eventually rend a hole in the embankment. Or, perhaps most insidiously, the flood could instead stealthily penetrate the foundations of the levee, with boils and small springs on the landward side being the only hint of the catastrophic deluge to come.[78] Massive torrents replaced the comparatively quiet floods of the deltaic landscape. Although impermeable engineering reduced the frequency of flooding, it had dramatically intensified the rate at which floodwaters poured across the landscape whenever levees finally broke.

A breach could sound like a powerful explosion, as many eyewitnesses still testified even in the early twenty-first century when Industrial Canal levees failed during Hurricane Katrina.[79] In the first few seconds of a crevasse, huge masses of earth and mud could be heaved dozens, or even hundreds, of feet from the river bank, moving buildings off of their foundations and unleashing torrents of water across the land.[80] Once the river had found a way out of its confines, rushing waters tore the gash wider and deeper until it was either repaired or the flood subsided.

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[78] On the sources of crevasses—overtopping, saturation, wave action, and boils—see: Eric Wood, “An Analysis of Flood Levee Reliability,” *Water Resources Research* 13 (1977): 665-671.

[79] For accounts of explosion sounds during Katrina, see: Spike Lee, *When the Levees Broke: A Requiem in Four Acts* (HBO, 2006). Eyewitness testimony around explosions during Katrina led to conspiracy theories suggesting intentional dynamiting of the levees. While completely untrue, those theories were born out of a troubled history of intentional levee destruction in the 1927 flood coupled with centuries of profound racial and class inequality in New Orleans. Eyewitness accounts of crevasses in the Great Flood can be found in Pete Daniel, *Deep’n as It Come: The 1927 Mississippi River Flood* (New York: Oxford University Press, 1977).

[80] On heaving earth and shifting buildings off their foundations, see: Rogers et al., “Geologic Conditions Underlying the 2005 17th Street Canal Levee Failure in New Orleans,” *Journal of Geotechnical and Geoenvironmental Engineering* vol. 134, no. 5 (2008): 583-601; Stephen A. Nelson and Suzanne F. Leclair, “Katrina’s Unique Splay Deposits in a New Orleans Neighborhood,” *GSA Today* vol. 16, no. 9 (2006): 4-10.

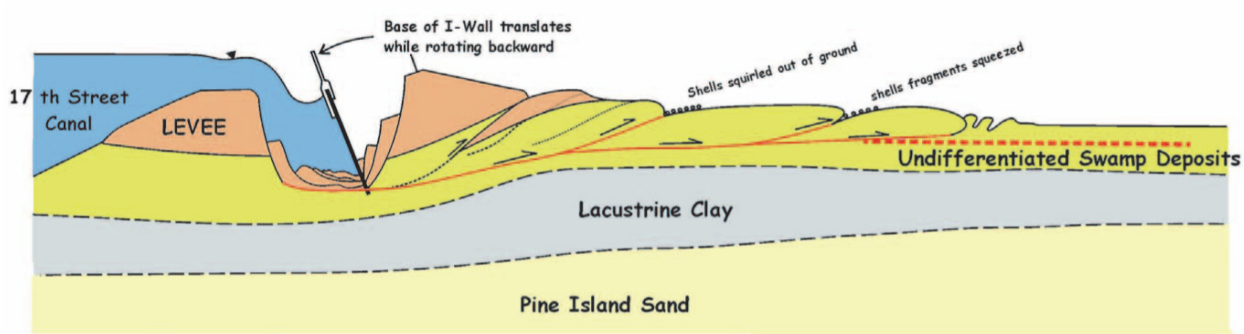

Figure 1-1: The 17th Street Canal levee failure in New Orleans during Hurricane Katrina. Storm surge undermined floodwall foundations and levee stability. Note the soil heaved away from the levee. Figure used with permission from Rogers et al., "Geologic Conditions," 595.

One such explosive crevasse occurred on Sunday April 11th, 1858. That spring had in general brought considerable anxiety to southern Louisiana.[81] Snowmelt and rains had made for notably high water on the Mississippi, and newspapers like the *New Orleans Daily Crescent* regularly reported on the height of the river.[82] On this particular day, the Mississippi had burst through the levees fronting John M. Bell's plantation, just upstream and across the river from the French Quarter (Figure 1-2). Word immediately spread to planters downstream. Eleven miles almost due south of Bell's plantation, the overseer at Mavis Grove began anxiously eyeing the river that flowed beside the property under his care. One of the largest and most productive of southern Louisiana's sugar plantations, Mavis Grove spread over 3,700 acres and was worked by 158 slaves and 75 mules.[83] The crevasse eleven miles north threatened not only its prosperity, but that of the many other plantations on the lower west bank of the river.

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[81] Spring freshets wrought 45 recorded crevasses, or levee breaches, along the lower Mississippi, a degree of destruction that would be unmatched until the great floods of 1882-1884. Humphreys and Abbot dedicate almost 40 pages of *Physics and Hydraulics* to demonstrating that the 1858 floods should be used as a "safe standard by which to estimate the necessary measures for protection." Humphreys and Abbot, *Physics and Hydraulics*, xiv-xvi, 112-150. Again, while the document was problematic for its errors, it was still hugely influential. Davis, "Historical Perspective on Crevasses," 95; United States Department of Agriculture, *Report of the Chief of the Weather Bureau, 1896-97* (Washington, D.C.: Government Printing Office, 1897), 395.

[82] "The Bell's Plantation Crevasse," *New Orleans Daily Crescent*, April 13, 1858

[83] Frederick Stielow, "The Bell Crevasse at Mavis Grove," *Louisiana History* 18 (1977): 474-478; Betsy Swanson, *Historic Jefferson Parish: From Shore to Shore* (Gretna, LA: Pelican Publishing, 1975), 148.

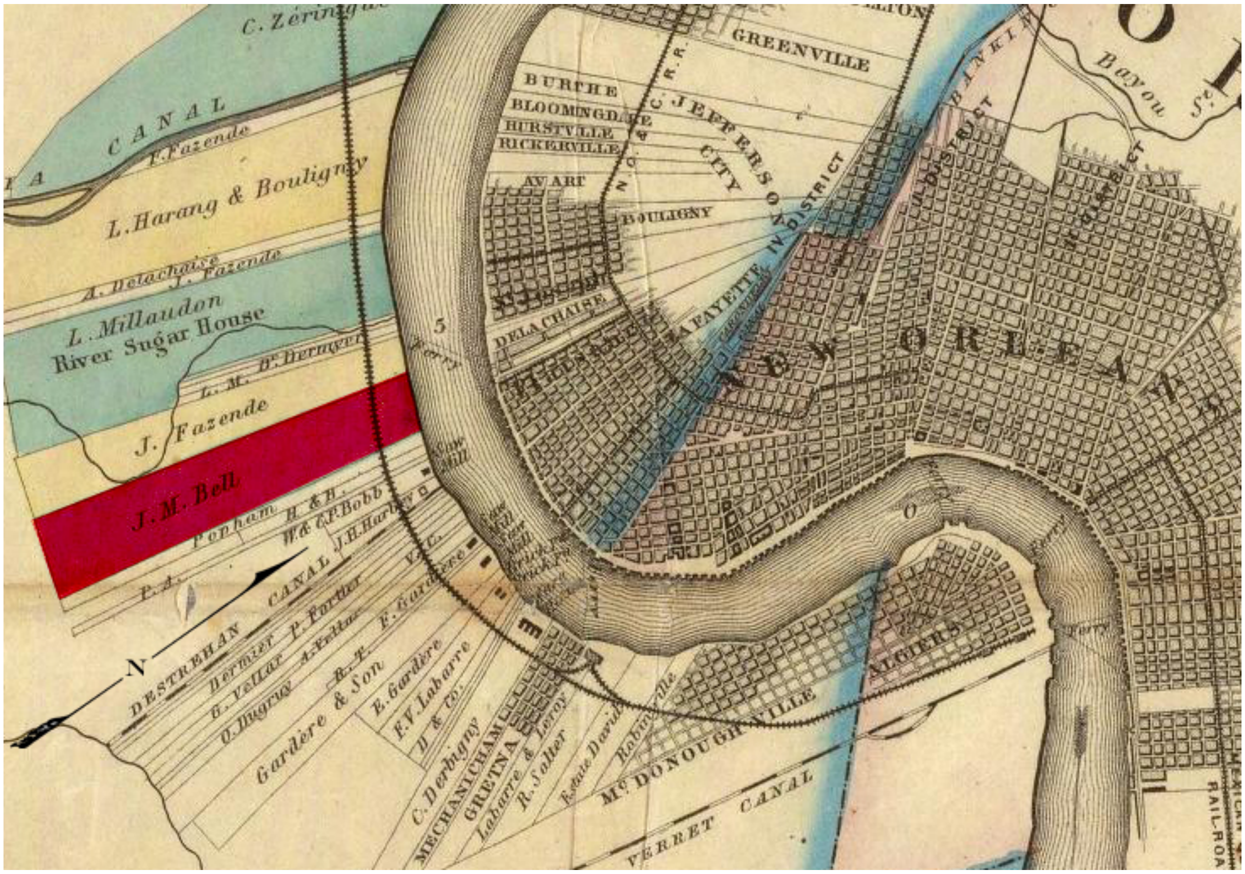

Figure 1-2: John M. Bell's Plantation. Adapted from A. Persac, "Norman's Chart of the Lower Mississippi River," 1858.

Within three days, the breach had grown to over seventy feet in width and the torrent of water raging through it had scoured a channel fifteen feet deep. A flatboat that some creative soul had hoped would dam the hole had been tossed aside and the eddying waters were scouring away more and more of the banks each hour. Meanwhile, the backswamp was filling with water and the Opelousas Railroad already lay several feet below the flood. Over the next several days the overseer at Mavis Grove observed the color and flow of Bayou Barataria change significantly as it filled with floodwaters from the Bell Crevasse. On Sunday the 18th, he assigned six slaves to dam the plantation's canals while levee maintenance began in earnest. By April 22nd, the crevasse had made news as far away as New York. All efforts to close the breach had failed. The overseer at Mavis Grove was fighting a losing battle.[84]

Figure 1-3: "The Bell Crevasse," Supplement to *The Picayune*, May 16, 1858.

But while planters and their slaves below the crevasse were suffering considerably, the breach had also become something of a tourist attraction for New Orleanians (Figure 1-3). Anglers gathered at the cut to catch fish using dip-nets, while large masses of spectators on both the intact portions of the levee and boats plying the floodwaters looked on in curiosity. Indeed, a supplement to the *Picayune* remarked that thousands of visitors passed by the crevasse daily, spurring some entrepreneurs to create new ferry lines and fleets of skiffs outfitted with awnings and other comforts. A Boston periodical observed that even a makeshift "bar-room" had been set

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[84] "The Mississippi Crevasse," *The New York Times*, April 22, 1858; "The Bell Crevasse," supplement to *The Picayune*, May 16, 1858; "The Crevasse at Mr. Bell's Plantation," *Ballou's Pictorial*, June 5, 1858; Stielow, "The Bell Crevasse at Mavis Grove," 474; "Local Intelligence," *New Orleans Daily Crescent*, April 14, 1858; "The Bell Crevasse: Extent of the Inundation—List of the Principal Sufferers," *The Daily Picayune*, April 22, 1858.

up on the spot. The event seemed to prove so entertaining that a piece of dance music was composed in its honor: “The Bell Crevasse Mazurka.”[85]

Despite the attraction the crevasse presented for New Orleans residents, conditions were far more grave back at Mavis Grove. On May 25th, the overseer lamented a crevasse of his own in Mavis Grove’s bayou levees, a sure sign he was losing not only the battle, but also the war: “fields all covered with water & water had risen up into the SH [sugar house] yard…. Everything begins to look gloomy & the prospect of holding back the water diminishes every day…. [must] begin to think of arrangements in case of general overflow….” After another week of miserable and impossible labor, Little Caeser, a slave youth, drowned in one of the overflowing canals. Giving up, the overseer began arranging for Mavis Grove’s slaves to board steamers and barges for Grand Terre, a barrier island across Barataria Bay. On June 9th, he and the “hands” left the plantation’s sheep and cattle on the high ground afforded by some shell mounds and abandoned the property to the ravages of Bell’s breach.[86]

In a season that eventually saw 45 crevasses on the Mississippi, the Bell Crevasse was by far the worst. Even as early as May 16th, the destruction wrought by Bell’s crevasse had become apparent. Over 250 feet wide and 22 feet deep, the breach sent floodwaters from Bell’s plantation to fields as far as 27 river miles below New Orleans. Boats were freely navigating over what had been cultivated lands for up to fifteen miles back from the crevasse. *The Picayune* estimated damages ranging from four to five million dollars.[87] At Mavis Grove alone, the disaster claimed one life and 862 acres of crops in cultivation. Since efforts to patch the crevasse

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[85] “The Bell Crevasse,” supplement to *The Picayune*, May 16, 1858; “The Crevasse at Mr. Bell’s Plantation,” *Ballou’s Pictorial*, June 5, 1858; N.A. Barbé, *The Bell Crevasse Mazurka* (New Orleans: P.P. Werlein & Co., 1858).

[86] Stielow, “The Bell Crevasse at Mavis Grove,” 476-478.

[87] Between $115-$144 million in today’s dollars.

continued to fail, the breach eventually grew to over 800 feet in width. Its waters poured across the region through late August, at which point the high ground at Mavis Grove was covered in five feet of water. Work on that plantation would not recommence for another six weeks, while damage estimates reported in May were likely far short of actual losses.[88]

But what was it that caused this particular disaster? To be sure, it was a "great flood" year and levee failures were not uncommon during this time. Historical geographer Don Davis refers to the years between 1750 and 1927 as the "crevasse period."[89] But in this case one specific factor had led to the breached levee fronting Bell's property. As *The Picayune* explained, "through the levee at this point there was a wooden sluice, enclosed on all sides, through which water was conveyed from the river to rice fields in the rear of the plantation."[90] Although Bell's plantation no longer cultivated rice and the sluice had been removed and patched, these alterations to the levee had created a weak spot easily overcome by the swollen river. The Bell Crevasse was not a simple levee failure in the face of overwhelming flood. Rather, it was in part the result of a specific technology installed in the levee, a technology that would provoke a forgotten struggle over permeability in southern Louisiana.

The Permeable Plantation

The sluice "enclosed on all sides" found on Bell's plantation was a device that would eventually be known in Louisiana as a "flume." Constructed from bald cypress until 1890 when

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[88] "The Bell Crevasse: Extent of the Inundation," *The Daily Picayune*, April 22, 1858; "The Bell Crevasse," Supplement to the *Picayune*, May 16, 1858; "The Great Bell Crevasse," *Harper's Weekly*, May 29, 1858, 341; J.H. d'Hémécourt, "Plan Representing J.M. Bell Crevasse," 1858, archived at the Louisiana State Museum: F6C2D1; Stielow, "The Bell Crevasse at Mavis Grove," 474-8.

[89] Davis, "Historical Perspective on Crevasses," 85.

[90] "The Bell Crevasse," Supplement to the *Picayune*, May 16, 1858.

most planters switched over to iron pipes, flumes were box-like conduits placed through the levee. A rice planter might insert a flume at the time of levee construction, or cut an existing levee to lay a flume and then bury the conduit with fresh earth to patch the cut. An archaeological survey published in 1990 documented a handful of remaining flumes constructed from cypress boxes, iron pipes, and hybrids of the two. The survey provides a sketch of how these devices appeared (Figure 1-4).[91] But while rice agriculture in Louisiana reaches back to the first years of European settlement in the early 1700s, flumes only appeared in the region sometime in the first half of the nineteenth century. Before we can fully understand the importance of the flume and the conflicts that would surround it, we have to understand the broader place of rice agriculture in colonial Louisiana.

Many of the first efforts at settling and cultivating the landscape depended on rice. Historian Christopher Morris recounts how early eighteenth-century rice cultivation in Louisiana helped these settlers realize that the mucky, muddy, flood-prone environment could actually sustain a colony. The grain allowed French Louisianans to become independent from wheat imports and to have some alternative to the local corn, which was stigmatized as Indian food. By demonstrating that the colony could viably sustain itself, rice encouraged investment in the region. Moreover, rice helped feed both the soldiers who helped carry out the occupation of native lands and the slaves who worked to transform those lands into some semblance of permanently habitable terrain. Rice, according to Morris, suggested for early settlers that

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[91] R. Christopher Goodwin, James M. Wojtala, Lawrence L. Hewitt, and George W. Shannon, Jr., *Rice Agriculture in the River Parishes: The Historical Archeology of the Vacherie Site (16 SJ 40), St. James Parish, Louisiana* (New Orleans: US Army Corps of Engineers, 1990). Note that flumes, as hollow conduits, somewhat resemble the trunk sluices—literally a hollow tree trunk—found on early Carolina rice plantations. Judith Carney suggests these early trunks were a form of technology transfer from West Africa. Judith Ann Carney, *Black Rice: The African Origins of Rice Cultivation in the Americas* (Cambridge, MA: Harvard University Press, 2001), 95-96.

Louisiana's unstable waterways and disquieting wetlands could in part be managed.[92] But despite being a commercial crop in the eighteenth century, early Louisiana rice was still cultivated on a relatively small scale—on the order of a few miles lining the Mississippi.[93]

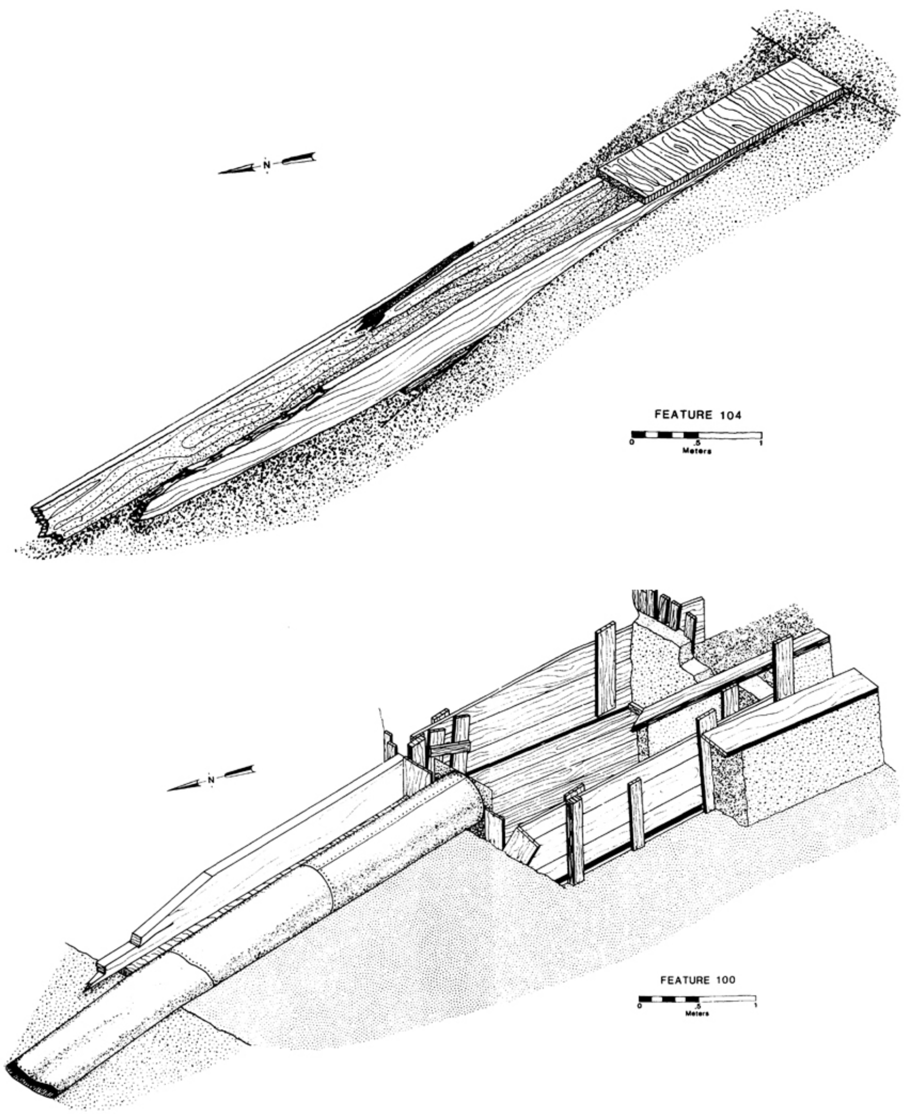

Figure 1-4: A cypress box flume and a combined pipe-and-wood flume excavated in St. James Parish in the 1980s. Figure from Goodwin et al., *Rice Agriculture in the River Parishes*, 1990.

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[92] Christopher Morris, *Big Muddy*, 48-69.

[93] Charles Gayarré, "Historical Notes on the Commerce and Agriculture of Louisiana, 1720-1766," *Louisiana Historical Quarterly* vol. 2, no. 3 (1919): 286-291.

The geographer Chan Lee suggests much of the crop at this time was known as "providence rice."[94] Raised without much artificial irrigation, providence rice was cultivated in the low, soggy elevations away from the river where planters could rely on persistent inundation from rainfall and flooding backswamps over the growing season. Two sources suggest, however, that there may have been considerably more artificial irrigation than this. In 1731, an officer returning to France described cuts in the levees irrigating rice fields.[95] And, at the turn of the nineteenth century, Pierre-Louis Berquin-Duvallon's 1802 travelogue likewise noted canals through the levees that connected the river with agricultural fields and backswamp.[96]

Such open cuts in the levees likely would have made sense to settlers in the eighteenth century when the more unreclaimed and sodden landscape lent itself to a more predominantly rice-based agricultural economy. But, as we have seen, the nineteenth century's turn toward sugarcane was another matter. After Etienne de Boré's 1795 granulation of Louisiana sugar, a new crop began to dominate regional agriculture, resulting in an intensified effort to separate wet from dry. The nineteenth century witnessed both sugar's ascendance in the region and the use of increasingly contiguous, consistent levees. Commercial rice agriculture—and presumably open cuts in the levees—fell into decline for several decades.

By 1848, however, a new suite of rice-irrigation technologies was observed along Louisiana's rivers and bayous. Robert Andrews Wilkinson wrote for *DeBow's Review* about the commercial production of rice in the state. Noting its diminishing popularity in comparison with

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[94] Chan Lee, "A Culture History of Rice With Special Reference to Louisiana" (PhD diss., Louisiana State University, 1960), 89-92, 95.

[95] Marcel Giraud, *A History of French Louisiana: The Company of the Indies, 1723-1731, Vol. 5*, trans. Brian Pearce (Baton Rouge: Louisiana University Press, 1991), 192.

[96] Pierre-Louis Berquin-Duvallon, *Travels in Louisiana and the Floridas, in the year, 1802, giving a correct picture of those countries*, trans. John Davis (New York: I. Riley & Co., 1806), 15.

sugar, Wilkinson advocated for the crop as a valuable endeavor for the "middling and poorer classes."[97] Rice required fewer drainage interventions in the landscape compared with sugar and therefore required less capital to cultivate. While he never used the word "flume," Wilkinson described an elaborate network of irrigation conduits, ditches, gates, and containment levees designed to manage the flow of water from the river, in to the rice fields, and out to the backswamp. Rather than leave the crop to providence or invite disaster with open cuts in the embankments, rice planters were preparing fields and irrigation infrastructure in advance of the high-water season, when they would make use of the rising river or bayou to intentionally—but carefully—flood their fields. Wilkinson was describing what would become the primary mode of commercial rice production in Louisiana for the next half century: river rice.

How did river rice work?[98] Ditch digging and cleaning began in February—in anticipation of the rising river or bayou around March—and continued through July. Levees were fit with cypress box flumes or, in the 1880s, iron pipes to connect the river with their irrigation ditches, each of which could be opened or closed to control the rate at which water flowed onto the plantation. The flume or pipe drew rising water from the river into one or two main ditches about four feet wide and up to five feet deep. Running perpendicular to the river, these ditches were the main channels by which water was distributed across fields. Several cross ditches created a grid of intersecting waterways. Parts of the grid were surrounded by small containment levees that retained water on the fields. Cypress boards were placed at the junctions and could be raised or lowered to further control the flow of water from the main ditches into

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[97] R.A. Wilkinson, "Production of Rice in Louisiana," *DeBow's Review* 6 (1848): 53-57.

[98] This description is based on Wilkinson, "Production of Rice"; Lee, "A Culture History of Rice"; G.V. Soniat, "Review of the Rice Industry of Louisiana," *Louisiana Planter and Sugar Manufacturer*, February 9, 1889, 65; and *Villere Plantation Record, 1875-1877*, Gaspar Cusachs Collection, Plantation Series 531 (14), Tulane Louisiana Research Collection.

various parts of the grid. Finally, another channel at the rear of the plantation contained a sluice that could be opened to draw water out of the network of ditches and into the backswamp. Figure 1-5 offers a plan view of one possible river-rice irrigation network. Although technologically and ecologically distinct from tidewater rice operations in the southeast, Louisiana river-rice plantations similarly worked to carefully manage the flow of water across the landscape.[99]

Of course, in all of this, there remained one important limitation: the river or bayou itself. If in a given high-water season the river or bayou failed to reach the height at which the flume was placed in the levee, then the rice plantation was effectively reduced to the providence system. In Louis Bouchereau's report of 1872-73 he noted the "falling-off" of the rice crop that season because "the rivers and bayous, on which we depend for this irrigation, were too low to furnish to it in the months of May and June, when this irrigation is most necessary."[100] In later years, rice planters used steam-powered pumps to raise water to the height of their flumes, but the cost of doing so could greatly reduce their margin of profit.[101]

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[99] On irrigated rice agriculture in the southeast, see: Joyce E. Chaplin, *An Anxious Pursuit: Agricultural Innovation and Modernity in the Lower South, 1730-1815* (Chapel Hill: University of North Carolina Press, 1993), 227-276; Stewart, *"What Nature Suffers to Groe,"* 98-116; Carney, *Black Rice*. For a rebuttal to Carney's "black rice" thesis, see: David Eltis, Philip Morgan, and David Richardson, "Agency and Diaspora in Atlantic History: Reassessing the African Contribution to Rice Cultivation in the Americas," *The American Historical Review* 112, no. 5 (2007): 1329–58.

[100] Louis Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1872-73* (New Orleans: Pelican Book and Job Printing Office, 1873), vii.

[101] "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, April 19, 1890, 275; "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, May 31, 1890, 396.

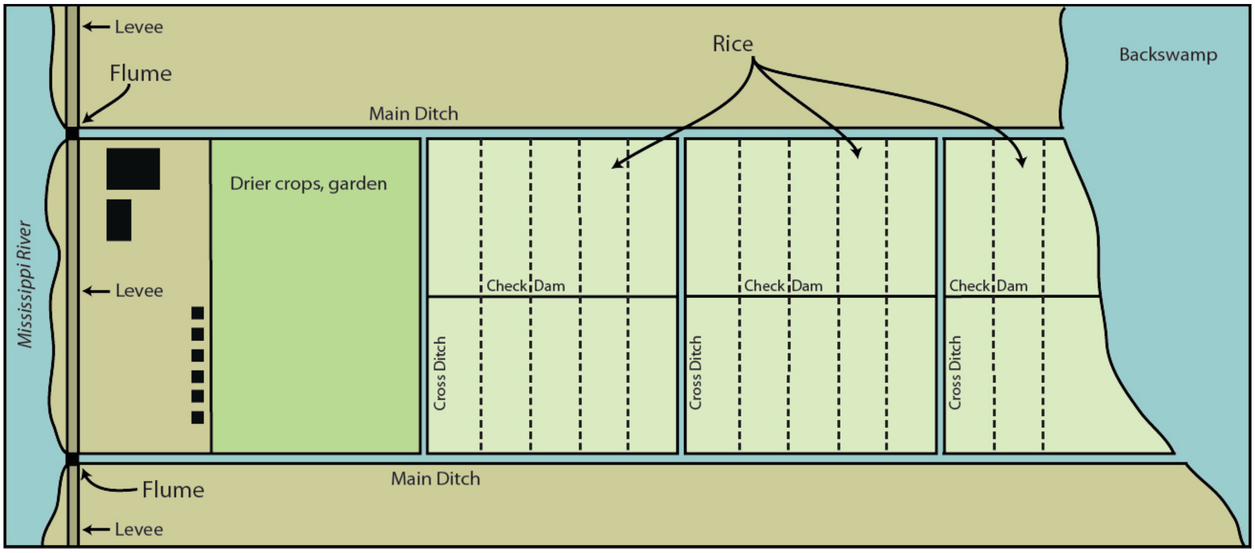

Figure 1-5: Plan view of river-rice system. Adapted from: Lee, "A Culture History of Rice," 131.

Since at least the 1840s, flumes introduced very literal porosities into the levees at both the front and rear of rice plantations. But there were other, much more metaphorical ways in which antebellum plantations—and not just those raising rice—were also articulated with the watery landscapes of both river and backswamp. From the establishment of the very first agricultural settlements in eighteenth-century Louisiana, through to the close of the nineteenth century, the Mississippi River and distributaries like Bayou Lafourche were the economic lifeblood of the plantation. River frontage was essential for moving crops to market, purchasing supplies and equipment, exchanging news, and acquiring humans as property.

But, as the historian Thomas Buchanan has shown, the Mississippi steamboat world created not just a system of oppressive slavery and racism, but also a subversive web of "liberating ideas and pathways to freedom."[102] Waterways connected slaves across the agricultural south and free blacks in the urban north, creating the foundations for anti-slavery alliances, fostering far-flung geographies of resistance, and offering a means of maintaining

[102] Thomas C. Buchanan, *Black Life on the Mississippi: Slaves, Free Blacks, and the Western Steamboat World* (Chapel Hill: University of North Carolina Press, 2004).

communication between family members and loved ones separated by slavery. Enslaved African Americans working on steamboats often labored at a distance from their owners. Although such labor could be brutal—particularly in the boilers—such distance between owner and slave afforded a degree of autonomy and demonstrated for those remaining on plantations that there were some small means of resisting the total oppression of slavery. Plantation slaves, in turn, sought freedom on the Mississippi's steamboats, using the very same network that transported sugar, rice, and slaves to build social ties that might eventually aid in their escape via the river.[103]

Fleeing slaves used the plantation backswamps as escape routes and refuges, mimicking the geography of porosity that marked both the front and rear levees of rice plantations. The uncertain, frequently impassable, and—at least for whites—often threatening watery landscapes of southern Louisiana's wetlands offered runaway slaves ideal territory for building fugitive communities. Some of these communities even grew into sizable settlements that regularly traded (albeit illegally) with whites living at the swamp's margins. Virginia and North Carolina's Great Dismal Swamp is thought to have harbored around 2,000 escaped slaves and their descendants. "Maroon" societies in the wetlands not only offered havens for more fugitives, but also served as bases for executing plantation raids and as the headquarters for organized revolts.[104] Meanwhile, enslaved blacks unable to make an escape (or unwilling to take the

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[103] Judith Kelleher Schafer, *Slavery, The Civil Law, and The Supreme Court of Louisiana* (Baton Rouge: LSU Press, 1994); Walter Johnson, *River of Dark Dreams: Slavery and Empire in the Cotton Kingdom* (Cambridge: Harvard University Press, 2013), 139-150. For other ways in which slaves on Louisiana plantations wrested some measure of independence from their masters, see: Roderick Alexander McDonald, *The Economy and Material Culture of Slaves: Goods and Chattels on the Sugar Plantations of Jamaica and Louisiana* (Baton Rouge: LSU Press, 1993).

[104] One of the most famous of these maroon societies was in Virginia and North Carolina's Great Dismal Swamp, which played host to about 2,000 fugitives and their children. Herbert Aptheker, "Maroons Within the Present Limits of the United States," in *Maroon Societies: Rebel Slave Communities in the Americas*, ed. Richard Price (Baltimore: Johns Hopkins University Press, 1979), 151-167; John Hope Franklin and Loren Schweninger, *Runaway Slaves: Rebels on the Plantation* (Oxford: Oxford University Press, 1999), 50, 88; Nelson, *Trembling Earth*. Note that even for planters, the swampy boundaries at the rear of their property may have been a good deal more permeable or ambiguous than the lines demarcating the front and sides of the plantation. Surveys of early land grants

enormous risks involved) made use of plantation backswamps to carve out small measures of independence and even material gain. Swamps offered slaves opportunities to forage for firewood, gather moss for mattresses, and to trap, hunt, and fish to augment their diets.[105]

Runaway slaves escaping into the watery environment often had the best chance of success if they could also "pass" across still yet another kind of boundary. Historian Walter Johnson suggests racial passing made whites especially nervous because it served as concrete, empirical evidence of the fundamentally porous boundaries of classifying human beings in the antebellum south.[106] In Louisiana, and particularly in New Orleans, such boundaries had been hardening over several decades from the close of the eighteenth century through the eve of the Civil War. "Creole" had emerged as a category of nativeness in the region as tens of thousands of European immigrants, Anglo-Americans, and Saint-Domingue refugees arrived at the turn of the nineteenth century. Creole, however, at first carried no racial markers and such a Creole "native" could be white, black, or mixed, and often implied some Spanish or French ancestry. But by the mid-nineteenth century, with the ongoing Anglo-Americanization of Louisiana, Creole and Caribbean-influenced notions of racial fluidity had given way to much more severe distinctions between whites and, well, everyone else.[107] Johnson observes how such increasingly rigid definitions of whiteness and blackness were enmeshed in anxieties about freedom and slavery, culminating in events like Jane Morrison's 1857 suit—just months after the U.S. Supreme Court ruled African Americans had no legal standing in the nation's courts—against a

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in Louisiana depict clear property boundaries at the front and sides of plantations, but the rear boundary at the backswamp disappears off the page, e.g., see: Louisiana State University's LLMVC survey collection, 1786-1928.

[105] Mart Stewart discusses slave uses of swamplands in "Rice, Water, and Power," 56-7.

[106] Johnson, *River of Dark Dreams*, 141.

[107] Campanella, *Bienville's Dilemma*, 161-5

slave trader for her wrongful sale as a free, white woman, as opposed to a passing black slave.[108] By 1896, those fictional racial boundaries would be made fundamentally imporous when the name of a light-skinned Creole called Homer Plessy marked the Supreme Court's decision to legalize the strict segregation of whites from people with any measure of black ancestry. Light-skinned African Americans leaking across the river levees of antebellum plantations were breaching a set of racial boundaries that increasingly calcified toward the Civil War and beyond after Reconstruction.

The flow of black bodies on and off the plantation and across racial lines, then, mirrored the movement of water through the rice plantation and in the river, bayous, and backswamps beyond its perforated levees. The concretely permeable rice plantation, marked by flumes and other flood-irrigation infrastructure, directs our attention to other kinds of permeabilities in antebellum Louisiana. Flowing water, muddy swamps, and porous racial boundaries presented African Americans with at least a few opportunities to seize some measure of autonomy under slavery. Within a few decades of the advent of flume-based river rice in the 1840s, the Civil War intervened to free black bodies from the boundaries of *all* southern plantation properties. It also intervened—if temporarily—to create a more permeable landscape in which a broken levee systems and new labor arrangements in the American South facilitated the ascendance of a new agricultural ecology where rice would triumph over sugar.

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[108] Walter Johnson, "The Slave Trader, the White Slave, and the Politics of Racial Determination in the 1850s," *The Journal of American History* 87 (2000): 13-38.

Permeability and the Civil War

One of the most immediate effects of the Civil War on Louisiana's landscape was the vast destruction the conflict wrought on levees and other agricultural infrastructure. Not only were many plantations looted, ransacked, neglected, and confiscated (estimates range from $26 to $70 million in losses), but both Union and Confederate armies also regularly destroyed flood-protection infrastructure to undermine the enemy (Figure 1-6).[109] These intentional depredations of the levee system combined with the overall wartime decline in maintenance to render the environment considerably more waterlogged and flood-prone.

In 1867, *DeBow's Review* bemoaned the state of Louisiana's levees "in many places cut through and destroyed" during the war. The article provided statistics documenting how two years of resulting overflows had rendered valuable croplands unproductive. The accompanying polemic described the millions of dollars in damage affecting an already war-torn region, the much-needed tax revenues lost to both Louisiana and the US treasury, and the lost employment hopes of thousands of freedmen. The author concluded by appealing to Congress for aid in preventing "the most valuable and fertile portion of Louisiana from again becoming an uninhabitable swamp."[110]

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[109] Between $300 million and $1 billion in today's dollars. Charles P. Roland, *Louisiana Sugar Plantations During the Civil War* (Leiden, Netherlands: E.J. Brill, 1957), 57-74.

[110] "The Louisiana Levees," *DeBow's Review* 3 (1867): 469-473.

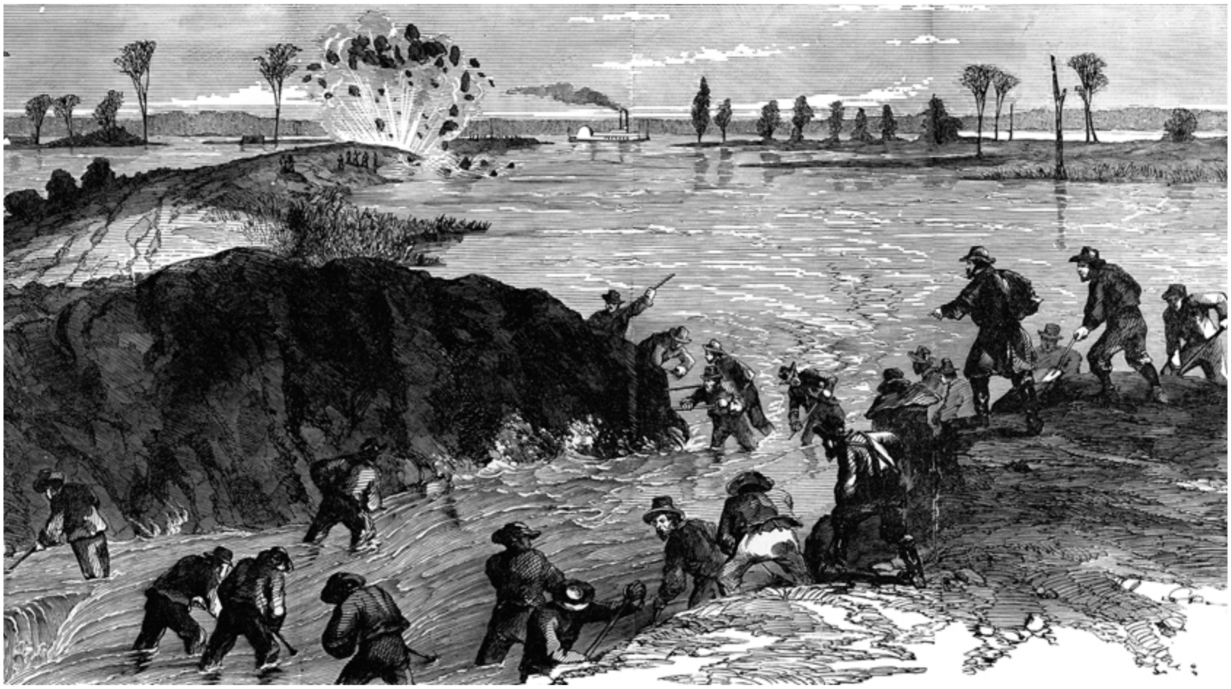

Figure 1-6: Cutting levees near the Louisiana-Arkansas border during the Civil War. Illustration from Frank Leslie, *Famous Leaders and Battle Scenes of the Civil War* (New York: Mrs. Frank Leslie, 1896).

Historian Walter Prichard notes that in the immediate aftermath of the Civil War, the cost of repairing only the crevasses in Louisiana would have totaled more than $625,000, an expense the region's planters could not afford. And while levee maintenance was recognized as a responsibility of the state in 1866—rather than of individual property owners, as previously determined—neither could war-torn Louisiana itself afford the expense. Despite these pleas and many more like it from planters and politicians alike, the United States would not invest in flood protection in Louisiana until after creation of the Mississippi River Commission in 1879.[111]

But perhaps even more disruptive than its impact on flood protection and agricultural infrastructure was the Civil War's dramatic reorganization of labor in the south. In 1877, Louis Bouchereau wrote to US Commissioner of Agriculture William LeDuc to enumerate many of the obstacles in the way of a fully recovered sugar industry. In addition to the still-beleaguered levee

[111] Prichard, "Effects of the Civil War on the Louisiana Sugar Industry," 329. On federal flood control and the Mississippi River Commission, see: Morris, *Big Muddy*, 140-164; Poe, "Reconstructing the Levees," 217-252.

system, Bouchereau also noted the labor challenges that plagued plantations over a decade into the postbellum world. Bemoaning the supposed “indifference to hiring” of freedmen, he claimed only ten percent of sugar planters had managed to retain the number of hands necessary to maintain a plantation.[112] And this was not a novel protest. In 1868, nine years before his letter to LeDuc, Bouchereau had also complained about “the objectionable characteristics of the present system of labor, which gives no effectual means for coercing the performance of the contracts entered into by the freedmen.”[113] Prior to the war, sugar had succeeded in Louisiana for sixty years thanks to slave labor. Emancipation exacted a heavy toll on the industry. Not only did the comparatively high price of free labor hinder planters in their direct efforts to raise sugarcane, but it also made the cost of reforming the deltaic landscape prohibitive. As a result, planters had been hesitant to put new land under cultivation. Additionally, raising cane on the same soils for decades had led to poor harvests and the application of fertilizers presented a secondary costly expense for sugar planters operating in an era of free labor.[114] The dramatic transformation of Louisiana’s labor system soon saw increasing planter demands for “coolie” labor imported from China; workers who nominally embodied a step toward a free labor system while actually enabling planters to sustain some of slavery’s most repugnant features.[115] In short, the Civil War effectively destroyed Louisiana’s sugar industry, with total losses amounting to almost 97

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[112] Letter from Louis Bouchereau to Hon. Wm. G. LeDuc, Commissioner &c., October 8, 1877, in Alcée Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1877-1878* (New Orleans: Pelican Book and Job Printing Office, 1878), xix-xxi.

[113] Louis Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1868-1869* (New Orleans: Young, Bright, & Co., 1869), viii.

[114] Letter from Louis Bouchereau to Hon. Wm. G. LeDuc, Commissioner &c., October 8, 1877, in A. Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1877-1878*, xix-xxi. For more on the labor disruptions of the Civil War: Prichard, “Effects of the Civil War,” 318-328; Sitterson, *Sugar Country*, 205-51; Robert F. Pace, “‘It Was Bedlam Let Loose.’”

[115] Moon-Ho Jung, *Coolies and Cane*.

percent of its antebellum value.[116] In addition to the assets lost in destroyed plantations and skittish investors creating a massive shortage of investment capital for a region woefully in the need of cash, the environmental changes proved too much to sustain the ecologies of sugarcane.[117] Without slaves to both raise the crop and maintain the leveeing and drainage that had allowed cane to thrive in the first place, Louisiana's sugar bowl ran empty.

Under these circumstances, many planters made the switch to rice cultivation. Louis Bouchereau, writing for the sugar report of 1872-3, observed:

> Many large plantations are now cultivated in Rice which formerly produced large quantities of sugar. Before the war, Rice was only cultivated in a small portion of the Parish of Plaquemines and only in small patches—now it is largely cultivated in several parishes, as appears elsewhere in this book, and there are still vast quantities of marsh lands which could be advantageously devoted to it, wherever the proper irrigation can be applied at the proper time.[118]

Indeed, in the decade between 1859 and 1869, Louisiana went from producing just over three percent of the nation's rice to over twenty percent.[119] Fundamentally less capital and labor-intensive than sugar thanks to its wetter ecologies, river-rice agriculture was the perfect adaptation to a region drained of credit and bereft of slave labor.[120] Rice was simply better suited to the suddenly more sodden ecology of the region. While crevasses also sometimes destroyed rice crops, the plant thrived in saturated soils. A plantation could recover from inundation in a

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[116] Prichard estimates losses at $193 million out of the $200 million total value of the industry, "Effects of the Civil War," 322.

[117] On the shortage of credit and investment capital, see: Sitterson, *Sugar Country*, 231-251; Pace, "Bedlam Let Loose."

[118] Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1872-1873*, vii. Other observers remarked on the replacement of sugar with rice: Alcée Bouchereau, *Sugar and Rice Crops made in Louisiana in 1877-1878*, xx; "Mechanical Aids to Agriculture," *DeBow's Review* [Revived Series] 6 (1869): 505-526, 524, has a footnote implying that sugar planters switched to rice when their labor was emancipated. Also see: Lee, "A Culture History of Rice."

[119] Peter A. Coclanis, "Distant Thunder: The Creation of a World Market in Rice and the Transformations It Wrought," *American Historical Review* vol. 98, no. 4 (1993): 1050-1078.

[120] Although Louisiana river rice was not without its own labor demands, it should not be compared with the far more labor-intensive tidewater rice: c.f., Mart Stewart, *What Nature Suffers to Groe*.

fraction of the time needed to drain and dry sugar fields subjected to similar flood. Not only did rice ultimately surpass sugar as southern Louisiana's most important commodity in the 1870s, but by the late 1880s the state was regularly producing 60-65 percent of the nation's crop.[121]

River rice thus evolved from relative obscurity in the 1840s into a widespread agricultural practice by the 1880s. On January 25th, 1889, rice planter Gustave Soniat addressed the State Agricultural Society in Monroe. Providing a review of the state's rice industry and its emergence from the "ashes and ruins" of sugar plantations, Soniat suggested that rice had been Louisiana's savior, "lifting her people from the slough of despond to the heights of prosperity and happiness. . . . We had no alternative but to plunge into the midst of waters and water has befriended us, as it did Moses of old."[122] Purple prose aside, this was not hyperbole. Successful rice crops planted after the Civil War had in truth compensated for the dire state of postbellum sugar. Considering the crucial role that rice played in rehabilitating the state's economy, modernity in Louisiana was for a time dependent on the permeability that flumes accommodated in the landscape.[123]

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[121] For statistics on Louisiana rice production in the nineteenth century, see: Mildred Kelly Ginn, "A History of Rice Production in Louisiana to 1896," *Louisiana Historical Quarterly* 23 (1940): 544-588. Statistics for Louisiana rice production in the 1880s would also have begun to include quantities of the grain produced in the state's southwestern prairies—Louisiana rice was no longer entirely river rice by that time. It's also worth noting that Louisiana's dominance of US rice production at this time came at the expense of the historic rice-producing areas of the South Atlantic. That decline occurred in part due to declining fertility and disruptions occasioned, ironically, by the Civil War. Historian Peter Coclanis, however, notes that it would be misleading to attribute the shifting geography of North American rice agriculture solely to the Civil War's interventions in the Tidewater region. Rather, global capitalism played a part here as well as the late nineteenth century saw considerable "expansion, elaboration, and integration" of a world market in rice. See: Coclanis, "Distant Thunder."

[122] Soniat, "Review of the Rice Industry of Louisiana." Soniat was also a member of Jefferson Parish's policy jury—equivalent to a county council—from 1888-1891.

[123] Historian Robert Pace argues in "It Was Bedlam Let Loose" that it was "resilience and adaptation" that allowed the sugar industry to eventually recover from the Civil War. Just as in many other histories, as well as in Louisiana's popular culture, the vast importance of rice to the state gets elided in favor of sugar. Historic plantations interpret their sugar past, the vast majority of books focus on the sugar economy, and even the state's major bowl sporting event is referred to as the "sugar bowl." Given just how far the sugar industry plummeted, it's clear that rice played a crucial role in restoring revenues and attracting capital to the state after the Civil War. Rice, in many ways, prepared the ground for sugar's recovery.

The Culture of Permeability

The Civil War had exposed the extent of sugarcane's incompatibility with the sodden ecology of southern Louisiana. Without a functioning levee system, nor abundant slave labor to repair it and ensure good drainage, the landscape had reverted to a waterlogged state. Growing rice, by contrast, required far less re-engineering of the landscape, an absolute necessity in the saturated postbellum world of broken and inconsistent levees. Rice flumes helped facilitate an agricultural industry that could function in such an environment, especially when emancipation and the war had disrupted the availability of cheap labor and capital.

By the 1890s, planters had spent almost five decades engaged in river rice. Flumes had enabled rice agriculture to develop on a commercial scale. By replacing both "providence" cultivation and the open cuts associated with eighteenth-century irrigation, flumes had allowed rice planters a significant measure of control and predictability in flooding their crops. Although planters were still subject to the whims of a rising river, annual floods were far more foreseeable than the vagaries of day-to-day rain. That control and predictability created the conditions necessary for both expanding cultivation and producing a reliable crop, both of which allowed planters to build a commercial market in rice.

Not only did rice flumes allow planters to better cultivate the postbellum biophysical landscape, they also provided distinct services in their own right. In addition to basic irrigation, the technology provided a valuable means of weed control. By regularly inundating the crop, planters could eliminate water-intolerant weeds, significantly reducing at least one labor input on the plantation.[124] Inundation also provided some measure of protection against some of the

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[124] On weed control, see: Wilkinson, "Production of Rice in Louisiana," 55; "Mechanical Aids to Agriculture," *DeBow's Review* [Revived Series] 6 (1869): 505-526, 524.

climatic challenges of growing rice in Louisiana. Although rice was far better suited than sugar to the muddy, mucky terrain of Louisiana's deltaic plain, it too faced what historian J. Carlyle Sitterson called a "lack of complete harmony between land and product." Recall that Louisiana's climate sometimes entailed "devastating" frosts. If the region faced a cooler spring season after the rice had been sown, planters would sometimes open their flumes neither for irrigation nor weed control, but simply to flood the crop as a form of insulation against freezing.[125] Geographer Chan Lee also notes that a few years of growing rice crops using flume irrigation on swampier fields helped planters improve drainage, allowing them to occasionally plant other crops like corn and sugar in drier years.[126] There was also some recognition that flooding fields helped maintain soils and fertility by ushering new sediments onto plantations.[127] *The Picayune* described this feature of inundation in its reporting on the Bell Crevasse of 1858:

> As soon as the water passes the breach and begins to spread over the lower plains, its velocity is diminished, and the earthy matter which it had previously borne in suspension is deposited, the heaviest particles nearest the river and the finer atoms of soil at correspondingly greater distances. Thus the cultivable lands along the margin of the river become greatly widened by every Crevasse and the subsequent increase in the fertility of plantations is a measurable compensation for the disadvantages of an overflow.[128]

The risks posed by rice flumes were perhaps not only tolerated in some quarters, but also perhaps seen to carry a silver lining. Allowing for some measure of permeability in the landscape not only maintained soil fertility, but also allowed sediments to maintain and build upon the region's slender stretches of high ground. Although the geological history of southern Louisiana's deltaic

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[125] On frost, see: Rehder, *Delta* Sugar, 12-19; Sitterson, *Sugar* Country, 13; *Villere Plantation Record, 1875-1877*, entry for April 17th, 1875, 3. Note again that sugarcane, although also cold intolerant, could not endure similar flooding to protect against frost because of the deleterious effects of saturation on its root system.

[126] On drainage, see: Lee, "A Culture History of Rice," 116-117.

[127] On fertility and sediment, also see: J.B. Wilkinson, "Rice: Its Uses and Production," *DeBow's Review* 16 (1854): 535-538, 537; "Rice Culture in Louisiana," *DeBow's Review* 21 (1856): 290-292, 291.

[128] "The Bell Crevasse," supplement to the *Picayune*, May 16, 1858.

plain would not begin to be widely understood until the 1930s, nineteenth-century Louisianans still had some understanding of the land-building potential of the river's suspended sediments.[129]

Finally, there was one other element of river rice's flume-based ecology that earned adherents throughout the region: the promise of human health. From his first observations of river rice agriculture in 1848, Robert Andrews Wilkinson remarked on the apparently healthy landscapes created by the constant flow of water from perforated levees across rice fields:

> It is a well-known fact, that the rice plantations, both as regards whites and blacks, are more healthy than the sugar and cotton. From what cause does this arise, has been often asked by many? . . . At the time the Mississippi is high the rice is at watering stage, and the water here not being taken off at all, is kept constantly running from the river back, preventing the back water from becoming stagnant, and carrying off with the rapidity of its current, the vegetable matter that in decomposing causes malaria. . . . Why is not more attention paid to the improvement of the cultivation and manufacture of this valuable and lucrative staple?[130]

Wilkinson's etiology of malaria of course does not resemble our own and we might be tempted to think him mistaken. But regardless of our own understandings of health and illness, Wilkinson lived in a world in which, for him, the flow of water through rice plantations was so protective against miasmatic disease that he believed more territory in the region should be dedicated to river-rice cultivation.

This notion that rice plantations were uniquely healthy places thanks to irrigation grew increasingly popular. While traveling throughout the American south in the early 1850s, Frederick Law Olmsted both noted Wilkinson's article and quoted another from the *New Orleans Delta*. It claimed rice cultivation in Louisiana did not promote illness as it did in the Atlantic

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[129] On the history of geological knowledge on the Mississippi River's deltaic plain, see: Harry Roberts, "Delta Switching: Early Responses to the Atchafalaya River Diversion," *Journal of Coastal Research* 14 (1998): 882-899. Note that as early as 1897, E.L. Corthell remarked in *National Geographic* that leveeing had deprived the delta of sediments that would combat subsidence: E.L. Corthell, "The Delta of the Mississippi River," *National Geographic* 8 (December 1897): 351-4. Three decades later in 1928, freshwater and marine biologist Percy Viosca would suggest that leveeing and drainage was "killing the goose" that laid Louisiana's golden egg: Percy Viosca, "Louisiana Wet Lands and the Value of their Wild Life and Fishery Resources," *Ecology* 9 (1928): 216-229.

[130] R.A. Wilkinson, "Production of Rice in Louisiana," 54.

states. The flow of the muddy Mississippi seemed to offer protections from miasma that the waters of the southeast did not.[131] In 1854, Joseph Biddle Wilkinson, brother of Robert and both a physician and planter of Plaquemines Parish, recounted a story for *DeBow's Review* in which a sugar slave, ill with diarrhea, had been sent to work on a rice plantation only to see a full recovery. "My experience as a physician," he wrote, "which extends through a series of fourteen years of active practice, inclines me positively to the opinion that the ratio of mortality is decidedly greater on sugar plantations than upon rice plantations situated in similar localities." Wilkinson then suggested that the healthfulness of Louisiana rice plantations was owed to the "water of the Mississippi."[132] In 1856, *DeBow's Review* again suggested the "perfect immunity" enjoyed in the rice district thanks to the "purifying qualities of the Mississippi water."[133] These ideas persisted at least as late as 1889, when rice planter Gustave Soniat suggested the healthfulness of flowing water as a remedy for sickly agricultural emanations.[134] Through the late nineteenth century, rice planters understood the permeable plantation, marked by constantly flowing water, to be in better harmony with not only the environment, but also with the bodies of its inhabitants and laborers.

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[131] Article from *The New Orleans Delta*, February 20, 1853, quoted in: Frederick Law Olmsted, *A Journey in the Seaboard Slave States, with Remarks on their Economy* (New York: Dix & Edwards, 1856), 463

[132] J.B. Wilkinson, "Rice: Its Uses and Production," 536.

[133] "Rice Culture in Louisiana," *DeBow's Review*, 291.

[134] Soniat, "Review of the Rice Industry," 66. Detractors would later question the healthfulness of Louisiana's rice plantations. The Jefferson Parish police jury—one of the most aggressive anti-flume juries in the river parishes by the 1890s—demanded in 1877 that the New Orleans Board of Health investigate the public health effects of the "effluvial" emanating from rice fields and "believed to be the cause of the sickness now prevailing." They based their request on an appeal to the dangers both Charleston and Savannah recognized in rice cultivation near urban areas. See: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 26, Jefferson Parish (Gretna), Series 1 Police Jury Minutes, Vol. IV. 1870-1879*, (Mss. 2984, Reel 239, Special Collections, Louisiana State University Libraries), 409. For more on nineteenth-century conceptions of health, water, and environment, see: Conevery Bolton Valenčius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York: Basic Books, 2002), 133-158.

Flumes thus promised not just agricultural success and economic gain in southern Louisiana's flood-prone environment; they also facilitated considerable ecological benefits, benefits that even extended to the everyday well-being of human bodies. Accordingly, many rice planters were deeply attached to flumes as the devices seemed to offer a multitude of advantages in the pursuit of progress in watery Louisiana. But, by the early 1890s, southern Louisiana also no longer looked as it had in the first decade after the Civil War. Economic recovery and federal involvement in levee construction and maintenance had begun to largely reclaim the region from its soggy postbellum setbacks, especially as evidenced by the resurgence of the sugar industry. Sugarcane's return to southern Louisiana signalled a growing conflict over permeability in the landscape, with planters and engineers struggling over how best to organize the boundaries between land and water in the deltaic environment.

The Menace of Flumes

Although crevasses in the late nineteenth century were not unusual, the specific kind of havoc wreaked by 1858's Bell Crevasse was itself far from unique. Flume-related levee breaches like the one on Bell's plantation were actually quite common by the 1880s and 1890s. Reports from the Mississippi River Commission, the Louisiana Board of State Engineers, and newspapers provide a record of at least 34 flume-attributed crevasses occurring between 1884 and 1897 alone (see Table 1-1).

Year	Crevasse	Location[135]	Date	Cause
1884	Davis	22 miles above New Orleans.	March 8-early October	"washing out of loose earth in an imperfectly refilled rice-flume"
1884	Wego	St. Joseph Parish.	March 13	"defective rice flume"
1884	Virginia	Iberville Parish.	March 15	"Crevasse caused by rice-flume; promptly closed by citizens."
1884	Waterloo	Pointe Coupee Parish.	March 23	"due to an imperfectly constructed rice flume in the levee."
1884	Guidry	17 miles below Donaldsonville.	March 25-30	"giving way of new rice-flume in old levee"
1884	Elina	10 miles below Donaldsonville.	March 31	"washing-out of old rice-flume"
1890	Brulard	Bertrandville. Plaquemines Parish.	February 23	"caused by an old rice flume"
1890	St. Sophie	35 miles below New Orleans.	March 4-10	"an old rice flume . . . caused a great deal of trouble in stopping this crevasse."
1890	Pattenville	On Bayou Lafourche. Assumption Parish.	March 14-21	"Rice flume."
1890	Nita	L bank. 5 miles above College Point. St. James Parish.	March 14-low-water season	"caused by a badly constructed rice flume."
1890	Harlem	38 miles below New Orleans. Plaquemines Parish	March 21-25	"caused by an old rice flume"
1890	Martinez	L bank. 8 miles below Baton Rouge.	April 22-28	"said to have been due to the existence of a rice flume."
1891	Ames	Opposite New Orleans. Jefferson Parish.	March 16 or 17-August 1	"caused by an iron pipe placed in the levee . . . intended for the irrigation of rice, though not then in use."
1892	Gravolet	L bank. Plaquemines Parish.	Unknown	"Rice flume."
1892	Little Texas	R bank, Bayou Lafourche. Assumption Parish.	May 10	"Old rice flume."
1892	Harlem	L bank. Plaquemines Parish.	May 12- July 1	"Crayfish holes and rice flume. Eleven breaks closed between May 15 and July 1"
1892	Happy Point	R bank. Plaquemines Parish.	May 18-28	"Rice flume."
1892	Cedar Grove	R bank. Plaquemines Parish.	May 24-28	"Rice flume."
1893	Lafourche Crossing	R bank. Bayou Lafourche. 0.5 mile above S. Pacific RR.	May 14	"old rice flume, not completely removed."
1893	Bartholemy	R bank. Plaquemines Parish.	June 14-15	"washing out of an old rice flume."
1893	Harlem	L bank. 3000 feet below upper line of Harlem Plantation. Plaquemines Parish.	June 18-29	"a new rice flume allowed by the authorities to be placed in the levee while under construction."
1897	2 unnamed	Melrose, Plaquemines Parish.	Unknown	"All the flumes in the district gave trouble. . . . [two] quite large crevasses were occasioned by . . . flumes."
1897	13 unnamed	Between Savoies & Bohemia, Plaquemines Parish.	Unknown	"thirteen [flumes] in all blew out"

Table 1-1: Flume-attributed crevasses in southern Louisiana from 1884-1897. For sources, see footnote.[136]

While not all of these breaches resulted in disasters comparable to the Bell Crevasse, the

135 Stream is always Mississippi River, unless otherwise noted. Bayou Lafourche is a distributary of the Mississippi.

136 *Report of the Board of State Engineers of the State of Louisiana to the General Assembly for the years 1882 and 1883, and to April 20th, 1884* (Baton Rouge: Leon Jastremski, 1884), 66-67; *Annual Report of the Mississippi River Commission for 1884* (Washington, DC: Government Printing Office, 1885), 107; *Annual Report of the Mississippi River Commission for the Fiscal Year ending June 30, 1890* (Washington, DC: Government Printing Office, 1890), 3297-3299; "Map Supplement," *The Times-Democrat*, September 1, 1890; *Annual Report of the Mississippi River Commission for the Fiscal Year ending June 30, 1891* (Washington, DC: Government Printing Office, 1891), 3414, 3713; *Report of the Board of State Engineers of the State of Louisiana to His Excellency Murphy J. Foster, Governor of Louisiana, from April 20, 1892 to April 20, 1894* (Baton Rouge: News Publishing Co., 1894), 151-157; *Annual Report of the Mississippi River Commission for the Fiscal Year ending June 30, 1894* (Washington, DC: Government Printing Office, 1894), 3025-3026; *Annual Report of the Mississippi River Commission for the Fiscal Year ending June 30, 1897* (Washington, DC: Government Printing Office, 1897), 3789, 3827-3828.

Davis Crevasse of 1884 was eventually described in the *Daily States* newspaper as "by far the most destructive crevasse known in the history of Louisiana."[137] Beginning much like the breach on John Bell's plantation, the crevasse opened on March 8, 1884 as a break in a weak segment of levee adjacent to the Davis railroad station in St. Charles parish. Just a few months prior to high water, an abandoned rice flume had been "imperfectly dug out and refilled" and the patched embankment was no match for that year's floods.[138] By late May, the Davis Crevasse had become a gash over 1000 feet wide and 30 feet deep, dwarfing the Bell Crevasse of 1858. Torrents bursting through the levees were so powerful they swept away over 7,000 cubic yards of earth and left an enormous scour pit (or "blue hole") present to this day as Davis Pond (Figure 1-7).[139] Covering an area of 3,000 square miles, the crevasse's floodwaters destroyed tens of thousands of acres under cultivation. And that was only in May. It took until October before the breach (then over 1400 feet wide) was successfully repaired, and even then the levee needed strengthening for many months afterward.[140] Six years later, a *Baton Rouge Truth* editorial estimated the total cost of the disaster at over $10 million, with many successful plantations having been converted "into a wilderness of bog and willow trees."[141]

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[137] R.A. Wilkinson, "Territory Submerged by the Davis Crevasse," *Daily States*, May 22, 1884.

[138] *Report of the Board of State Engineers of the State of Louisiana to the General Assembly for the years 1882 and 1883, and to April 20th, 1884* (Baton Rouge, 1884), 7, 67.

[139] Sidney F. Lewis, "The Davis (Crevasse) Levee," *Transactions of the American Society of Civil Engineers* vol. 17, no. 367 (1887): 199-203. "Blue holes" in: Saucier, *Geomorphology*, 105.

[140] Width of the crevasse in October comes from Alcée Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1884-1885* (New Orleans: L. Graham & Son, 1885), xlvi.

[141] $240 million in today's dollars. The editorial was reprinted in the *Louisiana Sugar and Planter Manufacturer* as: "The Rice Flume," *Louisiana Sugar and Planter Manufacturer*, March 29, 1890, 226.

Figure 1-7: Davis Pond, a "blue hole" carved out of the landscape by the Davis Crevasse.[142]

Other flume-related crevasses unleashed ruin between 1884 and 1897. The Nita crevasse of 1890 began with a rice flume and eventually tore a hole in the levee 3,000 feet wide that discharged up to one-third of the river's volume across the landscape.[143] Thanks to quirks of geography and hydrology, however, it was not as materially devastating as the Davis Crevasse, although it still caused havoc on plantations throughout the adjacent parishes. A rice flume—this time of the iron pipe variety—was also responsible for the Ames Crevasse of 1891, which inundated around 2,000 square miles and wrought an estimated $8 million in damage to agriculture, drainage infrastructure, buildings, and railroads.[144] Finally, an 1897 Mississippi

[142] Just downriver of Davis Pond, a diversion with a maximum capacity of up to 11,000 cfs—a trickle compared to what flowed through the Davis Crevasse—now flushes freshwater and sediment into the Barataria Basin for wetland preservation. Between the end of the "crevasse period" in the early twentieth century and the diversion's completion in 2002, these wetlands would have been completely starved of the sediments that created them.

[143] *Mississippi River Commission, 1891*, 3091, 3107. One-third of the river's volume at that moment was 400,000 cubic feet/second, or four times the flow over Niagara Falls during the high season.

[144] $208 million in today's dollars. *Mississippi River Commission, 1891*, 3414.

River Commission report mentions *fifteen* unique crevasses due to rice flumes in Plaquemines Parish alone. Though not as spectacular as the Bell, Davis, Nita, or Ames crevasses, these smaller breaches are noteworthy just for their sheer number. The Commission described them as "one of the striking features of this high-water campaign."[145] During the last decades of the nineteenth century, multiple, sometimes simultaneous, crevasses associated with flumes regularly drowned portions of southern Louisiana. The presence of so many rice flumes—flumes that were apparently prone to failure—is especially remarkable given that this period was also defined by an engineering consensus advocating impregnable levees (and levees-only) as the sole guarantor of future prosperity in the region. Both engineers and sugar planters would thus together campaign to remove flumes from the landscape—although without much success until the turn of the twentieth century. Over several decades, the rice flume would come to lie at the center of a forgotten struggle over permeability.

Naturally, state and federal engineers generally saw flumes as a menace. Civil engineer William Hewson, a staunch member of the levees-only contingent, wrote an 1878 treatise on embanking the Mississippi that was unequivocally opposed to anything that might create additional porosity or other inconsistencies in levees.[146] Similarly, in 1880, the Louisiana Board of State Engineers lamented that the "reckless cutting of levees to supply water for rice culture, and the imperfect construction, and neglect of repairs to flumes, trunks and other water ways, has been for years recognized as a great and growing evil."[147] Mississippi River Commission reports

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[145] *Mississippi River Commission, 1897*, 3789.

[146] William Hewson, *Principles and Practice of Embanking Lands from River Floods as applied to 'Levees' of the Mississippi* (New York: D. Van Nostrand, 1878), 79-101; on Hewson and levees-only, see: Pabis, "Subduing Nature," 65-6.

[147] *Report of the Board of State Engineers to His Excellency Sam'l D. McEnery, Governor of Louisiana, for the years 1880 and 1881, and to April 20, 1882* (Baton Rouge: Leon Jastremski, 1882), 102. The Board of State

from the 1880s and 1890s, meanwhile, document significant hostility to flumes at the federal level. Engineer John Ewens wrote in the Mississippi River Commission's 1884 report that the floods of that year and the ruin unleashed at Davis demonstrated conclusively "that rice flumes are the great crevasse makers, and that they should be abolished."[148] In 1890, the Mississippi River Commission argued that cuts "in the levees for roadways for flumes, or for pipes are all serious sources of danger, and they should not be permitted under any circumstances."[149] After the Nita and Ames crevasses of the following year, the agency reported: "these and other disasters have led the Commission to condemn the dangerous practice of placing rice flumes in the levees. . . ."[150] The agency even raised the stakes by resolving that "hereafter no levees shall be constructed or enlarged by the Commission in which any such device is to be placed or allowed to remain."[151] Such a resolution was sure to put the Commission on a collision course with the interests of at least local rice planters, if not legal authorities at the parish, and even state, level. Six years later in 1897, after describing flumes as "the greatest menace," the agency's report went on to editorialize against levee cutting as not only one of the five primary causes of crevasses, but also as "the operations of malicious persons or people of deranged mind."[152] Despite the fact that cutting the levees was a pre-requisite for installing rice flumes, the report made no effort to distinguish between various forms of cuts with regard to either

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Engineers was first created in 1871, but went through several changes in composition and authority. Act 33 of 1879 created the final iteration of the Board, which persisted through 1940. See: Reuss, *Designing the Bayous*, 58-61.

[148] *Mississippi River Commission, 1884*, 108

[149] *Mississippi River Commission, 1890*, 3293.

[150] *Mississippi River Commission, 1891*, 3414.

[151] *Mississippi River Commission, 1891*, 3414.

[152] *Mississippi River Commission, 1897*, 3827, 3789.

maliciousness or derangement. Not just a dangerous nuisance, perforated levees were also fundamentally understood as irrational and disturbed.[153]

Regulating Permeability

As sugar returned to southern Louisiana plantations and with flumes increasingly perceived in some quarters as a menace, 1880 marked the beginnings of a legal framework that at first regulated, and then ultimately abolished flumes from the riparian landscape. In February, levee commissioners in Louisiana's Second and Third Levee Districts met in Darrowville and Algiers, respectively.[154] Both meetings produced letters demanding that the state legislature act to protect the public from, in the words of the Darrowville commissioners, "the damages of crevasses arising from the reckless frequent [sic] and unskillful cutting of the public levees and the defective method of securing flumes."[155] The letter from Algiers demanded that the state place all authority over flumes in the hands of the Board of State Engineers, fearing that the local police juries (equivalent to county councils) were neither diligent nor resourceful enough to regulate the technology. Just a few months later, the state legislature passed Act 88 on April 10th,

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[153] If flumes themselves weren't enough cause for alarm, Commission engineers also argued that flumes, sluices, and other conduits in the levees invited problems from meddling animals. The 1884 report cited muskrats burrowing in the softer materials that had replaced an old sluice while the 1897 report noted that crawfish and eels used such conduits to work their way into levees only to riddle them with holes: *Mississippi River Commission, 1884*, 107; *Mississippi River Commission, 1897*, 3827.

[154] The levee districts mentioned here were created by Act 33 of 1879 (which also created the Board of State Engineers). See Act 33 for details of the six district boundaries. Boundaries change over time as districts get renamed and reapportioned, e.g., the First District becomes the Lake Borgne Levee District with Act 14 of 1892, encompassing all of St. Bernard Parish and the left bank of Plaquemines down to Bohemia. Later, Act 18 of 1894 creates the Buras District, which includes the right bank of Plaquemines Parish, from Riceland plantation down to "The Jump." "No. 33," *Acts Passed by the General Assembly of the State of Louisiana at the First Session of the Sixth Legislature begun and held in the city of New Orleans, January 6, 1879* (New Orleans: Democrat Publishing Company, 1879), 51-4.

[155] Letters appear in *Report of the Board of State Engineers . . . for the years 1880 and 1881*, 28-9, 40-41.

1880 with several sections devoted to rice flumes.[156] The new law required the Board of State Engineers to produce a set of plans and construction specifications for rice flumes and required that all flumes to be placed in levees not only conform to those plans, but also receive prior written approval by the local parish police juries.[157] Planters wishing to build rice flumes would also have to pay an annual license (essentially a tax) to their parish's police jury. Finally, Act 88 also determined that unapproved and unlicensed tampering of levees for the purposes of building rice flumes would constitute a crime against the state, punishable by between one and twelve months' imprisonment and a fine of up to five-hundred dollars.

In the opinion of the Board of State Engineers, however, Act 88 was a political compromise insufficient to the task of protecting the public from flume-related crevasses.

> The diversity of interests and opinions, and the prejudices due to immemorial custom in the various localities, however, seemed to render it politic (if not absolutely necessary) to leave the details of form and construction of rice-flumes largely to the discretion of [parish] inspectors. . . .[158]

Much like the levee commissioners in Algiers and Darrowville, the Board feared that the local police juries were not capable of exercising the necessary regulatory power to avert these disasters. While the Board acknowledged that this devolution of authority likely helped reconcile rice planters to the new law, it also began regularly petitioning the state legislature for sole jurisdiction over the regulation of rice flumes. For the moment, however, the Board had to be content with merely specifying the manner of flume construction. These tensions marked the emergence of two increasingly divergent visions for managing water in the landscape. On the

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[156] "No. 88," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session begun and held in the city of New Orleans on the twelfth day of January, 1880* (New Orleans: E.A. Brando, 1880), 112-115.

[157] Specifications for flumes are in *Report of the Board of State Engineers . . . for the years 1880 and 1881*, 98-101.

[158] *Report of the Board of State Engineers . . . for the years 1880 and 1881*, 94.

one hand, state and federal agencies grew increasingly insistent on the rigid segregation of river and plantation. On the other, rice planters (often with support from their parish police juries) insisted on the right to carefully control the flow of water through perforated levees.

In its report for 1882-1883, the Board of State Engineers suggested the police juries were unlikely to refuse flume licenses and argued that the legislature should instead enact an outright prohibition on all alterations to the levees except in cases of repair or new construction. Published some months after the disastrous 1884 breach at the Davis railroad station, the report went on to try and make an empirical case for its argument: "the damage caused this year by a single crevasse (Davis), that need not have occurred had rice-flumes never been permitted, will exceed the entire value of the rice crop."[159]

On September 1st of 1884, Act 84 of that year's session of the state legislature took effect.[160] It replaced the 1880 law with a few key provisions. In addition to requiring that flumes meet Board of State Engineers specifications, it also compelled the parish police juries to remove any flumes in violation of those specifications. This time, however, the law did not require the Board to furnish any plans whatsoever for flume construction. In what it perhaps imagined to be a shrewd legal maneuver, the Board refrained from providing any new flume designs in the hope that planters would feel at least some legal compulsion to abandon them in favor of pumps and siphons that carried water over, rather than through, the levee.

> The Board of State Engineers has not, under this Act [84], approved, prepared or adopted any plans or specifications for rice flumes or pipes or other conduits, in or through the public levees; and as its members believe that the water necessary for irrigation and all other useful purposes, can be obtained by means of siphons and pipes passing over the levees, it is not probable that any

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[159] *Report of the Board of State Engineers . . . for the years 1882 and 1883*, 15.

[160] "No. 84," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session, begun and held at the city of Baton Rouge, on the twelfth day of May, 1884* (Baton Rouge: Leon Jastremski, 1884), 109-111.

> plans and specifications involving the cutting of levees, will be approved or adopted by this Board.[161]

The Board even attempted to cast some doubt on both the engineering qualifications and legality of anyone using Act 88's 1880 designs under the new Act 84 of 1884.

> Under the provisions of Act No. 88 of 1880, the Board of State Engineers was required to prepare plans and specifications for rice flumes; but as this Act was repealed by Act No. 84, above referred to, it is, perhaps, questionable whether the plan and specifications prepared under its provisions are sufficient to satisfy the requirements of the existing law.[162]

The Board had to be satisfied with these kinds of legal technicalities until 1890, when new, much more stringent legislation on rice flumes finally passed. Act 144 was an explicit shift in authority away from the parish police juries and toward the state of Louisiana.[163] First, it required that the police juries remove *all* existing flumes over September through October of 1890. The law also demanded that labor costs be billed to landowners. Any default would be mortgaged against their property with a ten percent fee. Anyone who obstructed the police juries from removing these pre-existing flumes faced a fine of $500 or six months in jail, or some combination of the two. Act 144, however, still made provisions for new rice flumes to replace the old, but these new devices were restricted solely to iron pipes constructed and inserted into the levees according to very clear specifications in the law, subject to regular inspection, and requiring written application to the police juries. The juries would also collect licenses in the amount of fifteen dollars for the first year and ten dollars for every year thereafter.

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[161] Letter to police juries, rice planters, etc. in *Report of the Board of State Engineers of the State of Louisiana to His Excellency Samuel D. McEnery, Governor of Louisiana, from April 20, 1884, to April 20, 1886* (Baton Rouge: Leon Jastremski, 1886), 135-6.

[162] Letter to police juries, rice planters, etc. in *Report of the Board of State Engineers . . . from April 20, 1884, to April 20, 1886*, 135-6.

[163] "No. 144," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session, begun and held at the city of Baton Rouge, on the twelfth day of May, 1890* (New Orleans: Ernest Marchand, 1890), 183-185.

Act 144 was certainly an improvement as far as the Board of State Engineers was concerned, but nonetheless, it expressed disappointment in its 1890-1892 report. The Board reiterated its recommendation that all such technology be banned outright, citing its reports from the previous decade. Limiting the form and material of flumes to iron pipes was clearly a disappointment for the Board and it went on to note that the Ames Crevasse of 1891 occurred where just such an iron pipe had been placed in the levee. And so the Board followed with another exhortation:

> Considering the repeated costly lessons of the past, and the inherent dangers of the system now authorized, . . . it is to be hoped that the coming session of the General Assembly will see the wisdom of prohibiting forever hereafter all openings, pipes, flumes or other conduits in, through or under the public levees of the State.[164]

Though difficult to assess the Board's actual legislative influence, it was not long after this report that Louisiana's state engineers saw their wishes granted. Act 5 of 1892 made *all* flumes and conduits—even the iron pipes—illegal by October of that year.[165] Any existing hardware in the levees was to be removed by January 1, 1893. Failure to do so, as well as any attempt to reintroduce flumes into the levees, constituted a misdemeanor incurring either fines up to $500, up to sixty days imprisonment, or some combination of the two. Following over a decade of acting as a vocal critic of both rice flumes and the capacity of parish police juries to enforce their regulation, the Board was finally appeased; progress had at last been made law. But while this legal history unfolded in the Louisiana statehouse, everyday residents were also engaged in a growing struggle over the place of porous levees in the region.

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[164] *Report of the Board of State Engineers of the State of Louisiana to His Excellency Francis T. Nicholls, Governor of Louisiana, from April 20, 1890, to April 20, 1892* (New Orleans: E.P. Brando, 1892), 15-17.

[165] "No. 5," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session, begun and held at the city of Baton Rouge, on the ninth day of May, 1892* (Baton Rouge: The Advocate, 1892), 6.

The Struggle Over Permeability

Sugar planters joined state and federal engineers in their opposition to rice flumes and undoubtedly pressed lawmakers to pursue legislation against the technology. When levees broke, the ensuing deluge frequently laid waste to sugar fields. In the case of the Bell Crevasse of 1858, preliminary damages were estimated at between four and five million dollars, much of which would have been sugar losses as cane was by far the dominant crop grown along the river and its bayous at that time. Those damages were compounded by fears that "for two seasons no sugar crops can be raised on the submerged plantations."[166] The Davis Crevasse of 1884 produced similar ruin across the sugar landscape. While the industry had seen a significant decline in the years during and after the Civil War (reaching a low of 10,000 hogsheads in 1864), by the 1880s it was beginning to see some of its former output, producing over 240,000 hogsheads of sugar in 1882.[167] When the Davis Crevasse inundated tens of thousands of plantation acres, it caused some panic. R.A. Wilkinson, who covered the crevasse for the *Daily States*, reported that the flood had destroyed the entire sugar industry of Jefferson Parish as well as substantial cropland in St. James, St. John the Baptist, St. Charles, and Lafourche parishes. He then lamented the fate of several plantations along Bayou Barataria in Plaquemines Parish: "[They] will never be devoted to sugar again." Wilkinson estimated commodity losses at 30,000 hogsheads of sugar and 40,000 barrels of molasses. Wilkinson also observed the crevasse's impact on rice plantations with 75,000 barrels of the grain lost to floodwaters.[168] It is clear, however, that the

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166 Between $115-$144 million in today's dollars. "The Bell Crevasse," supplement to *The Picayune*, May 16, 1858.

167 1882 and 1883 saw production of 241,220 and 221,515 hogsheads of sugar, respectively, up from a low of 10,387 hogsheads in 1864, Alcée Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1883-1884* (New Orleans: L. Graham & Son, 1884), xlviii.

168 Wilkinson, "Territory Submerged." R.A. Wilkinson was son of the Wilkinson who first reported on river rice in the 1840s. For Wilkinson's parentage, see: Stanley Clisby Arthur, *Old Families of Louisiana* (New Orleans: Hamanson, 1931), 392.

sugar industry bore a disproportionate share of the breach's devastation, not least because flooding rendered sugar fields uncultivable for at least one or two subsequent seasons whereas it simply prepared rice fields for planting.

Thus, sugar planters and other residents uninvolved with rice cultivation deeply resented flumes. After all, they struggled enough to combat regular crevasses without the threat of additional breaches arising from a technology that seemed to undermine levee integrity. An editorial from the *Baton Rouge Truth* reprinted in the *Louisiana Planter and Sugar Manufacturer* held forth in March of 1890:

> The experience of a hundred years of levee building and levee holding teaches us that the rice flume is the fruitful breeder of crevasses. It is nothing more nor less than an ingenious trap set in the levee warranted to let loose at the critical moment to admit the waters of the river to accomplish their mission of ruin and disaster. The flume has more crevasses credited to it than any other single cause. Some of the papers estimate that it has occasioned more damage than could be repaired by the value of all the rice crops of all the years this staple has been cultivated in Louisiana…. We somtimes [sic] think it forunate [sic] that the fool killer does not visit Louisiana during high water, for we are certain he would reap a rich harvest in the district of the rice flumes. If the damage was confined to the landowner whose carelessness caused it, the subject would not be of such widespread importance; but others are involved with him in a general ruin.[169]

Just a few weeks later, a letter from Ascension Parish commented on the destruction wrought by the Nita Crevasse and noted that the "aspect of the country around Nita today is a solemn protest against the rice flume," before prophesying: "These two industries of rice and sugar are decidedly incompatible, and either will eventually have to succumb to the other."[170]

Problems also arose in less disastrous circumstances. Sometimes the river might reach an adequate stage for irrigation without resulting in a crevasse, but then rice planters might subsequently fail to properly manage the amount of water flowing through their plantations. By allowing flumes to remain constantly open during high water and heavy rains, rice planters

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[169] "The Rice Flume," *Louisiana Planter and Sugar Manufacturer*, March 29, 1890, 226

[170] "Ascension Letter," *Louisiana Planter and Sugar Manufacturer*, April 19, 1890, 275.

contributed to higher waters in the backswamp, thereby backing up the drainage canals of neighboring sugar planters. One complaint in the *Louisiana Planter and Sugar Manufacturer* noted such "abuses in taking water from the bayou," while two legal cases record sugar planters suing for damages due not to crevassing, but to the everyday spread of water from flume-irrigated rice fields.[171]

Despite the complaints of both engineers and sugar planters beginning at least in the early 1880s, however, flumes endured. Some of the earliest and most disastrous flume-attributed crevasses—like Bell in 1858 and Davis in 1884—yielded no definitive legal intervention against the technology. In fact, it took twelve years from the establishment of the first state regulations concerning flumes before anything resembling a ban—in the form of Act 5 of 1892—materialized. In the late 1880s, the Board of State Engineers complained that regulations passed through 1886 had done little to stem the tide of flumes and counted 300 of the devices between Baton Rouge and New Orleans, and perhaps 100 more below New Orleans and on Bayou

[171] "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, May 3, 1890, 315; "Nagel v, Madere et als.," in *Reports of Cases Argued and Determined in the Various Courts of Appeal of the State of Louisiana*, reported by Hon. Frank McGloin (New Orleans: F.F. Hansell, 1881), 325-326; "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, December 21, 1889, 391. There is some irony to the conflict between rice and sugar planters when it came to permeability. For one, rice planters were not the only ones to use conduits or flumes in the levees. An 1884 police jury inspection of flumes in St. Bernard Parish found a flume in safe condition belonging to a slaughterhouse: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 44, St. Bernard Parish (St. Bernard), Series 1 Police Jury Minutes, Vol. II. 1880-1895* (Mss. 2984, Reel 401, Special Collections, Louisiana State University Libraries), 213. In 1890, the Board of State Engineers report noted that in addition to 434 flumes, inspections had discovered 217 "sugar house and other pipes" piercing the levees: *Report of the Board of State Engineers of the State of Louisiana to His Excellency Francis T. Nicholls, Governor of Louisiana, from April 20, 1888, to April 20, 1890* (New Orleans: E. Marchand, 1890), 10. It seems that sugar planters who, as a group seemed so quick to condemn the irrigation practices of rice planters, also occasionally required some degree of permeability in their levees. Indeed, an October 1892 letter from Lafourche Parish in the *Louisiana Planter and Sugar Manufacturer* claimed that the ban on flumes had seriously crippled some sugar planters as the law also applied to pipes in the levees that had supplied their reservoirs: "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, October 22, 1892, 298. Finally, it's worth considering for a moment another way sugar planters created permeability on their plantations. Alcée Bouchereau's observed in 1885 that during periods of heavy rain, planters had cut levees in order to drain water off their fields and back into both the river and backswamps: A. Bouchereau, *Statement of the Sugar and Rice Crops made in Louisiana in 1884-85*, xlvii.

Lafourche.[172] Four years later, there were still at least 434 flumes in the state's public levees. Even in 1897, five years after Act 5, fifteen flume crevasses record the technology's persistence in Plaquemines Parish.[173] Almost a century later, excavations in St. James Parish revealed nine flumes preserved in relict levees spanning two plantations. Again, according to Act 5 of 1892, these levees should have long been rid of any such technology.[174]

The persistence of flumes in the landscape through the 1880s, 1890s, and beyond to the 1980s suggests just how deeply this technology of permeability was embedded in the landscape. In the eyes of two powerful sets of Louisiana interests, rice flumes manifested a fundamental threat to modernity and progress. And yet both the historical and archeological record reveal that rice planters were able to present significant resistance to the impermeable ideologies of most engineers and sugar planters. That such a struggle could unfold for so long suggests that the stakes of permeability (or its absence) were extremely high in nineteenth-century Louisiana.

Local government was one of the chief arenas in which this struggle unfolded. While the Board of State Engineers and Mississippi River Commission regularly campaigned against flumes, Louisiana's parish police juries were often supportive of the technology, almost universally granting flume licenses between 1880 and 1890. That permitting process also involved a system of taxation, regulation, inspection, and specific legal actions for dealing with

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[172] *Report of the Board of State Engineers of the State of Louisiana to His Excellency Samuel D. McEnery, Governor of Louisiana, from April 20, 1884 to April 20, 1886* (Baton Rouge: Leon Jastremski, 1886), 11

[173] 434 flumes documented in: *Report of the Board of State Engineers of the State of Louisiana to His Excellency Francis T. Nicholls, Governor of Louisiana, from April 20, 1888, to April 20, 1890* (New Orleans: Ernest Marchand, 1890), 10.

[174] Archaeology from: R. Christopher Goodwin, James M. Wojtala, Lawrence L. Hewitt, and George W. Shannon, Jr., *Rice Agriculture in the River Parishes: The Historical Archeology of the Vacherie Site (16 SJ 40), St. James Parish, Louisiana* (New Orleans: US Army Corps of Engineers, 1990). Note that the site contained nine flumes in just a relatively short stretch of the Mississippi, spanning only a few plantations, in just one parish. What might a systematic excavation of the state's southern riverbanks have yielded? According to the archaeologists conducting the project, such search would not even reveal all the flumes that might have endured illegally since 1892. Almost a century of river action and development would have destroyed a great deal of riparian archaeological material.

violators. When the Board of State Engineers refused to produce an approved flume design in 1884, many police juries filled the regulatory vacuum with their own, highly detailed specifications for flume construction. Arguably, by not providing a state-sanctioned set of design specifications the Board had created room for a parish-level flume culture to flourish. Parishes also designated levee inspectors whose responsibilities included overseeing flume construction, function, and maintenance. All of this served to create a local institutional culture of permeability. Flumes were codified as part of parish government, regardless of the inclinations of either legislators or state and federal engineers. Far from being a manifestation of persisting technological backwardness or ignorant folk practice, rice flumes were engrained into the cultures and markets of the river parishes. Naturally, that was frustrating for the Board of State Engineers: it complained in 1886 that despite police jury oversight, flumes were being installed with "no decided evidence of improvement in their condition."[175]

Which is not to say that the parishes that supported flumes never came into conflict with rice planters. While most police juries in the 1880s were usually happy to institutionalize flumes through inspections, permits, and taxation, they were still compelled to obey state legislation that superseded their authority. Those legal obligations sometimes brought the police juries into direct conflict with the rice planters, whose flumes were subject to both parish and state authority. Following Act 88 of 1880, the Lafourche Parish police jury passed ordinance 139 to collect a tax of fifty cents per linear foot of flume that would support inspections and regulation.

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[175] Police jury minutes for Iberville, Jefferson, St. Bernard, St. Charles, and St. John the Baptist parishes record dozens upon dozens of permissions granted for flumes between 1880 and 1892. Police jury minutes for each of these parishes were transcribed the Works Progress Administration and are archived in full at Louisiana State University: W.P.A. Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records*, Mss. 2984, Louisiana and Lower Mississippi Valley Collections, LSU Libraries, Baton Rouge, Louisiana. Flume figures and quote from: *Report of the Board of State Engineers of the State of Louisiana to His Excellency Samuel D. McEnery, Governor of Louisiana, from April 20, 1884 to April 20, 1886* (Baton Rouge: Leon Jastremski, 1886), 11.

By the first week of July, a petition signed by 191 rice planters demanded the police jury lower the tax.[176] Similarly, in late 1884, a group of 24 rice planters and other parish residents had convinced a district court in St. Charles Parish to forbid the police jury from removing rice flumes in violation of Act 84 of that year. Frustrated by the court order, the jury resolved to have news of the injunction sent to two railroad companies and three newspapers. Here was an effort to secure more powerful legal allies in guaranteeing "the protection of the people of this and other Parishes from another such calamity as that caused by the Davis Crevasse."[177] It is important to note that the St. Charles police jury was not completely opposed to flumes. Rather, it simply wanted to preserve its authority—as guaranteed by the state in Act 84—to determine which flumes posed the threat of a possible crevasse. St. Charles Parish rice planters, however, clearly resented anyone possessing such authority besides themselves.

Some local governments, meanwhile, were altogether hostile to flumes even comparatively early in post-1880s struggle over permeability. The police jury of Jefferson Parish, for example, is particularly notable for its increasing opposition to rice flumes. On February 4th of 1885, the jury resolved to register a formal protest with the city of New Orleans against a plantation on the right bank of Orleans Parish. By placing flumes in its levees, the police jury contended, the plantation was endangering the residents and citizens of neighboring Jefferson.[178] That hostility toward flumes only seemed to grow over the next five years when on

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[176] Lafourche Parish police jury minutes from May 4, 1890 and July 5, 1890: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records, 1811-1940: Lafourche Parish, 1883-1885*, (Mss. 2984, Reel 276, Special Collections, Louisiana State University Libraries) 590, 594.

[177] Injunction against St. Charles police jury recorded on December 1, 1884: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 45, St. Charles Parish (Hahnville), Series 1 Police Jury Minutes, Vol. 7. 1883-1897*, (Mss. 2984, Reel 404, Special Collections, Louisiana State University Libraries) 46.

[178] Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 26, Jefferson Parish (Gretna), Series 1 Police Jury Minutes, Vol. V. 1879-1888*, (Mss. 2984, Reel 239, Special Collections, Louisiana State University Libraries), 173.

May 31st, 1890, the Jefferson Parish police jury passed a resolution petitioning the state legislature "to pass the most stringent laws" on the cutting of levees for any purpose and that "all rice flumes, pipes, and other conduits now placed in the levees be ordered removed." The jury then noted that it would send its president and three other members to confer about the possibility of passing anti-flume legislation with the joint committee on levees then in session in Baton Rouge. When Act 5 of 1892 finally banned all flumes, the jury was also sure to emphasize the fact, passing a local resolution explicitly reinforcing the new state law.[179] And, indicating that local government attitudes could change, other parishes that once supported flumes also swiftly followed suit. St. Charles, St. John the Baptist, and Lafourche, all eventually came to the anti-flume fold and explicitly reinforced the passage of Act 5 with their own police-jury resolutions.[180] Thus while many river-parish local governments supported the perforated levees on which this particular form of rice agriculture depended, the sentiment was by no means universal, resulting in all manner of struggles over permeability at the local level.

Of course, for almost as many parishes that reinforced the ban passed in Act 5, there were others that made no such effort. The Iberville and St. Bernard police juries (and possibly others) let Act 5 go unremarked, a deeply suggestive silence in the archival record. Furthermore, in May

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[179] Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 26, Jefferson Parish (Gretna), Series 1 Police Jury Minutes, Vol. VI. 1889-1895*, (Mss. 2984, Reel 240, Special Collections, Louisiana State University Libraries) 97, 258-9. In an interesting reversal, Act 144 of 1890, passed by the state legislature, would likely have frustrated Jefferson Parish's police jury since it still allowed for flumes made from iron pipes. Indeed, only five months later, the jury found itself compelled to grant Fernand Reynaud's application for just such a flume: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 26, Jefferson Parish (Gretna), Series 1 Police Jury Minutes, Vol. VI. 1889-1895*, 128.

[180] The St. Charles Parish police jury passed such a resolution on October 3, 1892: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 45, St. Charles Parish (Hahnville), Series 1 Police Jury Minutes, Vol. 7. 1883-1897*, 229. The Lafourche Parish police jury passed an ordinance to support Act 5: "Lafourche," *Louisiana Planter and Sugar* Manufacturer, October 22, 1892, 298. St. John the Baptist Parish also reiterated Act 5 with its own policy jury resolution on September 6, 1892: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records, 1811-1940: St. John the Baptist Parish, 1892-1902*, 244 (Mss. 2984, Reel 423, Special Collections, Louisiana State University Libraries).

of 1890, the Iberville Parish police jury, after approving a local plan for rice flumes and conduits, petitioned the legislature to pass a law preserving the integrity of *both* levees and the rice industry, suggesting officials hoped for a regulatory compromise that could produce flumes that were both usable and safe.[181]

Indeed, many Louisianans in the 1880s and early 1890s believed that the risk of crevasse was not intrinsic to flumes and the porous levees they created, but rather a matter of construction and maintenance. The Mississippi River Commission report of 1884 described people living near the site of the Davis Crevasse who, for several flood seasons, had feared a breach in the old rice flume, but, "by watching it vigilantly" had prevented such a disaster. The levee only broke when, according to residents, a family instrumental in crevasse prevention had moved away immediately prior to the 1884 flood season, leaving the device vulnerable to failure.[182] Similarly, while reporting on the Davis crevasse, R.A. Wilkinson wrote:

> No properly constructed rice flume, made in strict accordance with the laws of this State on the subject is, has been, or will be, responsible for a crevasse. The lax enforcement of this State Law by parish police juries leaves many rice flumes in bad condition, and those not kept up in compliance with the demands of the law have been responsible for several disastrous crevasses.[183]

A letter from Lafourche Parish appearing in the *Louisiana Planter and Sugar Manufacturer* on April 26, 1890, echoed Wilkinson's sentiments. Crevasses that managed to break through a rice planter's perforated levee, the author claimed, did so in cases of poor workmanship and timing. The writer also observed that many crevasses occurred entirely unrelated to flumes.[184] Meanwhile, a letter to the editor on July 30 of 1892, expressed skepticism that crevasses were

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[181] Iberville Parish petition recorded on May 12, 1890: Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 24, Iberville Parish (Plaquemine), Series 1 Police Jury Minutes, Vol. II. 1880-1901*, (Mss. 2984, Reel 232, Special Collections, Louisiana State University Libraries) 191.

[182] *Mississippi River Commission, 1884*, 108.

[183] Wilkinson, "Territory Submerged."

[184] "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, April 26, 1890, 295.

still associated with the technology now that rice planters had "learned to make good flumes." It argued that "crawfish and musk rats" were the true source of devastating levee breaches.[185] A letter to the editor from just 4 weeks prior had made a similar argument, noting that while legislation had eliminated flumes, crayfish would never learn to respect the law.[186]

These letters were part of what was a long-running effort to convince Louisianans that rice flumes were, in fact, completely safe.[187] For example, on April 21st of 1890, E.D. Leche chaired a meeting of rice planters in New Orleans who collectively "protested against the popular belief that rice flumes are a fruitful cause of danger and disaster in seasons of high water." Ironically, despite Mr. Leche's efforts to promote flumes in the public eye, a conduit on his plantation gave way just three days later.[188] Similarly, letters to the *Louisiana Planter and Sugar Manufacturer* regularly attempted to combat the opinions of sugar planters hostile to rice flumes. One letter attempted (somewhat brazenly) to blame flume-related crevasses not on the technology, but on sugar planters who failed to report careless or neglectful rice planters to the authorities.[189] But not all opinions were so obviously partisan. A letter from Lafourche Parish in May of 1890 revealed that some rice planters conceded the dangers of flumes and recognized the state's interest in inspecting and certifying the technology.[190] And, while some of these arguments may have emerged from a combination of bias and wishful thinking, some of these writers were entirely correct in suggesting that flumes could not always be to blame. We know

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[185] "The Rice Flume Law," *Louisiana Planter and Sugar Manufacturer*, July 30, 1892, 89.

[186] "Levees Alone Won't Do," *Louisiana Planter and Sugar Manufacturer*, July 2, 1892, 8.

[187] One writer argued flumes almost never failed: "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, April 26, 1890, 295.

[188] "Ascension Letter," *Louisiana Planter and Sugar Manufacturer*, April 26, 1890, 295;

[189] "Lower Coast Letter," *Louisiana Planter and Sugar Manufacturer*, May 3, 1890, 317.

[190] "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, May 3, 1890, 315.

today, for example, that the physical geography of the river near Davis has rendered that area particularly prone to crevassing, regardless of perforations in the levees.[191] At least some "flume-attributed" crevasses would have taken place even had there been no flumes in the levees. By the late 1880s and early 1890s, a multifaceted, energetic campaign had emerged to promote and preserve flumes in the landscape. Rice planters and their supporters were advocating for permeability as a legitimate component of progress.

Naturally, that campaign was also expressed as resistance to new, more impermeable technologies. As tensions over flumes mounted, a debate over a potential alternative irrigation technology—the siphon—further documented the deep attachments of most rice planters to porous levees. The siphon was a conduit of either iron or tightly assembled cypress that passed over, rather than through, the levee. Using a siphon required a steam pump to at least start, if not maintain, the flow of water against the force of gravity. From May of 1890, letters to the *Louisiana Sugar and Planter Manufacturer* routinely debated the merits of siphons versus flumes. While some rice planters embraced siphons, most found the new technology to be fundamentally inferior to flumes. First, steam-powered irrigation was often too large a capital investment for smaller planters. Second, even once purchased, running a steam engine could be prohibitively expensive since a levee might be upwards of twenty feet higher than the river.[192] Perhaps predictably, sugar planters and engineers wrote to the *Louisiana Planter and Sugar Manufacturer* in support of siphons, with the ensuing debates resulting in condescension and

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[191] L.D. Britsch and J.B. Dunbar, *Geomorphic Investigation of Davis Pond, Louisiana* (Vicksburg: U.S. Army Engineer Waterways Experiment Station, 1990).

[192] "Siphons Versus Flumes," *Louisiana Planter and Sugar Manufacturer*, May 31, 1890, 393; "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, May 31, 1890, 396. A similar argument was again made two years later in "Lafourche Letter, *Louisiana Planter and Sugar Manufacturer*, July 2, 1892, 6.

accusations of “gross libel.”[193] The siphon debate also perhaps signaled a broader rejection of increasing state and federal oversight in the region. Both the Board of State Engineers and the Mississippi River Commission simultaneously endorsed siphons while denouncing flumes. The Commission’s report of 1884, declared the use of flumes “in such an advanced age as this is a mystery, as a syphon [sic] would be more efficient and perfectly safe.” Unfortunately for siphon proponents, even by 1890, the Board of State Engineers counted only 23 siphons in the region, as compared with over 430 flumes.[194] Resistance to adopting siphons illustrates how deeply flumes were embedded in the economics, practical concerns, and cultural lives of river parish rice planters, planters who were also convinced their technology could be made safe.

Conversations concerning safe versus defective flumes also sometimes appeared in engineering reports from the Mississippi River Commission, recording a certain degree of ambivalence toward porous levees even among its engineers. In 1884, the Commission reported that it was “defective” rice flumes that were responsible for crevasses in that year. An 1894 Commission report on the Harlem crevasse of 1893 meanwhile observed that the breach was not so much the fault of a flume, but rather of human error in leaving the conduit open in a time of flood. These reports suggest that for some engineers, modern flumes, regulated by the police juries, properly operated, and maintained in good repair, could safely bring floodwaters onto rice plantations without posing a hazard to land or life.[195]

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[193] “Note from West Baton Rouge Sugar Planter,” *Louisiana Planter and Sugar Manufacturer*, June 14, 1890, 447; “Lafourche Letter, *Louisiana Planter and Sugar Manufacturer*, July 2, 1892, 6; “Siphons vs. Flumes,” *Louisiana Planter and Sugar Manufacturer*, July 30, 1892, 89; “Lafourche Letter,” *Louisiana Planter and Sugar Manufacturer* October 22, 1892, 298.

[194] *Mississippi River Commission, 1884*, 108; *Report of the Board of State Engineers of the State of Louisiana to His Excellency Francis T. Nicholls, Governor of Louisiana, from April 20, 1888, to April 20, 1890* (New Orleans: Ernest Marchand, 1890),10.

[195] *Mississippi River Commission, 1884*, 108; *Mississippi River Commission, 1894*, 3026.

Indeed, some engineers may have even nurtured an appreciation for porous levees that ran even deeper than ambivalence toward Louisiana's rice flumes. Landscape architect Richard Hindle has revealed that the US Patent and Trademark Office archives tell an alternate history of levee design in the late-nineteenth and early-twentieth century.[196] George B. Boomer, for example, submitted an 1891 patent for multiple sets of parallel levees. These staggered, compartmentalized embankments created successive buffer zones dedicated to particular crops or other land-uses that were more tolerant of inundation, essentially widening the floodplain and increasing storage capacity in high water.[197] Boomer's design would not have worked in a deltaic landscape—where elevation decreases away from the river's natural levees—but it documents a rather different approach to flood control than that of the Army Corps. As Hindle observes, the scale and ubiquity of the American levee system—extending most notably along not just the tributaries and distributaries of the Mississippi watershed, but also the rivers and streams of California's Great Central Valley—make it difficult to imagine any other approach to embanking waterways in the United States. And yet, the US patent archive suggests that for a few decades engineers and inventors were busy conceiving of "the levees that might have been": speculative designs for flood-protection infrastructure that was a great deal more porous and multi-functional than the hulking embankments we know today.

But it was not only parish governments and a handful of engineers that embraced permeability. Some elements of state government also seemed to recognize that flumes were a valuable technology to preserve in at least some parts of the landscape. As we have seen, flumes still persisted even after the passage of what appeared to be an outright ban in 1892. The

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[196] Richard L. Hindle, "Levees That Might Have Been," *Places Journal*, May 2015, accessed May 19th, 2015, https://placesjournal.org/article/levees-that-might-have-been/.

[197] George B. Boomer, "Method of Constructing Levees," US Patent No. 452,989, May 26, 1891.

Mississippi River Commission's 1894 report documents an operational flume in the high water of 1893, one year after Act 5 had gone into effect. Similarly, the agency's 1897 report described at least fifteen flumes—all resulting in crevasses—in Plaquemines Parish. It so happens that these devices were not all operating outside the law. Accompanying the history of increasingly anti-flume legislation seen so far was a series of amendments that preserved a specific geography of permeability in southern Louisiana. First, in 1886, the state legislature passed Act 112 to exempt Lafourche Parish and downriver parts of Plaquemines Parish from all flume regulations enacted in 1884. In a move that limited the power of the Board of State Engineers, Act 112 also explicitly preserved the authority of the Lafourche and Plaquemines police juries over levee cutting and flume design.[198] Second, and perhaps most important, the 1892 legislative ban on flumes was also actually more fluid than it appeared at first glance. Act 5 contained exemptions unannounced in the summary of the ban, the most crucial being that the law did not apply to levees in lower Plaquemines Parish.[199] This small detail—buried in the legislation, mentioned only in passing by the Board of State Engineers, and unremarked by the majority of parish police juries—explains the presence of the active flume on Harlem plantation in 1893, as well as the fifteen flumes that crevassed in 1897. The amendments contained within Act 5 show that even at the state legislative level, there was some recognition of the technology's value and importance. Permeability had seeped into the law.[200]

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[198] "No. 112," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session begun and held in the city Baton Rouge, on the tenth day of May, A.D. 1886* (Baton Rouge: Leon Jastremski, 1886), 209.

[199] "No. 5," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session Begun and Held in the City of Baton Rouge, on the Ninth Day of May, 1892* (Baton Rouge, 1892), 6; The Board of State Engineers makes two scant mentions of the continuing legality of flumes in Plaquemines Parish in 1893: *Report of the Board of State Engineers of the State of Louisiana to His Excellency Murphy J. Foster, Governor of Louisiana, from April 20, 1892 to April 20, 1894* (Baton Rouge, 1894), 36, 157.

[200] It's important to remember that flumes also persisted *illegally* in southern Louisiana, as documented by the nine devices excavated in St. James Parish in the 1980s: Goodwin et al. *Rice Agriculture in the River Parishes*.

Of course, despite all of this—the Louisiana legislature's enacting of a particular geography of flumes, some engineers embracing alternative models of flood control, and the cultural category of the "good," or safe, modern flume—we know that porous levees did in fact sometimes result in crevasses, and that Louisiana residents knew as much. Even despite those very real and understood risks, however, we see rice planters so invested in flumes that they were resigned to the possibility of disaster. In 1890, a letter from Lafourche country to the *Louisiana Planter and Sugar Manufacturer* described an interview with rice planter Oscar Lepine. Lepine felt strongly that Lafourche Parish should be exempted from legislation banning flumes. Containing much of Bayou Lafourche, but none of the Mississippi River, the parish usually experienced crevasses of smaller magnitude because the bayou's discharge was significantly lower. Lepine argued that:

> On the left bank, no crevasses will affect the railroad that passes through the parish, and but little damage will be done to the farmers and planters along the bayou. On the right bank the railroad will not be affected, and when the drainage that is in contemplation for that section shall have been completed, comparatively little damage will be done there.[201]

He went on to describe what he believed were the minimal losses resulting from three previous crevasses. For Lepine, the risk of crevasse associated with flumes entailed acceptable tradeoffs. Certainly, flumes could result in flood, but life in southern Louisiana could be conducted in such a way as to make that risk manageable.

In fact, some planters were so committed to porous levees that they refused flood-protection improvements from the federal government. The 1897 report from The Mississippi River Commission described a number of property holders in Plaquemines Parish who were

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[201] "Lafourche Letter," *Louisiana Planter and Sugar Manufacturer*, May 31, 1890, 396.

opposed to federally supported levee enlargement because it threatened their flumes.[202] Any work undertaken by the Mississippi River Commission would have required removing rice flumes, based on an 1891 resolution that "no levees shall be constructed or enlarged by the Commission in which any such device is to be placed or allowed to remain."[203] Although the parish had suffered fifteen flume-related crevasses that year, these rice planters not only insisted on preserving their flumes, they also rejected flood-protection improvements in order to do so.

Rice planters could be so committed to maintaining the permeable landscape of southern Louisiana that they sometimes even threatened violence. In the first week of April, 1890, Iberville Parish police jury president Jacob McWilliams had directed the rice flume inspector to distribute a circular demanding all flumes be closed within three days. Rice planters of the fourth and fifth wards called a meeting to declare the parish's flumes were in good condition and perfect legal standing. The collected rice planters then officially denounced the order and resolved to resist it to the best of their abilities, even "by force of Arms [sic] if necessary."[204] The tensions here are particularly remarkable given that this was not an order for permanent closure. Rather, McWilliams had issued a *temporary* order in the face of a swelling river. That rice planters had threatened violent resistance demonstrates just how deeply flumes were embedded in the parish's culture and economy, even in the face of potential flood.

Rice planters were profoundly invested in flumes and porous levees for the ecological, economic, and even health benefits that permeability seemed to offer. For at least this segment of

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[202] *Mississippi River Commission, 1897*, 3825.

[203] *Mississippi River Commission, 1891*, 3414.

[204] The conflict was resolved when McWilliams's order was repealed by motion of E.D. Leche, an organizer of the assembled rice planters *and* a member of the parish police jury, suggesting flumes had direct representation in local government. Louisiana Historical Records Survey, *Transcriptions of Louisiana Police Jury Records: No. 24, Iberville Parish (Plaquemine), Series 1 Police Jury Minutes, Vol. II. 1880-1901*, 186; "Iberville Letter," *Louisiana Planter and Sugar Manufacturer*, April 19, 1890, 276.

nineteenth-century Louisiana society, the risk of crevasse that perforated levees might have invited was clearly acceptable; it was but one trade-off in the pursuit of prosperity and progress. As such, they did their best to struggle against the growing culture of impermeability and to defend what they believed was their right to manage the flow of water across the landscape. When rice planters perceived threats to their way of living in the deltaic environment, they engaged in political organizing, legal action against local governments, and editorial campaigns. They resisted outside aid and expertise while also rejecting alternative technologies like siphons that preserved the impermeability of the region's levees. And sometimes they even threatened violence in their struggle to maintain a certain degree of permeability in southern Louisiana's watery environment.

But by the turn of the twentieth century, however, permeability in Louisiana was in short supply. A moral, political, and economic consensus had emerged around imporous levees, and despite the economic, ecological, and social values rice planters attributed to flumes, the technology gradually faded into obscurity. A large part of that consensus had developed no doubt thanks to the region's sugar renaissance. By 1898, the Louisiana legislature had finally passed a total ban (with no exemptions) on altering levees for irrigation purposes.[205] For a time, a handful of riparian planters would still cultivate rice with the use of steam pumps and siphons that carried water over, rather than through, levees. In general, however, river rice was in steep decline and expanding settlement in Louisiana's southwestern prairies in the mid-1880s yielded a competing, large-scale, mechanized rice industry far away from the river parishes. This new industrial rice

[205] "No. 196," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session Begun and Held in the City Baton Rouge, on the Sixteenth Day of May, 1898* (Baton Rouge: The Advocate, 1898), 448.

agriculture consolidated in the 1890s and within a decade the older riparian system had receded almost entirely from view.[206]

Meanwhile, other factors having less to do with sugar or state politics also helped strike blows against permeability in Louisiana. The federalizing of the levee system that had begun in 1879 meant that states, rather than property owners, were increasingly liable for their maintenance. A legal case concerning a crevasse in May of 1892 at Happy Point indemnified landowners against any responsibility to close breaches in the public embankments fronting their property.[207] Levees had been cleaved from the private property they occupied to become a state responsibility, and individual tampering with those levees was tolerated less and less. Flumes were also indirectly implicated in the final consolidation of levees-only as official policy in Louisiana. In 1890, the United States Congress held hearings concerning floods and levees along the lower Mississippi. Louisiana's enormous Nita Crevasse of that spring—and the broken flume that caused it—were held up as evidence that outlets along the Mississippi would fail to reduce the height of the river in flood. In response, the Louisiana legislature formally condemned outlets for flood mitigation, adding its own legal endorsement of the impermeable landscape. The first ban on flumes came just two years later.[208] Sugar's renaissance as the region's primary

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[206] On southwestern prairie rice in Louisiana, see: Ginn, "A History of Rice"; Coclanis, "Distant Thunder."

[207] *New Orleans, Fort Jackson & Grand Isle RR Co. v. Horace B. Turcan*, 46, Lou. 1st, 155 (Lou. Sup. Ct. 1894). Note that a flume complicated the crevasse at Happy Point, but the device would not be rendered illegal for another five months.

[208] Benjamin G. Humphreys, *Floods and Levees of the Mississippi River: Supplemental Report* (Washington, DC: GPO, 1914), 220-223; "Concurrent Resolution No. 2," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session, Begun and Held at the City of Baton Rouge, on the twelfth day of May, 1890* (New Orleans: Ernest Marchand, 1890), 3-4. While the legislature's resolution makes no mention of rice flumes, it's perhaps no coincidence that Act 144 was also passed in that session. As the first truly restrictive law on flumes, Act 144 required removal of all existing flume technology and that any planter still wishing to irrigate their lands through the levees had to do so using an iron pipe, rather than the wooden box flume. "No. 144," *Acts Passed by the General Assembly of the State of Louisiana at the Regular Session, begun and held at the city of Baton Rouge, on the twelfth day of May, 1890* (New Orleans: Ernest Marchand, 1890), 183-185.

agricultural crop and a new geography of rice production both joined with federal oversight of the levees and the culmination of levees-only dogma to end the struggle over porosity and permeability in southern Louisiana.

Within a few decades, this culture of impermeability would result in the most destructive river flood in United States history. The Mississippi River Commission's levees-only policy had created the world's longest system of unbroken embankments along the river. Constrained by enormous levees, the heavy spring rains and snowmelt of 1927 gathered and intensified to a height never before seen. Numerous crevasses on the lower Mississippi inundated over 23,000 square miles of territory and revealed sharp inequalities of race and class throughout the valley, with long-lasting social and political consequences for the nation.[209]

In the aftermath of the Great Flood of 1927, the Mississippi River Commission swiftly abandoned levees-only in favor of a more diversified flood control system. But although that new system included outlets and diversions, it was not at all more porous as far as the river delta was concerned. Almost paradoxically, outlets and spillways were integrated into a model of the river that even more rigidly distinguished land from water (Figure 1-8). After 1927, the Army Corps of Engineers essentially completed the process, begun in the nineteenth century, of severing the river from its delta. Completely and definitively starving this environment of the sediments that created it, the US Army Corps of Engineers set the stage for the rapid erosion of the Louisiana coast discussed in chapter three.[210]

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[209] On the history of the Great Flood and its affects on American society, see: Barry, *Rising Tide*.

[210] Chapter three discusses land loss after 1927. Chapter five discusses the consequences of post-1927 impermeable engineering, including the "project flood" illustrated in Figure 1-8. The history of flood protection in Louisiana and its implications for the Mississippi River Delta are a prime example of the oftentimes-catastrophic unintended consequences of controlling nature. See, for more examples and discussion: Nancy Langston, *Forest Dreams, Forest Nightmares: The Paradox of Old Growth in the Inland West* (Seattle: University of Washington Press, 1995); John McPhee, *The Control of Nature* (New York: Farrar, Strauss & Giroux, 1989). McPhee's classic essay "Atchafalaya"

Today, Louisianans are struggling to confront the threat of rising seas and more powerful hurricanes, all amidst the tragedy of deltaic land loss. Wetland scientists, landscape architects, engineers, planners, and policymakers are together attempting to find ways of restoring the coast and buffering Louisiana from catastrophic storm surges. Key to those efforts, are new visions for reincorporating the flow of water and sediment through the landscape (discussed in chapter 5). Knowing that there is a historical precedent for such an ethic of permeability can only aid in imagining alternative visions for living with the watery dynamism of the Mississippi River Delta.

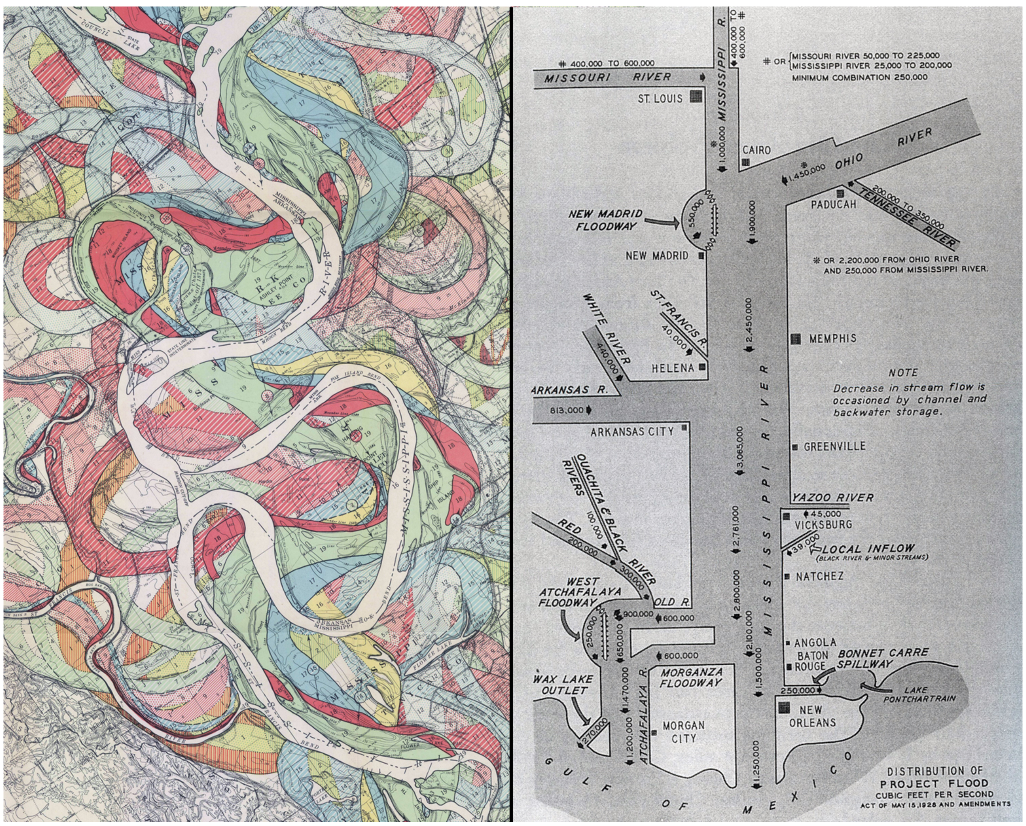

Figure 1-8: *Left*: Detail of historic meanders of the Mississippi River between Cape Girardeau, MO, and Donaldsonville, LA in: Harold N. Fisk, *Geological Investigation of the Alluvial Valley of the Lower Mississippi River* (Vicksburg, MS: Mississippi River Commission, 1944). *Right:* A 1952 diagram of the Army Corps of Engineers "Project Flood." The Project Flood was a baseline for modeling the desired capacity of post-1927 flood infrastructure. Compare the rigid plumbing of that document with Fisk's meander maps to see just how imporous the new system was, even with its spillways and outlets.

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is especially pertinent here. James Scott discusses the ways large-scale projects to organize nature have been deeply misguided features of modern states: *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998).

Although rice flumes have long since disappeared from parish, state, and federal records (but perhaps remain buried as archaeology in some Louisiana riverbanks), the technology was once at the center of a divisive struggle over the region's watery ecologies. This was a period in which rice planters—and even a handful of engineers designing patents for more porous, multifunctional levees—offered an alternative way of knowing, inhabiting, and improving southern Louisiana's flood-prone environment. Contrasting with dominant visions of an impermeable modernity, rice flumes represented an embrace of seasonal flooding and an adaptation to the region's watery ecology. By managing, rather than halting, the flow of water across the landscape, flumes offered practical efficiencies of labor and fertility that contrasted with the ecological demands of sugar agriculture. In the minds of some Louisiana residents, flumes also suggested the promise of improved health in a region long known for its struggles with ague and miasma. Perhaps most importantly, flumes fostered economic development in the world of tattered flood infrastructure and emancipated labor that followed the Civil War. Nineteenth-century Louisiana rice found markets across the nation and became, for a time, the leading commodity produced in a state marked by vanished credit and broken levees. River rice, and the permeability it entailed, helped restore revenues and attract capital to the state. Indeed, river rice ultimately arranged for its own demise by preparing the economic ground for sugar's return. Far from a backward-looking agricultural holdout against modern impermeability, southern Louisiana's perforated levees in fact ushered the region into post-bellum progress. Flumes offered another vision of modernity for watery southern Louisiana and the complete severing of the Mississippi from its delta was thus perhaps not as inevitable as we might imagine. Which is not to say that a permeable society built on river rice would have prevented land loss in Louisiana. After all, flumes and porous levees still embodied some form of control over the watery landscape, still entailed at least some stabilizing of the dynamic delta. But that stability and control were not totalizing. Flumes, the porous levees they created, and forgotten speculative flood-control inventions of the late nineteenth century all suggest an alternative present and future for coastal Louisiana. These were "the levees that might have been," the permeable engineering that, while far from perfect, might in places have still allowed flood and silt to sustain at least some parts of the delta's sedimentary terrain.

As river rice declined in the 1890s, a new wetland industry was materializing in earnest throughout the backswamps of southeastern Louisiana. Bald cypress, a prized regional resource since even before European arrival, was coming into its own as a commodity. Entirely new technologies, wetland interventions, and social arrangements emerged to facilitate its extraction. Where river rice illustrated a social struggle over permeability in Louisiana's settled agricultural lands, industrial cypress logging represented the careful balancing of wet and dry ecologies in more remote corners of the deltaic plain. Here, lumber companies confronted a wetland organism that, neither fully aquatic nor completely terrestrial, was embedded in both a complex hydrological regime and a seemingly impenetrable environment. Bald cypress was something fundamentally in-between, governed by a shifting, watery terrain wholly unfamiliar to nineteenth-century industrial capital. Transforming bald cypress into a commodity would require enormous (and unusual) extractive efforts in which Louisiana lumber companies disentangled the "wet" and the "land" from the region's forested wetlands.

Chapter 2: The Cypress Frontier

If you ever fly out of Louis Armstrong International in New Orleans, book a late-afternoon flight and grab a window seat. As the aircraft wheels northwards on takeoff, it becomes immediately apparent that the Crescent City is completely embedded in amphibious terrain. Golden-hour sunlight suffuses the greens and browns of the world below, tingeing it with orange highlights. The "wet" of this wetland environment glistens into relief, the low sun providing the perfect angle for revealing the pockets of open water that proliferate throughout the landscape. At first, these mirrored pools and puddles will seem scattered essentially at random, appearing here and there according to the whims of topography, hydrology, and ecology. But as your regional jet passes above the Manchac Swamp, just across Lake Pontchartrain to the northwest of New Orleans, a far more organized, distinctively human pattern glistens and gleams amid the wetlands below. Flashing in the afternoon sun, sets of gold-and-silver spokes radiate from an assortment of hubs deep within the swamp. These blazing watercourses, far too straight and geometrical to be the product of wetland ecology, extend their way across the landscape, revealing an unmistakable pattern of wagon wheels stamped across Manchac's sodden territory.[211]

First appearing in Louisiana swamps over 120 years ago, the hub-and-spoke patterns of Manchac mark the first industrialization of bald cypress (*Taxodium distichum*) logging in

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[211] This view out the airplane window is hardly mine alone. Several authors have used it to illustrate or introduce nineteenth-century bald cypress logging in Louisiana. I discuss questions of ownership, influence, and "cryptomnesia" around this imagery in a blog post: "Telling Familiar Stories: The Anxiety of Influence," November 11, 2013, accessed April 15, 2015, http://www.adammandelman.net/2013/11/11/anxiety-of-influence/. Other authors writing about the view out the airplane window include: Julia Sims, *Manchac Swamp: Louisiana's Undiscovered Wilderness* (Baton Rouge: Louisiana State University Press, 1996), 27; Richard Campanella, *Time and Place in New Orleans: Past Geographies in the Present Day* (Gretna, LA: Pelican Publishing, 2002), 9.

Louisiana. But how exactly were they made? Beginning in 1889, a suite of technological developments helped dramatically increase the scale and intensity of bald cypress logging in the region's swamps. Chief among these was a curious, ungainly vessel called a pullboat. Essentially a small barge outfitted with a steam engine and a set of winches, the pullboat navigated its way deep into Louisiana's swamps, where it would set anchor and reel in felled cypress logs, scarring the landscape in the process.

Pullboating, however, was but one expression of a much longer history of Euro-Americans harvesting bald cypress in Louisiana. Small-scale commercial logging of *Taxodium* began shortly after Europeans arrived in the eighteenth century. This early phase grew largely as an export trade from the 1720s until the 1800s, when geopolitical developments both eliminated foreign markets and rendered swamp logging equivalent to banditry for half a century. Many decades later, shortly after the pullboat first industrialized cypress extraction in the 1880s, still another system of steam-powered rail skidding developed in the region's watery forests. Skidding and pullboating persisted alongside one another until the cypress industry fell into decline in the 1930s. The two-hundred year history of swamp lumbering in Louisiana thus unfolded in two main periods: almost 150 years of pre-mechanized (and sometimes illegal) harvest, followed by a larger-scale steam-powered industry that decimated the region's cypress forests in under five decades.[212]

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[212] While this chapter discusses the geographical patterns that steam-powered capital can produce in wild landscapes, it is not a sustained political-economic engagement with the ecologies of industrial forestry. For such a project, see: Scott Prudham, *Knock on Wood: Nature as Commodity in Douglas Fir Country* (New York: Routledge, 2005). Note that the long regeneration time of *Taxodium* and the hydrological problems that have thwarted regrowth make Louisiana swamp logging an awkward case for comparison with industrial Pacific Northwest forestry. Additionally, Prudham's book mostly examines a cultivated, rather than extracted, resource. For a discussion of the distinctions between the two, see: William Boyd, Scott Prudham, and Rachel Schurman, "Industrial Dynamics and the Problem of Nature," *Society & Natural Resources* vol. 14, no. 7 (2001): 555-570.

These two phases of bald cypress logging should be understood as part of a broader Euro-American effort to impose order, mark boundaries, and establish rigid categories in the Mississippi River Delta. Euro-Americans applied a handful of extractive strategies to southern Louisiana's forested swamps, finding ways to create value out of what they had otherwise imagined as waste wetlands. If rice flumes and porous levees suggested that stabilizing the flood-prone environment was an object of intense social conflict, bald cypress logging reveals the prodigious (and often unusual) labors that went into other attempts to bound and reorder the region's amphibious terrain. First, settlers would redefine a swamp organism—*Taxodium distichum*—into useful lumber, severing a tree from its watery ecology to create an exchangeable commodity. Second, over a period of several decades, lawmakers and bureaucrats would reclassify the trackless, soaking forests of the deltaic environment into clearly bounded territory that could be legitimately leased and logged. And finally, beginning in the late 1880s, lumber companies would reconfigure the wetland environment in order to facilitate the steam-powered intensification of their harvest—frustrating and unpredictable amphibious terrain would be carved into more discrete parcels of either firm land or open water.

Altogether, this represented a strenuous and distinctive three-fold effort to reorder the forested wetlands of the Mississippi River Delta. The hubs and spokes of Manchac emerged as humans struggled to wring valued resources from swampy nature, enclose territory from apparently undifferentiated waste, and rationalize the dynamic in-betweenness of a watery wilderness. This was the reorganization of what Euro-Americans experienced as a chaotic and unstable morass of water, muck, and vegetation into a productive resource frontier.[213]

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[213] My thoughts on frontiers began with: William Cronon, "Revisiting the Vanishing Frontier: The Legacy of Frederick Jackson Turner," *The Western Historical Quarterly* vol. 18, no. 2 (1987): 157-176. Rejecting Turner's teleology and sweeping claims about national identity, Cronon suggests that the frontier idea is still useful because it

The Nature of *Taxodium distichum*

Taxodium distichum is one of North America's most remarkable tree species. Discovering a grove in the wild is a treat that few nature lovers forget, not least because such an encounter usually takes place in the continent's southern swamps (Figure 2-1). Festooned with Spanish moss (*Tillandsia usneoides*), swollen at its base, and surrounded by knobby protuberances (or "knees") emerging from the water or saturated soil around its trunk, *Taxodium* is a singular organism found in a singular ecology. Writing for an 1875 travel memoir of the southern United States, journalist Edward King furnished a haunting description of a cypress swamp. He described a "hopelessly irreclaimable, grotesque water wilderness" in which ghostly tree trunks, decaying and festooned with Spanish moss, stood atop earth that "seemed firm," but which offered no safe purchase for a human visitor.[214]

Not actually a cypress, the tree is one of the few deciduous conifers and sheds its needles seasonally, growing "bald" with each winter. Its habitat is almost entirely restricted to low-lying landscapes that are at least intermittently flooded. In Louisiana, both winter rains and the spring high waters of the Mississippi bring flood to the bald cypress swamps. In some years, these inundations can cover a swamp in ten feet or more of water. Despite their height, these floods are

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focuses attention on encounters between humans and wildness. On the frontier, we see the enclosure of wild nature, its entanglement with human labor and cultural values, and its eventual articulation with metropolitan economies. For further elaboration of these arguments, see: William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W. W. Norton & Co., 1991). Since this is a project about boundary-making, anthropologist Anna Tsing makes a particularly irresistible observation about resource frontiers in Indonesia: "Frontiers are not just edges; they are particular kinds of edges where the expansive nature of extraction comes into its own." I interpret that "expansive nature" as suggestive of all the cascading consequences of the frontier edge—carving up territory, framing value, and reorganizing the physical landscape of resource-rich environments. Anna Tsing, *Friction: An Ethnography of Global Connection* (Princeton: Princeton University Press, 2005), 27. For more on resource frontiers, see: Keith Barney, "Laos and the Making of a 'Relational' Resource Frontier," *The Geographical Journal* 175 (2009): 146-159. On frontiers as spaces of enclosure for capitalism, see: Massimo de Angelis, "Separating the Doing and the Deed: Capital and the Continuous Character of Enclosures," *Historical Materialism* 12 (2004): 57-87.

[214] Edward King, *The Great South: A Record of Journeys in Louisiana, Texas, the Indian Territory, Missouri, Arkansas, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Kentucky, Tennessee, Virginia, West Virginia, and Maryland* (Hartford: American Publishing Company, 1875), 70, 84.

rarely violent. Sluggish and hardly ever flowing at much more than four miles per hour, cypress swamp floodwater often appear as if they are not moving at all.[215]

Figure 2-1: *Taxodium distichum* in the Atchafalaya Basin. Photo by Kari Nousiainen, January 20, 2010, used under a Creative Commons Atrribution-NonCommercial license: https://creativecommons.org/licenses/by-nc/2.0/.

The torpid and variable waters of a swamp are key to the entire ecology of Taxodium. The tree's seeds are primarily distributed across the landscape by high water. Although a few squirrels and wood ducks assist in these reproductive efforts, the seasonal flooding of cypress forests is what guarantees the spread of succeeding generations.[216] But as much as *Taxodium* appears to thrive in thoroughly inundated circumstances, it also requires at least some drainage to

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[215] L.P. Wilhite and J.R. Toliver, "Baldcypress," in U.S. Department of Agriculture, U.S. Forest Service, *Silvics of North America, Vol. 1*, ed. Russell M. Burns and Barbara H. Honkala, Agriculture Handbook no. 654 (Washington, DC: Government Printing Office, 1990), 563-572.

[216] On seed distribution: U.S. Department of Agriculture, U.S. Forest Service (USFS), *Silvics of Forest Trees of the United States*, Agriculture Handbook no. 271 (Washington, DC: Government Printing Office, 1965); Wilhite and Toliver, "Baldcypress"; John V. Dennis and Steve Maslowski, *The Great Cypress Swamps* (Baton Rouge: Louisiana State University Press, 1988), 4-5.

fully reproduce. Although its seeds travel primarily by water, they cannot germinate while fully submerged. Remaining viable for up to thirty months of inundation, *Taxodium* seeds need light and air in order to take root. Thus, new trees emerge in a swamp only at those moments where the soil is saturated, but still exposed to the air. Saplings in turn only survive if their crowns can reach high enough to avoid being submerged more than just a few days in the next season's waters. Although juvenile bald cypress can grow up to twenty inches in their first two seasons, that often is not an adequate height to avoid drowning. Saplings thus often need at least a few seasons of shallower flooding before their crowns are safely out of harm's way.[217] These distinctive trees thus depend on the ebb and flow of seasonal floodwaters to best reproduce. Without high water, *Taxodium* fails to adequately spread its seeds. Without a brief period every few years in which floodwaters recede, no seeds will sprout and survive to replace their parents.

For that very reason, many of southern Louisiana's *Taxodium* groves are today at risk of disappearing. Anthropogenic changes to the landscape have left many of the region's forested swamps permanently flooded. Where these soils once intermittently breathed open air, they are now perpetually drowned. When all the mature cypress dies within a few hundred years, these permanently flooded forests will give way to either open water or grass-dominated marsh.[218] It seems that water, though useful to spreading the tree's progeny, can also be hostile to *Taxodium*.

In fact, experiments have shown that bald cypress grows just as easily in well-drained soils that, while maybe moist, never see any flooding. But while *Taxodium*'s physiology does not

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[217] On germination, growth rates, and submersion: Delzie Demaree, "Submerging Experiments with Taxodium," *Ecology* vol. 13, no. 3 (1932): 258-62; Wilbur Reed Mattoon, *The Southern Cypress*, (Washington, DC: Government Printing Office, 1915), 20, 30; Wilbur Mattoon, "Water Requirements and Growth of Young Cypress," *Proceedings of the Society of American Foresters* vol. 11 (1916): 192-193; U.S. Department of Agriculture, U.S. Forest Service, *Silvics of Forest Trees*, 674.

[218] Clair A. Brown, "Cypress: The Tree Unique, the Wood Eternal," *Garden Journal* vol. 1 (1951): 36-3; Melanie Torbett, "Too Much Water for Cypress Forests," *Forests and People* vol. 57 no. 2 (2007): 6-9; Demaree, "Submerging"; Wilhite and Toliver, "Baldcypress."

depend on rising water, *Taxodium*'s ecology does. Without regular inundation, bald cypress is vigorously outcompeted by all manner of other trees and vegetation. While *Taxodium* might be happier with slightly drier feet, its competitors are even more so. By dispersing seeds, eliminating competitors, and receding just long enough for saplings to germinate and grow, the highly variable seasonal floods of a place like the Mississippi River Delta guarantees bald cypress a place in the world.[219]

Wilbur Mattoon, a forester in the first decades of the twentieth century, once noted that the "exacting moisture requirements" for germination provided the "key to the whole question of cypress distribution." But Mattoon's assessment did not extend quite far enough. Bald cypress expresses "exacting moisture requirements" at almost every instance of its life.[220] Though fundamentally dependent on floodwaters to disperse seeds, saturate seedbeds, and hold back competition, *Taxodium* is also far from being a fully aqueous organism. It is a kind of goldilocks tree; much like the wetlands it calls home, it is deeply in-between. Bald cypress thrives in places where the landscape is subjected to the dynamic changes wrought by significant, and even long-lasting flood, but only in as much as it also depends on at least a few intermittent periods in which those waters recede. Even its most distinctive physiological features—its swollen, buttressed trunks and the curious knees protruding around its base—develop most prominently through the interplay of air and water. Bald cypress trunks swell in proportion to how much they are exposed to *both* air and water. Similarly, cypress knees tend to emerge only around trees that see more dynamic inundation and floodwater recession. When a swamp is either only rarely submerged or persistently covered by a foot or more of standing water, its bald cypress trees will

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[219] On growing in drier environments: Brown, "The Tree Unique," 38; Mattoon, *The Southern Cypress*, 24. On competition: Wilhite and Toliver, "Baldcypress."

[220] Mattoon, "Water Requirements," 192.

develop few, if any, knees.[221] *Taxodium distichum* is thus in many ways a synecdoche for the ecosystems in which it is most abundantly found. Without the right mix of air and water, land and flood, bald cypress at best grows without its most recognizable characteristics. At worst, it fails to grow at all. Too dry and it gets pushed out by other plants. Too wet and it drowns.

As such, *Taxodium* thrives in southern Louisiana's youthful deltaic environment. This landscape occupies a liminal and fleeting geologic moment where land built up over just a few thousands years meets open Gulf waters not yet colonized by the Mississippi's land-building floods.[222] Here, *Taxodium distichum*—an in-between organism—flourishes in the in-betweenness of a saturated landscape. Conceiving of the tree in isolation from its amphibious habitat is to risk ignoring the very nature of the species. In the words of pioneering ecologist Arthur Tansley, "Though the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form one physical system."[223] That the nature of *Taxodium* cannot be easily disentangled from an ecosystem often deemed inhospitable and impenetrable by humans suggests just how much work would be required to produce the resource.

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[221] On buttress and knees: Herman Kurz and Delzie Demaree, "Cypress Buttresses and Knees in Relation to Water and Air," *Ecology* vol. 15 no. 1 (1934): 36-41. The question of whether bald cypress knees helped aerate the tree's roots was the subject of longstanding debate, largely because they knees are absent in both unusually dry *and* wet swamps. They are now thought to provide supplemental (but by no means critical) aeration as well as additional anchoring in soft, swampy soils. See: Wilhite and Toliver, "Baldcypress."

[222] Mattoon, *The Southern Cypress*, 20. In Mattoon's words: "Broadly speaking from a geological standpoint, cypress therefore belongs characteristically to young lands. . . . It advances slowly, but ahead of all other trees, as river and sea marshes gradually build up, flourishes in the deep alluvial soils submerged for a portion of the year, and later is driven out by the competition of hardwoods as the lands are further built up and become drained."

[223] Arthur Tansley, "The Use and Abuse of Vegetational Concepts and Terms," *Ecology* 16 (1935): 284-307, 299. Tansley's paper popularized the term "ecosystem," which had been originally suggested to him by botanist Arthur Roy Clapham in the early 1930s. A.J. Willis, "The Ecosystem: An Evolving Concept Viewed Historically," *Functional Ecology* 11 (1997): 268-271.

The process of transforming *Taxodium distichum* (the organism embedded in its ecology) into cypress (the marketable, abstract commodity) would require substantial and distinctive boundary-making labor.[224] The tree would have to be severed from its ecosystem and recognized as useful timber. For cypress timber to be successfully logged and profitably traded, the in-betweenness of its watery habitant would also have to be rationalized and transformed. Forested wetlands would need to be reimagined as a resource territory. And that territory would in turn need to be carved and sculpted into discrete patches of open water and drier land that could facilitate consistent, large-scale extraction. Ultimately, the wet and the land would be strained from Louisiana's wetlands so the machinery of industry could take root and operate.

Making Cypress from *Taxodium*

Soon after their arrival in the early eighteenth century, Europeans noticed bald cypress might be an unusually valuable wetland resource. One of the few abundant trees in the watery environment, it was harvested at first simply out of necessity. But Europeans soon realized that in addition to being a soft, highly workable wood, the tree's swampy ecology had conferred on it some other remarkable features. In 1709, French colonists at Dauphin Island—off the coast of present-day eastern Alabama—submerged ten different varieties of wood in seawater for several months. Only the cypress sample emerged unscathed by marine worms.[225] Subsequent use of

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[224] For the remainder of this chapter, "*Taxodium*" is used as a marker of unbounded, watery nature, and "cypress" is used as a marker of that nature stabilized and reconfigured into resource territory. William Cronon's *Nature's Metropolis* offers one of the best examples there is of the process of transforming a complex organism into a simplified, bounded commodity. Also see: Morgan Robertson, "No Net Loss: Wetland Restoration and the Incomplete Capitalization of Nature," *Antipode* vol. 32, no. 4 (2000): 463-493; Morgan Robertson, "The Nature that Capital Can See: Science, State, and Market in the Commodification of Ecosystem Services," *Environment and Planning D*, vol. 24, no. 3 (2006): 367-387.

[225] "Memoir On Louisiana By Mandeville," April 27, 1709, " in *Mississippi Provincial Archives, 1701-1729: French Dominion, vol. 2*, ed. and trans. Dunbar Rowland and Albert Godfrey Sanders (Jackson, MS: Press of the Mississippi Department of Archives and History, 1929), 51.

bald cypress lumber demonstrated the wood was generally impervious to water, resisting not just pests, but also moisture and rot, two qualities that were highly prized in the region's humid, watery environment.[226] In fact, it was these qualities that also helped build a significant export trade in cypress throughout the Caribbean, from Saint-Domingue to Martinique.[227]

The water-resistant qualities cypress would see some of the very first buildings constructed from the wood still in good condition two hundred years later. Similarly, early water mains made from hollowed cypress trunks laid in New Orleans around 1810 were found in a "splendid state of preservation" when excavated on Canal Street over a century later in 1915. Nineteenth-century sugar houses used the wood to construct cane-juice vats, syrup-cooling tanks, and molasses cisterns. Rice flumes constructed between the 1840s and 1890s were almost always made of cypress precisely because of its reliability under prolonged exposure to water. In the late nineteenth century, a booming bald cypress lumber business had labeled it "the wood eternal." And by the 1910s, it could be found in a variety of places where wood was subjected to extremes of heat and moisture: creameries, breweries, bakeries, dye works, distilleries, soap and starch factories, greenhouses, pumps, laundry appliances, caskets and coffins, and as boat planks, river pilings, and shingles. Forester Wilbur Mattoon even noted that it outlasted all other roofing materials save slate and tile. Despite the apparently useless terrain of the disordered swamps that *Taxodium* called home, those watery ecologies had made cypress lumber quite useful.[228]

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[226] On water and rot resistance: Le Page du Pratz, *The History of Louisiana* (London: T. Becket, 1774; reprint edition, New Orleans: Pelican Press, 1947), 216; Mattoon, *The Southern Cypress*, 9.

[227] On the cypress export trade to the Caribbean: John Hebron Moore, "The Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," *Louisiana History* vol. 24, no. 1 (1983): 25-47, 28, 30-32; John Hebron Moore, *Andrew Brown and Cypress Lumbering in the Old Southwest* (Baton Rouge: Louisiana State University Press, 1967), 5.

[228] On buildings: Mattoon, *The Southern Cypress*, 9. On water mains: "Find Century-Old Cypress Pipes," *The Lumber Trade Journal*, May 1, 1915, 41. On sugar applications: J. Carlyle Sitterson, *Sugar Country: The Cane Sugar Industry in the South, 1753-1950* (Lexington: University of Kentucky Press, 1953), 143. On other uses:

But before an industry could emerge that would facilitate putting bald cypress to so many uses, people had to transform the watery, in-between organism *Taxodium distichum* into an extractable natural resource. People had to find a way to negotiate an environment that, saturated with unpredictable waters, was largely impassable and often unpleasant—what was, in Edward King's words, a "hopelessly irreclaimable, grotesque water wilderness."[229] Even in 1915, during the industry's heyday, Mattoon observed that "the present logging of cypress is attended by difficulties of a kind unknown in handling any other commercial timber" and that the tree grew naturally "in commercially important quantities only in regions where logging is difficult and expensive." The challenge of bringing it under artificial forest management was "intimately related to that of reclaiming swamp land on an extensive scale."[230]

Which is to say, *Taxodium* embodies a kind of ecology that often thwarts human efforts to develop large-scale, commercial economies of extraction. Either water needed to be evacuated from the landscape, or entrepreneurs needed to find a way to remove valuable resources from the otherwise confounding environment. But Mattoon was making these observations at the height of the bald cypress industry in Louisiana. Though he discussed the profound obstacles that confronted transformation of the swamp tree into a commodity, he was doing so at a time when those obstacles were more easily surmounted than ever before. Over almost two hundred years, people had poured enormous amounts of labor into negotiating Louisiana's forested wetlands. Through developing water-adapted logging practices, bounding a resource territory, introducing new extractive technologies, and reorganizing the composition of the physical environment, the

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Mattoon, *The Southern Cypress*, 10; James A. Kirby, "Cypress As An Educational Force," *The Southern Lumberman*, December 17, 1921, 106-110; Wilhite and Toliver, "Baldcypress."

[229] Water wilderness quote, again, is from: King, *The Great South*, 70.

[230] Mattoon, *The Southern Cypress*, 11, 2, 1.

lumber industry had by Mattoon's time established a highly productive resource frontier on the region's cypress swamps. To understand the challenges the industry had already overcome by the 1910s, we must turn back to the days of pre-industrialized cypress lumbering.

Pre-Industrial Cypress

For almost the entire colonial period, lumber was one of Louisiana's most important export commodities, both in its own right and as a supplement for the indigo and tobacco trade. At the turn of the eighteenth century, the French Crown had hoped pearls and buffalo wool would be the primary trade products of the new territory, but the quality of Louisiana pearls soon proved almost worthless. An attempt at exporting dried fish was also swiftly abandoned in the first decade of settlement in lower Louisiana.[231] By the time of the establishment of New Orleans in 1718, colonial officials had turned their attention to agricultural products like tobacco, cotton, indigo, sugar, and coffee. But where the Caribbean colonies had proven exceedingly lucrative in developing an agricultural trade, the cooler climate and watery environment of the New Orleans region regularly thwarted the attempts of most settlers to consistently raise export crops of sufficient quantity and quality.[232] Agriculture alone, so it seemed, would not provide a secure economic foundation for the colony. For decades after their arrival, colonists would help pay for many of their costly imports with shipments of lumber. It certainly helped that the cypress trade accommodated the seasonal labor demands of settling and surviving in the new colony. During the agricultural lulls of the fall and winter, farmers and their slaves would turn to the cypress

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[231] On pearls, wool, and fish: N. M. Miller Surrey, *The Commerce of Louisiana During the French Regime, 1699-1763* (Tuscaloosa: University of Alabama Press, 2006), 156.

[232] Jean-Baptiste Le Moyne, Sieur de Bienville, the founder of New Orleans, complained about the challenges of producing agricultural returns in the watery environment: "Memoir on Louisiana," in *Mississippi Provincial Archives, 1701-1729: French Dominion, vol. 3*, ed. and trans. Dunbar Rowland and Albert Godfrey Sanders (Jackson, MS: Press of the Mississippi Department of Archives and History, 1929), 525.

swamps to fell trees and saw timber to be sold at New Orleans.[233] Cypress, through no intention of the colonists, would become an important source of revenue for New Orleans until the beginnings of the sugar industry at the end of the eighteenth century.[234]

But if the sodden landscape made early attempts at export agriculture a challenge, it also posed significant obstacles to extracting timber. In eighteenth-century Louisiana, periodic flooding made stands appear all but inaccessible. When swamps were not covered in water, the exceedingly soft, saturated soil often failed to support the weight of wheeled conveyances and draft animals. Moreover, a shortage of horses and oxen in the colony frequently meant that slaves had to be employed in *dragging* logs out of the swamps, a frustrating, intensely laborious task. The difficulties in extracting cypress are suggested by the fact that for the year 1724, landowners using slaves in this way failed to clear more than 300 yards of depth from the cypress swamps in their grants.[235] Despite these challenges, the 1709 immersion tests at Dauphin Island suggested to the French that lumber harvested from the peculiar tree might in fact be worth overcoming the challenges of its ecological habit.

In the first years of the cypress lumber market, loggers would work in the swamps at the lowest stages of the river seeking some semblance of dry ground. Because of the challenges of extracting logs from the environment, these first axemen cut planks right on the spot using large two-man handsaws. Some loggers at this time also experimented with chopping trees during high

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[233] Bienville's "Memoir" also describes the seasonal rhythms of cypress lumbering, 520.

[234] On the importance of lumber in colonial Louisiana, see: John Garretson Clark, *New Orleans, 1718-1812: An Economic History* (Baton Rouge: Louisiana State University Press, 1970), 56, 152, 192.

[235] Craig Colten, "Cypress in New Orleans: Revisiting the Observations of Le Page du Pratz," *Louisiana History* vol. 44, no. 4 (2003): 463-477, 466.

water—while standing in a small boat—and then floating the logs out to market.[236] But because green cypress was extremely heavy with sap, this alternative method tended to risk losing timber as "sinkers." A report written 200 years later suggests that only 10-20 percent of these green logs would have floated. Some sawyers strapped green cypress logs to other, more buoyant species of timber to create a raft, but these watercraft were very unwieldy.[237]

But lumbermen soon began to find ways of turning the watery environment to their advantage in solving the problem of buoyancy. In the early 1720s, sawyers began to fell trees in the dry season, when green logs contained less sap, already making them more buoyant. Logs would then be rolled and dragged together to form a raft, which would be left to dry on the forest floor. When high water came in the spring, timbermen could float the rafts out of the swamp and into a waterway that would carry the timber down to New Orleans.[238]

By 1725, loggers further improved this approach by girdling the tree far in advance of the actual felling. Loggers would cut a strip of bark several inches deep around the trunk of a bald cypress, severing the tree's phloem, that part of the vascular system transporting water and nutrients throughout its tissues. The girdle killed the tree without felling it, allowing the cypress to dry and season while still standing.[239] The seasoned cypress was then easier to fell and would

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[236] Moore, *Andrew Brown*, 10. Even in the 1880s, some swampers—or subsistence loggers—still chose to split lumber in the forest, depending on its final application, see: Martha Field, "Livingston Parish: Swampers [c. 1892]" in *Louisiana Voyages: The Travel Writings of Catharine Cole*, edited by Joan B. McLaughlin and Jack McLaughlin (Jackson: University Press of Mississippi, 2006), 70-6.

[237] Moore, "Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," 29. Statistics for floating green logs are from Mattoon, *Southern Cypress*, 12.

[238] Moore, *Andrew Brown*, 10-11.

[239] On girdling in 1725: "The Superior Council of Louisiana to the General Directors of the Company of the Indies," in *Mississippi Provincial Archives, 1701-1729: French Dominion, vol. 2*, ed. and trans. Dunbar Rowland and Albert Godfrey Sanders (Jackson, MS: Press of the Mississippi Department of Archives and History, 1929), 403. For an 1880s eyewitness description of girdling cypress—largely unchanged from the 1720s—see: Martha Field, "Livingston Parish: Swampers [c. 1892]" in *Louisiana Voyages: The Travel Writings of Catharine Cole*, edited by Joan B. McLaughlin and Jack McLaughlin (Jackson: University Press of Mississippi, 2006), 71.

float 95 percent of the time.[240] Loggers would return to the swamp in high water, attacking the trees from either small boats or by standing on planks inserted into a notch in the tree's trunk (Figure 2-2).[241] Girdling in advance and felling in high water had the added benefit of allowing sawyers to assemble their rafts much more easily with floating logs, as opposed to rolling and dragging heavy green timber together across the mushy ground of a "dry" swamp. This system offered lumbermen a significant adaptation to the inconsistent and unstable terrain of Louisiana's swamps; flotation logging would define cypress extraction through the late 1880s.

Figure 2-2: A swamper preparing to fell a bald cypress tree to be floated out of Bayou Close in Pointe Coupee Parish, Louisiana, c. 1888. George Coulon, *350 Miles in a Skiff Through Louisiana Swamps* (New Orleans: George Coulon, 1888).

As historian John Hebron Moore observes, however, this water-adapted system also made cypress logging a complicated, multi-stage process in which whole seasons needed to pass

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240 Statistics for floating girdled logs are from: Mattoon, *The Southern Cypress* 12.

241 For a later account of felling in water, see: Charles S. Sargent, *Report on the Forests of North America, Exclusive of Mexico* (Washington, D.C.: Government Printing Office, 1884), 525.

between first felling a tree and bringing it to market.[242] It could even be years before floodwaters would reach a high enough stage to float logs out of some swamps. In the 1840s, for example, New Orleans experienced a timber famine for a few seasons until the floods of 1847 rose high enough to float cypress logged in the swamps bordering the Homochitto, Arkansas, Red, and Yazoo rivers.[243] Similarly, after several dry years had stranded tens of thousands of logs throughout the lower Mississippi Valley, the floods of 1858—when the Bell Crevasse unleashed havoc outside New Orleans—yielded $5 million worth of cypress rafted out of the Yazoo River alone.[244] Flotation logging, though it allowed lumbermen to overcome the frictions of the watery landscape, was still at the mercy of unpredictable availability of high water.

In fact, since flotation logging depended so crucially on pulses of flood through the landscape, swamp timbermen often resented the levees that increasingly severed the river from the backswamps. The increasingly uninterrupted and impermeable levee system that engineers and sugar planters were developing in the nineteenth century only compounded the problems posed by intermittent low-water years. Unlike Louisiana's river-rice planters, however, cypress loggers did not use flumes or other technology to carefully manage the flow of floodwaters through an embankment. Instead, they simply blasted holes in the levees in order to bring high water into their tracts of cypress swamp.[245]

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[242] Moore, *Andrew Brown*, 11.

[243] Moore, *Andrew Brown*, 57.

[244] *Natchez Daily Courier*, May 1, 1858. Over $140 million in today's dollars.

[245] Accounts suggest the practice of cutting levees to facilitate float logging was restricted to the earlier phase of cypress extraction from the eighteenth century through perhaps as late as the Civil War. Some sources also suggest such stories are based on planter prejudice. Regardless, it is clear that, in the words of an 1884 observer speculating on this history, "An overflow does not frighten a swamper [swamp logger] as it does a planter." D.D. "The Atchafalaya Basin," *Times-Piacyune* March 30, 1884. Also see: "The Overflow in the Mississippi," *Clarksville Chronicle*, April 16, 1858; "The Swampers and the Levees, *The Weekly Iberville South*, March 20, 1897.

But if both seasonal low water and levees could frustrates loggers, so too could floods that were too high. For as much as loggers depended on inundation to extract their timber, extreme high water could sometimes just as easily disrupt the cypress trade. If the river was so swollen that floodwaters failed to crest and subside in a timely manner, there could be insufficient current to help propel heavy rafts out of the swamp, potentially leaving the logs stranded until the next high water. If, on the other hand, there was still enough current during a large flood to navigate rafts out of the swamps, loggers would then have to contend with the extremely turbulent waters of the Mississippi. Large and ungainly, these logs-cum-watercraft were extraordinarily difficult to pilot. One cypress raft in the bonanza flood year of 1858 measured 560 feet long by 200 feet wide. The river sometimes broke apart these vessels, sending runaway rafts onto inundated plantation lands, providing a source of salvage income for planters. The floods of 1849—when New Orleans saw major flooding thanks to a crevasse on Pierre Sauvé's plantation—sent several cypress rafts beyond the banks of the Mississippi, leaving lumbermen to scour the region for weeks afterwards in search of lost timber.[246] And sometimes the Mississippi reached a flood stage so high that sawyers were completely unable to fell cypress at all. The floods of December of 1734 inundated swamps through the following April, creating a timber shortage in Louisiana that would result in tripled prices for as much as two years hence.[247] In normal flood years, flotation logging usually solved the problem of getting cypress out of the swamps. But the dynamic extremes of high and low water in the delta still frequently thwarted the lumber trade.

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[246] On the need for a swift enough current to float out timber, see: Moore, *Andrew Brown*, 64. For an example of the dimensions of a large timber raft, see: *Natchez Daily Courier*, May 14, 1858. On lost timber and salvaging, see: Moore, *Andrew Brown*, 75-76.

[247] On the 1734 floods and the resulting timber shortage, see: Surrey, *The Commerce of Louisiana*, 184.

The unpredictable waters of the flat and mucky deltaic environment also posed problems for milling lumber harvested from the region. Although two sawmills had been in operation in Louisiana territory since 1716, these facilities were likely located out of the delta to the east, around the main French settlement at Biloxi.[248] Here, topography ensured that streams offered sufficient head to turn a water wheel. In southern Louisiana, however, the Mississippi and its distributaries offered only the most sluggish of currents flowing across an unrelentingly flat landscape. Fittingly, when the first mill servicing New Orleans was erected in 1729, it was powered by horses instead of water. Other early mills also experimented with wind power.[249]

As the lumber industry grew, however, mill owners soon discovered ways of bounding the flooded backswamps in order to create millraces capable of running saws. After high water had filled the lowlands at the rear of the natural levees, millers directed the flow of water in the backswamps back to the subsiding river through a series of ditches and checkdams, which in turn created enough head to turn a waterwheel and power the mill's equipment. Naturally, for such a system to work, the ditches necessarily had to cut through the river levees, much as early rice planters had done. These waterways also conveniently offered a way of floating logs from the swamp into the river. The artificial topographies offered by levees, checkdams, and ditches continued to power millraces in the deltaic landscape until around the 1820s when steam power began to replace water wheels.[250]

Although steam power transformed lumber milling as early as the first decades of the nineteenth century, it would take over sixty more years before the cypress industry would also

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[248] Surrey, *The Commerce of Louisiana*, 284

[249] Moore, "Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," 32-33.

[250] Moore, *Andrew Brown*, 11-12. On water-powered sawmills in Louisiana around the turn of the nineteenth century, also see: Irene Blanche Pujol, "Robin's Voyages Dans L'Interieure de La Louisiane: Translated and Annotated" (MA Thesis, Louisiana State University, 1939), 142.

apply steam power to extracting that lumber from Louisiana's swamps. From the 1720s through the 1880s, float logging would remain almost the sole means of harvesting bald cypress from the watery landscape. The lumbering process would thus hardly change for much of the nineteenth century. The way swamp timber resources became property, however, was another matter. Economic and political forces materializing in the late 1700s would blur for almost a century the legal geographies of cypress territory and extraction in Louisiana's amphibious terrain.

Making Territory on the Cypress Frontier

While Louisiana's lumber trade was primarily export-oriented over the eighteenth century, by the 1790s those markets fell into decline largely thanks to disruptions associated with the French Revolution. Subsequent revolt in Haiti and the abolition of slavery in the French West Indies saw demand for cypress plummet, particularly given its use in building containers for Caribbean sugar. American lumbermen, meanwhile, took advantage of wartime instability to outcompete Louisiana and secure their own Caribbean markets from what was left of the sugar container trade. But while lumber exports out of New Orleans grew almost insignificant by the turn of the century, the rapid growth of both the South's Cotton Kingdom and Louisiana's emerging sugar society created a new domestic market for cypress. Over the course of the nineteenth century, Louisiana's lumber trade would be almost entirely bounded by the shores of the United States.[251]

Despite the growing domestic demand for lumber, however, the US government's approach to natural resources concessions on its public lands complicated the renewed development of a bald cypress market in the first half of the nineteenth century. Where the

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[251] Moore, "Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," 45-47.

French and Spanish governments had happily facilitated lumbering on crown lands with the barest of restrictions, the organic act of 1804 establishing Orleans Territory explicitly outlawed trespass on government land, turning most lower Louisiana lumbermen—none of whom had logging title—into outlaws. Congress was so concerned with controlling these resources that in 1807 it authorized the use of the army to prevent such trespass.[252]

In fact, the Euro-American cultural values that abhorred watery environments indirectly ensured that trespass laws disproportionately affected the cypress industry. The US was unwilling to sell off tracts of its public lands until they had been surveyed. But because most Americans associated swamplands with waste, the cypress forests of lower Louisiana would be some of the last territory assessed by federal surveyors.[253] The federal government had thus effectively withdrawn the means of making legal property in Louisiana's wetlands.

An 1811 story exemplifies this metamorphosis of cypress lumbering into banditry. That year's high water had enticed fifteen crews of loggers to raft out large quantities of timber on the public swamps near the mouth of the Homochitto River. If illegal logging were not enough, the crew leaders had taken to poaching cattle for food and intimidating local residents. Only the intervention of the army, the loggers claimed, would force them to abandon their cypress poaching.[254] The watery spaces of Louisiana's cypress forests had been pushed outside the bounds of normal society and property. Here, outlaw loggers operated almost with impunity in the liminal deltaic landscape.

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[252] For a lengthy explanation of the U.S. federal government's position on timber extraction in the first half of the nineteenth century, see: John Hebron Moore, "The Cypress Lumber Industry of the Old Southwest and Public Land Law, 1803-1850," *The Journal of Southern History* vol. 49, no. 2 (1983): 203-222.

[253] Moore, "The Cypress Lumber Industry of the Old Southwest," 207.

[254] John Eisterhold, "Lumber and Trade in the Lower Mississippi Valley and New Orleans, 1800-1860," *Louisiana History* vol. 13, no. 1 (1972): 71-91, 84.

It was thus a combination of lax legal enforcement and the absence of clear territorial boundaries that allowed the cypress trade to persist through the early nineteenth century. US policy essentially amounted to a regulatory vacuum that not only left lumbermen to operate outside of any formal extractive regime, but also resulted in extremely wasteful extraction practices. Without any enforcement ordering the resource frontier, cypress crews had little reason to efficiently or carefully log a swamp. The only directive structuring cypress extraction at this time was haste, since the cypress swamps were first-come, first-served. As such, large quantities of valuable timber were left to rot as timbermen sped through swamps to secure the right of first poaching.[255] But despite the voracious outlaw industry developing in Louisiana's forested swamps, the black market in cypress was insufficient to feed the lumber appetite of New Orleans. As the fastest growing city in the antebellum south, New Orleans would become a lumber importer, even with the illegal timber pouring out from the region's cypress wetlands.[256]

The 1840s marked the beginning of three decades of legislation that would ultimately define the boundaries of Louisiana's cypress swamps as legal resource territory. First, in 1841, Congress, relenting on its approach to settling the western public lands, passed a preemption act that allowed loggers—acting as settlers—to occupy up to 160 acres for twelve months before having to make a purchase. Although an improvement on the previous state of banditry that characterized cypress extraction, the law essentially offered cover to poachers who, if caught in the act, would simply purchase the tract. True change came, however, with the Swamp Land Acts of 1849 and 1850. When the federal government transferred over ten million acres of public swamp and inundated lands to Louisiana, it also rid itself of the responsibility of protecting

[255] On illegal logging, see: Moore, "The Cypress Lumber Industry of the Old Southwest."

[256] On New Orleans as a lumber importer: Eisterhold, "Lumber and Trade," 72, 90.

lumber reserves in the region. It would now be up to the state of Louisiana to redefine the region's cypress swamps into a lumber frontier.[257]

Over the next decade until the eve of the Civil War, the state legislature passed several laws tracing the boundaries of a legal (and legible) resource territory in its watery forests.[258] Surveys and sales disposed of hundreds of thousands of acres of Louisiana land in this way. Unfortunately, graft and fraud also ensured that enormous acreages of dry ground were also sold under the guise of swamp land. Corruption in the 1850s likewise allowed individual lumbermen to accumulate thousands of acres of virgin cypress without any limit on their holdings. Nonetheless, Louisiana still endeavored to conceive of and distribute a resource geography unspoiled by poachers. A March 1855 law sought to prevent illegal timbering with penalties of up to $500 and one year imprisonment. Gunboats, meanwhile, took to patrolling the Atchafalaya River and its distributaries to compel poachers to purchase legal logging title.[259] Surveys and sales, combined with more enforcement had begun to transform the undifferentiated muck of outlaw cypress swamps into a more clearly bounded resource frontier.

But just as a lawful cypress industry began to unfold in the 1850s, the Civil War completely disrupted the region. In the aftermath of the conflict, Congress enacted the Southern Homestead Act of 1866, requiring that Florida, Alabama, Mississippi, Arkansas, and Louisiana

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[257] Moore, "The Cypress Lumber Industry of the Old Southwest," 218-19; For more on preemption through 1841, see: Benjamin Horace Hibbard, *A History of the Public Land Policies* (New York: Macmillan, 1924), 144-164.

[258] On the making of resources, territory, and commodities "legible," see: James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998); Gavin Bridge, "Acts of Enclosure: Claim Staking and Land Conversion in Guyana's Gold Fields," *in Neoliberal Environments: False Promises and Unnatural Consequences*, ed. Nik Heynen et al. (London: Routledge, 2007), 74-86; Robertson, "The Nature that Capital Can See." For other examples of the challenges of making legal property in unruly environments, see: On the making of property in unruly environments, see: Theodore Steinberg, *Slide Mountain, or, The Folly of Owning Nature* (Berkeley: University of California Press, 1995).

[259] For more details on this history, see: Rachel Edna Norgress, "The History of the Cypress Lumber Industry in Louisiana," *Louisiana Historical Quarterly* vol. 30, no. 3 (1947): 979-1059, 986-994.

dispose of their public lands under the terms of the 1862 Homestead Act, that is, in lots of 160 acres for the purposes of agricultural improvement, rather than resource extraction. The 1866 law was intended to reduce the explosion of sharecropping and tenant farming in the postbellum south, but since Louisiana's remaining public lands were mostly swamp and almost entirely unfit for cultivation, the Southern Homestead Act effectively made any unclaimed cypress unavailable for legal harvest.[260] American preoccupations with arable land—and perhaps even American distaste for wetlands—had once again left Louisiana's forested swamps outside the boundaries of the state's geography of property and resources.

The region's cypress territory would remain in political-economic limbo until 1876 when Senator Powell Clayton of Arkansas succeeded in repealing the provisions of the Southern Homestead Act.[261] With Congress having opened up the southern forests for sale, Louisiana's cypress swamps were at last rendered legible and legally accessible for lumber companies hoping to build a renewed wetland resource frontier. Between 1877 and 1888, Louisiana sold almost two million acres of public lands.[262] Largely in cypress, these lands had originally been granted to the state through the Swamp Land Acts of 1849 and 1850, but had been subsequently blocked for sale by the 1866 Southern Homestead Act. But although the state had finally created the legal conditions for owning property on the resource frontier, the amphibious nature of the landscape could still produce significant ambiguity when it came to the boundaries of such

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[260] Norgress, "History of the Cypress Lumber Industry," 994-5.

[261] Rachael Norgress mistakenly calls this the Timber Act of 1876, an error that has been repeated in almost every piece of literature concerning the history of cypress logging in Louisiana. The actual law makes no mention of timber and focuses broadly on public lands: *Statutes At Large of the United States*, volume 19, chap. 165, 73-4.

[262] On Louisiana land sales from 1877-1888, see: Paul Gates, "Federal Land Policy in the South, 1866-1888," *Journal of Southern History* vol. 6, no. 3 (1940): 303-330, 325. Gates observes that speculators made many of the initial purchases and subsequently sold those titles to timber operators.

property. Several lawsuits from the late nineteenth and early twentieth century suggested lumbermen were often unable to agree on the precise geography of a tract of cypress swamp.[263]

At the same time, a marked late-nineteenth century expansion of the American West's transportation infrastructure greatly reduced the geographical frictions of time and distance that had prevented Louisiana timbermen from connecting the cypress swamps with other major markets. New Orleans had finally been integrated into a continent-spanning rail system that promised that the region's watery, liminal forests might actually be incorporated into trade networks reaching to the lumberyards of Chicago and, within just a few more years, California.[264] These connections with large metropolitan economies across the continent, would help drive the intensification and acceleration of Louisiana's bald cypress trade.

The Industrialized Frontier: Pullboating

With these legal and transportation developments having set the conditions for a renewed extractive frontier, how much *Taxodium* actually remained in Louisiana's wetland forests? From the early 1980s through the early twenty-first century, the historiography on swamp logging in Louisiana suggested that colonial-era flotation logging had been so aggressive as to almost completely decimate the New Orleans region's cypress swamps.[265] Largely unchecked poaching in the first half of the nineteenth century hardly would have improved the state of timber

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[263] State ex rel. Des Allemands Lumber Co., Limited, v. Allen, Judge, vol. 110, *Louisiana Reports*, pp. 854-855 (La., 1903); Breaux et al. v. Albert Hanson Lumber Co., Limited, vol. 125, *Louisiana Reports*, pp. 421-432 (La., 1910); Akers v. Iberia Cypress Co., Limited, vol. 131, *Louisiana Reports*, pp. 833-834 (La., 1912).

[264] New Orleans was connected with Chicago in 1873 and California in 1883. See: Ervin Mancil, "An Historical Geography of Industrial Cypress Lumbering in Louisiana" (Ph.D. diss., Louisiana State University, 1972), 77.

[265] For two examples, see: Moore, "Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," 37; Ann Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands* (Washington, D.C.: Island Press, 1997), 48.

reserves. Geographer Craig Colten traces these arguments back to uncritical readings of colonial historian Antoine-Simone Le Page du Pratz.[266] Published in 1758, du Pratz's *L'Histoire de la Louisiane* observed that "the cypress were formerly very common in Louisiana; but they have wasted them so imprudently, that they are now somewhat rare."[267] John Hebron Moore, whose work on the early history of Louisiana cypress logging is otherwise immensely valuable, used du Pratz to suggest that French settlers had logged the region around New Orleans as thoroughly as nineteenth-century lumbermen had cut over the Great Lakes.[268]

Such a claim, however, is completely at odds with the emergence, beginning in the late 1880s, of a largely mechanized cypress lumber industry in Louisiana, some of which were located only just across Lake Pontchartrain from the Crescent City. This industrialized cypress frontier produced immense quantities of lumber through the first decades of the twentieth century. Colten uses a wide variety of sources spanning the late-eighteenth and early-nineteenth centuries that reveal large quantities of cypress remaining in the landscape. Historians like John Hebron Moore and Anne Vileisis likely over-interpreted the geographical extent of Du Pratz's observations, observations that may have even been exaggerated to boost a vision of Louisiana tamed.[269] Indeed, by 1909—at the height of the industrialized trade—estimates suggested that Louisiana still boasted almost sixteen billion board-feet of standing bald cypress, or almost forty percent of the nation's estimated reserves.[270]

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[266] Colten, "Cypress in New Orleans."

[267] Le Page du Pratz, *The History of Louisiana* (1774; reprint edition, New Orleans: Pelican Press, 1947), 217.

[268] Moore, "Cypress Lumber Industry of the Lower Mississippi Valley during the Colonial Period," 37.

[269] Colten, "Cypress in New Orleans."

[270] Mattoon, *The Southern Cypress*, 4-5. For discussion of several estimates for the original area of bald cypress in Louisiana, as well as harvest trends from the late 1860s through the precipitous decline in the late 1920s and beyond, see: William H. Conner and John R. Toliver, "Long-Term Trends in the Bald-Cypress (Taxodium Distichum) Resource in Louisiana (U.S.A.)," *Forest Ecology and Management* vol. 33-34 (1990): 543-547.

And so, with abundant cypress resources remaining in Louisiana's swamp in the 1880s, the old flotation logging system in place since the early eighteenth century gave way to a mechanized, far more ecologically invasive set of logging practices. At its peak, the industrialized harvest produced over 650 million board-feet of cypress lumber each year, a massive intensification compared with the flotation logging of the eighteenth and nineteenth centuries.[271] Float logging had been almost a perfect adaptation to Louisiana's swampy forests in that it relied on little infrastructure other than the seasonal rise and fall of the Mississippi and its distributaries. Compared with the mechanized industry to come, it produced almost no secondary ecological impacts beyond the logging of the forest itself. But the very reasons that flotation logging left a comparatively light footprint on Louisiana's cypress swamps meant that lumber operations remained at the mercy of the capricious watery environment. Soggy terrain, unpredictable flood seasons—both in timing and magnitude—and the late nineteenth century's increasingly leveed riparian environment meant that—as far as logging was concerned—swamps were often, all at once, not dry enough, too dry, not wet enough, and too wet to consistently produce a steady supply of bald cypress.[272]

The industrialization of the industry sought to even out the intense variability of the cypress harvest. Extracting bald cypress had previously occurred at the whims of the seasons and the size of annual floods. Those uncertainties had only grown worse by the late nineteenth century, when an extensive levee system had begun to effectively blockade a large number of cypress swamps from the floodwaters that formerly facilitated logging.[273] By mechanizing

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[271] Conner and Toliver, "Long-Term Trends," 546.

[272] On comparative ecological impacts: Mattoon, *The Southern Cypress*, 33.

[273] One 1901 advertisement made the connection between levees and mechanization quite clear: "Then the extension of the levee system has prevented floods from the Mississippi and other rivers from reaching many portions of the

lumber extraction, the industry hoped to sever its dependence on high water. Doing so would overcome the variability that had for so long thwarted a stable and consistent supply of cypress (and therefore profits) while also compensating for the late-nineteenth century's increasingly impermeable landscape. But in order to gain their independence from flooding, lumber companies would have to turn their attention to reforming the inconsistencies and frictions of a saturated and in-between environment.

The first attempt at mechanized swamp lumbering took place in North Carolina. In 1883, a Michigan engineer named Horace Butters patented a system of removing trees from soggy terrain by using a steam engine to hoist logs along an overhead cableway. Although originally focused on the shallow wetlands of the Great Lakes region, Butters also turned his attention to the flooded forests of the south and mounted his engine-and-cable system on scows that could be floated in North Carolina swamps. Because the Butters system relied on an overhead cable, however, it only had a limited range of about 800 feet—any longer and the cable could no longer bear the weight of large trees without sagging.[274]

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cypress belt, so other means had to be devised." See: "Louisiana Red Cypress: The Universal Wood, Chapter III," *American Lumberman*, December 7, 1901, 4.

[274] Ralph Clement Bryant, *Logging: The Principles and General Methods of Operation in the United States* (New York: J. Wiley & Sons, 1913), 196.

Figure 2-3: A pullboat operating somewhere in Louisiana sometime between 1889 and 1920. Photo by George Francois Mugnier, reproduced courtesy of the collections of the Louisiana State Museum.

In 1889, New Orleans resident William Baptist improved on Butters's scow-mounted cable skidder by outfitting a shallow-draft boat with a set of steam-powered drum winches (Figure 2-3). Instead of using an overhead cable, Baptist's system would drag logs across the surface of the swamp. Once anchored at a suitable location, the so-called pullboat's drum winches would run cables in and out of the forest, dragging in felled cypress logs from as far as 2,000-3,500 feet away.[275] By 1905, improvements in pullboat design would allow loggers to

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[275] Bryant, *Logging*, 105, 196, 208, 211-212; Mattoon, *The Southern Cypress*, 12. Ervin Mancil discusses an unsubstantiated claim that a man named Thornton invented an earlier version of the pullboat in Louisiana sometime in the early-mid 1880s: Mancil, "Historical Geography of Cypress Lumbering," 82, 90.

extract timber from as much as 5,000 feet distant.[276] Baptist also invented a steel cone that was attached to the leading end of a log, thereby reducing snags and facilitating the flow of cypress across the soggy landscape (Figure 2-4). That steel cone rendered the mucky, inconsistent elements of the swamp into a much smoother extractive surface—something like the comparatively frictionless ice logging roads used in the nineteenth-century north woods.[277] In fact, pullboat loggers would drag several cone-tipped logs down the same path. With each successive pull, the logs would gouge a deeper, smoother, more watery channel, rendering each extraction faster and more efficient than the last. The muddy pulling runs would even eventually turn red with the tons of cypress bark stripped and ground from logs dragged out of the swamp.[278] Because of its immense weight, the Baptist cone was abandoned sometime around 1910 in favor of "sniping" the log—rounding both its underside and front end and then inserting a steel plug that was then chained to the pull cable.[279]

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[276] Lidgerwood Manufacturing Company, *Logging by Steam: Employing Improved Systems Under the Patents of Baptist, Beekman, Miller, Dickinson and Others* (New York: Logging Machinery Department of the Lidgerwood Manufacturing Company, 1905), 64; Bryant, *Logging*, 208.

[277] Note that in some ways nineteenth-century ice roads more resemble flotation logging, as they were largely associated with non-mechanized extraction. And yet, in the ways they similarly reduced the frictions of uneven terrain, they are an apt comparison.

[278] On red pulling runs: Robert B. Mayfield, "Cypress—A Wood of Many Wonders," *The Southern Lumberman*, December 17, 1921, 111.

[279] Baptist cones fell out of use sometime between publication of the Lidgerwood Manufacturing Company's 1905 book/catalog and William Clement Bryant's 1913 treatise on logging. A brief eyewitness account of a pullboat operating in early 1892 can be found in: Martha Field, "Livingston Parish: Swampers [c. 1892]" in *Louisiana Voyages: The Travel Writings of Catharine Cole*, edited by Joan B. McLaughlin and Jack McLaughlin (Jackson: University Press of Mississippi, 2006), 76.

Figure 2-4: Loggers standing with a Baptist cone, c. 1900-1915. Photo by Theodore S. Woolsey, Jr., used with permission of the Forest History Society.

The pullboat brought steam power within reach of cypress resources.[280] Navigating along a bayou or across a lake to the edge of cypress swamps, pullboats eliminated the need to rely on annual floods to extract timber from the forest, while also bringing an industrial-scale energy source to bear on the process of extraction. But if pullboats could only float to cypress stands either at the edges of existing waterways or in the most deeply flooded swamps, they would only have eliminated the constraints of flotation logging as far as the cable could reach. Instead, pullboats were soon paired with dredging vessels, which allowed the new extractive technology

[280] Note that similar steam-powered mechanizations of the logging industry were occurring at about the same time all over the country, particularly in the Pacific Northwest. For other forms of steam-powered logging, see: Bryant, *Logging*; Lidgerwood Manufacturing Company, *Logging by Steam*; Asa S. Williams, "Logging by Steam," *Forestry Quarterly* vol. 6, no. 1 (1908): 1-33.

to operate not only at the open-water margins of the swamps, but also in their interior, and even during low-water seasons and years. Logging companies dredged canals forty to fifty feet wide to a depth of six to ten feet.[281] A main line could reach several miles into a swamp—one 1906 observer described a seven-mile long pullboating canal.[282] Once a crib of cypress was assembled at the pullboat, it was rafted out along this canal to a main waterway where a larger boat then towed the collected logs to a mill as much as 125 miles distant, offering still more evidence that the pullboating system was connecting formerly inaccessible swamps with the lumbering economy.[283] Dredgers provided a means for timber companies to rationalize the mucky mix of cypress swamp into new aqueous roads through the forest. Traveling along freshly dredged canals, the pullboat went where no rail car or steam-powered cart could previously go, without depending on the unpredictable timing and reach of high water. Pullboating was an intensification of an industry reaching back to the 1720s, accelerating the rate of both frontier development and the physical reorganization of Louisiana's amphibious terrain.[284]

Despite the promise of a new extraction method that both flattened the seasonal variability of high water and reduced the frictions of swampy viscosity, pullboat logging did not always proceed smoothly. Hasty felling and pulling could choke timber runs with woody refuse.[285] Invasive water hyacinths—introduced at the 1884 Cotton Centennial Exposition in

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[281] Bryant, *Logging*, 208.

[282] George E. Watson, "Cypress," *Southern Lumberman*, December 25, 1906, 44-46, 44.

[283] Watson, "Cypress," 44.

[284] Note that flotation logging was not entirely abandoned. In years of exceptionally high water, it could offer a cheaper alternative to pullboating. See: F.B. Williams, "Cypress Stocks Broken, *American Lumberman*, March 11, 1899, 39; Norgress, "History of the Cypress Lumber Industry," 1033-34.

[285] Des Allemands Lumber Co., Limited v. Morgan City Timber Co., Limited, vol. 117, *Louisiana Reports*, pp. 13-17 (La., 1905-1906).

New Orleans—could render canals impassable.[286] In one particularly odd case, drought and high tide in 1902 combined to increase salinity in brackish marshes, pushing millions of fish into a six-mile long logging canal belonging to the Louisiana Cypress Lumber Company. So choked was the canal with dying fish that a steamboat was "grounded" and the lumber mill shut down for several days for lack of cypress.[287] Another two-year drought in the mid-1920s made swamps too dry for even pullboating.[288] Whether the poor lumbering practices of careless humans, or the unruly natures of invasive aquatic plants, climate, and wayward schools of fish, pullboats and their canals could not always overcome the frictions of *Taxodium*'s watery habit. For all the effort lumber companies put into reorganizing the in-between environment, they could never completely disentangle the swampy morass of water, land, and vegetation.

Perhaps one of the biggest obstacles to effective pullboating was just the dredging itself. The soupy mix of biomass that defined a Louisiana swamp regularly thwarted even the bite of steam-powered excavation. In 1915, forester Wilbur Mattoon observed that, "The masses of roots [and knees] at the base of cypresses have proved such an expensive obstacle to the digging of canals through swamps as to cause the financial failure of numerous timber operations dependent upon this form of logging."[289] The swampy biology of *Taxodium* itself regularly defeated attempts to mechanize cypress logging with pullboats. In Louisiana's watery environment, even the trees resisted human attempts to bound and reorder wet from dry.

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[286] "Crescent City News," *American Lumberman*, July 9, 1904, 32. On the introduction of water hyacinth in Louisiana see: John Klorer, "The Water Hyacinth Problem," *Journal of the Association of Engineering Societies* vol. 42-43 (1909): 33-48.

[287] "Dead Fish Check Operations at a Big Cypress Plant," *American Lumberman*, July 12, 1902, 25; "From the Crescent City," *American Lumberman*, July 19, 1902, 43.

[288] Vileisis, *Discovering the Unknown Landscape*, 121.

[289] Mattoon, *The Southern Cypress*, 26.

As such, dredging canals in Louisiana's swamps was difficult and costly. In 1913, almost 25 years after the first pullboats plied the region's bayous, dredging cost between $3,000 and $5,000 per mile.[290] Indeed, pullboating in general involved significant investment. In 1902, for example, the Morgan City Timber Company listed the following value for its holdings:

Pull boat No. 1 cost, including machinery and wire	$7,625.51
Pull boat No. 2 cost, including machinery and wire	$4,026.85
Pull boat No. 3 cost, including machinery and wire	$3,785.92
	$15,438.28
Two-story camp boat cost	$1,661.71
Barge No. 1 cost	$400.00
Barge No. 2 cost	$303.00
Pile driver cost	$250.00
	$2,614.71
Three camps on land cost	$400.00
Two small wooden barges cost	$150.00
Large camp boat on land	$200.00
Camp boat on barge	$160.00
Steamer Richmond cost	$1,450.00
Dugouts, tools, etc.	$500.00
	$2,860.00
Add 110 cords wood on hand April 25th at $2.50	$275.00
Total	$21,187.99[291]

This was a combined investment of over $20,000, or more than $600,000 today's terms. But without a line item for canal dredging, those numbers do not even begin to reflect the full cost of pullboating in Louisiana at that time. For a complete picture, we can turn to a contract with the Morgan City Timber Company to deaden, fell, and pull cypress in a 5,000-acre tract of Paradis Swamp. The canals intended to facilitate the cypress harvest in that plot had been dredged by the

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[290] Bryant, *Logging*, 208. Equivalent to between $70,000 and $125,000 in today's dollars.

[291] Des Allemands Lumber Co., Limited v. Morgan City Timber Co., Limited, vol. 117, *Louisiana Reports*, pp. 7-8 (La., 1905-1906).

Des Allemands Lumber Company for an additional $10,000.[292] All in all, then, in 1902, a single pullboating operation planned for 5,000 acres of swamp containing around 12,000 board-feet of cypress per acre cost at least $30,000, or around $850,000 in today's dollars.[293] The pullboats and dredging accounted for over eighty percent of that outlay. Given the high cost of pullboating, many companies offset their expenses by still using flotation logging—which entailed almost zero capital investment besides labor—in high-water years.[294] Understood more broadly, the capital required to dredge canals and maintain a fleet of pullboats also suggests the scale of the effort behind intensifying the cypress harvest. In order for mechanization to succeed, lumber companies had to reconfigure Louisiana's swamps to suit an entirely new extraction method.

Because reconfiguring the watery landscape was so cost and labor-intensive, it was important for lumber companies to maximize their returns on investment. Every canal dredged in a given tract of cypress swamp raised the cost of extracting each log from that tract. Reducing and controlling those basic operating costs—that is, the marginal cost of extraction per unit of cypress—was crucial to the success of the mechanized swamp lumber industry.

Bald cypress logging companies were thus often quite strategic when reorganizing Louisiana swamps in preparation for pullboat operations. They typically excavated (or commissioned) canals that simultaneously minimized the cost of dredging while maximizing the

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[292] The Des Allemands Lumber Company estimated the cost of its dredging based on having spent over $20,000 on equipment and supplies. Des Allemands Lumber Co., Limited v. Morgan City Timber Co., Limited, vol. 117, *Louisiana Reports*, p. 47 (La., 1905-1906). The Des Allemands Lumber Company was one of R.H. Downman's many logging concerns. Downman's total possessions in 1905—spread across five different lumbering operations—included over 37 miles of railroad, 134 rail cars, eight locomotives, over 21 miles of wire cable, five pullboats, five steamboats, four tugboats, seven "sinker boats," two "wood and oil boats," four barges, four dredgers, several dozen skiffs and pirogues (Cajun canoes), three pile-drivers, nine rail skidders, and five sawmills: "A Journey through the vast Downman Cypress Interests with Camera and Pen," *American Lumberman*, August 5, 1905, 43-82, 46.

[293] On board-feet and acreage of cypress in Paradis Swamp: Des Allemands Lumber Co., Limited v. Morgan City Timber Co., Limited, vol. 117, *Louisiana Reports*, pp. 67-68 (La., 1905-1906).

[294] For examples of the continued use of flotation logging, see: F.B. Williams, "Cypress Stocks Broken, *American Lumberman*, March 11, 1899, 39; Norgress, "History of the Cypress Lumber Industry," 1033-34.

reach and efficiency of a pullboat. These twin efforts at reducing the marginal cost of cypress extraction resulted in some very particular patterns in the landscape, the most striking of which appear to this day in the Manchac Swamp. A pullboat anchored at the end of a canal dredged just far enough into a wetland so that its pulling cables could reach the maximum amount of *Taxodium*. Trees were then felled, pulled back to the canal terminus, cribbed, and floated out of the tract to be towed back to the mill. In Manchac, for example, bald cypress was extracted from a central point with a fixed maximum range, resulting in the radiating spokes described at the very beginning of this chapter (Figure 2-5).

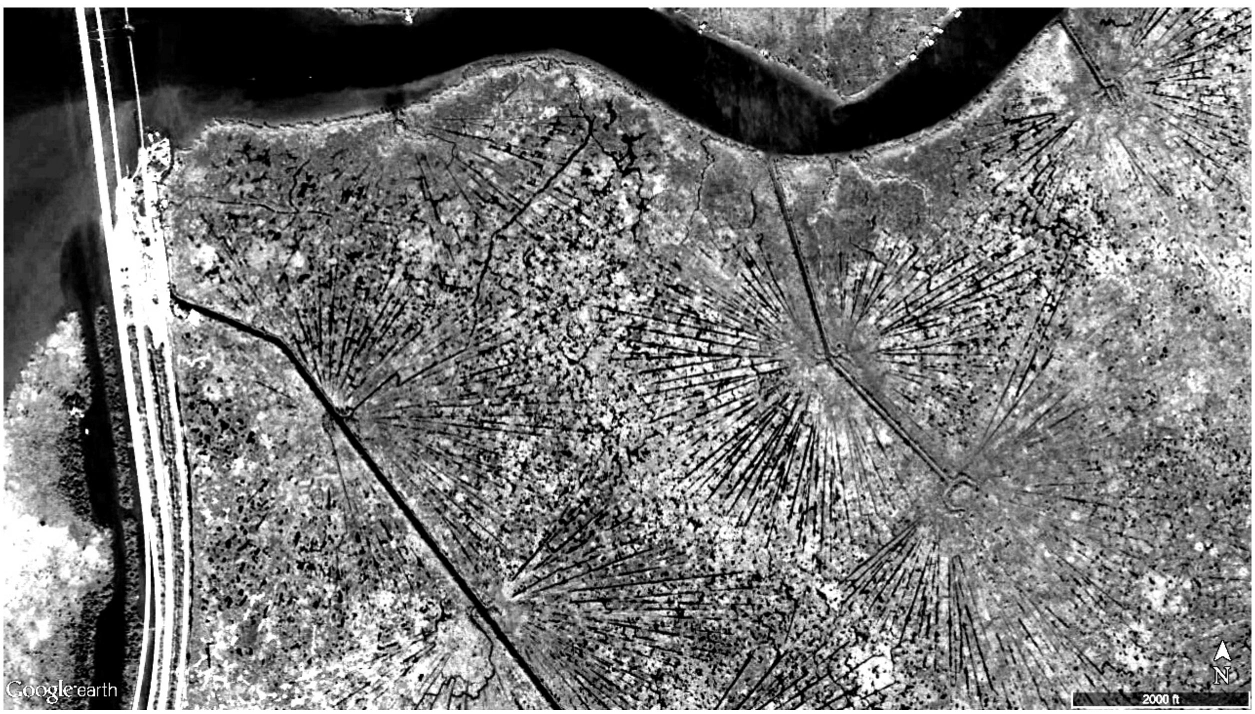

Figure 2-5: The hubs and spokes of pullboat sets have persisted in Manchac Swamp from the last decades of the nineteenth century to this day. Satellite image captured in October 2014. The image has been modified for contrast. Google Earth.

We can observe this effort to minimize marginal costs (and thereby maximize return on investment) in legal records that surrounded a logging contract between the Morgan City and Des Allemands lumber companies. The Des Allemands Lumber Company, having dredged a series of pullboating canals in the Paradis Swamp, had contracted the Morgan City Timber Company to fell and pull the swamp's cypress. Conflict ensued for a variety of reasons, including where and how the Morgan City Timber Company had felled trees. Now, although not directly an issue in the case, the Des Allemands Lumber Company had insisted that the Morgan City Timber Company pull cypress in precisely the radial arrangement seen in Manchac, also sometimes called a fantail (Figure 2-6). The Morgan City Timber Company, however, resisted, arguing that it preferred to pull timber at right angles to the canal, creating more of a rectangular extraction pattern. Though unexplained in court records, this method would likely have been more efficient for the Morgan City Timber Company, since it allowed pullboat operators to reach the maximum amount of cypress without creating overlapping fans. For the Des Allemands Lumber Company, however, the rectangular pattern would have greatly increased its own marginal costs by multiplying the number of anchoring "pockets" that would need to be dredged off of the main canal. More canals, understandably, were not in the interests of the company financially responsible for the dredging. Although this argument over fantails versus rectangles went unresolved in the courts, it illustrates how a timber company's financial stake in dredging affected the pattern by which water and land were reorganized to facilitate logging in Louisiana's cypress swamps.[295]

[295] Des Allemands Lumber Co., Limited v. Morgan City Timber Co., Limited, vol. 117, *Louisiana Reports*, p. 30 (La., 1905-1906). Curiously, the case claims in passing that fantail extraction was secondary and of doubtful economy. This is almost certainly an error, since fantail (or wheel-and-spoke) patterns predominate in the pullboating literature, particularly in Bryant's definitive manual from the period. Indeed, this court case is perhaps the only account I have seen of the rectangular pattern to which the Morgan City Timber Company was committed. Regardless of which is ultimately more efficient and cost-effective and for whom, both patterns are physical manifestations of lumber company strategies aimed at minimizing marginal cost.

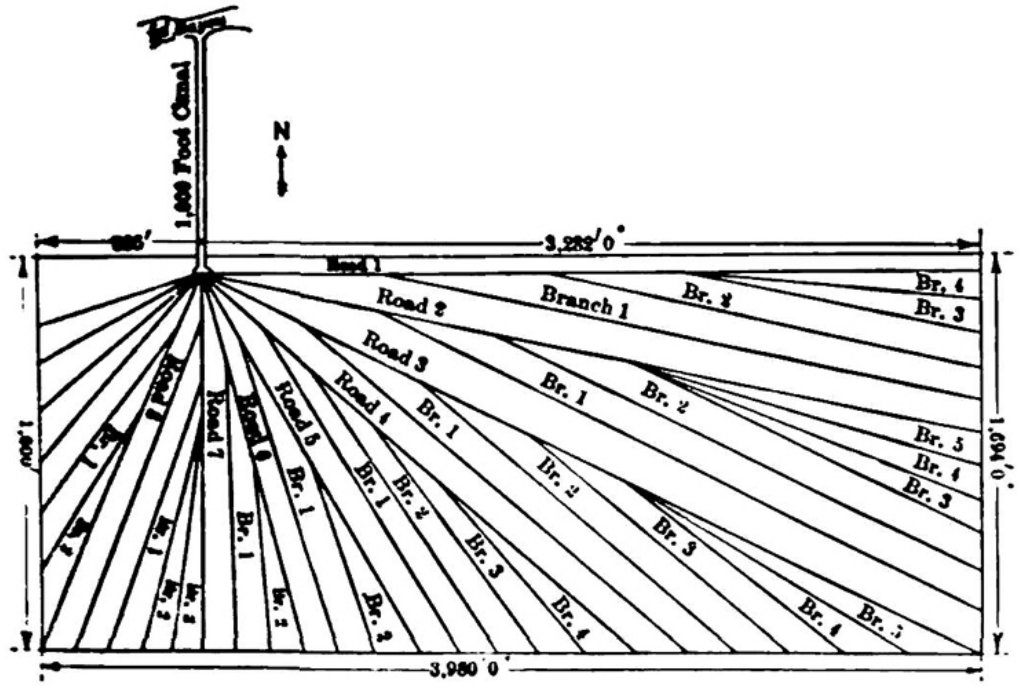

FIG. 58. — The Arrangement of the Roads down which Logs are pulled to the Pullboat. This system is known as fantailing. The figure is adapted from an actual operation in a Louisiana cypress swamp.

Figure 2-6: 1913 captioned illustration of pullboat "fantail" operation, Ralph Clement Bryant, *Logging*, 209.

Driven by concerns about marginal cost, hub-and-spoke (or fantail) extraction patterns accumulated lumber at a single point, a process that further reorganized the wetland environment in service to bald cypress extraction. With each tree felled and pulled, the line it etched through the swamp deepened and filled with water. Each subsequent pull along that run grew faster and easier. In this way, pullboating subsumed the swampy environment into its capitalist logic.[296] Pullboat runs represented an adaptation of wetland nature to the process of extracting resource for market. Saturated with cypress bark, these red-tinged muddy channels became one component by which *Taxodium* was enclosed from its watery habitat. Where soggy,

[296] On the subsumption of nature see: William Boyd, Scott Prudham, and Rachel Schurman, "Industrial Dynamics and the Problem of Nature," *Society & Natural Resources* 14, 7 (2001): 555-570. Boyd, Prudham, and Schurman observe that a more superficial subsumption of nature results when capital must adjust to the landscape, rather than vice-versa. But while that clearly took place in part with pullboat logging, the landscape was also clearly being remade into an instrument of the extractive system, suggesting the genuine subsumption of nature.

undifferentiated muck had once posed a major obstacle to the wholesale logging of Louisiana's swamps, Baptist cones and sniped logs sculpted that muck into an extension of the pullboat.[297]

By the time a pullboat had completely extracted a "set," a striking array of channels had been etched across the watery landscape, all converging on a single point where the swamp-adapted organism—*Taxodium distichum*—was transformed into a resource. The in-betweenness of the amphibious terrain ultimately served as a kind of revelatory canvas for an invisible, abstract concept associated with capitalism: marginal cost. The wheels and spokes of pullboat logging are the materialization of the cypress industry's need to maximize its return on investment in capital-intensive wetland extractive regime. The rigidly straight lines, repetitive pattern, and centralized organization of Manchac's logging scars document an amphibious resource frontier—the enclosure of a wild, watery nature and its articulation with distant markets.[298] Fundamentally constrained by a wetland environment, capital was, quite literally, inscribed into the landscape as lumber companies reconfigured amphibious terrain.[299]

For present-day observers, one of the most astonishing features of Manchac's hub-and-spoke inscriptions is their age. The markings left by an industrialized cypress industry have persisted for over a century. Those logging scars remain visible in the landscape today largely because of the impermeable flood-protection infrastructure that had come to define Louisiana by the close of the nineteenth century. Indeed, these logging canals were first created at a time when

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[297] On the extraction—and thus abstraction—of commodities from the complex web of relations that define them as organisms, see: Cronon, *Nature's Metropolis*; Robertson, "No Net Loss"; Robertson, "The Nature that Capital Can See." Note that creating a commodity usually involves a process of classifying and valuing the organism, but here we also see a process of classifying (through reordering water and land) and valuing (through wrestling with marginal cost and the resulting pattern of extraction) the environment as well.

[298] Rod Giblett suggests that straight lines amidst wetlands are expressions of capital in: *Postmodern Wetlands: Culture, History, Ecology* (Edinburgh: Edinburgh University Press, 1996), 22.

[299] On the "inscription" of capital in landscapes, see: Neil Smith, *Uneven Development: Nature, Capital, and the Production of Space* (Athens: University of Georgia Press, [1982] 2008), 133.

many engineers, sugar planters, and state legislators in Louisiana were calling for more definitive action against rice flumes. But the levees that were erected to rigidly divide wet from dry and eliminate the risk of flood also starved the flood-dependent physical environment of fresh sediments. As federal oversight of levee maintenance and construction increased, crevasses and the silts they once brought to Manchac Swamp grew infrequent. And, after the Great Flood of 1927, new flood-protection infrastructure definitively severed most of southern Louisiana from the river that had created it. With no annual floods flowing through Mancha, there would be no new sediments to fill in the spokes gouged by countless Baptist cones and sniped logs.[300] Erosion, subsidence, and saltwater intrusion across Lake Pontchartrain, meanwhile, ensure that the spokes of Manchac's wagon wheels will just widen over time.[301] As historical documents etched in the swampy environment, these patterns reveal not just the work of rationalizing the deltaic environment, nor only the materialization of capital in the region's swamps, but also the culture of impermeability that overtook Louisiana in the nineteenth century. In this way, Manchac's hubs and spokes become testimony not only to the logging industry's struggles to sort and stabilize the deltaic environment, but also to a much broader suite of boundary-making efforts in the Mississippi River Delta.

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[300] This is especially true for the Manchac Swamp since Bayou Manchac—the primary Mississippi distributary that would have delivered water and sediment to the wetland—was dammed in 1828. *Annual Report of the Chief of Engineers, United States Army* (Washington, D.C.: Government Printing Office, 1921), 954.

[301] Randell S. Myers, Gary P. Shaffer, and Daniel W. Llewellyn, "Baldcypress (Taxodium distichum [L.] Rich.) Restoration in Southeast Louisiana: The Relative Effects of Herbivory, Flooding, Competition, and Macronutrients," *Wetlands* vol. 15, no. 2 (1995): 141-148; Gary P. Shaffer et al., "Degradation of Baldcypress—Water Tupelo Swamp to Marsh and Open Water in Southeastern Louisiana, U.S.A.: An Irreversible Trajectory?," *Journal of Coastal Research* Special Issue no. 54 (2009): 152-165. Both of these papers also attest to the persistence of pullboating scars due to lack of new sediments.

The Industrialized Frontier: Skidding

Although Manchac's hub-and-spoke patterns began this story, they are not the only extraction scars recording a past industrialized cypress resource frontier. Even in Manchac Swamp, one can find numerous sets of parallel, rather than radial, pullboat runs. These were etched into the swamp along stretches of Bayou Manchac, where the existing waterway eliminated the need to dredge canals and thus eliminated one consideration of marginal cost. Whatever the typology of logging patterns left in Louisiana's swamp forests, they are *all* expressions of capital in the landscape—expressions of the various spatial calculations of return on investment. If hubs and spokes represented a profit-maximizing strategy of a lumber company's encounter with an environment too soggy for land-based equipment, but too dry to float logs, then what took place in the swamps that were not wet enough even for canal-building?

Lumber companies did not rely only on pullboats and the occasional high-water float to extract bald cypress. Just a few years after the advent of Baptist's logging watercraft, a handful of companies also began building short, temporary rail spurs into cypress swamps deemed too dry and impenetrable for dredging. From the early 1890s, skidders—essentially rail-mounted steam engines pulling overhead (rather than surface) cables—featured alongside pullboating and floating right up until the industry's decline.[302] These devices did not just pull in felled timber

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[302] Asa S. Williams, "Logging by Steam," 4. Note that Williams claims rail-based skidding replaced pullboating, but in fact, pullboating persisted until the decline of the industry around 1930. Also see: E.C. Glenn, "A Few Facts Concerning the Cypress Industry," *The Southern Lumberman*, December 15, 1931, 68-73. The FB Williams Cypress Company operated both skidders and pullboats up until at least 1926, as documented in archival film footage: Lewis Kemper Williams, *A Trip to The Logging Camps of the F.B. Williams Cypress Co., Ltd.*, c. 1926, on file at the Historic New Orleans Collection, call no.: 1978.24.12.1. For technical details on the numerous forms of rail-based skidding—and comparisons with pullboating (essentially water-based skidding), see: Bryant, *Logging*, 196-221. Although diesel engines were fairly common by the first decades of the twentieth century, they are never mentioned in the literature until smaller swamp logging firms re-emerge in the 1950s and 1960s. Steam dominates the entire life of the industrialized cypress industry until its decline in the late 1920s-early 1930s, as recorded in the F.B. Williams Cypress Company film footage and a 1931 account of skidding: John S. Hecker, "Skidding With a Self-Propelling Machine," *The Southern Lumberman*, November 1, 1931, 27-B.

from the tract surrounding the railway, but would also load the lumber onto logging cars to be trucked out of the swamp.

Rail skidding, in contrast to pullboating, contrived to make what forester Wilbur Mattoon called the "soft and treacherous ground" of the in-between landscape more solid, rather than liquid. Mattoon identified the rail-mounted system as "the principal factor in opening up vast regions of cypress previously considered inaccessible because not [sic] sufficiently inundated."[303] By 1915, so much bald cypress had been logged in Louisiana that virgin timber now lay "so far from the water fronts and places where canals are practicable" that pullboating could cost from $1 to $3 more per 1,000 board-feet of lumber than rail skidding.[304] But it was not just the voracious lumber industry that had left cypress out of pullboating reach. Ongoing drainage and development in southern Louisiana had also conspired to render cypress tracts inaccessible to pullboats. Assiduous leveeing in the nineteenth century had made the in-between landscape far drier, while new transportation infrastructure could frustrate dredging efforts. After nine years of pulling cypress, for example, a Louisiana cypress logger named Oscar Marsan switched to skidding when the LR&N Railroad blocked his main canal.[305] As wetter swamps were increasingly cut over or drained and as new development sometimes made canal-dredging unfeasible, the skidder and its solidifying effect on the watery landscape came to overshadow—but not entirely replace—the pullboat in the final years of the industry.

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[303] Mattoon, *The Southern Cypress*, 11-12.

[304] Mattoon, *The Southern Cypress*, 15. Easy timber was in fact disappearing all over the country at this time, resulting in similar steam-powered mechanizations of the logging industry nationally. See: Bryant, *Logging*; Lidgerwood Manufacturing Company, *Logging by Steam*; Asa S. Williams, "Logging by Steam."

[305] "Marsan Compares Railroads and Pullboats," *Chicago Lumberman*, November 10, 1921, 92. The LR&N was most likely the Louisiana Railway and Navigation Company, succeeded by the Louisiana and Arkansas Railway.

Lumber companies also turned to rail skidding because the cost of building rail infrastructure declined just as it was becoming ever more expensive to extract shrinking cypress reserves on the drier terrain that was increasingly unreachable by pullboat. In 1906, one observer estimated that a railway on pilings might cost as much as $15,000 per mile.[306] By 1915, however, costs had dropped to between $9,000 and $12,000 per mile of railway on pilings while more temporary rail beds built on cribbing could be had for as little as $1,000 to $2,000 per mile.[307] These new, cheaper, and more temporary spurs made rail skidding especially competitive with pullboating given the much higher marginal costs associated with canal-dredging in comparatively dry swamps. Instead of rationalizing the in-between landscape to create more open water, the logging industry would re-organize Louisiana swamps in the opposite direction to produce more firm land.[308]

But how firm was this new land in the swamps, and how exactly did lumber companies go about building it? An article in a 1901 issue of *Lumber Trade Journal* offers a particularly evocative account of the "peculiar operation" of preparing drier ground for skidder infrastructure in Louisiana's cypress swamps. Timber cutters first cleared trees along a right-of-way through the swamp. Those logs and their stumps were then cleared from the line to create a mostly level, unobstructed path for the rail bed. Much of this path, however, could be "from six inches to two or three feet under water." Tupelo gum and other small trees along the right-of-way were then

[306] Watson, "Cypress," 44.

[307] Mattoon, *The Southern Cypress*, 15.

[308] This new effort to solidify Louisiana's comparatively drier cypress swamps, however, still depended at least somewhat on water for bringing logs to market. Film footage from F.B. Williams Cypress Company operations around 1926 documents a remarkable railroad bridge—"the boom"—that would rotate partially on its axis so logging cars could dump lumber into the waterway below. Once in the water, the logs would be cribbed and towed as usual back to the mill. Lewis Kemper Williams, *A Trip to The Logging Camps of the F.B. Williams Cypress Co., Ltd.*, c. 1926, on file at the Historic New Orleans Collection, call no.: 1978.24.12.1.

felled across the path to create a three or four-ply corduroy foundation for the rail bed. Once ties and rails were spiked to the corduroy, it was ready for "the real work of surfacing" (Figure 2-7). Logging refuse was worked under the ties so the railway presented "the appearance of an ordinary roadbed." The *Lumber Trade Journal* article concluded its description by asserting that the process made "a comparatively solid road, perfectly safe, high and dry enough to operate the logging equipment without fear of accident."[309]

"One can imagine what railroad building means in a cypress swamp."

Figure 2-7: Laying a skidder railbed near Bowie, Louisiana, c. 1901. "R.H. Downman and Louisiana Red Cypress," *Lumber Trade Journal*, August 1, 1901, 29.

Stabilizing cypress swamps to create higher, drier skidding ground, however, was neither as simple nor as certain as this observer suggests. The article's claims about the skidding spur's height, dryness, and safety were likely significant exaggerations, not least because such a project

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[309] "R.H. Downman and the Louisiana Red Cypress," *Lumber Trade Journal*, August 1, 1901, 29-30.

began with a mushy surface "from six inches to two or three feet under water."[310] Much as the uneven, saturated terrain posed significant obstacles to creating open water for pullboats plying the swamps, the soft, soggy ground of even the driest swamps constantly threatened to undermine the skidding system. Robert Mayfield, writing for the *Southern Lumberman* in 1921, described "half-floating, half-earth-supported roadbeds" that were also under constant threat of heavy rain and, in some years, unusually high floods. Another observer, writing for the *Chicago Lumberman* in 1921, lamented, "How many a track goes under, never to rise again, the cypress logging foreman knows to his sorrow and to the companies' expense."[311] Oscar Marsan, who invested in a skidder system after the railroad blocked his canals, noted that at one point the Mississippi inundated his tracks for a month. The tracks, meanwhile, even if they approximated solid land, were still "half-floating" in water and mushy ground. Their "tipsy surfaces" meant that railcars had to be "just so," otherwise they might jump the springy tracks, sinking lumber and equipment into the surrounding swamp and potentially maiming or killing workers.[312] Marsan found that after building eight miles of railroad, only one of those miles was solid enough to bear the weight of his machinery and freshly pulled logs. As a remedy, he surfaced the track with sawdust, but then had to hire a team of men to watch for engine and wheel sparks igniting the material. Making the watery landscape into solid land greatly increased the risk of fire.[313] Altogether, resorting Louisiana's in-between cypress swamps to produce drier ground was an immensely risky, laborious process that was at frequent risk of failure.

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[310] "R.H. Downman and the Louisiana Red Cypress," *Lumber Trade Journal*, August 1, 1901, 29-30.

[311] Mayfield, "Cypress," 110-111.

[312] "Tipsy surfaces" from: Mayfield, "Cypress," 111. "Just so" from: "Marsan Compares Railroads and Pullboats," *Chicago Lumberman*, November 10, 1921, 92.

[313] "In the fall of 1924, a particularly bad swamp fire consumed the railways, logging trains, and cutover cypress lands of both the FB Williams and Rathborne lumber companies. Crews even dynamited holes in the swamp in order

But for all the uncertainties and challenges of reconfiguring cypress swamps for rail skidding, the harvest was more or less successful—perhaps excessively so. The extraction pattern of railway skidding often mimicked that of pullboating, but since the overhead cable was necessarily shorter—from 600 to 1,500 feet long—to avoid sagging, it extracted timber in a circle with a smaller radius.[314] This meant lumber companies needed more rail spurs in order to cut over a tract, and more rail spurs entailed even greater alterations of the watery landscape.[315] Even if its effects do not remain as visibly etched into the landscape today, rail skidding devastated Louisiana's cypress swamps. Indeed, the mechanization of the cypress industry had in general wrought considerable destruction in the delta's forested wetlands. Where flotation logging interfered almost not at all with uncut stock, pullboating had scoured swamps with arrays of cleared pulling runs. The spoil banks of dredged material deposited alongside pullboating canals, meanwhile, had acted as unintentional levees, interfering with swamp hydrology by altering drainage patterns and the flow of surface waters. But by far the most destructive of cypress extraction methods was rail skidding. For one, it similarly interfered with swamp hydrology as the system's proliferating rail beds also acted as imporous barriers in the wetland environment, sometimes impounding so much water that young cypress drowned or new

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to create a convenient water source for fighting the flames: "Swamp Fire Loss Heavy for Both Lumber Companies," *Ponchatoula Enterprise*, October 3, 1924.

[314] On skidding cable lengths, see: Mattoon, *The Southern Cypress*, 12; Lidgerwood Manufacturing Company, *Logging by Steam*, passim. Mattoon also mentions a heavier system that had to be removed from the track and mounted on pilings. It had a reach of 2,000 feet and produced a rectangular pattern perpendicular to the rail stem.

[315] Overhead skidding, in addition to being less spatially efficient than pullboating because of its shorter reach, could also sometimes take longer. Oscar Marsan claimed he could log twice the cypress in a day with one pullboat as compared with two skidders. "Marsan Compares Railroads and Pullboats," *Chicago Lumberman*, November 10, 1921, 92.

saplings failed to germinate.[316] Those disruptions of the watery landscape were compounded by skidding's overhead extraction method. Although rail skidders may have avoided gouging the swamp's surface, they required a clear overhead path for extracting logs. Skidding, observed Mattoon, resulted in "almost complete destruction of any part of the forest which happens not to be taken."[317] As skidding began to overshadow pullboating in the second and third decades of the twentieth century, Louisiana's cypress swamps came under increasingly unbearable extractive pressure. By the close of the 1920s, the cypress industry was teetering on the brink of collapse, in part because of dwindling timber resources. But before we witness the decline of cypress logging in Louisiana, we should turn briefly to the ways industry established a year-round labor force in the in-between landscape.

Organizing Life on the Cypress Frontier

By significantly reducing the frictions of the amphibious environment, pullboating and skidding almost completely eliminated the seasonal constraints of logging in Louisiana's cypress swamps. Whatever the time of year, lumber companies now had mechanized extraction methods for navigating the wetland environment, no matter whether it was too wet, not wet enough, too dry, or not dry enough. From the 1720s through the late 1880s, cypress logging in the region had been in part defined by the rhythms of annual flooding, allowing the trade to serve in part as a complement to regional agriculture. But now that timber companies no longer relied solely on floods to extract their logs, bald cypress could be harvested from the swamps year-round. By

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[316] Mancil, "An Historical Geography of Industrial Cypress Lumbering in Louisiana," 161, 167; Karen M. Wicker, *Assessment of Extent and Impact of Saltwater Intrusion into the Wetlands of Tangipahoa Parish, Louisiana* (Baton Rouge: Coastal Environments, Inc., 1981).

[317] Mattoon, *The Southern Cypress*, 33.

eliminating the seasonality of the *Taxodium* harvest, industry created demand for a year-round labor force, completely transforming the lumber trade's working conditions.

Logging companies thus began to establish camps within the swamp proper.[318] These took two different forms, both of which, like pullboating and skidding, *also* worked to reconfigure the in-betweenness of the landscape. Camps like the Hammond Lumber Company's Lorraine (Figure 2-8), for example, worked much like railroad skidding to solidify the soggy landscape by raising a community above the muck with pilings and walkways. Another, somewhat less obvious, solution for maintaining a workforce in the swamps was the quarterboat. Essentially a floating residence, the quarterboat (Figure 2-9) plied the same newly dredged canal systems as its pullboat cousin, depending on a sodden environment rendered more aquatic than terrestrial. Some of R.H. Downman's pullboat operations were even accompanied by a "wanigan," or floating commissary.[319] Pullboat logging operations, then, were often were marked by at least a trio of strange watercraft, floating in and out of cypress swamps made more navigable with the open water of dredged canals: the dredger itself, the pullboat, and the quarterboat, all occasionally accompanied by a floating storefront. Whether raised on pilings or floating in canals, lumber camps also depended on the sorting the in-between environment into either firmer ground or more open water.

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[318] On life and labor in cypress swamps before mechanization facilitated the rise of company camps in the swamps, see the following firsthand accounts of market "swampers" and their communities, some of which had existed for decades: "The Swamper," *New Orleans Times*, September 14, 1866; Coulon, *350 Miles in a Skiff Through Louisiana Swamps*; "Swamper Jim," *Daily Picayune*, March 17, 1889; Martha Field, "Livingston Parish: Swampers [c. 1892]" in *Louisiana Voyages: The Travel Writings of Catharine Cole*, edited by Joan B. McLaughlin and Jack McLaughlin (Jackson: University Press of Mississippi, 2006), 70-6; "Swampers," *Daily Picayune*, February 28, 1892. For an example of what life was like in one of the later company camps of the industrialized industry, see: Thurston H.G. Hahn and Cherie A. Schwab, *Donner, Louisiana: Historical and Archaeological Investigations of an Early-Twentieth Century Sawmill Community* (Baton Rouge, LA: Louisiana Department of Transportation, 1998).

[319] On floating commissaries, see: "Unusual Commissaries in the North and South," *American Lumberman*, May 16, 1908, 87-9.

Figure 2-8: Lorraine, Louisiana, a logging camp of the Hammond Lumber Company. Light areas in the foreground are water. Date unknown, but likely between 1900 and 1915. Photo used with permission of Southeastern Louisiana University's Center for Southeast Louisiana Studies, Judge Leon Ford Photo Collection.

Figure 2-9: A Bowie Lumber Company quarterboat, c. 1903-1904. Note the dredger behind it. Photo used with permission of the Forest History Society.

But although the mechanization of the industry sought to mitigate the swampy instability of the environment for its pullboats, skidders, and logging camps—its invested capital—there was little similar effort for the men who worked in the industry. While housing and storefronts might be raised on stilts or floating in waterways, the men themselves often had no choice but to be thoroughly exposed to the dangers of muck and mud while they worked. In 1906, George E. Watson, secretary of the Southern Cypress Manufacturers' Association, wrote: "A class of men must do this latter work [girdling and felling trees] who are immune to swamp fever, snake bite and other little inconveniences. A large part of the time they must be hip deep in the water."[320]

The "class" that Watson shies from naming included any person who was not "the average white man," for whom wetland logging conditions were "altogether too difficult," but rather far more marginalized segments of the population. Logging companies used the cultural boundaries around whiteness to rationalize the division of labor in the cypress swamps. "It is said," remarked a 1901 article in *Lumber Trade Journal*, "that nobody but a 'nigger' or a ''Cajin' can stand it. . . . These hardy men, however, born and reared in and near the cypress brakes, suffer no inconveniences from their method of life. They go right ahead and do their cutting as happily and as contentedly as workers in other fields under conditions more favorable do theirs."[321] Since it seemed unavoidable that worker bodies would be directly exposed to the dangers and difficulties of the in-between landscape, the cypress industry chose to manage that exposure by imposing an entirely different set of boundaries on nature. Instead of reconfiguring the biophysical environment, logging companies reordered the social landscape. That is, industry brought the social fictions of race and ethnicity to bear on the work of organizing labor in

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[320] Watson, "Cypress," 44.

[321] "R.H. Downman and Louisiana Red Cypress," *Lumber Trade Journal*, August 1, 1901, 30. For another account of the hardships "negroes" had to endure in swamp logging, see: "Logging Cypress: A Peculiar Industry in Southern Swamps," *Irish American Weekly*, March 9, 1896. On black life in a cypress sawmill community, see: James Patrick Whelan, Jr. and Charles E. Pearson, *Archaeology of an Early Twentieth Century Black Community: the Good Land Cypress Sawmill Company, Terrebonne Parish, Louisiana* (Baton Rouge, LA: Louisiana Department of Transportation, 1999).

amphibious terrain. Indeed, the fact that Cajuns were of European descent, but still imagined as biologically different, illustrates quite nicely the ways race was but a figment—albeit a powerful one—of the lumber industry's imagination.[322] With land, water, and labor bounded and sorted in the forested swamps, Louisiana's logging industry would extract enormous quantities of cypress. At its height, industry tore over 650 million board-feet of cypress lumber from the reconfigured wetland environment each year.[323]

But within just a few decades of their development, skidding and pullboating in Louisiana swamps would run out of steam. The onset of the Great Depression combined with a dwindling supply of timber to send the industry in steep decline. In September of 1928, the F.B. Williams Cypress Company, a pioneer of Louisiana pullboating and one of the largest timber operations in the region, announced that it had exhausted its supply of cypress and shuttered its mills after 56 years of operation.[324] The very next year, cypress giant Joseph Rathborne closed his largest mill.[325] The bald cypress timber harvest plummeted from a peak of almost 745 million board feet in 1913, to under 30 million board feet in 1932. By 1934, over 1.6 million acres of cypress swamp had been completely cut over, with only about 22,000 acres remaining.[326]

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[322] For a discussion of the murky boundaries around race and whiteness in the twentieth-century United States, see: David Roediger, *Working Toward Whiteness: How America's Immigrants Became White: The Strange Journey from Ellis Island to the Suburbs* (New York: Basic Books, 2005). For more on race and the Louisiana lumber industry in the late-nineteenth and early-twentieth centuries, see: Amy R. Sumpter, "Environment, Labor, and Race an Historical Geography of St. Tammany Parish, Louisiana, 1878-1956" (PhD diss., Louisiana State University, 2008).

[323] Conner and Toliver, "Long-Term Trends," 546.

[324] "Williams Cypress Company Closes; Exhausts Supply of Cypress After 56 Year Run," *Ponchatoula Enterprise*, September 21, 1928.

[325] Norgress, "History of the Cypress Lumber Industry in Louisiana," 1008.

[326] For timber harvest trends, the area cutover by 1934, and the acreage that remained, see: Conner and Toliver, "Long-Term Trends."

Some reorganization in the industry would allow a few companies to continue operating, but only as shadows of their formers selves.[327] The Louisiana Cypress Lumber Company—borne out of Rathborne's holdings—would continue to extract cypress on trembling rail beds built atop swamp until closing its doors in 1956.[328] Some newer, smaller companies would also harvest bald cypress in Louisiana in the mid-twentieth century, including Fernwood Industries, which operated the last remaining pullboat in the region from the late 1940s through 1960.[329] Similarly, in the late 1950s, May Brothers, Inc., undertook a creative, industrialized approach to float logging by building containment levees around a 1,000-acre tract of cypress. After felling their girdled trees, May Brothers flooded the impounded area, cut one of the embankments, and floated out their logs.[330] Still other small cypress companies have extracted logs piecemeal using helicopters, while boutique operations continue right up to the present by raising lost "sinkers" preserved for over a century in the murky waters of Louisiana swamps and bayous.[331] Although *Taxodium* extraction continued in fits and starts for some years after the late 1920s, the industrialized cypress trade only thrived for about four decades. Bald cypress as a resource steadily shrank in importance in Louisiana and the industry would never truly recover.

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[327] On the decline and reorganization of the industry, see: Melanie Torbett, "Williams Company Grew From Swamps," *Forests and People* 57 (2007): 12-15; and Mancil, "Historical Geography of Industrial Cypress Lumbering." Mancil discusses the last "integrated industrial cypress operation" shutting down in 1956 (pp. 85). Although he does not name the company, it can be none other than the Louisiana Cypress Lumber Company.

[328] Louisiana Cypress Lumber Company footage from 1951 features *extremely* bouncy railways: *Steam Logging in the Swamps*, archived at Southeastern Louisiana University's Center for Southeast Louisiana Studies, Tangipahoa Parish Collection, Box 5.

[329] Ervin Mancil, "Pullboatin' on the Blind," *Forests and People* vol. 10, no. 4 (1960): 12-16.

[330] Donald Davis, "Louisiana Canals and their Influence on Wetland Development" (Ph.D. diss., Louisiana State University, 1973), 117-118; George Lucas, "Flotation Logging," *Southern Lumberman*, February 15, 1957, 53-4.

[331] On helicopter logging, see: Ervin Mancil, "Pullboat Logging," *Forest & Conservation History* 24 (1980): 141; Willie Prophit, "The Swamp's Silent Sentinel: A History of Louisiana Cypress Logging," *Forests and People* 33 (1982): 8. The boutique industry in sinker logs is discussed in Sims, *Manchac Swamp*. See also: Christopher A. Hurst, "Sinker Cypress: Treasures of a Lost Landscape" (MA thesis, Louisiana State University, 2005).

Even decades after the Great Depression had passed, bald cypress logging would never return to Louisiana on the same scale. That was largely due to the biology of *Taxodium distichum*. For one, although very long-lived, the tree is also extremely slow-growing.[332] It can take up to two-hundred years for a single tree to build a significant proportion of valuable heartwood.[333] Industrialized logging operations in Louisiana had harvested bald cypress at a rate and scale that far outpaced its regenerative capacity. But perhaps more importantly, *Taxodium* also failed to regenerate in Louisiana because people had so reorganized and stabilized the wetland environment that many swamps could no longer support the organism.

Levees, along with canals, spoil banks, and rail beds—and not just those created by the cypress industry, but also by agricultural, oil and gas, and other transportation interests—had dramatically altered swamp hydrology. Many cutover bald cypress forests became more permanently inundated when these environmental changes interrupted the seasonal ebbs and flows of Louisiana swamps. New germination became almost impossible.[334] Levees contributed doubly to the problem since the landscape, starved of new sediments, had begun steadily subsiding. Standing water in many southern Louisiana swamps would only grow deeper, drowning cypress before they even had a chance to sprout. And finally, the sinking coast also

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[332] Some trees harvested in Louisiana were almost one thousand years old: Mattoon, *The Southern Cypress*, 23.

[333] On growth rates, see: U.S. Department of Agriculture, U.S. Forest Service, *Baldcypress: An American Wood*, by Harvey E. Kennedy, Jr., FS-218 (Washington, DC: Government Printing Office, 1972).

[334] Some troubled efforts to plant bald cypress began in the mid-twentieth century, see: Edward Kerr and Elemore Morgan, "Long Live King Cypress," *Forests and People* vol. 3, no. 1 (1953): 10-15, 46, 48-49. On more recent restoration attempts, including those undertaken by various cypress experiment stations, see: Prophit, "The Swamp's Silent Sentinel"; P.A. Keddy et al., "The Wetlands of Lakes Pontchartrain and Maurepas: Past, Present and Future," *Environmental Reviews* vol. 15, no. 1 (2007): 43-77. Invasive nutria (*Myocaster coypus*) have also taken their toll on bald cypress restoration. A South American rodent introduced to Louisiana in 1933, nutria feeds on *Taxodium* saplings, chewing through the tree at its base, and then immediately moving on to the next. One Soil Conservation Service attempt at bald cypress restoration in the mid-1950s saw nutria destroy ninety percent of the saplings in just four months: R.M. Blair and M.J. Langlinais, "Nutria and Swamp Rabbits Damage Baldcypress Seedlings," *Journal of Forestry* 58 (1960): 388-389.

rendered swamps more vulnerable to saltwater intrusion. In areas like Manchac, where Lake Pontchartrain and other waterways provide direct connections with the Gulf of Mexico, subsidence has seen salinity substantially increase in former freshwater swamps, stressing—if not outright killing—salt-intolerant *Taxodium*.[335] By attempting to reorder and stabilize the delta with levees and transportation infrastructure, people had made many of its swamps fundamentally inhospitable for bald cypress.

Perhaps that should come as no surprise. After all, *Taxodium distichum* is a wetland organism perfectly adapted to watery in-betweenness and dynamism. The extractive practices and technologies that converted the species into a mass-market natural resource were themselves efforts to reorder and stabilize on what was believed to be disordered nature. *Taxodium* was transformed into cypress timber. Waste wetlands were parceled into extractive territory. Undifferentiated swamps were reconfigured into canals and railways. And even human beings were sorted into groups of "niggers" and "'Cajins." Over the course of two centuries, lumbermen and logging companies opened Louisiana's impenetrable swamps to a multi-pronged exercise in bounding and reorganizing nature in the Mississippi River Delta. Connecting bald cypress with markets in New Orleans, the Caribbean, Chicago, and California required redefining the organisms, territory, and composition of the region's forested wetlands. By making bald cypress a legible, accessible, and extractable resource, Euro-Americans transformed a place perceived as disorganized and unstable into a resource frontier.

That process, of course, took considerable labor. Industrial bald cypress logging developed in a region defined by environmental uncertainty; southern Louisiana's profound

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[335] On the many threats to *Taxodium*, see: Conner and Toliver, "Long-Term Trends"; Torbett, "Too Much Water for Cypress Forests."

hydrological variability and dynamism posed real obstacles to the extractive interests of logging companies. The dredge and pullboat, Baptist cone and pull path, railbed pilings and corduroy, raised camp and quarterboat—these were all ways of rationalizing the in-betweenness of the cypress swamp into something much more definitive: either open water or solid terrain, rather than a frustrating and unpredictable mixture of the two. The suite of technologies and environmental adaptations surrounding pullboating and skidding were part of an enormous effort to eliminate almost all aspects of the watery uncertainty of Louisiana's cypress swamps, whether the unpredictable seasonality of flood or the highly inconsistent textures of the landscape. The various phases and forms of cypress lumber production were thus not only distinctive new techniques for extracting natural resources, but also strenuous attempts to bound and rationalize the watery wilderness. This was a process of "sorting things out," of reclassifying a both-yet-neither landscape into an either-or landscape.

Ultimately, these interventions in the muddy ground of southern Louisiana's forests allowed lumber companies to more systematically disentangle *Taxodium* from the complex biophysical webs of its watery habitat. Severing a wetland organism from its watery ecology allowed lumber companies to produce a marketable commodity on an industrial scale. The mechanization of bald cypress extraction created a qualitatively different resource than the cypress extracted through float logging, largely because of the marked transformations in the physical environment that mechanization entailed. In isolation, the lumber produced by floating was essentially the same as that produced by mechanized pullboating and skidding. Understood ecologically, however, industrialized bald cypress—extracted with the help of steam powered dredgers, cable winches, and skidders—produced changes never before seen in the wetland environment. That process of extraction and disentanglement even made the abstract concept of marginal cost materialize in the landscape as enormous wagon wheels still visible today in the leveed and subsiding deltaic environment.

Indeed, the hub-and-spoke patterns that remain etched across Manchac Swamp offer striking evidence of some of those changes. The persisting hub-and-spoke patterns of Manchac's swamps record an industry's attempt to expand a resource frontier by reorganizing a particularly frustrating, dynamic, and in-between environment. That these marks have persisted for so long, meanwhile, is once again testimony to that other boundary-making project that had taken place in the Mississippi River Delta: the draining and embanking of the landscape carried out since European arrival. But Manchac's logging scars do not just evoke the pre-1930s past. They also point to the future as well. The hubs and spokes of Manchac heralded the oil and gas industry's perforations of the Louisiana coast. For, just as the cypress industry began to collapse, a new frontier of wetland resource extraction had begun to emerge. The discovery of petroleum reserves hidden below the featureless wetlands of coastal Louisiana would launch a new petroleum boom and still another extractive industry bent on reordering the deltaic environment. Much as they did for parts of the cypress frontier, dredgers would dominate this new industry in oil and gas, converting amphibious marshes, swamps, and bays into much more rigid configurations of land and water.

Chapter 3: The Perforated Coast

On July 24 of 2013, the Southeast Louisiana Flood Protection Authority-East (SLFPA-E) filed a historic suit against almost 100 energy companies for damage to the region's coastal wetlands. The Flood Protection Authority, led by author John Barry, argued that corporations like Exxon-Mobil, Chevron, and, of course, BP, should be held accountable not just for recent disasters like the 2010 Deepwater Horizon blowout, but also for over eight decades of environmental destruction.[336]

Beginning in the late 1920s, companies including Texaco, Gulf Oil, and Phillips Petroleum—all long since swallowed up by the likes of Chevron and Exxon-Mobil—began exploring for and producing oil throughout Louisiana's coastal swamps and marshes.[337] Here, the oil and gas industry, using technological innovations not unlike the pullboating practices of the cypress logging companies, dredged canals for water-based exploration, transportation, and extraction. But where the cypress industry had restricted its operations to more inland wooded swamps, oil and gas companies reconfigured the coastal wetlands into a new resource frontier by

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[336] Board of Commissioners of the Southeast Louisiana Flood Protection Authority—East v. Tennessee Gas Pipeline Company, LLC et al., Civil District Court For the Parish of Orleans, State of Louisiana, no. 13-6911, July 24, 2013.

[337] Jason Theriot has told this story masterfully, revealing the technological innovations and infrastructural adaptations that created a wetland and, ultimately, offshore petroleum frontier. Theriot also traces the emergence of the environmental sciences that first became concerned with the problem of land loss. His book is arguably the most important historical treatment of industry's role in Louisiana's coastal crisis. Jason Theriot, *American Energy, Imperiled Coast: Oil and Gas Development in Louisiana's Wetlands* (Baton Rouge: LSU Press, 2014). Other histories of offshore petroleum also discuss early extraction in Gulf Coast wetlands: Robert Gramling, *Oil on the Edge: Offshore Development, Conflict, Gridlock* (Albany, NY: SUNY Press, 1996); Tai Deckner Kreidler, "The Offshore Petroleum Industry: The Formative Years, 1945-1962" (Ph.D. diss., Texas Tech University, 1997); Tyler Priest, *The Offshore Imperative: Shell Oil's Search for Petroleum in Postwar America* (College Station: Texas A&M University Press, 2007); Tyler Priest, "Extraction Not Creation: The History of Offshore Petroleum in the Gulf of Mexico," *Enterprise & Society* vol. 8 (2007): 227–267; Tyler Priest, "Technology and Strategy of Petroleum Exploration in Coastal and Offshore Gulf of Mexico," in *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 1: Papers on the Evolving Offshore Industry*, edited by Diane Austin et al. (New Orleans: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, 2008), 11–35.

dredging an expansive network of waterways. Those have since been implicated in pervasive deterioration of the deltaic environment.

By the early 1970s, wetland and coastal scientists had begun suggesting that the industry's canals and pipelines had catastrophically hastened the erosion and subsidence of Louisiana's coast: the Gulf of Mexico was reclaiming the delta at a staggering rate.[338] Over the last eighty years, almost 1,900 square miles of coastal Louisiana have fragmented into open water. An area about the size of Delaware, this amounts to 25 percent of the land area of Louisiana's coastal basins that existed prior to 1932. At its peak in the 1970s, Louisiana land loss occurred at an average rate of almost forty square miles each year.[339] Although that rate has since slowed to around sixteen square miles per year—more than a proverbial football field every hour— projections of land loss through the middle of the century still look profoundly frightening, with another 1,750 square miles at risk of eroding into the Gulf (Figure 3-1).[340] Land loss in Louisiana is thus not simply a wetland ecological tragedy; it also has disastrous consequences for fisheries, migratory birds, and the environmental security of not just Louisiana residents, but also—ironically—the oil and gas industry itself.

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[338] Sherwood Gagliano, *Canals, Dredging, and Land Reclamation in the Louisiana Coastal Zone* (Baton Rouge: Center for Wetland Resources, 1973).

[339] The peak rate of loss was 100 sq. km/year. John W. Day, Jr. et al., "Restoration of the Mississippi Delta: Lessons from Hurricanes Katrina and Rita," *Science* vol. 315, no. 5819 (2007): 1679–84; Bradley Couvillion et al., *Land Area Change in Coastal Louisiana from 1932 to 2010* (Reston, VA: U.S. Geological Survey, 2011).

[340] State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Baton Rouge, LA: Coastal Protection and Restoration Authority of Louisiana, 2012), 18, 29. The 2012 coastal master plan puts the average rate at over sixteen square miles/year, ranging annually from as low as fifteen to as much as 51, depending on storms and hurricanes.

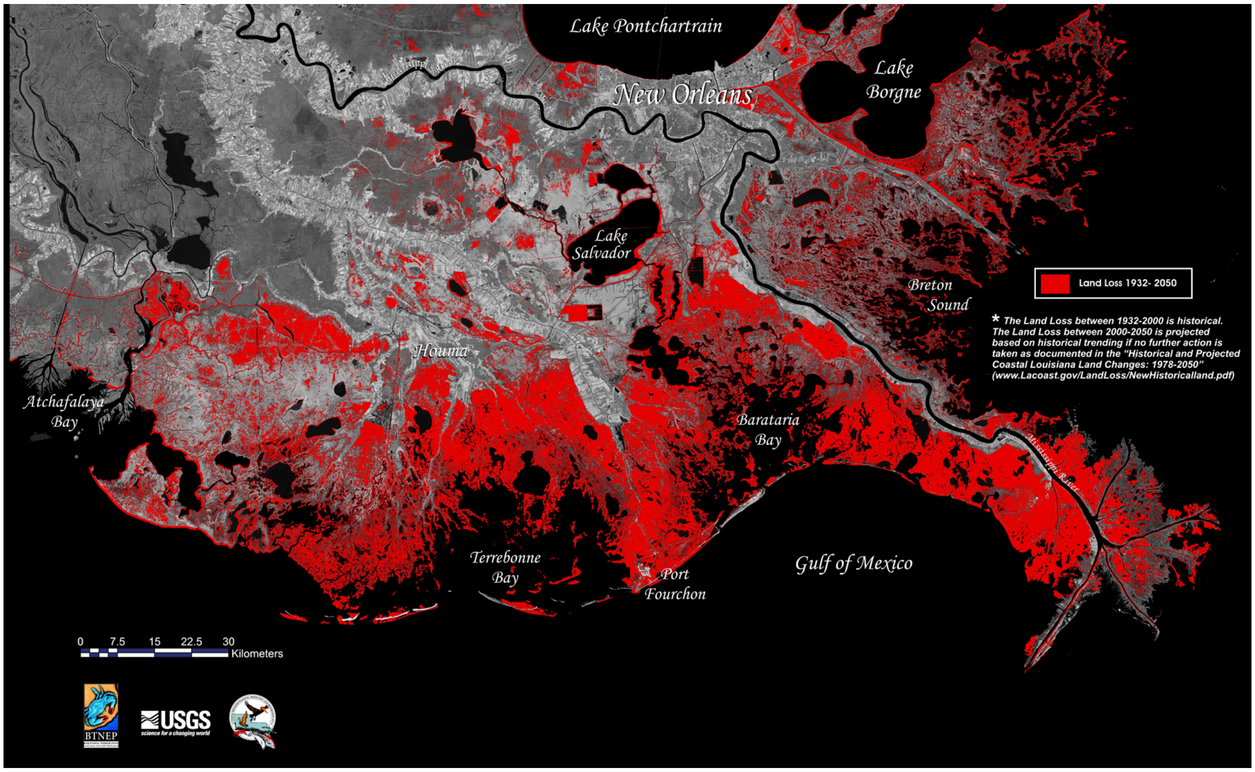

Figure 3-1: Land loss since 1932 projected through 2050, USGS and Louisiana CWPPRA, 2004.[341]

Citing these transformations of the coastal wetlands into open water—and at least ten other environmental impacts—the SLFPA-E lawsuit made three legal claims for reparations.[342]

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[341] U.S. Geological Survey and National Wetlands Research Center, "Southeast Louisiana Land Loss: Historical and Projected Loss in the Deltaic Plain" (Lafayette, LA: CWPPRA, 2004). This map is the most striking representation of past and future land loss, but more detailed maps of existing coastal erosions and projected losses are available in: Couvillion et al., *Land Area Change*; State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan*.

[342] The SLFPA-E suit essentially sought tens of billions of dollars from the petroleum industry to supplement coastal restoration efforts. Louisiana's 2012 coastal master plan budgets approximately $50 billion over fifty years to build between 580 and 800 square miles of land to protect southern Louisiana from storm surges and further erosion. A large portion of those funds will come from approximately $18 billion in penalties to be paid by BP and other parties responsible for the 2010 Deepwater Horizon blowout. Under the 2011 RESTORE Act, eighty percent of those penalties will be dedicated to Gulf Coast restoration, but Louisiana will only have direct access to as little as thirteen percent of the awarded total. After eighteen months of political uproar that included Governor Bobby Jindal's attempts to reconfigure the composition of the SLFPA-E and the introduction of legislation designed to kill the lawsuit, a Louisiana district court judge dismissed the proceedings, arguing that the SLFPA-E did not have standing. As of spring 2015, the levee board was weighing whether to appeal. Nathaniel Rich, "The Most Ambitious Environmental Lawsuit Ever," *New York Times Magazine*, October 2, 2014; Bob Marshall, "What are the Key Issues in Lawsuit Against Oil & Gas Companies for Coastal Loss?," *The Lens*, accessed July 15, 2015, http://thelensnola.org/2013/07/26/explainer-what-are-the-legal-political-issues-in-lawsuit-against-oil-gas-companies-for-coastal-loss/; Bob Marshall, "Flood Authority Discusses Appeal of Judge's Smackdown to its Oil and Gas Lawsuit," *The Lens*, February 19, 2015, accessed July 15, 2015, http://thelensnola.org/2015/02/19/flood-authority-discusses-appeal-of-judges-smackdown-to-its-oil-and-gas-lawsuit/.

First, the oil and gas industry had violated state permitting stipulations requiring environmental restoration of dredged canals. Second, in degrading the coastal wetlands, the petroleum industry had placed flood-protection infrastructure at risk of increased storm surge, thereby violating the federal Rivers and Harbors Act. And third, by increasing the risk of higher, more destructive storm surges, industry had violated a principle of Louisiana's civil code established in 1870 that prohibits increasing the flow of water onto another's property.[343] When the SLFPA-E filed suit in 2013, it argued, "This protective buffer took 6,000 years to form. Yet . . . it has been brought to the brink of destruction over the course of a single human lifetime."[344]

In geologic terms, it seems that Louisiana has experienced a rapid acceleration of time. Although deltaic landscapes are constantly eroding and subsiding, the Mississippi River Delta has undergone enormous transformation in just a few generations. Geologic processes typically imperceptible to humans have been compressed into the span of a human lifetime; a trickle of environmental change has become a flood. This bleeding together of vastly different timescales in the delta—decades, millennia, and even epochs—emerged as humans, while developing a petroleum frontier in Louisiana's coastal marshes, effectively reconfigured the deltaic environment on a geological scale.

By the early 1920s, petroleum geologists had begun to suspect that the flat, featureless wetlands of the Louisiana coast hid a vast expanse of untapped oil reserves. Improvements in sensing the unseen underground of the coast allowed prospectors to define a new resource below

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[343] Marshall, "What are the Key Issues?". The part of Louisiana's civil code in question was "The Natural Servitude of Drainage." It seems this would have been part of the legal landscape in late-nineteenth century struggles over rice flumes, and yet I have not found any legal cases from the period that make reference to it. Edwin C. Schilling, "Natural Servitude of Drainage—Extent of Burden Upon Owner of Servient Estate—Article 660, Louisiana Civil Code of 1870," *Louisiana Law Review* vol. 8, no.1 (1947): 147-150.

[344] Board of Commissioners of the Southeast Louisiana Flood Protection Authority—East v. Tennessee Gas Pipeline Company, LLC et al., Civil District Court For the Parish of Orleans, State of Louisiana, no. 13-6911, July 24, 2013.

the shifting deltaic environment: wetland oil. Although not substantially different physically and chemically from other forms of petroleum, this was an entirely new kind of oil inasmuch as the amphibious terrain necessitated an entirely new extractive infrastructure. Producing wetland oil demanded reconfiguration of the muddy chaos of Louisiana's diffuse coastal margins into a network of rigid waterways; impassable and uncertain *terra anfíbia* would give way to clearly bounded *aqua liquida*.[345] Bounding and stabilizing the apparently disordered environment would, much as it had for the cypress industry, facilitate the identification, extraction, and transportation of a wetland resource—in this case, petroleum.

But these reorganizations of the delta produced consequences of even greater concern than a permanently scarred swamp or a decimated wetland forest. Despite the seemingly chaotic amphibiousness of southern Louisiana, the Mississippi River Delta had in fact functioned with a muddy order of its own. As oil companies reconfigured the wetland environment into an extension of their petroleum extraction infrastructure, industry undermined that muddy order. Industry canals and pipelines perforated the coast on an enormous scale, fundamentally altering the physical processes sustaining the delta. Not only was the region rendered far more vulnerable to incursion by storm surges and rising seas in the Gulf of Mexico, its sedimentary fabric also began to unravel. By bounding and stabilizing parts of the deltaic landscape, the oil and gas industry frayed and destabilized the structure of the deltaic system. In so doing, industry also dramatically accelerated the pace of geologic time. By perforating the Louisiana coast, petroleum canals and pipelines had ensured that the slow seep of deltaic time would bleed into, and ultimately overwhelm, the pace of everyday human experience.

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[345] *Terra anfíbia*, or amphibious terrain, is from: Hugh Raffles, *In Amazonia: A Natural History* (Princeton, NJ: Princeton University Press, 2002), 16, 42, 182.

The Geologic History of a Perforated Coast

By around 12,000 years ago, the last ice age was substantially in retreat and global temperatures were rising to interglacial levels. Over the next 4,000 years, sea levels would fluctuate dramatically thanks to changing climatic conditions and enormous quantities of glacial meltwater. But as temperatures and ice cover subsequently stabilized around 8,000 years ago, sea levels also stabilized at elevations that left coastlines far further inland than during the height of the ice age. With these new coastlines more or less established, the unceasing flows of sediment that rivers deposited on ocean shores all over the world were once again allowed to accumulate into brand new deltas.

One of those deltas emerged at the new, post-glacial mouth of the Mississippi River. Gathering enormous quantities of sediment thanks to a network of tributaries spanning vast stretches of North America, the Mississippi deposited mud and silt along the ancient Gulf Coast, then considerably inland of its present-day shoreline. As the river approached the end of its journey to the sea, its waters slowed, allowing particles to settle and accumulate into new land. In creating all this new land, the riverbed and its overflowing banks, accumulating greater and greater quantities of continental sediments, came to occupy a subtly higher elevation than the surrounding landscape. At some point, a particularly large spring flood would carve a new path for the river away from the higher land that it had created, and the process would begin anew. At a larger scale, these avulsions resulted in a process of delta switching, in which the active river mouth meandered back and forth across Louisiana's ancient coast, extending the shore here and there right up until the recent past (Figure 3-2).

Southern Louisiana is thus entirely the product of muck, sediment, and flood. As a deltaic landscape that emerged up out of the Gulf, it is fundamentally flat and soggy. Indeed, almost any topography one finds in the region exists only thanks to the ancient and present-day riverbanks where the greatest quantities of sediment once accumulated. Most importantly, and perhaps paradoxically, land in southern Louisiana only accumulated thanks to the regular delivery of sediment-laden water to the region; this is a saturated deltaic landscape dependent on the flow of sediment and fresh water to survive.

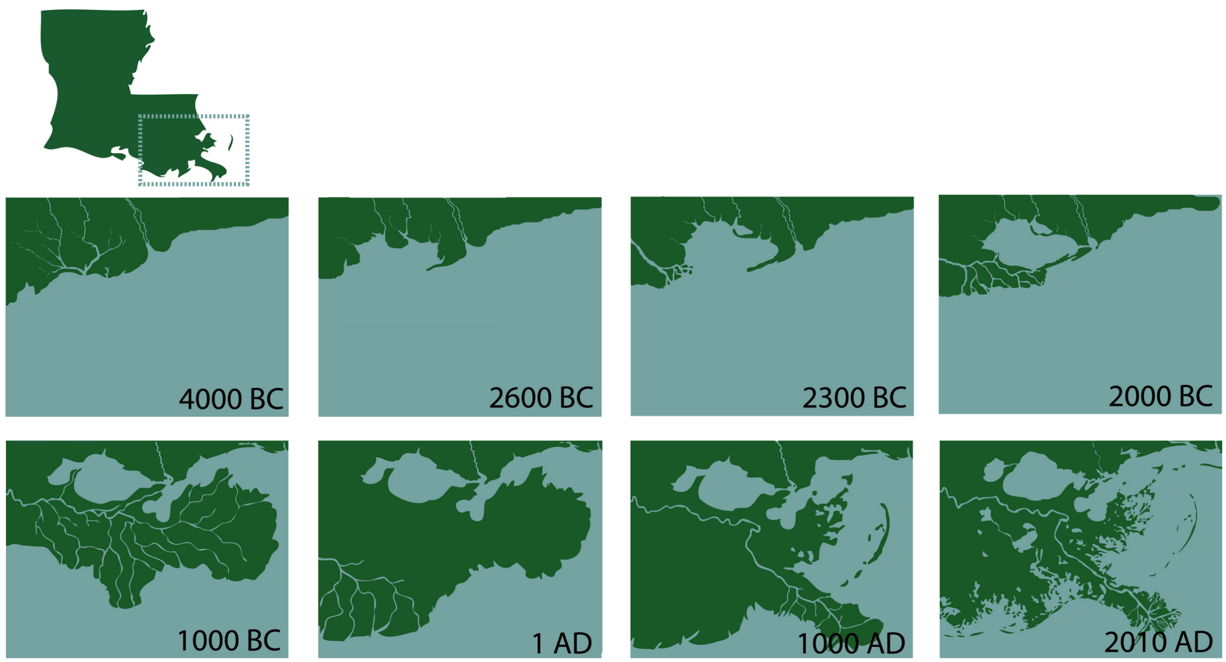

Figure 3-2: Development of southern Louisiana over the last 6,000 years. Image from Wikimedia Commons.[346]

But, as we saw in chapter one, nineteenth-century Louisianans began working assiduously to end the threat of flood. By the late nineteenth century, humans had effectively severed the delta from its river, with the exception of a few crevasses in high-water years. After the catastrophic flood of 1927, the Army Corps of Engineers ensured that mighty, contiguous levees and outlets would prevent future deluges. But that infrastructure also starved the landscape of the annual flow of sediments that had created land over the previous eight thousand years. The land began to shrink, subsiding and eroding as all deltaic landscapes—in a wild

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[346] Also see: Harry H. Roberts, "Dynamic Changes of the Holocene Mississippi River Delta Plain: The Delta Cycle," *Journal of Coastal Research*, vol. 13, no. 3 (1997): 605-627

choreography of flood, sediment, waves, storms, and ocean currents—are always already doing.[347] Without a steady flow of sediment to maintain it, the delta began decaying as all abandoned deltas do. With the delta severed from its river, the oil industry then began working in the late 1920s to dramatically accelerate that process of decay.

Fully understanding that story, however, requires reaching far deeper into the geologic past to around 165 million years ago in the middle Jurassic period. While giant reptiles roamed the earth, a proto-Gulf of Mexico was just beginning to form as present-day Mexico's Yucatan Peninsula started to rotate away from the rest of what is now North America. Much larger than the present Gulf and encompassing all of Louisiana and some of southern Arkansas, this proto-Gulf was in a hot, arid part of the globe. It intermittently filled with seawater depending on shifting regional geologies and fluctuations in global sea level. Over millions of years, these ebbs and flows of oceanic water evaporating in a steamy, sub-tropical basin formed the Louann Salt, a layer of gypsum, anhydrite, and rock salt as much as two miles thick in some places.[348]

The Louann plays a crucial role here because salt, despite its brittle, crystalline structure, becomes plastic under pressure and flows like toothpaste. And crucially, this plastic, pressurized salt also tends to be much less dense than other sedimentary geology. Over the next 165 million

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[347] Deltas are also constantly subsiding due to the sheer weight of sediments deposited on the lithosphere. When no new sediments are deposited in a delta, there's no material available for compensating for that downwarping. Sediment-starved deltas sink at an even faster rate because old sediments are also steadily being compacted. Comparing Harold Fisk's meander maps of the Mississippi and the Army Corps of Engineers' schematic for the Project Flood—both featured at the end of chapter one—offer a powerful impression of these transformations. James M. Coleman, "Dynamic Changes and Processes in the Mississippi River Delta," *Geological Society of America Bulletin* 100, no. 7 (1988): 999–1015; John W. Day et al., "Restoration of the Mississippi Delta: Lessons from Hurricanes Katrina and Rita," *Science* 315, no. 5819 (2007): 1679–84; Michael D. Blum and Harry H. Roberts, "Drowning of the Mississippi Delta due to Insufficient Sediment Supply and Global Sea-Level Rise," *Nature Geoscience* 2, no. 7 (2009): 488–91; Ricardo A. Olea and James L. Coleman, "A Synoptic Examination of Causes of Land Loss in Southern Louisiana as Related to the Exploitation of Subsurface Geologic Resources," *Journal of Coastal Research* 297 (2014): 1025–44.

[348] Darwin Spearing, *Roadside Geology of Louisiana* (Missoula, MT: Mountain Press Publishing Company, 1995), 7, 19; Amos Salvador, "Triassic-Jurassic," in *The Gulf of Mexico Basin*, edited by Amos Salvador (Boulder: Geological Society of America, 1991), 143-192, 146.

years, volcanic eruptions and uplift in the Rockies and Appalachians sent periodic surges of eroding sediments into the Gulf basin, burying the Louann Salt in tens of thousands of feet of material. Under all that pressure, the salt began to behave, at least geologically speaking, like bubbling ooze.[349] Additionally, warm Gulf waters ensured those sediments were often rich in organic matter. Nutrient-rich continental runoff combined with abundant sunshine and subtropical temperatures to breed megablooms of phytoplankton. These microorganisms, dying by the billions in long cycles of boom and bust rained down to the muddy Gulf floor, where they were preserved as organic sludge. Under growing pressure and heat, these sediments became sandstones and shales, while the billions upon billions of microorganisms fossilized into hydrocarbons in the interstices between the grains of these new rocks.[350] Through all of this surging deposition of sediments and sludge, the bubbling, plastic Louann was flowing upward, providing some of the key requirements for petroleum gather. The sedimentary rocks accumulating over millennia in the Gulf may have been rich in organic matter, but oil usually needs to collect into large pools to allow humans to be able to find and extract it. By pushing through layers of sedimentary rock, large bubbles of salt—or diapirs—facilitated the migration of fossil phytoplankton upwards through the surrounding strata.[351] Those bubbles of salt also created caps and seals that, in concert with more imporous shales, turned porous sandstone into reservoirs of petroleum. Some diapirs reached so near the surface that they formed barely

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[349] Amos Salvador, "Origin and Development of the Gulf of Mexico Basin," in *The Gulf of Mexico Basin*, edited by Amos Salvador (Boulder: Geological Society of America, 1991), 401-456. William E. Galloway, "Depositional Evolution of the Gulf of Mexico Sedimentary Basin," in *Sedimentary Basins of the World*, edited by Andrew D. Miall (Boston: Elsevier, 2008), 505-549.

[350] On fossilizing microorganisms, see: Dorrik Stow, *Vanished Ocean: How Tethys Shaped the World* (Oxford: Oxford University Press, 2010).

[351] For some time there was considerable debate over the timing of petroleum formation in the northern Gulf. Most of the reservoirs are in Miocene geology (5-23 million years old), but most geologists agree that the oil in those reservoirs bubbled up from the Paleogene layer (25-65 million years old): M.C. Kennicutt et al., "The Origins of Petroleum in the Northern Gulf of Mexico," *Geochimica et Cosmochimica Acta* 56 (1992): 1259-1280.

perceptible, low, roughly circular hills up to one hundred feet tall. Found throughout present-day coastal Texas and Louisiana, these hills guarded pockets of oil trapped on their flanks below the surface.[352] With petroleum having thus formed and accumulated in reserves below the Gulf Coast, it would wait patiently for millions of years before being discovered by humans.[353]

The Coming-Into-Being of Wetland Oil

Understanding the oil and gas industry's encounter with southern Louisiana's watery margins, and the disastrous environmental transformations that ensued, requires understanding something about the nature of the resource they were extracting. That is, wetland oil had to be detected, its physical and chemical qualities classified, and its geography mapped before petroleum companies could be concerned with devising an infrastructure for its extraction. Wetland oil had to come into being as a natural resource, as a category distinct from the rest of wild nature, before it could be produced from wells and brought to market.[354]

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[352] Perhaps the best, most beautiful description of the relationship between oil and salt comes from John McPhee, in *Basin and Range* (New York: Farrar, Strauss, and Giroux, 1981), 75-6: "Salt has a low specific gravity and is very plastic. Pile eight thousand feet of sediment on it and it starts to move. Slowly, blobularly, it collects itself and moves. It shoves apart layers of rock. It mounds upon itself, and, breaking its way upward, rises in mushroom shape—a salt dome. Still rising into more shales and sandstones, it bends them into graceful arches and then bursts through them like a bullet shooting upward through a splintering floor. The shape becomes a reverse teardrop. Generally, after the breakthrough, there will be some big layers of sandstone leaning on the salt dome like boards leaning up against a wall. The sandstone is permeable and probably has a layer of shale above it, which is not permeable. Any fluid in the sandstone will not only be trapped under the shale but will also be trapped by the impermeable salt. Enter the strange companionship of oil and salt. Oil also moves after it forms. You never find it where God put it. It moves great distances through permeable rock. Unless something traps it, it will move on upward until it reaches daylight and turns into tar. You don't run a limousine on tar, let alone a military-industrial complex. If, however, the oil moves upward through inclined sandstone and then hits a wall of salt, it stops, and stays—trapped. Run a little drill down the side of a salt dome and when you hit 'sand' it may be full of oil."

[353] For some excellent journalistic coverage of this geologic history, see: William J. Broad, "Tracing Oil Reserves to Their Tiny Origins," *New York Times*, August 2, 2010; Paul Voosen, "Gulf of Mexico's Deepwater Oil Industry is Built on Pillars of Salt," *New York Times*, July 28, 2010.

[354] My phrase "coming into being" attempts to thread the needle between "constructivist" and "realist" understandings of natural resources. An important landmark in the history of constructivist thought concerning resources is: Erich Zimmermann, *World Resources and Industries* (New York, Harper and Brothers, 1933). For an important rebuttal, see: Priest, "Extraction Not Creation." One example of a both/and approach can be found in

That coming-into-being, however, was far from a straightforward process. Hardly the universal, unvarying phenomenon that the phrase "natural resource" would suggest, petroleum has actually materialized in markedly different ways over time. What humans have classified as "oil" for over a century now is a highly variable collection of hydrocarbons, other organic compounds, and trace metals. And while petroleum geologists today might all agree that some of this oil formed in the Gulf of Mexico over the last 65 million years, this collection of substances has worked in concert with humans to produce many different kinds of oil phenomena over the last several centuries, each with different properties, effects, and affects. For these substances to ultimately become the petroleum we recognize today, a complex history of discovery and classification—of boundary-making—had to first unfold.

The earliest written record of a substance found in the Gulf of Mexico that today we would call petroleum comes from "a gentleman of Elvas," an anonymous Portuguese member of

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Gavin Bridge, "Material Worlds: Natural Resources, Resource Geography and the Material Economy," *Geography Compass* vol. 3, no. 3 (2009): 1217–44. My own thinking has been substantially influenced by Lorraine Daston, Bruno Latour, and other science-studies scholars working to understand the ontology—the nature of existence—of scientific objects. For Daston and others, scientific objects (and, in my estimation, natural resources) are simultaneously real, present, and material *and* historical, situated, and constructed. The seemingly purely natural things that people struggle over, consume, and study actually have histories; they come into being, develop, and fade out of existence in partnership with the labors and ideas of human beings. Which is not to say they are passive, socially constructed phenomena that exist only thanks to the agency of said humans. Rather, something like oil is *both* extracted *and* created. Petroleum both has an intrinsic, forceful material nature independent of humans and is also a product of human values and labors. Petroleum, although it has always been bursting with the fossilized energy of ancient sunlight, was only able to completely transform the entire planet *after* it was recognized and categorized by humans as a resource. Rather than a resource passively constructed by humans, we might say that oil—in the most active sense—waits to be discovered (thanks to Jake Fleming for the phrase). Oil both makes and has history. Lorraine Daston, "The Coming into Being of Scientific Objects," in *Biographies of Scientific Objects*, ed. Lorraine Daston (Chicago: University of Chicago Press, 2000), 1–14; Bruno Latour, "The 'Pédofil' of Boa Vista: A Photo-Philosophical Montage," *Common Knowledge* vol. 4, no. 1 (1995): 145–87. My thinking here has also been influenced by Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010); Bruce Braun, "Environmental Issues: Inventive Life," *Progress in Human Geography* vol. 32, no. 5 (October 1, 2008): 667–79; Karen Bakker and Gavin Bridge, "Material Worlds? Resource Geographies and the 'Matter of Nature,'" *Progress in Human Geography* vol. 30, no. 1 (2006): 5–27. Bruno Latour's framing of Louis Pasteur's breakthroughs in bacteriology is especially pertinent: "Pasteur's microbes are neither timeless entities discovered by Pasteur, nor the effect of political domination imposed on the laboratory by the social structure of the Second Empire, nor are they a careful mixture of 'purely' social elements and 'strictly' natural forces." Bruno Latour, "One More Turn After the Social Turn," in *The Social Dimensions of Science*, ed. Ernan McMullin (Notre Dame: Notre Dame University Press, 1992), 272-292, 284.

Hernan De Soto's ill-fated 1539 expedition. In July of 1542, just a few months after De Soto's death, the remnants of the expedition were dispersed and run ashore by foul weather somewhere west of the Mississippi. Reunited at the mouth of a creek, the party found a spring of black, tacky resin the Spaniards called "copee."[355] They then used the substance as a substitute for pitch—derived at that time from tree resin—to repair their leaky brigantines. What the party had undoubtedly found was a bitumen seep, the product of buoyant oil leaking to the earth's surface, where it evaporates, oxidizes, and biodegrades into asphalt.[356]

Almost two hundred years later, Daniel Coxe, in an account of his travels in the lower Mississippi Valley from 1702 to 1716, noted the large quantities of "stone pitch" that could be found on shores east and west of the Mississippi, especially after strong southerly winds. He even suggested that sailors could navigate in part by the pungent smell of the substance as it floated throughout the region's water. Although we would once again recognize Coxe's stone pitch as asphalt, the nature of this substance was still profoundly uncertain for observers at the time. Coxe wondered whether the substance was perhaps similar to a liquid he had heard was extracted in Persia and burned in lamps "instead of oil." But in an age when petroleum had not yet superseded whale oil as a source of illumination, he also speculated whether enough

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[355] "Copee" is likely a mistaken transliteration of "copé"; it is also found in some sources as "copey." "A Narrative of the Expedition of Hernando de Soto into Florida. By a Gentleman of Elvas. Published at Evora 1557. Translated from the Portuguese by Richard Hackluyt. London, 1609," in Benjamin Franklin French, ed., *Historical Collections of Louisiana: Embracing Translations of Many Rare and Valuable Documents Relating to the Natural, Civil and Political History of That State. Compiled with Historical and Biographical Notes, and an Introduction*, vol. 2 (Philadelphia: Daniels and Smith, 1850), 114–220.

[356] The first record of petroleum in the region as a whole probably comes from G. Fernandez de Oviedo y Valdés who wrote of natural seeps of bituminous pitch flowing near Puetro Principe, Cuba in 1526: R. J. Forbes, *Studies in Early Petroleum History* (Leiden, Netherlands: E.J. Brill, 1958).

spermaceti whales, "kill'd by the natives, and sometimes by storms," were being washed ashore to create the floating scums and resin balls he had observed.[357]

As yet another example of the ways oil materialized for humans in ways unfamiliar to our present experience, the substance that people found in the Gulf was also thought to have some medicinal applications. Not just an aromatic resource for repairing boats or lighting lamps, bitumen offered Indians—and subsequently Europeans—a variety of medical treatments for toothache, headache, swelling, rheumatism, and sprains. Indeed, for Indians, asphalt existed as a multitude of substances that could be used as decorations, adhesives, and construction materials, as well as in religious observances.[358]

The buoyancy of oil allowed first Indians, and then Europeans, to discover asphalt bubbling to the surface of the Gulf in seeps. For Europeans, this unfamiliar material was at least three different kinds of petroleum—three pungent-smelling oozes that served the same purpose as tree resin, ambergris, or even medicine. Two of those kinds of petroleum had absolutely nothing to do with the practices, values, and economies that might surround a fuel. And as an analogue of ambergris, that third kind of petroleum hardly looked like the energy-dense resource that would eventually transform the globe. It would take several hundred years from the first European encounters with copee, stone pitch, and Indian bitumen in the Gulf before petroleum

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[357] Daniel Coxe, *A Description of the English Province of Carolana, by the Spaniards Called Florida, and by the French La Louisiane. As Also of the Great and Famous River Meschacebe Or Mississippi, the Five Vast Navigable Lakes of Fresh Water, and the Parts Adjacent. Together with an Account of the Commodities of the Growth and Production of the Said Province. And a Preface, Containing Some Considerations on the Consequences of the French Making Settlements There* (Saint Louis, MO: Churchill and Harris Printers, 1840), 71.

[358] Forbes, *Studies in Early Petroleum History*, 98-122; Raymond Foss Bacon and William Allen Hamor, *The American Petroleum Industry* (New York: McGraw-Hill, 1916), 198-9; Susan F. Hodgson, *California Indians: Artisans of Oil* (Sacramento: California Dept. of Conservation, Division of Oil, Gas, and Geothermal Resources, 2004); Archaeology from a Karankawa Indian shell midden on Texas's Padre Island revealed pre-Colombian pottery decorated and lined with asphalt: Thomas Nolan Campbell, *The Kent-Crane Site: A Shell Midden on the Texas Coast* (Abilene, TX: Abilene Printing & Stationery Company, 1952).

would become an energy resource that would ultimately define the twentieth century, particularly, the twentieth-century United States.[359] Before the search for petroleum could reorganize Louisiana's coastal wetlands, humans had to discover that oil's combustible tendencies could be harnessed into a source of power that far exceeded illumination.

Most early nineteenth-century wells that produced petroleum in the United States were actually dug for brine and salt production, with oil understood at best as a curiosity—an alternative lubricant and illuminant obtained from neither plants nor animals, or perhaps as a medicinal substance—or at worst as a nuisance byproduct.[360] By the 1850s, however, petroleum was beginning to take form as the resource we recognize today. Americans were regularly distilling oil from coal to produce lubricants and illuminants that were surpassing the animal and vegetable products that had been used previously. In 1859, Edwin Drake drilled for oil near Titusville, Pennsylvania, producing a crude superior to whatever could be distilled from coal and in quantities that held commercial promise compared with the small amounts yielded as the byproducts of brine wells or from skimming oil seeps. Drake's work is often described as the birth of the petroleum industry in the United States. But just as a birth requires gestation, fossil carbon only slowly came into being as a fuel and lubricant.[361]

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[359] On petroleum's role in defining the twentieth-century United States, see: Stephanie LeMenager, *Living Oil: Petroleum Culture in the American Century* (New York: Oxford University Press, 2014). For a provocative look at the ways fossil fuels can exert different forms of social agency in the world depending on their material properties, see: Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (New York: Verso, 2011). For a helpful critique of some of Mitchell's less convincing political arguments, see: Michael Watts, "Oil Talk," *Development and Change* vol. 44, no. 4 (2013): 1013–26; Mazen Labban, "Book Review—Timothy Mitchell's 'Carbon Democracy: Political Power in the Age of Oil,'" *Antipode Foundation*, accessed July 1, 2014, http://antipodefoundation.org/2013/03/19/book-review-mazen-labban-on-timothy-mitchells-carbon-democracy/.

[360] Bacon and Hamor, *The American Petroleum Industry*, 199-200.

[361] Bacon and Hamor, *The American Petroleum Industry*, 216-219; Edgar Wesley Owen, *Trek of the Oil Finders: A History of Exploration for Petroleum* (Tulsa: American Association of Petroleum Geologists, 1975), 11-12.

Within a year of Drake's findings in Pennsylvania, oilmen came to Louisiana, prospecting in the southwestern reaches of the state where flowing oil springs had revealed themselves to residents in the 1830s. But after decades of unsuccessful efforts to drill for oil, the state's first Geological Survey Report in 1899 listed Louisiana petroleum an "unimportant" mineral product.[362] Given that on their first attempts, geologists failed to discover and conceive of significant petroleum resources below the Gulf Coast reveals that it was hardly inevitable that oil would ultimately (and catastrophically) transform Louisiana's coastal wetlands. A great deal had to happen before that landscape would be made legible as a frontier for oil exploration.

First, oil prospectors had to trace the boundaries of both a geology and a geography that would make the long history of seeps and springs in the Gulf intelligible as petroleum. One of the key moments in that process of sensing and classifying Louisiana's petroleum landscape took place in Texas at the turn of the twentieth century. People had observed the close relationship of salt and petroleum in brine wells often contaminated with oil byproducts. But in 1901, a Croatian mining engineer named Anthony Lucas made the first definitive association between salt geological structures and oil reserves when he unleashed a blowout at Spindletop, near Beaumont, Texas. Producing more oil in a day than all other fields in the nation combined, the gusher, proclaimed the dawn of a twentieth century defined by petroleum.[363] Lucas's discovery

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[362] Thomas D. Hayes, "History of Petroleum in Southwestern Louisiana: Discovery and Industrial Development" (MA thesis, University of Southwestern Louisiana, 1971). 17-18, 22.

[363] Lucas's investigations into the relationship between petroleum and salt domes had begun in the 1890s amongst the Louisiana's Five Islands—five salt domes on the coastal plain. Hayes, "History of Petroleum in Southwestern Louisiana," 18-24. Stephanie LeMenager writes that Spindletop "invited" the twentieth century: *Living Oil*, 167.

at Spindletop made the contours of the unseen, invisible, undifferentiated mineralogical underground suddenly much more legible.[364]

In producing a powerful jet of oil from Spindletop Hill, Lucas revealed a crucial empirical connection between subterranean domed salt structures and oil reserves. Occurring where large, ancient deposits of salt are less dense than the surrounding sedimentary strata, salt domes slowly bubble toward the surface. In pressing upwards, they create stratigraphic traps for oil and natural gas and can even produce small round hills at the surface. As we have seen, prior to Spindletop, geologists and oil producers were quite certain that no significant stores of oil lay under the deltaic sediments of the Gulf Coast.[365] But after Lucas's 1901 gusher, oilmen reimagined the boundaries of petroleum geology in the region. With the inland Gulf Coast now suddenly reclassified as an oil-producing environment, prospectors spent two decades feverishly searching for the next Spindletop throughout southern Texas and Louisiana.

The only tools available in this search were the surficial clues offered by topography, drainage, and direct invitations from petroleum itself: the presence of gas seeps, "sour waters" (mineral springs), asphalt beds, and paraffin dirt.[366] Between 1901 and 1913, almost forty salt domes were discovered courtesy of these physical clues in the landscape.[367] As prospectors drilled wells, geological samples from thousands of feet below the surface helped contribute still

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[364] On the "unseen underground" and the legibility of mineral resources, see: Gavin Bridge, "Acts of Enclosure: Claim Staking and Land Conversion in Guyana's Gold Fields," in *Neoliberal Environments: False Promises and Unnatural Consequences*, edited by Nik Heynen et al. (New York: Routledge, 2007), 74–86.

[365] Hayes, "History of Petroleum in Southwestern Louisiana," 22. In the words of petroleum consultant Michel T. Halbouty, the region was believed "unworthy of testing with the drill." Michel T. Halbouty, "Geological and Engineering Thinking in the Gulf Coast of Texas and Louisiana: Past, Present, and Future," *Journal of Petroleum Technology*, May, 1957, 19.

[366] R.A. Steinmayer, "The Oil Exploration Aureole," *Transactions—Gulf Coast Association of Geological Societies* vol. 7 (1957): 247-252, 249.

[367] E.E. Rosaire, "On the Strategy and Tactics of Exploration for Petroleum II," *Geophysics* vol. 3, no. 1 (1938): 22-39, 31

more geological data, rendering the region's deltaic underground increasingly intelligible. By the teens, however, new discoveries using these surficial methods steeply declined. It seemed all the easy discoveries had been made. Only a few more domes were discovered in the late 1910s, and just one in 1922.[368] The immediately detectable suggestions of the petroleum underground—as manifested through topography, drainage, and surface emanations—were no longer adequate for tracing the boundaries of oil and salt. With fewer and fewer payoffs, the cost of subsequent exploration steadily increased. The 1922 discovery came after 675 dry wells had been drilled at a total cost of around $20 million, making it a very expensive salt dome.[369]

Amid these declining returns on investment, new technologies were emerging that freed geologists from the dwindling surficial clues of petroleum geology. Where traditional methods of direct observation were failing to reveal new domes, a suite of budding geophysical remote-sensing methods would reimagine the boundaries of petroleum geography and geology, reinvigorating the age of oil exploration. The first of these was the torsion balance. Introduced from Europe, the torsion balance was based on a scientific apparatus dating back to the late eighteenth century. It worked by detecting minuscule gravity anomalies produced by salt's comparatively low density. In February of 1924, a geophysical team using a torsion balance discovered the Nash Dome about 25 miles southwest of Houston, Texas. This was the first discovery of a salt dome by remote-sensing geophysics. Just a few months later, a German crew working for Gulf Oil revealed the nearby Orchard Dome using yet another new remote-sensing method: seismography.[370] By detonating explosions at the surface and recording the subtle

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[368] Rosaire, "On the Strategy and Tactics," 31.

[369] Around $280 million in today's dollars. Rosaire, "On the Strategy and Tactics," 31.

[370] D.C. Barton, "Geophysical Methods in the Gulf Coastal Plain," *AAPG Bulletin* vol. 9, no. 3 (1925): 669-671; Owen, *Trek of the Oil Finders*, 505.

differences in subterranean sound waves that resulted, seismography teams were able to similarly trace the contours of invisible and inaccessible petroleum structures.

With the development of the torsion balance and seismography, the nature of the salt dome had suddenly changed. Formerly existing only where clues were directly observable at the earth's surface, salt domes could now potentially be found anywhere in the Gulf region, regardless of topography or petroleum and mineral seeps. Thinking among geologists and prospectors subsequently began to suggest that if many oil-bearing domes were invisible at the surface, then perhaps they could be found in even the most featureless landscapes.[371] The Gulf region's coastal margins suddenly took on a completely different aspect for oil prospectors and geologists. Might salt domes, in fact, lie hidden below the flat, watery marshes and shallow bays of Louisiana's coast? Hints of wetland oil were looming out of the underground.

Oil companies thus began an active exploration program in the seventy-mile wide strip of Gulf Coast that stretched from Edna, Texas, in the west, to just shy of the Mississippi in the east.[372] In April of 1926, Gulf Oil hired two German Seismos teams of geophysical explorers to investigate the featureless marshes of the deltaic plain for salt domes. Within three months one of the crews discovered two structures. A year later, other crews working in even more watery terrain discovered eleven domes in just nine months. Those discoveries cost about $50,000 each, a vast improvement over the 675 completely dry wildcat exploratory wells drilled for $2 million

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[371] Eugene Wesley Shaw, "Possibility of Using Gravity Anomalies in the Search for Salt-Dome Oil and Gas Pools," *Science* vol. 46, no. 1197 (1917): 553-556. As early as 1920, oil speculator E.F. Simms of the Louisiana Land and Exploration Company believed salt domes could be found underwater: Rosaire, "On the Strategy and Tactics," 29. In 1924, David T. White of the National Research Council similarly suggested domes could be found offshore and made a public statement to that effect: Charles E. Kern, "Possibility of Oil Structures Out in the Gulf of Mexico," *Oil & Gas Journal* vol. 25, no. 42 (20 March 1927): 80, 225-226.

[372] Sydney A. Judson, "Operations in the Gulf Coast of Texas and Louisiana for 1926," *Petroleum Development and Technology* vol. 4 (1927): 659-673, 668.

in 1922.[373] By the close of 1926, over a thousand men were employed on torsion balance, seismography, and other geophysical survey crews. The number of drilling permits issued by the Louisiana Department of Conservation surged that year to 1,312.[374]

In the years that followed, petroleum geologists improved their understanding of the relationship between salt domes, stratigraphic traps, and oil reservoirs. Similarly, engineers refined the remote-sensing technologies that allowed geophysical teams to suggest where drilling should take place.[375] By the early 1930s, seismography crews had shot millions of acres of marshy, swampy coastal Louisiana with dynamite, recording seismic anomalies that revealed a new geography of petroleum. Companies like Gulf, Humble, Roxana (later Shell), Pure, and the conjoined Texas and Louisiana Land and Exploration Companies together found forty domes on the Texas and Louisiana Gulf in just four years.[376] And these discoveries bore riches. In 1930, oil production in south Louisiana matched the quantities yielded by the better-known domes in the north.[377] Five years later, 52 geophysical crews—each composed of up to twenty men—were exploring the southern reaches of Louisiana.[378] By then, the flat, seemingly undifferentiated watery landscapes of the deltaic environment were producing five times as much oil as the

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[373] About $660,000 in today's dollars. L.C. Lawyer, Charles C. Bates, and Robert B. Rice, *Geophysics in the Affairs of Mankind: A Personalized History of Exploration Geophysics* (Tulsa: Society of Exploration Geophysicists, 2001), 16-17; Rosaire, "On the Strategy and Tactics," 32.

[374] Steinmayer, "The Oil Exploration Aureole," 249-250.

[375] J.W. Flude, "Exploring in Marsh and Water Areas of Louisiana and Texas Gulf Coast," *Oil & Gas Journal* vol. 34, no. 48 (16 April 1936): 142-144.

[376] Benjamin B. Weatherby, "The History and Development of Seismic Prospecting," *Geophysics* vol. 5, no. 3 (1940): 215-230, 221-5.

[377] Steinmayer, "The Oil Exploration Aureole," 250.

[378] Neil Williams, "Present Rate of Gulf Coast Exploration May Find All Reserves in Two Years," *Oil & Gas Journal* vol. 34, no. 21 (10 October 1935): 11-12. Williams counted 24 reflection seismography crews, two refraction seismography crews, and twenty torsion balance crews, and six crews using miscellaneous methods for a total of 52. The number of men in each crew is an estimate based on much later figures: Milton B. Dobrin, "Introduction to Geophysical Prospecting," *Oil & Gas Journal* vol. 50 (24 March 1952): 124-162.

state's northern fields.[379] Louisiana's coastal margins were crawling with geophysical and prospecting teams as wetland oil had fully materialized out of the amphibious terrain.

The physical and chemical properties of petroleum in the Gulf of Mexico, in partnership with humans, had come into being in profoundly different arrangements to different people at different times, all with different material effects in the world. One of these arrangements—wetland oil—would prove markedly different from the more conventional kinds of petroleum discovered elsewhere in the world. The process of apprehending wetland oil—of sensing, classifying, and mapping the resource—resulted in entirely new encounters between humans and the watery wilderness of Louisiana's coastal wetlands. Those encounters would profoundly influence the process of extracting wetland oil, a process that ultimately would reorder not just the space of southern Louisiana, but its time as well.[380]

Encountering the Oily Margins

Discovering and producing wetland oil was hot, difficult, and, above all, soggy work out in the swamps, bays, and marshes of the coastal plain. Trade journals and oral histories describe the textures of human encounter with an in-between landscape that began with geophysical exploration in the 1920s, and continued through the drilling and pipelining efforts that would extract petroleum from the wetland environment for decades to come.

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[379] Steinmayer, "The Oil Exploration Aureole," 250. For more on this history, see: Owen, *Trek of the Oil Finders*, 760-62; Lawyer, Bates, and Rice, *Geophysics in the Affairs of Mankind*, 15-18; Priest, "Technology and Strategy of Petroleum Exploration in Coastal and Offshore Gulf of Mexico."

[380] The main claims of this section also apply to Louisiana's history of bald cypress logging, as discussed in chapter two. While bald cypress was more or less the same kind of lumber resource for much of the industry's history, there was also an early period in in the eighteenth century during which European settlers had to discover the unique properties of the wood and create an account of its habitat that would inspire novel means of resource extraction.

Geophysical teams, followed by roughnecks, roustabouts, pipeliners, and other petroleum laborers worked in a trio of bewildering, unpredictable wetland environments, from the apparently open water of shallow bays and lakes, to the exceedingly uncertain terrain of grassy marshlands, to the more inland flooded cypress swamps plied by logging industry pullboats. Salt domes obeyed no laws of surface topography and ecology. Likewise, pipelines would inevitably cut across the subtle gradients of topography, vegetation, and salinity that in part determined the differences between wetland environments.

Men exploring these watery landscapes encountered marsh grass up to eight feet high or the seemingly open water of a shallow bay—perhaps so large the shoreline was not even visible from its middle—suddenly transformed into an impassable mudflat by the vagaries of wind and tide.[381] This was a world that was neither "open water nor dry land" and what little terrain existed was "soft and spongy."[382] If "ground" had become a relative term in being "covered with so much water," water too became uncertain; it was "slime" or a "noxious cess-pool."[383] Less hostile descriptions used curiously gastronomic language to compare southern Louisiana's waters to "chocolate pudding" and soup.[384] Observers also deployed the romantic register, describing "a strange and beautiful land that seems to rest lightly in a world of water."[385]

For the most part, whether swamp, bay, mudflat, marsh, or some combination of each, Louisiana's new petroleum frontier was a deeply disorienting place. Not only did apparently

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[381] Flude, "Exploring in Marsh and Water Areas."

[382] "Open water nor dry land" is from: Neil Williams, "Gulf Coast Transportation Problems," *Oil & Gas Journal* vol. 28 (16 January 1930): 41, 139. "Soft and spongy" is from: Ralph H. King, "Geophysics Has Played Important Role in Oil Discoveries," *Petroleum Engineer* vol. 10 (May 1939): 94.

[383] Robert P. Clark, "Geophysical Generalities," *Oil & Gas Journal* vol. 34, no. 48 (16 April 1936): 148-152.

[384] "Chocolate pudding" in: Clark, "Geophysical Generalities," 150; Comparisons to soup in: L. D. Myers, "Sixty Miles of 36-in. Pipe Across Louisiana Marshes," *Civil Engineering* vol. 32, no. 5 (1962): 52-55.

[385] Don Burns, "World of Water," *The Lamp*, November, 1948, 15-18.

natural, elemental categories like earth and water lose their meaning, but the boundaries between them were porous and blurry. Water and land mixed unpredictably and promiscuously, creating a sense of disorder and otherworldliness to produce a landscape out of place.[386] For some, Southern Louisiana was also a place that God had overlooked in the work of dividing land from water: one observer, recalling Genesis, even described the semi-aqueous region as a place "whose waters have receded from it only comparatively recently" (never mind that southern Louisiana existed not as a case of water receding, but of land emerging).[387] In these muddy margins, knowing nature and understanding one's place in it became exceedingly challenging.

Even a native of southern Louisiana could grow disoriented in the region's wetlands. Nelson Constant, born in Kraemer—a small town along Bayou L'Ours—and accustomed to tracing property lines and trapper leases, worked for Humble Oil as a surveyor beginning in the late 1930s. "In the swamp," Constant noted, "everything is the same, it's hard to keep straight." The watery environment presented a double challenge of orientation because "you couldn't bring them paper and write it down, 'cause it would be all wet. You have to remember the distances, certain bayous are so far, while you're doing your work."[388]

The coastal marshes, treeless and open to the horizon, were even more disorienting. Neil Williams, writing for *Oil & Gas Journal* in 1929, described the "the constantly shifting land

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[386] On matter out of place, see: Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Praeger, 1966).

[387] A settler in Ohio's Black Swamp once remarked: "we read that God divided the land from the water, here is a place He forgot." The quote was found in Bruce McGarvey, "Landscape Myths of the Black Swamp. Part One," *Northwest Ohio Quarterly*, vol. 60, no. 2, (1988): 57-68. On waters having receded only recently: "Submerged Regions of Gulf Coast Explored by Special Methods," *Oil & Gas Journal* vol. 33, no. 46 (4 April 1935): 69-71.

[388] Interview with Nelson Constant, July 23, 2001, conducted by Diane Austin, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

lines and changing islands" of the treeless environment, likening it to a "maze."[389] Another industry observer writing for *Shell News* noted the "land is scarcely more than a series of floating dirt rafts insecurely anchored by vegetation."[390] A marsh might consist of "black, mucky ooze" averaging 60 feet in depth, but covered in "a growth of swamp grass" forming a "floating carpet about 3 feet thick."[391] Something known in Cajun dialect as *flotant* abounds in these coastal marshes. Flotant—or "floating" in French—is marsh grass anchored to thin mats of decomposing debris that either float completely, or rest on some sort of "highly aqueous organic ooze."[392] Flotant, aptly named by a gerund, is fundamentally in-between—it is land always-already either becoming or eroding. Winds and waves could push mats of flotant across the landscape, effectively rearranging the geography of marsh grass and open water overnight. For most of the geophysical explorers and the petroleum workers that would follow, the amphibious landscape was a disordered and bewildering world of blurred boundaries.

Those blurred boundaries provided habitat for nonhuman creatures that were similarly disconcerting in their in-betweenness. In a 1942 article for *Geographical Review*, Richard Russell observed that flotant created a landscape "becoming neither land nor water," but rather "the milieu of the flying and crawling rather than the walking or swimming."[393] Russell's anxieties about a milieu of the flying and crawling resonate with anthropologist Mary Douglas's thoughts on what it is that horrifies about the "unclean animal" that "creeps, crawls or swarms." These are "indeterminate" forms of movement practiced by creatures that, in Douglas's words,

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[389] Neil Williams, "Drilling for Oil in a World to Itself," Oil & Gas Journal vol. 28, no. 31 (19 December 1929): 40-41.

[390] F.C. Embshoff, "Floating Derricks: Modern Drilling in the Swamplands," *Shell News*, July, 1938, 4-6.

[391] Williams, "Gulf Coast Transportation Problems," 41.

[392] Richard Joel Russell, "Flotant," *Geographical Review* vol. 32, no1. (1942): 74-98, 79.

[393] Russell, "Flotant," 98.

"cut across" basic classifications in a similarly indeterminate and unclassifiable landscape. "Eels and worms," Douglas observes, "inhabit water, though not as fish; reptiles go on dry land, though not as quadrupeds; some insects fly, though not as birds." The coastal wetlands were thus full of organisms that thwarted human taxonomies, becoming disorderly matter out of place in a watery environment that was itself confusing and uncertain.[394]

Geophysical teams, roughnecks, roustabouts, pipeliners, and other industry workers had to contend with snakes, alligators, leeches, mosquitos, "redbugs," ticks, "and a billion other poisonous and irritating pests."[395] Lorimer Comeaux, who worked as a pipeline walker for thirteen of his forty years with Humble Oil (now Exxon), would often come across thick swarms of insects that assaulted the senses. One day, he left his facemask home before setting out: "I thought them doggone sand flies were gonna poke my eyes out . . . sand flies likely killed me. I thought that was gonna, in fact my wife wanted me to quit."[396] Other animals even worked to further confuse the landscape and its shifting geographies of muck, water, and grass. Alligators and muskrats could both tear away at flotant and other vegetation so as to undermine the surface or create unseen "alligator" holes in the terrain, sending unsuspecting humans into thick ooze or even sudden patches of open water.[397]

Compounding the atmosphere of discomfort and instability of the amphibious terrain, wetland creatures—particularly snakes—also posed real dangers for humans working in the

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[394] Douglas, *Purity and Danger*, 57-8.

[395] Mosquitos in: "Down to the Sea for Crude, Part 1," *Texaco Star*, January, 1930, 3-6, 5. Ticks, redbugs, and mosquitos in: G.D. Harris, *Oil and Gas in Louisiana* (Washington, D.C.: Government Printing Office, 1910), 118. Leeches and "irritating pests" in: Clark, "Geophysical Generalities," 148.

[396] Interview with Lorimer Comeaux, March 22, 2002, conducted by Emily Bernier, item 98, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[397] Alligator holes in: Flude, "Exploring in Marsh and Water Areas," 142; Russell, "Flotant," 79. Muskrats in: Gordon B. Nicholson, "Road Construction in Swamps Presents Difficulties," *Oil Weekly* vol. 106, no. 10 (August 1942): 25-32.

petroleum industry. One day while walking the pipeline, Lorimer Comeaux came across a tangle of around fifteen snakes mating on the line. Water moccasins, also known as cottonmouths, were particularly dangerous and could bite and seriously poison a man.[398] Articles on safety campaigns featured news of training geophysical teams, prospecting, and drilling crews for dealing with snakebites, infections, and other dangers in a place in a place "where much time is consumed to reach doctors by boats."[399] Comeaux once came across a cottonmouth ready to strike and jumped back shouting, even though no one was present to help him. "If you'da dropped dead down in the, in the marsh, what the hell did they [his employers] know?"[400] One of Nelson Constant's survey crewmembers was in fact bitten by a moccasin when cleaning spanish moss out from a boat propeller. Entangled with and indistinguishable from the vegetation, the snake struck the young man, hospitalizing him for three days. Constant also recalled that moccasins would release a particularly recognizable smell, providing at least one way of recognizing danger in the disorderly environment.[401] Learning how to avoid death and serious injury at the hands of the nonhuman denizens in Louisiana's petroleum frontier, was at least one—albeit feeble—way of bringing order to the watery landscape.

While the nonhuman inhabitants of Louisiana's coastal wetlands had little trouble navigating its uncertain terrain, geophysical and petroleum workers had to learn new ways of being in a landscape "where land is sea and sea is land" and where humans found it "difficult to

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[398] Interview with Lorimer Comeaux, March 22, 2002, conducted by Emily Bernier, item 98, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[399] "Doctors by boats," in: Elizabeth Lord, "Safety Campaign Under Way," *Texaco Topics*, November-December, 1934, 3.

[400] Interview with Lorimer Comeaux, March 22, 2002, conducted by Emily Bernier, item 98, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[401] Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

distinguish land from water, and quite impossible to walk in most of it."[402] In this "desolate place" where the "ground grabs at your feet, making every step an effort," industry workers had to transform their understanding of what it meant to apprehend, inhabit, and move through the environment, both physically and cognitively.[403] P. Hearin, a geophysical crewmember writing an article titled "Liquid Land" for the Phillips 66 trade journal, told readers that he and his mates would "all have web feet soon" and looked "forward to a visit 'back in the states,'" suggesting just how much this was a "world to itself."[404] Houston Lejeune worked for Sun Oil on a geophysical team doing seismic exploration in the Louisiana marshes. He remembers that there was "an art in walking through a deep swamp and not getting tired. You have to learn what type of grass will support you and what type of grass would not, especially in the marsh. . . . And you learned as you went."[405] Nelson Constant recalled a similar process of learning the surprises and indeterminacies of the sodden landscape: "We knew what type of- of grass to step on. You- If you saw a certain type of grass growing that it would just be a little marsh sitting on top of the water [laughing] and it looked good to you. And if you didn't know- know it, you'd go sink to your neck in that hole."[406] Perhaps even more treacherous than marsh or swamp were the unpredictable stretches of mudflats spread throughout the coast. Lejeune remembers that some geophysical crewmembers would repurpose wooden dynamite boxes as a kind of snowshoe for the

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[402] William T. Ivey, "Pipelining in Marsh, Swamp, and Open Water," *Civil Engineering*, vol. 28, no.9 (September 1958): 640-643.

[403] "Heroic Rescue in the Swamplands," *Texaco Topics*, June 1941, 3.

[404] P. Hearin, "Liquid Land," *Philnews*, June 1940, 12-13; Williams, "Drilling for Oil in a World to Itself."

[405] Interview with Houston Lejeune, March 22, 2004, conducted by Jamie Christy, item 271, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries. I first found this quotation in: Theriot, *American Energy, Imperiled Coast*, 36.

[406] Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

mud. "You had to be careful or you'd sink up to your armpit."[407] To find one's way in the petroleum frontier was a struggle to adapt both one's body and one's mind to the delta's unpredictable mixtures of land and water.

Figure 3-3: "Seismic Party 18" laying cable near Lake Maurepas, Louisiana, circa 1952. W. Van London and L.D. Owen, "Indications Point to Another Record Year in Exploratory Drilling," *Oil & Gas Journal*, vol. 52, no. 6 (June 16, 1952): 213. Photo used with permission of *Oil & Gas Journal*.

Even unencumbered, walking in marsh and swamp was "very fatiguing," especially so for larger men.[408] If being in the landscape required new forms of embodied knowledge, not all bodies were equally adept at learning. Sun Oil seismic prospector Houston Lejeune recalled that being larger (and therefore stronger) helped up to a point, but "of course if you were too big and

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[407] Interview with Houston Lejeune, March 22, 2004, conducted by Jamie Christy, item 271, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[408] Flude, "Exploring in Marsh and Water Areas," 142.

you was real fat, you did not perform very well in the swamp or the marsh. It was a hazard then."[409] Morris Pyle, another seismic worker notes how the environment posed particular challenges especially for the Texans unfamiliar with watery places. "And, you know, they were sendin' us nice big, strappin', strong boys out of Houston and send 'em out there to work. But they can't, they didn't know how to walk in the swamp, they just bog down. I mean they, they didn't know how to move."[410] Nelson Constant's crews would try to accommodate their highland workers: "If we had one came in from out that didn't [sic] anything about the swamps or anything, we always tried to give 'em a lighter load, and also try to be with him. Not- not leave him behind or let him get scared or anything like that. There was always somebody that had to stay with him, that had to watch him, and in case he got in trouble, to help him out and all."[411] Not just fatiguing and inhospitable, the in-betweenness of Louisiana's coastal wetlands could provoke fear and anxiety in petroleum workers.

Aside from the profound challenges of simply moving in the environment, Louisiana's wetlands exerted other powerful effects on the human body. In the hot, humid—and, in the case of the marshes, windblown and sunburned—environment, staying hydrated often led petroleum workers to experience amphibious terrain in still more intimate ways. Jake Giroir began cutting right-of-ways in the swamps for Shell pipelines in 1936. Describing one of his first days on the job, he remembered that "it was hot. . . . And we run out of water, so they had those little pullboat runs,

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[409] Interview with Houston Lejeune, March 22, 2004, conducted by Jamie Christy, item 271, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries. Also reaffirmed by seismic worker Morris Pyle: "'Cause if you're overweight, you just can't walk a swamp hardly." Interview with Morris Pyle, August 7, 2002, conducted by Steven Wiltz and David DiTucci, item 361, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[410] Interview with Morris Pyle, August 7, 2002, conducted by Steven Wiltz and David DiTucci, item 361, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[411] Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

and the water was clear, and all you got to do is to wet your mouth, you know."[412] Nelson Constant took similar risks to drink directly from the landscape. "All we had to drink was a- a little canteen which would hold maybe a- a quart of water. Well, heck, in the summertime . . . if the swamps were dry, and you had just a little puddles of water, sometimes, you know, you had to push those snakes out of the way to fill your canteen up . . . Or you wouldn't make the day."[413] In the in-between world of the coastal wetlands, even water did not conform to human categories. Though certainly everywhere, very little of it was drinkable. And when a potable puddle happened to present itself, sometimes that water was filled with threatening creatures.

Not all geophysical workers and petroleum employees were so physically uncomfortable in the watery environment, however. Wetland natives like the Cajuns who had been raised practicing subsistence livelihoods in the swamps and marshes navigated the in-between ecology with far more grace and ability, even if they might still grow disoriented in more unfamiliar stretches of the delta. Morris Pyle remembers some Cajun seismic crewmembers hired from Choctaw Louisiana who "you take a guy that's raised in the marsh and swamp country, and who's trapped in it, trapped for muskrats and so forth, he knows how to walk in it. And uh, a guy like myself, I'm up to here and he's, he just goes above his knees [Inaudible]. It's just, it's an art that they can walk in it. So I'd walk behind him. . . . Once we found out about those guys, oh we were shootin' that thing up like we were runnin' on dry land. . . ."[414] Claude Sonnier, working for a Humble Oil seismic crew in the 1940s similarly remembers "one guy, he wouldn't get wet hardly. He'd hop along. . .

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[412] Interview with Jake Giroir, January 7, 2005, conducted by Diane Austin, Joanna Stone, and Colleen O'Donnell, item 201, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[413] Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[414] Interview with Morris Pyle, August 7, 2002, conducted by Steven Wiltz and David DiTucci, item 361, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

. He could walk around the swamp like a frog [Chuckling] jumpin'."[415] Cajuns, having grown up in communities with deep historical roots in the coastal wetlands, were often far more capable of (and comfortable with) traversing what foreigners perceived to be disordered nature.

Although the simple act of walking and surviving the landscape presented significant challenges for most industry workers, much of the time, however, men exploring southern Louisiana's petroleum frontier did not have the luxury of walking through swamp, marsh, and mudflat unencumbered. Shooting teams had to carry packs weighing fifty to seventy pounds, which included drinking water, explosives, pumps, drills, and sensitive seismic equipment like geophones and cables.[416] Indeed, those sensitive geophysical devices often placed extraordinary demands on prospectors. The gravimeter and torsion balance—which detected salt domes by measuring infinitesimally small variations in gravity—needed to be absolutely level in order to function.[417] This was especially ironic given the devices were being used in an environment defined by uneven and constantly shifting terrain. In swamps, Nelson Constant observed, "there's only a little bit of trees and no place to- to put your stuff on to be able to set all that up, you had to make it. . . . So, we'd cut the trees and try to make the best we could. Build 'em a place to where we thought it would- they could put their instruments on."[418] Meanwhile, cables, geophones, seismometers, and so on had to be kept in reasonable condition despite being transported through humid, saturated

[415] Interview with Claude Sonnier, July 23, 2003, conducted by Steven Wiltz, item 412, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries. Note the comparison (reduction?) of Cajun skills and lifeways to nonhuman or animal behavior, particularly given that Cajuns have historically been a marginalized ethnic minority.

[416] Pack weight information from: A.B. Hamil, "Portable Equipment Expedites Marine Seismic Surveys," *Oil & Gas Journal*, vol. 46, no. 4 (31 May 1947): 146-153, 156; Interview with Houston Lejeune, March 22, 2004, conducted by Jamie Christy, item 271, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries; Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[417] Dobrin, "Introduction to Geophysical Prospecting."

[418] Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

landscapes. Nelson Constant remembers that in swamp areas they would occasionally be able to float pirogues—small dugout Cajun canoes—into the area to be explored. The pirogues, however, were reserved for shooting equipment, with the men forced to brave the watery environment with their bodies: "We'd walk in the swamp, sometimes it'd get up to your chest in water . . . [and] bring the equipment that we need [in the pirogue]."[419] Given the weight and fragility of geophysical equipment, the work that men were doing in the swamps often required even more intimate encounters with mud and muck.

Overall, the soggy in-betweenness of southern Louisiana tended to dramatically slow the pace of geophysical prospecting. Where a drier environment might allow a seismic crew to shoot fifteen to eighteen holes per day, Houston Lejeune remembers that two or three was considered a good day's work in a "real bad swamp."[420] Robert P. Clark, writing for *Oil & Gas Journal* claimed that working in swamp and marsh meant that geophysical exploration was "a matter not of shots per day, but of days per shot."[421] Although operations in open water could carry their own challenges, even those were far superior to working in the treacherous, in-between worlds of flotant and choked cypress swamp. Morris Pyle observed that while shooting onshore in the swamps and marshes "might take you a month, they do it in a day out there [in open water]."[422] Amphibious terrain not only exacerbated the physical labor of enclosing wetland oil, it also thwarted the rate at which data about the invisible underground could be gathered.

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[419] Interview with Nelson Constant, July 23, 2001, conducted by Diane Austin, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[420] Interview with Houston Lejeune, March 22, 2004, conducted by Jamie Christy, item 271, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[421] Clark, "Geophysical Generalities," 150.

[422] Interview with Morris Pyle, August 7, 2002, conducted by Steven Wiltz and David DiTucci, item 361, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

Additionally, new developments in the geophysics started requiring crews to get even muddier. New seismographic methods offered more precision and promised to reveal more deeply seated salt domes. But they also required closer-spaced shot points and recording instruments, forcing geophysical workers to negotiate even more intimately and intensively with the watery terrain. In order to better trace the contours of the deltaic underground, prospectors ended up in chest-deep water and muck more frequently than ever.[423]

In southern Louisiana, "there were no roads in the marshes, no bridges over the bayous, no bases from which to move out into the bays . . . [it] was a sort of nature's no-man's land, neither land nor sea."[424] Geophysical workers, and later drill men, roustabouts, roughnecks, and pipeliners all worked to reveal, enclose, and produce wetland oil encountered an unpredictable, shifting, and seemingly disordered deltaic landscape. The stories presented here defined the textures and affects of several decades of development in Louisiana's wetland petroleum frontier. Men working in Louisiana's wetland oil industry continued to experience disorder and uncertainty in the watery environment long after the salt dome exploration bonanza of the later 1920s, and under many circumstances besides seismic exploration. In oral histories and trade journals, the industry's fieldworkers narrated their encounters with a floating place, neither land, nor water, but some promiscuous mixture of the two. This was amphibious terrain. But with abundant oil-bearing salt domes discovered in *terra anfíbia*, how would industry go about making those domes productive? Most importantly, how, amid the shifting deltaic environment, would oil companies maintain stable, reliable connections between the wells drilled in those domes and the voracious refineries and energy markets that industry aspired to feed?

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[423] Owen, *Trek of the Oil Finders*, 796.

[424] "Nature's no man's land" in Raymond Lankford, "History of Marine Drilling," in *History of Oil Well Drilling*, ed. John Edward Brantly (Houston: Gulf Publishing, 1971), 1358–1444, 1379.

Extracting Wetland Oil

While geophysical exploration had made the petro-underground of Louisiana's marshy coast legible, oil companies still needed some way of ascertaining property in this in-between environment of land and water. Political malfeasance around leasing state lands combined with prevailing attitudes toward the economic potential of wetlands to ensure that the size of early oil and gas leases on the coast were enormous. Euro-American prejudice against wetland environments meant that many who were unfamiliar with the trapping resources of the region believed Louisiana's coastal margins were a waste offering little potential for economic development. From the mid-1920s through the mid-1930s some parcels reached as large as 500,000 acres, with average lease size peaking at 90,000 acres in 1928. In some cases, oil and gas leases were granted for large water areas like Terrebonne and Barataria Bay without even setting clear boundaries or specific acreage.[425] As just one example of the kind of vast territory being opened for exploration and drilling, the Louisiana Land and Exploration Company's assets in 1927 included two million acres of coastal wetlands compiled from a combination of lease and fee lands.[426] In 1941, the State Mineral Board—formed five years prior to combat corruption and confusion surrounding these allocations—imposed a 5,000-acre limit on leases. But even with these new limits in place, huge acreages of coastal wetlands went to oil and gas companies, just simply in more fragmented form. The late 1940s, for example, saw approximately 1.25 million

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[425] Dianne M. Lindstedt et al., *History of Oil and Gas Development in Coastal Louisiana* (Baton Rouge: Louisiana Geological Survey, 1991), 33, 39-41.

[426] For more on the Louisiana Land and Exploration Company, see: Owen, *Trek of the Oil Finders*, 760-761.

total acres leased in the coastal zone.[427] Once wetland oil had been delineated from the invisible underground, oil companies rushed to establish property rights at the surface that would guarantee access to the new petroleum resource frontier.

With the underground made not only legible, but also transferable, industry now had to go about the material work of making it accessible. After all, this was still a "nature's no man's land" that, being "neither land nor sea," offered very little in the way of existing infrastructure.[428] The in-between ecologies of Louisiana's coastal wetlands had posed significant challenges for the geophysical explorers locating and identifying oilfields.[429] Similarly, the delta's shifting amphibious terrain proved no less challenging when it came time to produce and extract wetland oil. In order to develop a reliable petroleum frontier, oil and gas companies not only needed to drill productive long-term wells in the coastal wetlands, they also had to maintain a steady supply from those wells. As such, industry needed to create stable, long-term connections between oilfields and the broader petroleum production, transportation, and distribution network. The challenge, then, would be to build such a stable extractive infrastructure in an unstable deltaic landscape. Extracting petroleum from the relentless wateriness of the delta would drive a

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[427] Lindstedt et al., *History of Oil and Gas Development in Coastal Louisiana*, 33, 39-41. On the challenges of drawing property lines around unruly (and, in this case, watery) nature, see: Theodore Steinberg, *Slide Mountain, Or, The Folly of Owning Nature* (Berkeley: University of California Press, 1995).

[428] Quotes from: Lankford, "History of Marine Drilling," 1379.

[429] Those challenges to exploration produced several innovations. Environmental constraints forced crews to maximize the data gathered from each seismic detonation, while difficulties in traversing marsh and swamp led to lighter, more durable equipment. Clark, "Geophysical Generalities"; Hamil, "Portable Equipment." The marsh buggy, described as an "auto-tractor-boat in one," was fitted with oversize wheels made from wood, metal, or rubber and allowed explorers to travel across the soft watery landscape and even sometimes open water. Flude, "Exploring in Marsh and Water Areas"; "Auto-Boat-Tractor In One Aids in Oil Exploration," *National Petroleum News*, December 23, 1936, 52-54. On the trapper origins of the marsh buggy and further details of the technology, see: Randall A. Detro, "Transportation in Difficult Terrain: The Development of the Marsh Buggy," *Geoscience and Man* vol. 19 (1978): 93-99.

series of technological and infrastructural innovations in the oil and gas industry that ultimately reconfigured the coastal wetlands (and with disastrous consequences).[430]

Perhaps unsurprisingly, the first efforts to create stable infrastructure in the wetland petroleum frontier involved building on any existing dry land and fabricating more solid ground where there was none. Any slivers and patches of firm ground found in the coastal wetlands came highly valued and inspired new infrastructural forms, including ultra-compact shipbuilding and other fabrication facilities.[431] Almost any pre-existing communities bordering the marshes became important headquarters for at least some kind of petroleum-related operation. As for the rest of the watery coast, oil companies used wooden pilings and matting foundations to produce some semblance of firm land, allowing companies to erect drilling rigs and elevated structures including storage tanks, treatment plants, offices, and walkways.[432] The wood used in both pilings and mat foundations, meanwhile, was often treated with creosote in order to ward off naval shipworms (*Teredo navalis*), a saltwater species of mollusk specialized to bore through

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[430] The technological and infrastructural adaptations that emerged from extracting petroleum in Louisiana's coastal wetlands became central to the industry's later move offshore. Jason Theriot's history of oil and gas in Louisiana reveals the precise innovations petroleum companies undertook as they attempted to create a new resource frontier in a thoroughly disordered—at least from the perspective of industry—landscape. In so doing, they produced the technological capacity, confidence, and economic foundations that would allow the industry to grow beyond the continental shelf. Wetland oil and gas development would also later serve as intermediary infrastructure between open-water and deep-water drilling operations and petroleum processing and distribution networks further inland. Theriot, *American Energy, Imperiled Coast*.

[431] United States Fish and Wildlife Service, *Mississippi Deltaic Plain Region Ecological Characterization: A Socioeconanic Study*, by Douglas K. Larson et al., New Orleans, United States Fish and Wildlife Service, 1980 (FWS/CBS-79/05), 23.

[432] Williams, "Drilling for Oil in a World to Itself"; "Interesting Treating Plant Installation," *Petroleum Engineer*, April 3, 1932, 109; Neil Williams, "Sweet Lake Field in Coastal Louisiana is Good Example of Maritime Drilling Operations," *Oil & Gas Journal*, vol. 32, no. 48 (19 April 1934): 15-16; Neil Williams, "Laying Oil Line from Lafitte Field is More Than Ordinary Undertaking," *Oil & Gas Journal*, vol. 34, no. 37 (30 January 1936): 39; H.L. Scott, "Production Problems in Water Areas in South Louisiana," *Oil & Gas Journal* vol. 51, no. 6 (16 June 1952): 222-228.

wood.[433] Much like the raised camps and rail-skidding operations of the cypress industry, the first forays into producing wetland oil involved technologies and structures that were meant to render *terra anfibia* more like *terra firma*.

Perhaps one of the most labor-intensive of these efforts to solidify the landscape were board roads. Just as geophysical teams found themselves working in swamp and marsh far from the open water of Louisiana's bays and bayous, many new oil fields were located a considerable distance from existing waterways. Board roads provided some of the earliest access and transportation infrastructure for drilling sites located far from both artificial canals and natural waterways. Tools, drilling equipment, and of course all of the materials to build foundations for a drill site's various structures were trucked in on plank roads either elevated a few feet above areas of shallow water or laid on matting foundations across spongy marshland. Building such roads was far from either easy or economical. In the mid-1930s a crew of forty men labored for two months in Shell's swampy Gibson field to build a board road from over a half-million board-feet of lumber and a thousand pilings.[434] Oftentimes, oil companies even built board roads atop quivering mats of flotant. Here, road-builders had to be careful not to pierce the floating mats of vegetation, lest the entire road be swallowed by the oozing muck that lay below. Even then, a heavy load might disturb the road's flotant base, plunging both the truck and the infrastructure it drove on into several feet of slimy liquid.[435] Humans were not the only ones to cause failures in board-road infrastructure. Muskrats, native to the flotant environment, were constantly chewing

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[433] G.L. McBride, "Submergible Barges for Gulf Coast Drilling," *World Petroleum*, May 1936, 246-248, 247. That the oil industry did not use bald cypress for such infrastructure is perhaps testimony to the concurrent decline of the lumber industry.

[434] Theriot, *American Energy, Imperiled Coast*, 19-20.

[435] Williams, "Gulf Coast Transportation Problems," 138; "Swamp Baby . . . Shell's Newest Oil Field Lies Deep in a Louisiana Bayou," *Shell News*, July 1937.

through the marshy vegetation and could create weak spots in a road's floating base where none had previously existed. If the road failed, whether during construction, under heavy use, or because of muskrats, then a crew of at least twenty men would be sent out into the marsh to cut out the damaged mats of grass and create open water (Figure 3-4). The repaired segment of road would then be built atop pilings fixed to a matting foundation resting on the water bottom.[436] Flotant road repair crews not infrequently plunged into the marshy soup as they attempted to reorganize grass, ooze, and water into an approximation of firm ground.

Figure 3-4: Building a new board road after the previous one had collapsed in the marsh, c. 1942. Image from: Gordon B. Nicholson, "Road Construction in Swamps Presents Difficulties." Photo used with permission.

Building and maintaining timber-based infrastructure to approximate solid land, however, began to look like a significant long-term challenge for industry. Not only did teredo worms and muskrats threaten to undermine the integrity of board roads, drilling rigs, and elevated structures, but this infrastructure was also costly and labor-intensive, especially when wells did not prove lucrative. Shell's board road in the swamps only provided the company with access to an oilfield. Drilling individual wells and then producing oil from those wells would require the creation of still more *terra firma*. Every well site needed its own spur road. Every rig erected to drill a well

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[436] Gordon B. Nicholson, "Road Construction in Swamps Presents Difficulties."

required several hundred more pilings as well as ten days to erect (and another week to break down if the well failed to produce).[437] Most critically, the majority of oilfields lay so far into the wetlands that they were well beyond the practicable and economical reach of a board road. Griff Lee, once a manager at one of the foremost dredging operations associated with the oil and gas industry, described the shortcomings of such infrastructure: [it] couldn't go very far and it couldn't go in very severe conditions. That could only go into the marginal—somewhere between land and water. But when it got out into the real marsh or swamp, a board road wouldn't do. To build a timber trussel [*sic*] out there would be just too expensive."[438] Since building *terra firma* was proving untenable, industry began looking at other options for stabilizing the delta's amphibious terrain.

Since the beginnings of the industry, oil companies had taken advantage of natural water routes and pre-existing canal transportation networks. In 1929, a trade article observed that existing bayous, bays, and other forms of open water offered an ideal transportation medium with "advantages over inland operations as there need be no delays on account of muddy roads or lack of roads. The waterways are always there and passable by boat."[439] A few decades into the industry's operations in Louisiana's coastal wetlands, one commenter observed that "the very terrain which presents the problems, however, also contributes to the transportation solution. Southern Louisiana is interlaced with a network of canals and bayous."[440] Industry began looking

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[437] McBride, "Submergible Barges."

[438] Interview with Griff Lee, October 17, 1998, conducted by Joseph Pratt, University of Houston Special Collections. I found this interview and quote thanks to Jason Theriot, *American Energy, Imperiled Coast*, 20.

[439] Williams, "Drilling for Oil in a World to Itself," 40.

[440] Larry F. Resen, "Swamps, Bays, Marshes Mark T.G.T. Muskrat Line R.O.W.," *Oil & Gas Journal* vol. 54, no. 55 (21 May 1956): 188-190.

to the watery environment for infrastructural inspiration. "That," remarked Griff Lee, "is where the dredge canals first came."[441]

Adapting the in-between environment to water-based transportation had been a fact of life in southern Louisiana since at least European arrival and probably long before that. Geographer Donald Davis examined the use of canals in Louisiana to both facilitate travel by boat and to provide access to trapper leases going back to the 18th century. By 1936, the Gulf Intracoastal Waterway had opened in Louisiana in 1936 as part of a national program to create a safe inland shipping channel. Oil industry observers found the new waterway to be a huge boon to the rapidly growing petroleum business. Connecting several natural waterways, including the Mermenteau, Atchafalaya, and Mississippi Rivers, the new canal provided oil and gas companies with a wide, reasonably deep, stable channel through which to transport equipment, building materials, and, of course, the new flows of crude emerging from the coast's swamps, bays, and marshes.[442] The petroleum industry thus readily made use of an existing and expanding artificial canal network long in development by other industries and commercial interests. It also undoubtedly drew inspiration from the pullboat logging industry that had begun in the late 1880s. In fact, after the collapse of the cypress industry, several logging companies leased their cutover lands to oil and gas interests, managing to persist through extraction royalties, or even sometimes metamorphosing into a petroleum operation of their own.[443] Given these continuities

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[441] Interview with Griff Lee, October 17, 1998, conducted by Joseph Pratt, University of Houston Special Collections.

[442] Donald Davis, "Louisiana Canals and their Influence on Wetland Development" (Ph.D. diss., Louisiana State University, 1973); Theriot, *American Energy, Imperiled Coast*, 20-21.

[443] On continuities between the cypress and petroleum industries, see: Ervin Mancil, "An Historical Geography of Industrial Cypress Lumbering in Louisiana" (Ph.D. diss., Louisiana State University, 1972), 163, 175; Diane Austin, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 3: Morgan City's History in the Era of Oil and Gas – Perspectives of Those Who Were There* (New Orleans: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, 2008) 23, 25, 28. Mancil's dissertation also illustrates how

and the deep historical roots of canal construction in the region, it did not take much time for oil and gas companies to realize that dredging their own networks of artificial waterways was perhaps a more efficient and cost-effective means of reconfiguring and stabilizing the deltaic environment than the building of board roads.

In 1926, at the very moment of the first major wetland dome discoveries, oil companies began turning to dredgers and canals for transforming the deltaic landscape into a water-based oil-producing infrastructure.[444] As one headline in *Oil & Gas Journal* later declared: “Submerged wooded swamps and floating, sliding, and heaving marshes create problems and increase costs. Difficulties of building and maintaining fills and plank roads are met by waterways, boats and barges.”[445] While oil companies etched transportation canals across the land, industry engineers began steadily converting the suite of land-based petroleum extraction equipment into a new set of water-based technologies. The quarterboats of the pullboating era reappeared as field housing for oil workers migrating from a landscape of stilts and pilings (Figure 3-5) to a world of barges and skiffs.[446] Drilling rigs, storage tanks, pipelining equipment, and even the dredgers themselves all likewise converted to floating operations.[447] By 1933, the Texas Company (Texaco) had even developed a submersible drilling barge. Within two years a

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some cypress logging company records were ultimately transferred to oil companies, p. 141. Donald Davis has catalogued over forty lumber companies that obtained royalties from a total of over 3,000 petroleum wells. Donald Davis, *Washed Away?: The Invisible Peoples of Louisiana's Wetlands* (Lafayette, LA: University of Louisiana at Lafayette Press, 2010). The connections between Louisiana’s wetland cypress industry and the oil and gas industry also suggest something about the power of resource-dependent capital to find new frontiers for expansion.

[444] Donald Davis cites personal communication that suggests that the first petroleum-industry related canal was dredged in the Venice field in 1926: Davis, “Louisiana Canals and their Influence on Wetland Development,” 124-5. The next earliest record is from 1929, when Neil Williams describes a marshy site that required dredging of a canal: Williams, “Drilling for Oil in a World to Itself,” 40.

[445] Neil Williams, “Dredging Canals for Servicing Fields in Marsh and Swamp Districts of Louisiana,” *Oil & Gas Journal* vol. 43, no. 24 (21 October 1944): 95-96.

[446] On quarterboats, see: Williams, “Drilling for Oil in a World to Itself”; Williams, “Laying Oil Line from Lafitte Field”; Hearin, “Liquid Land.”

[447] On the conversion to water-based equipment in general, see: Theriot, *American Energy*, 22.

fleet of seven such rigs were being floated along a growing network of oilfield canals, sunk at drill sites to develop wells, and then resurfaced to be used elsewhere along the coast.[448] Just five years later in 1938, a petroleum company would excavate the very first canal ever to be dredged with equipment that was itself mounted atop a barge.[449] Building *terra firma* in the amphibious environment had given way to carving out *aqua liquida*.

Figure 3-5: A worker camp raised on stilts, c. 1929. Photo used with permission of *Oil & Gas Journal*. Neil Williams, "Drilling for Oil in a World to Itself," *Oil & Gas Journal* vol. 28, no. 31 (19 December 1929): 40.

As these technological innovations proliferated through the industry, artificial waterways rapidly spread througout the coastal wetlands. Water-based rigs and dredges opened up previously inaccessible fields to the petroleum industry and dramatically cut the costs of extracting petroleum in fields that previously would have been marked by board roads, matting foundations, and pilings. By mechanizing the process of building transportation infrastructure,

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[448] On the history of floating and submersible rigs, see: Lankford, "Marine Drilling"; McBride, "Submergible Barges."

[449] Ed McGhee and Carl Hoot, "Mighty Dredgers, Little-Known Work Horses of Coastal Drilling, Producing, Pipelining, Now 25 Years Old," *Oil & Gas Journal* vol. 61, no.9 (4 March 1963): 150-153.

dredgers also eliminated many of the large labor crews formerly needed to build board roads or drive pilings. Because there were no regulations at the time restricting canal development, industry found it convenient to dredge an individual canal for each well, thus vastly multiplying the number of new watery channels in the landscape. By the 1940s, water-adapted oil-field development had become so dominant and so cost effective that companies sometimes dredged in places where a combination of existing transportation infrastructure and more semisolid ground would have made a board road suffice.[450] As just one example of the rapid pace at which industry was reconfiguring the delta at this time, just a single company—Gulf Oil—had created 100 miles of canals along the coast by 1952.[451]

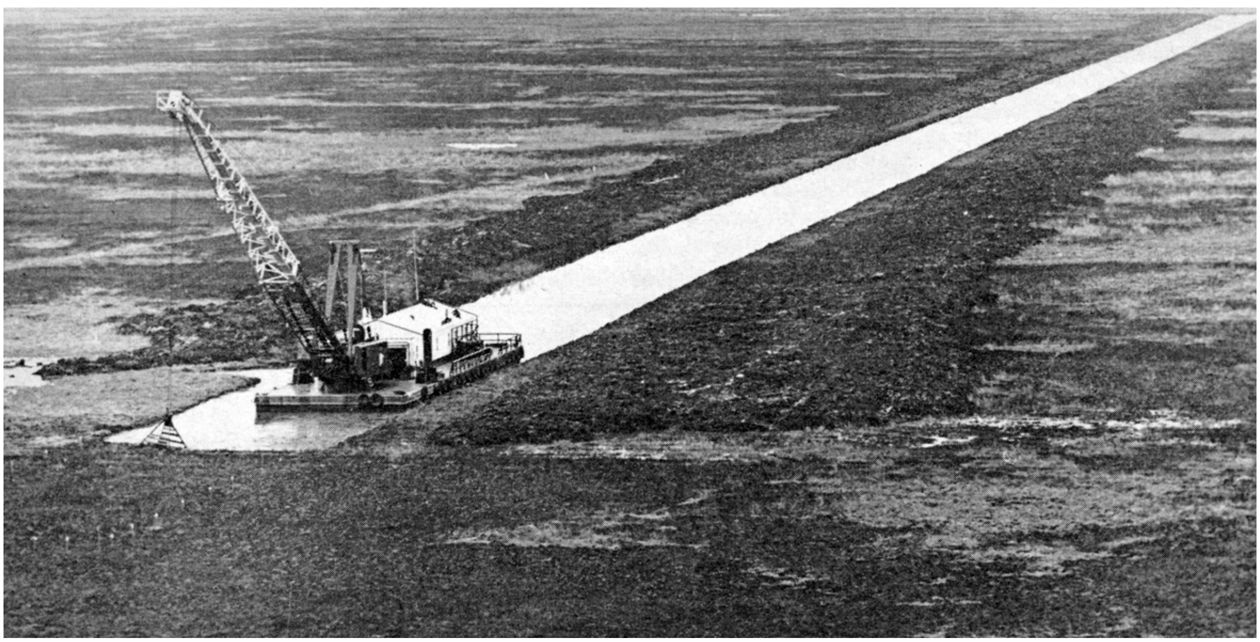

Figure 3-6: Dragline dredger excavating oil and gas canal, circa 1963. McGhee and Hoot, " Mighty Dredgers." Photo used with permission of *Oil & Gas Journal*.

[450] Theriot, *American Energy*, *Imperiled Coast*, 23-24. On the gratuitous dredging of canals, also see: Davis, "Louisiana Canals and their Influence on Wetland Development," 143.

[451] Scott, "Production Problems," 367.

In the earliest phases of the industry, when oil fields produced only a few thousand barrels of oil per day, shipping crude had actually been favored over laying pipelines.[452] But as Louisiana oilfields proliferated, production surged, and demand rapidly increased, barging crude came to make far less economic and logistical sense. Following World War II, an extensive network of large pipelines also began unfolding throughout the coast, an infrastructural operation that demanded the creation of thousands of miles of additional canals. By the close of the twentieth century, close to 10,000 miles of pipeline and transportation canals crisscrossed the wetlands of southern Louisiana, essentially reconfiguring the environment into a vast network of flowing petroleum.[453]

This new water-based infrastructure led to a variety of novel petroleum estates throughout southern Louisiana. From the Texas Company in Terrebonne Bay, to Shell in Black Bayou, to Tide Water in the Venice Field, the petroleum industry in the 1930s and 1940s developed innovative new operations and company towns in what had previously been largely inaccessible, in-between landscapes. Such towns featured floating school buses and grocery ferries, or petroleum storage facilities created from sunken tankers. Spoil banks from dredged canals were converted into foundations for housing and office buildings. Cajun marsh-dwellers combined subsistence and folk practices with their new labors as employees of the new swampy industry.[454] It was in this period that oil and gas development in Louisiana also began to make its first transitions into a fully marine environment, setting the stage for a move offshore in the following decade.

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[452] Theriot, *American Energy*, *Imperiled Coast*, 20-21.

[453] Day et al., "Restoration of the Mississippi Delta"; John W. Day Jr. et al., "Pattern and Process of Land Loss in the Mississippi Delta: A Spatial and Temporal Analysis of Wetland Habitat Change," *Estuaries* vol. 23, no. 4 (2000): 425–38

[454] Theriot, *American Energy, Imperiled Coast*, 26-31.

Over thirty years after the first dredger excavated a petroleum canal in southern Louisiana, a retrospective in *Oil & Gas Journal* observed that if it had not been for the "mighty dredgers," "a large share of the nation's oil and gas" would still be "beyond economic reach."[455] One of the most important segments of the American energy economy would not exist if not for three decades of dredging that had created a complex network of canals for exploration, transportation, production, and pipelining. A new resource frontier had connected wetland oil with American consumers.

And yet, despite all of the industry's efforts to stabilize the delta, these technological and infrastructural developments never managed to fully overcome the indeterminacy of Louisiana's watery coastal margins. Sometimes the tides made waterways too shallow, leaving barges stuck in the mud and unable to lay pipe or conduct other operations until the water rose again.[456] Heaving and sliding section of marsh could send spoil banks sliding back into newly dredged canals.[457] Changing tides, currents, and water levels in bayous and rivers could rearrange the landscape such that a canal might have to be redredged between the time a floating rig had arrived at a drill site and the moment the rig had completed its well.[458] Siltation problems sometimes arose when a marsh-based canal network was connected with open water areas like Grand Bay and West Bay. In such cases, what had been easily maintained canals in "more or less land fields" were suddenly connected to a new hydrological system that clogged the waterways

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[455] McGhee and Hoot, "Mighty Dredgers," 150. McGhee and Hoot were celebrating a 25 year anniversary for *floating* dredgers, but the first oil and gas canals were excavated about a decade prior in the late 1920s by *land-based* dredgers.

[456] "Laying Pipe in Delta Swampland," *The Petroleum Engineer*, vol. 23, no. 10 (September 1951): 40-44.

[457] Jason Theriot, "Building America's Energy Corridor: Oil & Gas Development and Louisiana's Wetlands" (Ph.D. diss. University of Houston, 2011), 60.

[458] Scott, "Production Problems," 367.

with silt and made maintenance costs "skyrocket."[459] But perhaps the greatest expression of the delta's intransigence would be its steadily increasing erosion and fragmentation. Imagining the instability of the region to be somehow durable—stable, even—the oil and gas industry's efforts to re-sort and reorder the environment had in fact been undermining the fundamentals of its deltaic morphology.

Figure 3-7: Oil and gas canals in the eroded coastal wetlands of Lafourche Parish, May 4, 2014. Photo by Jonathan Henderson, used with permission of Gulf Restoration Network.

Nature and Culture as Infrastructure

In both trade journals and historical analysis of the industry in Louisiana's coastal marshes, there's a widespread narrative of technological adaptation to a bewildering and uncertain watery environment. Oil and gas companies managed to find ways of working in the

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[459] Scott, "Production Problems," 367.

watery, in-between landscape and created technologies to make that wateriness work for them. But it is also important to emphasize that this is not just a story of adapting technology to environment, it is also one of adapting the environment to technology, a set of adaptations that would have dire consequences for the Mississippi River Delta.

Revealing this adaptive symmetry—technology to environment and environment to technology—in the oil and gas industry's activities in Louisiana suggests that the boundaries between technology and environment are fundamentally porous.[460] If technological innovation and environmental transformation are understood as two inextricable components of a single process of adaptation, it becomes harder to see the coastal crisis in Louisiana begins as simply the undesirable outcome of technological change. Rather, these environmental changes were built into industry's technological innovations on the coast from the very outset. By understanding the adaptations of Louisiana's saturated coastal environment as fundamentally necessary to the development of water-based machinery, the fragmentation of the delta ceases to be an unintended consequence, and is instead revealed as part and parcel of oil and gas development. Land loss is not the *outcome* of ill-conceived, unstable infrastructure, it *is* ill-conceived, unstable infrastructure. Petroleum operations on Louisiana's coastal resource frontier were not only the adaptation of a suite of technologies to the environment, but also of the environment to a suite of technologies, producing a kind of nature-as-infrastructure that was deeply in conflict with many of the biophysical processes previously at work in the region.[461]

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[460] Martin Reuss and Stephen H. Cutcliffe, eds., *The Illusory Boundary: Environment and Technology in History* (Charlottesville: University of Virginia Press, 2010). Also see: Richard White, *The Organic Machine* (New York: Hill and Wang, 1996); Mark Fiege, *Irrigated Eden: The Making of an Agricultural Landscape in the American West* (Seattle: University of Washington Press, 1999); Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993).

[461] Langdon Winner suggests, perhaps glibly, that some infrastructural forms do not simply have unintended political and social consequences, but that the system's political and social implications are built in from the outset.

The phrase "nature as infrastructure" comes from anthropologist Ashley Carse's reading of environmental management begun in the late 1970s to help maintain the Panama Canal.[462] Water shortages threatening to disable the system's locks and dams inspired the creation of new regional scale management practices that would guarantee the canal's water supply by preserving the ecological integrity of the surrounding drainage basin. Articulating the watershed with the rest of the Panama Canal system resulted in land-management practices, laws, and social institutions that rendered nature an intrinsic part of the infrastructure ferrying massive freight tankers betwixt the Atlantic and Pacific Oceans.

When we look for nature-as-infrastructure in southern Louisiana, when we understand the environment as having been adapted for infrastructural purposes, the comparisons become rather striking. Panamanian administrators and technocrats integrated watershed biophysical processes into canal infrastructure in ways that sought to preserve and even cultivate the forces, processes, and ecologies that constituted the watershed. In coastal Louisiana, by contrast, the petroleum industry created infrastructure that while certainly *of* nature, was not so similarly a harnessing of the forces, processes, and ecologies of deltaic wetlands. While those canals embodied a hybrid landscape of nature and infrastructure, their stability and rigidity—a necessary fact of their integration with a vast network of energy consumption—were in fundamental tension with the ecologies of Louisiana's deltaic environment. Reconfiguring and reordering the deltaic landscape into an increasingly expansive, durable, water-based petroleum infrastructure had enormous ecological consequences. Canals had converted wetlands to open water in their own right, but

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Here, I suggest we might make a similar move with the environmental consequences of some forms of infrastructure. Langdon Winner, "Do Artifacts Have Politics?," *Daedalus* vol. 109, no. 1 (1980): 121–136, 125.

[462] Ashley Carse, "Nature as Infrastructure: Making and Managing the Panama Canal Watershed," *Social Studies of Science* vol. 42, no. 4 (2012): 539–563.

they had also perforated the coastal margins, muddying and disrupting what had previously been a gently sloping gradient of saline ecologies. Saltwater from the Gulf entered these transportation and pipeline canals, devouring the more inland freshwater marshes from within. Coastal scientist Eugene Turner estimates that for every acre of dredged canal, the Louisiana coast lost five to seven acres of coastal wetlands.[463] Where environmental management in Panama had sought to preserve regional hydrological conditions in service to the Canal, the petroleum industry's efforts to reorganize amphibious terrain had created a dysfunctional deltaic environment.

The oil and gas industry, like the cypress industry that had preceded it, subsumed nature into a hybrid infrastructural landscape excellent at reliably and efficiently producing and conveying petroleum in the coastal resource frontier. But this was a natural infrastructure inimical to the dynamics of the delta, both as a landform and a continual process of sedimentation and erosion. This could no longer entirely be a place where sea is land and land is sea, where promiscuous mixtures of land and water efficiently and reliably produced *flotant* and

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[463] Turner is quoted in: WWNO, "Louisiana Last Call, Part 1," accessed July 30, 2015, http://wwno.org/post/louisiana-coast-last-call-part-one. The extent to which petroleum canals directly and indirectly contribute to land loss is still being quantified. See: Eugene Turner, *Relationship Between Canal and Levee Density and Coastal Land Loss* (Washington, D.C.: U.S. Fish and Wildlife Service, 1987); Scaife, W.W.; Turner, R.E., and Costanza, R. "Recent land loss and canal impacts in coastal Louisiana," *Environmental Management* vol. 7 (1983): 433–442; Day et al., "Restoration of the Mississippi Delta"; Olea and Coleman, "A Synoptic Examination of Causes of Land Loss in Southern Louisiana as Related to the Exploitation of Subsurface Geologic Resources"; Eugene Turner, "Discussion of: Olea, R.A. and Coleman, J.L., Jr., 2014," *Journal of Coastal Research* vol. 30, no. 6 (2014): 1330–34; Ricardo A. Olea and James M. Coleman, "Reply to: Turner, R.E., 2014. Discussion of: Olea, R.A. and Coleman, J.L., Jr., 2014," *Journal of Coastal Research* vol. 30, no. 6 (2014): 1335–37. Note that shipping and navigation canals—for the very same reasons as oil and gas canals—have also been responsible for significant erosion along the coast. Determining the primary cause of land loss at the most local scale can become an extremely challenging and variable affair. In lower Lafourche Parish around Leeville, oil and gas canals are likely most to blame. In the St. Bernard marshes outside New Orleans, however, land loss has probably been almost entirely the result of the Mississippi River-Gulf Outlet (MRGO, or "Mister Go") shipping canal. Note that coastal scientists describe that case as a "textbook example" of the kind of erosion associated with oil and gas canals: Gary Shaffer et al., "The MRGO Navigation Project: A Massive Human-Induced Environmental, Economic, and Storm Disaster, *Journal of Coastal Research* special issue no. 54 (2009): 206-224. See chapter 5 for more details on MRGO. I'm grateful for personal communication from Jason Theriot for these observations. For more on the role of navigation and shipping canals in coastal land loss, see: Shea Penland, Lynda Wayne, L.D. Britsch, S. Jeffress Williams, Andrew D. Beall, and Victoria Butterworth, "*Process Classification of Coastal Land Loss Between 1932 and 1990 in the Mississippi River Delta Plain, Southeastern Louisiana*, USGS Open-File Report 2000-418 (Reston, Va.: U.S. Geological Survey, 2000).

terra anfibia. The delta, a "land-making machine" deprived of fresh sediments and thus running on empty, had been converted largely into a machine for extracting and conveying petroleum. And, this new machine, made ineffectual at producing *flotant*, was now excellent at reliably and efficiently producing open water. While adapting technology to the marshes, the oil and gas industry also adapted the marshes to technology. Unlike Carse's case of the Panamanian watershed, the biophysical assemblages that embodied Louisiana's coastal marshes were not gently harnessed in service to oil and gas. Rather, the petroleum industry disentangled the region's soggy biophysical assemblages for its own ends, and in so doing began to unravel the sedimentary weave of the delta. The diffuse, constantly shifting, and muddy margins of the region had been stabilized into a network of hard edges.[464] And by imposing on the delta this rigid, durable order that disentangled water and land from wetland, oil and gas companies had—quite ironically—created the conditions for even more profound ecological instability.

These conversions of the landscape also drove (and were in part driven by) a set of cultural-economic transformations that served as yet another form of wetland infrastructure for the petroleum industry. One of the major ethnic groups to settle Louisiana's coastal wetlands since European arrival were the Acadians. The British expelled these French-speaking peasants

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[464] Brian Davis, "Land Making Machines," in *Making the Geologic Now: Responses to Material Conditions of Contemporary Life*, ed. Elizabeth Ellsworth and Jamie Kruse (Brooklyn: Punctum Books, 2013), 115-121. My thoughts on classification here come in part from: Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999); Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Praeger, 1966). Christopher Pastore makes some valuable observations about the important differences of fluid coastal margins and more clearly defined edges or coastlines: *Between Land and Sea: The Atlantic Coast and the Transformation of New England* (Cambridge: Harvard University Press, 2014), 6. The dysfunctional nature-as-infrastructure of southern Louisiana might also be called a broken "organic machine" after Richard White, *The Organic Machine*. On the subsumption of nature by capital, see the discussion of pullboating sets in chapter two and: William Boyd, Scott Prudham, and Rachel Schurman, "Industrial Dynamics and the Problem of Nature," *Society & Natural Resources* 14, 7 (2001): 555-570. Although I believe coastal Louisiana's oil and gas canals are in fact an example of the subsumption of nature, I emphasize the concept of "nature as infrastructure" here to distinguish between the very temporary life of pullboat runs—abandoned once a cypress forest is cutover—and the canals and pipelines that continued to support petroleum extraction for years or even decades.

from Nova Scotia (formerly Acadia) between 1755 and 1764 when they refused to swear allegiance to England. Deported and dispersed throughout the thirteen colonies, by 1764 a few hundred Acadian families had found their way to what until recently had been French Louisiana—the territory had been ceded to Spain just two years prior—to settle first along the Mississippi, and then along bayous Teche and Lafourche and elsewhere throughout the coastal margins. The Louisiana Acadians prospered in the region's wetlands and became Cajuns.[465] By the mid-nineteenth century, over 150 Cajun communities had spread throughout the wetlands. These villages were largely accessible only by water, affording a degree of isolation that preserved a distinct culture of French-speaking, Catholic hunters, trappers, and fishermen. Even by the time of oil boom of the 1930s, English was rarely spoken in Cajun communities.[466] Profoundly adapted to the in-between watery landscape, these settlements were sustained by the seasonal ebbs and flows of muskrat, waterfowl, shrimp, crabs, oysters, alligators, and fish, as well as some cypress logging and Spanish-moss gathering in the swamps. Cajuns also in part managed the landscape by digging canals, cutting hunting trails, seeding oyster beds, and engaging in other practices to maximize their harvests of each of these resources, gathering them for both subsistence and market.[467] Cajuns living for almost two centuries in Louisiana's coastal wetlands had developed a broad repertoire of skills and knowledge for inhabiting the watery

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[465] The word "Cajun" is the product of aphaeresis: Acadian→'Cadian→Cajun.

[466] The history in this paragraph was compiled from: Donald Davis, "Living on the Edge: Louisiana's Marsh, Estuary, and Barrier Island Populations," *Transactions of Gulf Coast Association of Geological Societies*, vol. 40 (1990): 147-160; Davis, "Louisiana Canals and their Influence on Wetland Development"; Edward J. Kammer, *A Socio-Economic Survey of the Marshdwellers in Four Southeastern Louisiana Parishe*s (Washington, D.C.: Catholic University of America Press, 1941); Tom McGuire, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 2: Bayou Lafourche – Oral Histories of the Oil and Gas Industry* (New Orleans: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, 2008); Woody Falgoux, *Rise of the Cajun Mariners: The Race for Big Oil* (New York: Stockard James, 2007).

[467] Davis, "Living on the Edge."

environment. For the petroleum industry, that wetland culture would prove indispensable in extracting wetland oil.

Oil and gas companies exploring and producing on the coast, however, proved highly disruptive to Louisiana's watery communities. Initially, Cajuns had little interest in working with the foreigners that came pouring in across the region. English-speaking, Protestant, rowdy, and entitled, the new Anglo-American presence irked southern Louisiana's wetland peoples. Cajuns derided them as *les maudits Texiens* (the damned Texans), no matter whether they were from Texas, Oklahoma, or even northern Louisiana. Oil companies seemed to treat the region as largely theirs to develop.[468] In his "socio-economic survey of the marshdwellers," sociologist Edward Kammer remarked on the late-1930s transformations taking place in Golden Meadow, along Bayou Lafourche:

> Because of the oil fields in the vicinity huge trucks are constantly rumbling up and down this road, while automobiles weave in and out among them. Tugs chuff up and down the bayou towing oil barges. And seldom does a day pass when an amphibian plane of one of the oil companies does not land in the bayou carrying important people on important business. The whole tempo of life has been speeded up.[469]

Over the course of the 1930s and 1940s, oil companies brought not only traffic and *maudits Texiens* to Golden Meadow, but also oil derricks, pumps, and slush pits that proliferated through town and subjected inhabitants to explosions, blowouts, and leaks as well as the pervasive smell of crude. But perhaps one upside to the oil industry's invasion of Golden Meadow was that it was also one of the few places where petroleum companies chose to pursue drilling leases with small landowners. If derricks, pumps, and slush pits were erupting across town, that also meant

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[468] Kammer, "Socioeconomic Survey," 159-161; Falgoux, *Rise of the Cajun Mariners*, 7-15.

[469] Kammer, "Socioeconomic Survey," 86.

that a host of Cajun families were poised to earn oil royalties.[470] And Golden Meadow was not the only town to be dramatically transformed by oil. Lafayette had been a small agricultural town of about 19,000 people in 1940. Within a decade, the population had almost doubled, creating a petroleum city full of new stores, restaurants, auto dealerships, theaters, and oil services. Such transformations also took place at much smaller scales throughout the coast. Petroleum companies essentially converted existing communities throughout the coast into extensions of the extractive industry.[471]

Figure 3-8: Oil and gas canals in Golden Meadow, Louisiana, September 30, 2013. Photo by Jonathan Henderson, used with permission of Gulf Restoration Network.

But such development would not have been as rapid nor as successful without the assistance of Cajun people themselves, and not just in terms of leases or property either.

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[470] Kammer, "Socioeconomic Survey," 159-161; Falgoux, *Rise of the Cajun Mariners*, 7-15.

[471] Shane K. Bernard, *The Cajuns: Americanization of a People* (Jackson: University Press of Mississippi, 2003), 37-8. For more on this history, see: Theriot, *American Energy, Imperiled* Coast, 31-41; McGuire, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 2*; Austin, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 3*; James L. Sell and Tom McGuire, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 4: Terrebonne Parish* (New Orleans: U.S. Dept. of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, 2008).

Certainly, Kammer notes the beginnings of a new leisure class in Golden Meadow and the few other places where petroleum royalties created new wealth disparities in wetland communities. But aside from granting a few leases here and there, the Cajuns became crucial to the petroleum industry because of the skills and knowledge they had developed over centuries of inhabiting the swamps and marshes of the coastal margins.[472]

As we have seen, the Texans and other foreigners to soggy southern Louisiana met profound challenges attempting to navigate the region's amphibious terrain. Of course, even wetland natives were not able to meet all the demands of the petroleum industry—in the marshiest and most unpredictable patches of the landscape, all humans were equally lost amidst the in-betweenness. But for the most part, native Cajuns were far better equipped to navigate the semi-aqueous worlds of their backyards and could serve as able guides and facilitators. Oil companies hired men who, after generations of fishing, hunting, logging, and trapping in the swamps and marshes of southern Louisiana, understood the unpredictable, seemingly unknowable nature of the landscape. Where *les maudits Texiens* lost their way in a "semiaquatic maze" or left boats entangled in ooze and grass, Cajuns could adeptly navigate, build, and repair watercraft.[473] Where the *maudits* sank to their waist or chest in muck, took fright from alligators, or grew frustrated by an apparently unmanageable environment, Cajuns "knew what type of- of grass to step on" and "wouldn't be wet above the knees."[474] For oil and gas companies, this vast

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[472] Kammer, "Socioeconomic Survey," 87.

[473] "Semiaquatic maze" from Theriot, *American Energy, Imperiled Coast*, 36.

[474] "What type of- of grass": Interview with Nelson Constant, January 13, 2005, conducted by Diane Austin and Betsy Plumb, item 100, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries. "Wouldn't be wet above the knees": Interview with Morris Pyle, August 7, 2002, conducted by Steven Wiltz and David DiTucci, item 361, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

store of knowledge, skill, and ecological intimacy offered a somewhat less tangible form of infrastructure for producing wetland oil.

From the late 1930s through the 1980s and even beyond, Cajuns were increasingly recruited as extensions of the petroleum frontier, first as shipbuilders and mariners, and then as oil workers themselves. The industry promised stable, far higher standards of living as well as tax revenues for local governments. As wetland communities saw increasing numbers of their inhabitants shift from seasonal, wetland-based commodity and subsistence trades to petroleum services, those communities began to change. Higher incomes meant many families would join the postwar consumer boom, while numerous individuals found themselves working in the wetlands under increasingly different circumstances and with a rather different relationship to the environment. As Cajuns worked for oil and gas companies, they transformed not only themselves, but also the wetlands.[475] If industry's reconfigurations of the coastal wetlands into infrastructure fundamentally were undermining the very nature of the delta, then industry's assimilation of local knowledge also fundamentally altered the nature of Cajun culture.

It is important to emphasize this was not some sort of fall from Edenic grace. Where the oil industry may have deeply romanticized Cajun lifeways as being "in perfect harmony with the setting," southern Louisiana's wetland inhabitants were no more pre-lapsarian ecological natives than pre-contact indigenous peoples had been.[476] Where pre-colonial native Louisianans had built shell mounds, burned vegetation, dug watery trails, and otherwise shaped the wetlands and

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[475] On oil industry and changes in Cajun communities and culture, see: On oil industry and changes in Cajun communities and culture, see: Bernard, *The Cajuns*; Theriot, *American Energy, Imperiled* Coast, 31-41; McGuire, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 2*; Austin, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 3*; Sell and McGuire, *History of the Offshore Oil and Gas Industry in Southern Louisiana, Volume 4*.

[476] "In perfect harmony" is from: Burns, "World of Water." Also see the depictions of Cajun life in Robert Flaherty's 1948 film, *Louisiana Story*, widely recognized as public relations for Standard Oil.

natural levees of the region for centuries, Cajuns had also manipulated the environment by cutting both small waterways (*trainasse*) for trapping and other networks of transportation canals. But if the oil industry had unleashed a flood of perforations across Louisiana's coastal wetlands, Cajun communities had simply leaked a trickle. Their transformations of the delta took place on a comparatively small scale, at a vastly slower pace and were not part of an extensive, necessarily permanent infrastructural network. Though Cajuns had etched small waterways across Louisiana's watery margins for their flat-bottomed pirogues for centuries, those alterations did not proliferate across the landscape with same rapidity, nor did those smaller waterways carry the same infrastructural heft and permanence as the canals of the oil and gas industry. Where petroleum extraction necessitated a wholesale reconfiguration of the delta's physical geography, trainasse and other small-scale rearrangements of deltaic geomorphology embodied a much more limited, comparatively ephemeral set of coastal perforations.[477]

Some Cajun interventions in the deltaic landscape could even result in land-building, rather than land loss. In 1862, an oyster fisherman named Cubit cut a small ditch for his pirogue across the natural levee along the very lowest reaches of the Mississippi in Plaquemines Parish. High water that year enlarged the channel and within five years the ditch had grown to a breach almost 2,500 feet wide and tens of feet deep. Over the next eighty years, Cubit's Gap would build over fifty square miles of new marshland into Bay Rondo, a body of water that had formerly been up to one hundred feet deep in some places (Figure 3-9).[478]

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[477] On Cajun alterations to the environment, see Davis, "Louisiana Canals and their Influence on Wetland Development"; Davis, "Living on the Edge." On Indian alterations to southern Louisiana, see: Tristram R. Kidder, "Making the City Inevitable: Native Americans and the Geography of New Orleans," in *Transforming New Orleans and Its Environs: Centuries of Change* (Pittsburgh: University of Pittsburgh Press, 2001), 9–21.

[478] Coleman, "Dynamic Changes and Processes in the Mississippi River Delta," 1003-4. Also see: Brian Davis, "Land-Making Machines."

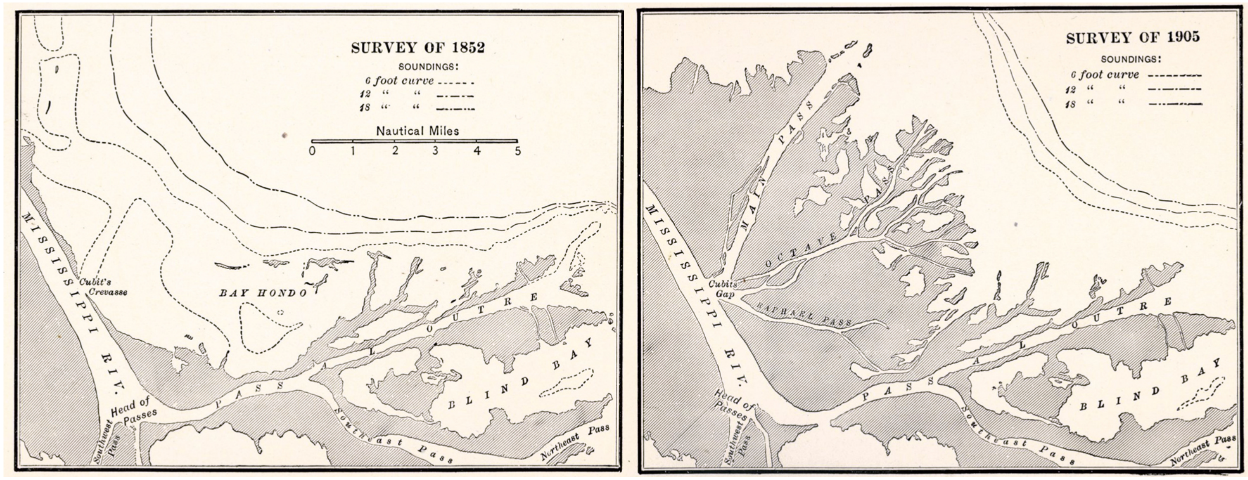

Figure 3-9: Growth of land at Cubits Gap from 1852 (left) to 1905 (right). George Rockwell Putnam, *Nautical Charts* (New York: John Wiley and Sons, 1908), 101.

These transformations of culture, society, and environment in southern Louisiana did not take place uniformly or without social struggle. Not all Cajuns immediately began working in petroleum services and even those who did sometimes maintained some sort of connection with their fishing, trapping, and hunting livelihoods. Although Robert Flaherty's 1948 film, *Louisiana Story*, imagined that both the wetlands of Louisiana and the traditional lifeways of the Cajuns could go untouched by oil extraction, communities all throughout the coast began complaining of pollution and disruption. If *Louisiana Story* presented an oil industry that had zero impact on the coast, Anthony Mann's 1953 film, *Thunder Bay*, imagined that, after a brief period of mistrust and conflict, petroleum and shrimping could coexist. This state of harmony was so perfect that drilling rigs attracted "the golden shrimp," a mythical crustacean that Mann's cinematic Cajuns had dreamed of, but never seen. In reality, however, seismic detonations, spilled and leaking crude, brine discharges, blowouts, increased traffic, and, of course, dredging for canals and pipelines served to significantly disrupt fisheries, muskrat habitat, and oyster beds. As early as the 1930s, oystermen were blaming petroleum companies for losses due to oil spills, and by the late 1950s observers recognized that the proliferation of canals throughout the coast could dramatically alter local hydrology and salinity gradients, negatively affecting oysters, fisheries, muskrats, and other natural resources.[479] While catastrophic land loss would not become a recognizable phenomenon for a few decades, conflict regularly erupted over the ways that petroleum companies, in searching for and extracting wetland oil, transformed the ecological resources that had sustained Cajun communities for centuries.[480]

Despite those struggles, increasing numbers of southern Louisiana wetland natives still found themselves working in service to the oil industry. Hired largely because they were some of the only people who understood the environment, they also tragically participated in an industry that ultimately worked to unravel the fabric of the very landscape in which they lived. Much like the way oil companies adapted the watery world to its technological innovations, industry incorporated the geographical knowledge and environmental competencies of Louisiana's Cajun residents into its extractive infrastructure. Just as industry's attempts to reconfigure the delta into stable infrastructure (ironically) created a profoundly unstable biophysical system, the local knowledge of the marshdwellers played a role in undermining the nature of the deltaic landscape. Incorporated into the extractive agenda of the petroleum industry, Cajun knowledge and culture was ultimately—and tragically—implicated in undermining the old Cajun way of life.[481]

Classifying and discussing infrastructure is, of course, an act of categorization. And in so far as categorization involves naming, selecting, omitting, and organizing, it is also an act of

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[479] On oystermen and oil damages, see: James McConnell, "Louisiana Oyster: Its Habitat and Value," *Louisiana Conservation Review* vol. 4, no. 3 (1934): 33-37; Audrey Maass, "Adapting Resilience to a New Hazard: Oil and Oysters in Coastal Louisiana," (MA Thesis, Louisiana State University, 2014). For observations in the late 1950s, see: Ivey, "Pipelining in Marsh, Swamp, and Open Water."

[480] Kammer, "Socioeconomic Survey," 160-1; Bernard, *The Cajuns*, 38; Theriot, *American Energy, Imperiled Coast*, 37-8. Theriot offers an especially good discussion about pipeline rights of way and conflict with oystermen in chapter two of *American Energy, Imperiled Coast:* pp. 53-65.

[481] While the oil and gas industry's entry into Louisiana was not explicitly a colonial project, the fact local inhabitants were incorporated into a petroleum infrastructure in ways that ultimately left no alternative still very much resembles colonialism. Compare with James Scott's analyses of state formation and wetland refuges around the world in *The Art of Not Being Governed: An Anarchist History of Upland Southeast Asia* (New Haven: Yale University Press, 2009), 25-6.

storytelling. I have told a story that suggests the canal-riddled coastal wetlands were a form of hybrid infrastructure created through adapting not just technology, but also landscape and environmental knowledge to the interests of petroleum companies. And of course, the building of infrastructure is, itself, a form of narration, of selecting and arranging technology, materials, knowledge, landscapes, and ecologies to do certain things for certain outcomes over others. In building an infrastructure to produce and convey petroleum, oil and gas companies re-narrated the landscape and its people. Finding a culture well adapted to subsisting in the watery landscape, the petroleum industry set about directing the knowledge that made such subsistence possible to facilitating a new arrangement of the environment. Confronted with the unstable "liquid land" of the delta, the industry reclassified and sorted the coastal margin's unpredictable mixtures of sediment, grass, water, and ooze into stable, separate categories bounded by hard edges. In adapting the environment to perform as infrastructure, oil and gas companies reorganized it into bits and pieces of *terra firma*—in the form of persistent infrastructure like oil wells, pipelines, routinely dredged canal beds, and the levee-like spoil banks lining canals—all articulated by *aqua liquida*. Such a "story" materializing in the coastal wetlands was fundamentally incompatible with the deltaic narrative that had created the landscape, that is, with the forces, materials, and ecologies of the delta itself. If the delta told a story of a amphibious terrain, the petroleum industry rewrote that script so as to disentangle the wet and the land from wetland, transforming shifting, porous, and muddy boundaries into hard, persistent edges.[482]

[482] On infrastructure as an act of categorization: Brian Larkin, "The Politics and Poetics of Infrastructure," *Annual Review of Anthropology* 42, no. 1 (2013): 327–343.

The Eventfulness of Dredgers and the Soggy Anthropocene

Ultimately, the petroleum infrastructure spun throughout the Louisiana coast was self-consuming. The oil industry's efforts to reconfigure and stabilize the deltaic wetlands now threaten the underlying stability of industry in the region. By so thoroughly fraying the fabric of the delta, the oil and gas industry itself is at risk of unraveling. Coastal erosion now undermines both the stability of pipelines and canals and the integrity of a crucial ecological buffer protecting the oil and gas production network from storms and waves. Nature as petroleum infrastructure in Louisiana is full of contradictions. And while many historical factors—economic, social, geological, ecological—contributed to the unfolding of land loss in relation to petroleum, one particular apparatus is most concretely responsible for the tragic consequences emerging from the petroleum industry's encounter with the delta: the dredger.[483]

As we have seen, beginning in 1926 with the excavation of the first petroleum-related canal in the Venice Field, a variety of dredging equipment spread across the Louisiana coast, reordering the wetlands to provide access to oil fields, build well sites, excavate pipeline right-of-ways, and facilitate the movement of petroleum services and transportation vessels across the landscape. As submersible and floating drill rigs worked to unveil the promise of new petroleum

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[483] My thinking here has been partly influenced by: Michael Watts, "A Tale of Two Gulfs," *American Quarterly* vol. 64, no. 3 (2012): 437-647. Watts suggests that understanding the contradictions and causal relationships between petroleum, society, and history means having a full view of the "oil assemblage." For Watts, the oil assemblage encompasses the complex intersection of everything from oil companies, financial institutions, petroleum services, and infrastructure, to carbon emissions, NGOs, regulatory structures, and extraction communities (and much, much more). He argues that by paying attention to petroleum's wider, more far-flung entanglements with the world, we gain a better understanding of what oil is and does. Most importantly, when the oil assemblage encounters the social forces at work in particular places and at particular times, we are more likely to observe the politics of oil's material presence in the world. But aside from carbon emissions, the biophysical hardly appears in Watts's conception of the oil assemblage. My insistence on following the dredger is in part due to my conviction that the biophysical matters for how we understand the consequences of oil.

wealth all throughout the coast, regardless of terrain, land-based dredgers gave way to fleets of floating machines gnawing away at the region's swamps, marshes, and shallow bays.[484]

At first, the petroleum industry used two main kinds of dredgers in the coastal wetlands: draglines (Figure 3-6) and hydraulic dredges. Draglines consisted of a crane-like boom fitted with two cables attached to a bucket, clamshell, or orange-peel excavator.[485] One cable hoisted and lowered the excavator vertically from the top of the boom. The other cable—the drag rope—pulled and released the bucket horizontally from the base of the boom. This combination of hoisting and dragging provides the force for a dragline to excavate material from the earth. The first floating draglines were built simply by anchoring a land-based machine onto the deck of a barge. Not designed to sit atop a floating vessel, however, these draglines had a comparatively short reach and often deposited spoil too close to the canal bank, resulting in collapses and slides. Under these earlier circumstances, a dragline dredge was only used to tear away the marsh surface. Once a shallow channel was cut, a hydraulic dredge was floated in to make the canal ready for actual use. Floating on water, hydraulic dredges work by scouring the bottom with a cutter attached to a long suction hose and then pumping the spoil as slurry on to a canal bank.[486] But because hydraulic dredges can only operate on open water and cannot cut canals through

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[484] Davis, "Louisiana Canals and their Influence on Wetland Development," 141-2.

[485] Orange-peel excavators are essentially clamshells with three or four jaws instead of two.

[486] Davis, "Louisiana Canals and their Influence on Wetland Development," 131-141; McGhee and Hoot, "The Mighty Dredgers"; Williams, "Dredging Canals"; Donald Cahoon and Joseph C. Holmes Jr. "Drilling Site Access," in *Onshore Oil and Gas Activities Along the Northern Gulf of Mexico Coast: A Wetland Managers Handbook*, ed. Donald Cahoon (Dallas: U.S. EPA Region 6, 1989), 25-55; Robert H. Baumann and Donald Cahoon, "Pipeline Installation," in *Onshore Oil and Gas Activities Along the Northern Gulf of Mexico Coast: A Wetland Managers Handbook*, ed. Donald Cahoon (Dallas: US EPA Region 6, 1989), 87-101. These machines have been widely used for deepening and widening harbors and other navigable waterways since 1855, when Nathaniel Lebby invented the first hydraulic dredge to deepen a new channel through Charleston Harbor. John B. Bonds, "Opening the Bar: First Dredging at Charleston, 1853-1859," *The South Carolina Historical Magazine* vol. 98, no. 3 (1997): 230-250. Today, hydraulic dredgers are one of the primary tools used to redistribute sediments in coastal restoration projects (see Chapter 5).

marsh, however, their use was limited to widening, deepening, and maintaining channels. Together, draglines and hydraulic dredgers were the first machines to reconfigure Louisiana's coastal wetlands into a working petroleum frontier.

But as technology improved, oil and gas companies would increasingly rely only on the dragline dredger, with important consequences for the Mississippi River Delta. First, newer, smaller draglines were fitted with crawler tracks, enabling them to "walk" on and off barges. These new models could then be used from atop a barge like the older draglines, or they could walk off the boat to operate in more solid marsh terrain. Second, by the late 1950s, smaller walking draglines were also mounted on large-wheeled marsh buggies. These dredged narrower canals for pipelines, saving oil and gas companies the expense of excavating full-width barge canals only to lay much narrower pipes.[487] And third, by the 1950s industry had designed larger, more powerful barge-mounted draglines that had a far greater reach than their predecessors (Figure 3-6). These could deposit spoil far enough from the canal edge to prevent the collapsing and sliding banks that had been a problem with the smaller draglines of previous decades. Altogether, these improvements not only allowed petroleum companies to operate more dredgers, deeper into the marsh, at less cost, they also—and this is crucial—almost completely eliminated the need for hydraulic dredges to deepen and widen canals.[488] The displacement of hydraulic dredging with draglines would compound the industry's perforations of the coast by dramatically altering marsh hydrology.

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[487] Davis, "Louisiana Canals and their Influence on Wetland Development," 131-141; McGhee and Hoot, "The Mighty Dredgers." Buggy-mounted draglines saved oil companies from dredging a full-width canal for pipeline-laying. Instead, the pipelining barge sat at one end of the right-of-way and pushed segments of pipe down a narrower canal dredged by a buggy-mounted dragline: Baumann and Cahoon, "Pipeline Installation."

[488] J.F. Ebdon, "Southern Natural Slushes through Louisiana Swamps," *Gas* vol. 34 (1958): 87-98; McGhee and Hoot, "The Mighty Dredgers"; Davis, "Louisiana Canals and their Influence on Wetland Development," 131-141; Cahoon and Holmes, "Drilling Site Access."

The tailpipe that deposits slurry from a hydraulic dredger was only moved periodically, creating discontinuous hillocks of spoil along a channel. The gaps in those spoil banks created fewer interruptions to the natural flow of water in a dredged area. Draglines, on the other hand, built continuous spoil banks. Acting as unintentional levees, these spoil banks compressed soils and created an imporous barrier to local hydrology both at and below the surface. Adjacent marsh often drowned in ponds of standing water as a result. And as marsh grasses died, their roots relinquished deltaic sediments, converting still more land to open water.[489]

Indeed, in many watery areas along the Louisiana coast, long lines of spoil peeking out of the water are the only suggestion that the region had once been a great deal more solid (Figure 3-10). Spoil deposited by draglines thus combined with the other ruin inflicted by coastal dredging—the direct conversion of wetlands into open-water canals, the widening of those canals through erosion, and the depredations of saltwater intrusion—to wreak havoc on Louisiana's coast. The excavator bites, the wetland gives way, a spoil bank accumulates, and the delta fragments. The subsidence and erosion of southern Louisiana, severed from the sediments that sustained it, was dramatically accelerated as draglines dredged and reconfigured the coastal wetlands into hard, stable infrastructure for the oil and gas industry.

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[489] Davis, "Louisiana Canals and their Influence on Wetland Development"; Cahoon and Holmes, "Drilling Site Access"; Turner, *Relationship Between Canal and Levee Density and Coastal Land Loss*.

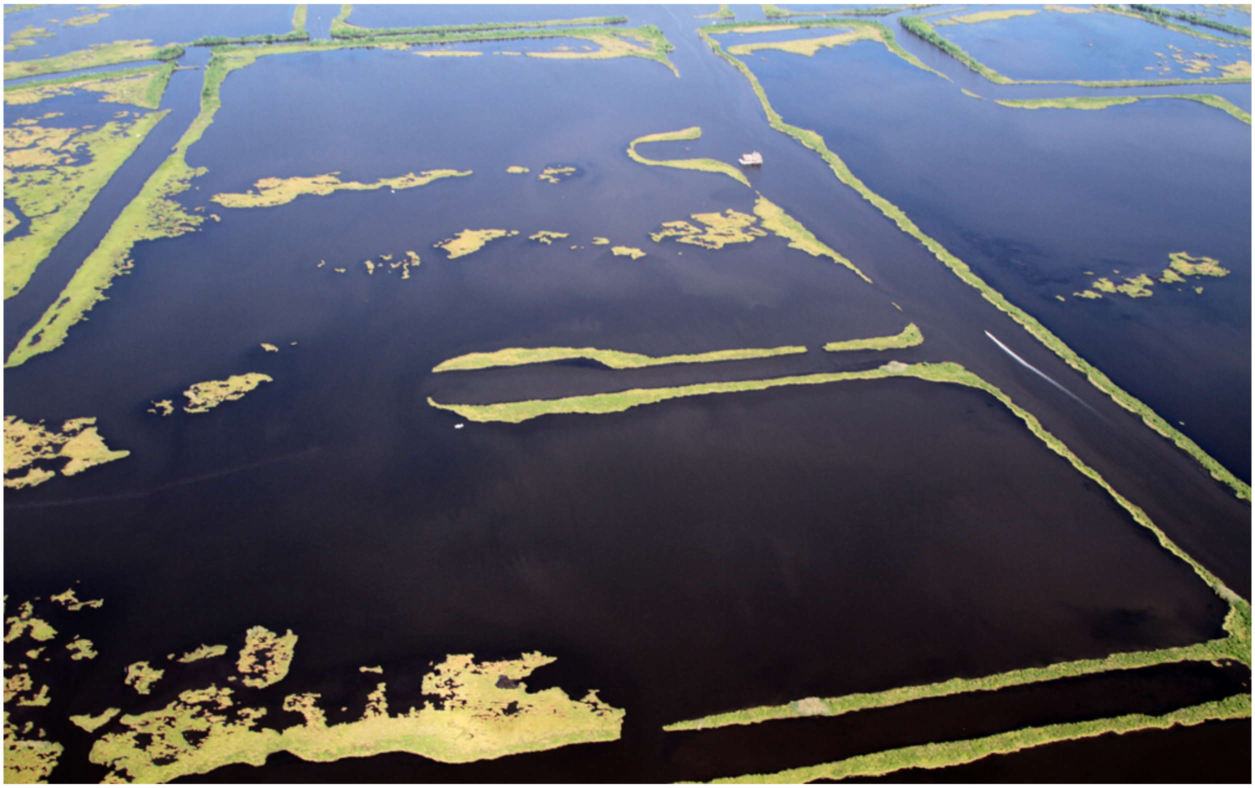

Figure 3-10: Spoil banks are almost all that remain in these Lafourche Parish coastal wetlands, May 4, 2014. Note the boats and wake for scale. Photo by Jonathan Henderson, used with permission of Gulf Restoration Network.

When the SLFPA-E filed suit in 2013, it argued: "This protective buffer took 6,000 years to form. Yet . . . it has been brought to the brink of destruction over the course of a single human lifetime."[490] Louisiana has experienced a rapid acceleration. The changes that have taken place in the delta, in large part due to the oil and gas industry, are geological in scope, and not just spatially. Geographers Bruce Braun and Sarah Whatmore, writing about the political lives of technology, argue that things like dredgers do not simply do material, meaningful work in the world, but that they are also "*eventful*." To recognize the eventfulness of technology is to recognize its potential to not only intervene in the world materially (say, by moving earth) and

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[490] Board of Commissioners of the Southeast Louisiana Flood Protection Authority—East v. Tennessee Gas Pipeline Company, LLC et al., Civil District Court For the Parish of Orleans, State of Louisiana, no. 13-6911, July 24, 2013.

meaningfully (say, by connecting marshlands with a petroleum economy), but also *temporally*.[491] Over eight decades, people collaborated with dredgers in Louisiana to stabilize the deltaic environment into a vast hybrid infrastructure that sated the demands of voracious energy consumers. Ultimately, however, that collaboration destabilized deltaic geology. Physical processes typically unfolding at a rate imperceptible to humans have erupted out of southern Louisiana's strata to become felt as a part of daily life. Jimmy Stewart, playing the role of a former naval engineer in Anthony Mann's *Thunder Bay* at one point soliloquizes:

> Maybe you don't know how oil was formed millions of years ago. It was formed by things dying and being held in the Earth. Well now, if I can reach down there, and bring up the results of all those millions of years, and make them work for the present and the future then I've done something haven't I? I'm going to put all time together.

Shot in 1953, *Thunder Bay* came at a time when Louisiana's petroleum industry was just beginning to move offshore. The impact of oil and gas canals in the coastal wetlands would not be realized for several decades, and yet Stewart still expresses a sense of the ways oil and gas infrastructure altered geology along the coast to "put all time together." In stitching the Paleocene and Eocene epochs to the present through a vast wetland petroleum frontier, the oil and gas industry completely rearranged the geography of the Louisiana coast, effectively compressing eight millennia of deltaic time into eight decades. What would normally appear to be vastly distinct, mutually unintelligible timescales—a human lifetime, a deltaic lifetime, and a petroleum lifetime—collided and became sensible all at once.

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[491] Bruce Braun and Sarah Whatmore, "The Stuff of Politics: An Introduction," in *Political Matter: Technoscience, Democracy, and Public Life*, eds. Bruce Braun and Sarah Whatmore (Minneapolis: University of Minnesota Press, 2010), xxi-xxiii. John May and Nigel Thrift have influenced my thinking on senses of time and space as well, see: Jon May and Nigel Thrift, "Introduction," in *TimeSpace: Geographies of Temporality*, eds. Jon May and Nigel Thrift (New York: Routledge, 2001), 1-46. A recent human-geography classic in this territory is: Doreen Massey, "Politics and Space/Time," *New Left Review* vol. 196 (1992): 65-84.

Today, a palpably different experience of time exists in Louisiana. Myrtle Phillips, whose family first settled Grand Bayou in Plaquemines Parish in the 1920s, recounts the slow devastation of her community as saltwater intrusion, erosion, and subsidence have rendered the landscape unrecognizable in her lifetime:

> At one point and time before I was ever born it was all fresh water . . . eventually the salt water came in and killed, there were cypress trees on both sides of the bayou and all they've got now is the stumps. When the tide goes real low you can see the stumps. And these were humongous trees. And to grow a cypress tree now I planted I think six of 'em, two of them grew for a little while and eventually when a tap root hit the salt water they died out. . . . Well the land, the water comes up too high now, the land is sinking . . . you have nothing to stop it from going down into the water it just washes and eventually it'll sink. . . . Just Friday I had about two and half foot of water in my yard. And that's unusual for this time of year. Summertime is when we expect the high tides. But now we getting it in the winter, the times have changed.[492]

Whitney Dardar, a fisherman and Houma Indian resident of Golden Meadow recounts similar changes to his hometown:

> Right across the bayou here, there used to be land. We used to set some traps there. Now, the water is all the way to the road. In the front there, they used to have a bunch of houses. They used to plant big gardens. . . . That is all water. That is how much it has been eaten up since I've been here and it is still being eaten up.[493]

Ancient deltaic and sedimentary geology becomes part of lived experience on the Louisiana coast, with all sorts of effects and affects, both barely noticed and deeply sensed. The imperceptible tilt of one's floor today becomes a whole community lost at sea tomorrow. Carmen, a resident of South Terrebonne Parish cautions: "Never take it for granted that the land

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[492] Interview with Myrtle and Maurice Phillips, February 25, 2003, conducted by Diane Austin, item 347, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries.

[493] Interview with Whitney Dardar, July 14, 2002, conducted by Diane Austin and Tom McGuire, item 119, series 7: Energy Development, Houston History Project, 1996-2008, University of Houston Libraries. Whitney Dardar and Myrtle Phillips's testimonies about the experience of land loss are just a few out of hundreds that emerged in interviews conducted as part of a multi-volume study history of the oil and gas industry in southern Louisiana. Commissioned by the (infamous) Minerals Management Service in 2001, the study included over 450 interviews, creating a massive body of oral history on energy development in the region. Of these, over 35 explicitly address the issue of coastal erosion, subsidence, and the watery transformations of the landscape.

you are on will always be there. Never take it for granted. It disappears in an instant."[494] Hundreds of such testimonials have been recorded in oral histories gathered from coastal communities throughout the coast beginning at the turn of the twenty-first century—even before Hurricane Katrina struck.[495] The encounter between the oil industry and the shifting uncertainties of the delta ultimately created a new sensibility of time and space. Geologic timescales in the Mississippi River Delta have become acutely felt over the course of a human generation.

By reconfiguring the soggy coastal margins of southern Louisiana, dredgers not only interrupted the permeable flows and mixtures of amphibious terrain, they also redrew the boundaries around epochs, millennia, and decades. Interwoven and entangled, these timescales came to be experienced in such a way that had disrupted the sedimentary layering of the geological past, thrusting ancient prehistory into the present, and even beyond into the future. By piercing the impermeable stratigraphic traps and cap rocks associated with salt domes, oil and gas companies ultimately "put all time together." Nature as infrastructure, assembled by dredgers, reorganized not just the delta's space, but also its time. Deltaic abandonment, a physical process typically unfolding as a trickle of environmental change across thousands of years, became a flood.

These disruptions of both space and time are hardly unique, however, for they are one among many expressions of the Anthropocene. The unofficial epoch in which human

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[494] Quote from Carmen found in: David M. Burley, *Losing Ground: Identity and Land Loss in Coastal Louisiana* (Jackson: University Press of Mississippi, 2010), 58.

[495] Joining the dozens of land-loss related interviews from the Minerals Management Service, are over 100 interviews on the subject conducted by David Burley for his book *Losing Ground*. In addition, the Louisiana Sea Grant worked with Louisiana high school students to gather several interviews on land loss, community, and identity for a Coastal Change Oral Histories Project. It was completed in October 2014: accessed June 8, 2016, http://www.lib.lsu.edu/oralhistory/collections/lasg. Finally, at least two independent documentary films have emerged on the topic of land loss, particularly as it affects Houma Indian communities on the Louisiana coast: *My Louisiana Love* (2012) and *Can't Stop The Water* (2013).

transformations of the planet have come to outpace physical processes, the Anthropocene is also sometimes described as the "Great Acceleration."[496] A few centuries of human activity have rivaled the long, ponderous processes that unfolded across the earth over millions—or even billions—of years. For example, petroleum—a resource produced at time scales, temperatures and pressures that, in the words of geographer Gavin Bridge, are "not replicable by society"—gets consumed at staggeringly rapid rates.[497] In one year, humans devour a quantity of petroleum and coal equivalent to four-hundred years' worth of *all* biomass—including plants, animals, and microorganisms—living on the planet that has been fossilized over an additional tens of millions of years.[498] Land loss is similarly a manifestation of the Great Acceleration. In fact, it is doubly so, since the fragmentation of the Mississippi River Delta has unfolded not just as a consequence of dredging, but also leveeing. As we saw in chapter one, humans worked as geological agents to

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[496] The ecologist Eugene Stoermer coined the term "Anthropocene" in the 1980s, but it did not begin to take on a more widespread appeal until atmospheric chemist Paul Crutzen began popularizing it in the early 2000s. By the second decade of the 21st century, the notion of a geological epoch defined by human activity seemed to have captured both scholarly and public imaginations. The Anthropocene has now come to occupy a shorthand for everything from pervasive anthropogenic environmental collapse to the complex hybridities of social nature. Note that the term as of yet has no formal scientific meaning, but the International Commission on Stratigraphy will consider formalizing it as a geologic category in 2016. Importantly, there is some dispute as to *when* the Anthropocene began, see: Dana Luciano, "The Inhuman Anthropocene," *Avidly*, March 22, 2015, accessed April 12, 2015, http://avidly.lareviewofbooks.org/2015/03/22/the-inhuman-anthropocene/. For more on the Anthropocene, its history, its significance for the humanities and social sciences, and its various deployments, see: Will Steffen, Paul J. Crutzen, and John R. McNeil, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?," *Ambio: A Journal of the Human Environment*, vol. 36 (2007): 614–21; Will Steffen, Jacques Grinevald, Paul J. Crutzen, and John R. McNeill, "The Anthropocene: Conceptual and Historical Perspectives," *Philosophical Transactions of the Royal Society A* vol. 369 (2011): 842-867; Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry*, vol. 35 (2009): 197–222; Paul Robbins and Sarah Moore, "Ecological Anxiety Disorder: Diagnosing the Politics of the Anthropocene," *Cultural Geographies* vol. 20, no. 1 (2013): 3-19; J.K. Gibson-Graham, "A Feminist Project of Belonging for the Anthropocene," *Gender, Place, and Culture* vol. 18, no.1 (2011): 1-21; Emma Marris, Peter Kareiva, Joseph Mascaro, and Erle C. Ellis, "Hope in the Age of Man," *New York Times*, December 7, 2011. On the unfortunately anthropocentric character of the Anthropocene category, see: Eileen Crist, "On the Poverty of Our Nomenclature," *Environmental Humanities* 3 (2013): 129-147. Note "The Great Acceleration," which was once occasionally used to describe the rapid social and political changes unfolding since the Enlightenment has now become synonymous with the rapid pace of anthropogenic ecological changed signified by the Anthropocene. Compare usage between: J.M. Roberts, *History of the World* (New York: Alfred A. Knopf, 1976) and Steffen et al., "The Anthropocene."

[497] Bridge, "Acts of Enclosure," 74.

[498] Jeffrey S. Dukes, "Burning Buried Sunshine: Human Consumption of Ancient Solar Energy," *Climatic Change* vol. 61 (November, 2003): 33-41.

reconfigure a continental-scale sediment delivery system. By erecting massive, continuous, imporous levees along the Mississippi, people ensured that almost no new land-building material reached the vast majority of the Louisiana coast. Flood protection infrastructure served to arrest a geologic process that was eight thousand years in the making. Having largely halted the sedimentary process of land-building, humans then began perforating the arrested delta with an extensive, decades-long project of dredging. Having halted the loom that weaves Louisiana's coastline, humans set about unraveling the very fabric of the landscape that remained.[499]

A Place Out of Space and Time

Land loss marks a very particular environmental catastrophe unfolding where land and water meet. The forces of subsidence and erosion locally driving land loss in southern Louisiana put the region at the forefront, or perhaps somewhere beyond the forefront, of a much more global phenomenon. Rising sea levels and a string of disastrous twenty-first century hurricanes—Katrina, Rita, Gustav, Isaac—all suggest deeply tragic watery futures for this landscape. A 2014 announcement from the National Oceanic and Atmospheric Administration revealed that, between the combined forces of subsidence and sea-level rise, Grand Isle had lost 1.32 inches of elevation since 2009. Areas of coastal Louisiana like Grand Isle are succumbing to the sea at a

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[499] In fact, in the age of the Anthropocene, humans have become an order of magnitude more significant in the movement of sediment across the globe than the sum of all other physical processes. Land loss on the Louisiana coast is the result of the combined effects of two such geologic-scale sediment reorganization projects. Roger Leb. Hooke, "On the History of Humans as Geomorphic Agents," *Geology* vol. 28, no. 9 (2000): 843-846; Wilkinson, "Humans as Geologic Agents: A Deep-Time Perspective," *Geology* vol. 33, no. 3 (2005): 161-164; Syvitski et al., "Impact of Humans on the Flux of Terrestrial Sediment to the Global Coastal Ocean," *Science* vol. 308, no. 5720 (2005): 376-380. My thinking on sediment, dredge, and the Anthropocene has been influenced in part by the Dredge Research Collaborative: accessed July 30, 2015, http://dredgeresearchcollaborative.org.

rate four times faster than the nation's other coastlines.[500] As essayist Nathaniel Rich observed in 2014, "Since 2011, the National Oceanic and Atmospheric Administration has delisted more than 30 place names from Plaquemines Parish alone. English Bay, Bay Jacquin, Cyprien Bay, Skipjack Bay and Bay Crapaud have merged like soap bubbles into a single amorphous body of water."[501] In a fragmenting delta set amidst a steadily rising, increasingly turbulent ocean, the places that give southern Louisiana human meaning—whether homes and communities, favorite hunting and fishing grounds, or wetlands rich in oil—are ceasing to be.

The disappearance of Louisiana entails a long list of devastating consequences. As the seventh largest river delta on the planet, coastal Louisiana embodies almost forty percent of the brackish and saltwater marsh of the United States. In the context of present-day land loss, this high proportion of the nation's wetlands means that Louisiana experiences some of the most profound wetland degradation in the country, with up to ninety percent of US coastal wetland erosion taking place in the state. This has enormous cascading ecological consequences for the region's biodiversity, migratory waterfowl, hunting and trapping, and both wild and commercial fisheries.[502] Sources of freshwater grow ever more imperiled by saltwater intrusion. Coastal communities find themselves increasingly adrift as the sea laps at roads, doorsteps, and

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[500] On Grand Isle subsidence: Bob Marshall, "New Measurements Show Sea Level Rise Swallowing Grand Isle at Record Rate," *The Lens*, May 7, 2014, accessed May 8, 2014, http://thelensnola.org/2014/05/07/grand-isle-sinking-rapidly-and-so-is-metro-areas-storm-surge-barrier/.

[501] Rich, "The Most Ambitious Environmental Lawsuit Ever."

[502] For statistic; DNR 1997; Brown pelicans, bald eagles, and nine other threatened or endangered species call Louisiana's sodden coast their home. For those just passing through, the coastal marshes provide a crucial winter rest stop for millions of ducks, geese, and other birds migrating along the Mississippi Flyway. At the peak of spring migration, 24 million birds will pass through Louisiana each day. Louisiana's coastal wildlife also hold enormous consumer value for humans. Over forty percent of furs and skins harvested in the United States comes from Louisiana's muskrat and alligator populations. A quarter of the nation's seafood also comes from Louisiana waters, with anywhere from half to three quarters of commercial species dependent on wetland ecologies at some point in their lifecycle (to say nothing of non-commercial species). See: State of Louisiana Department of Natural Resources, *Louisiana Coastal Wetlands Preservation Plan* (Baton Rouge: Department of Natural Resources, 1997); Couvillion et al., *Land Area Change in Coastal Louisiana*; State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan*.

landmarks. And, ironically, land loss even poses a grave threat to the oil and gas industry itself. As wetlands degrade into open ocean, pipelines and wells struggle to retain footing amidst a rising, surging Gulf. For Phil Turnipseed, the director of the USGS National Wetlands Research Center, land loss is thus "the greatest environmental, economic and cultural tragedy on the North American continent."[503]

But despite the acuteness of this ecological, social, cultural, and even industrial tragedy, land loss appears to be a persistently invisible phenomenon for those living outside Louisiana. Up until a spate of reporting in 2014,[504] Mike Tidwell's *Bayou Farewell* was perhaps the most well-known, sustained engagement with coastal erosion in the region.[505] Written for a broad audience, Tidwell's account of the disappearing Louisiana coast was published in 2003. But even though it came out well before Katrina, Tidwell's book hardly managed to raise the national profile of land loss as a sustained, ongoing calamity. Ecocritic Stephanie LeMenager notes, for

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[503] Turnipseed quoted in Gabrielle Bodin and Jennifer LaVista, "USGS Flyover Shows Storm Damage and Marsh Dieback," USGS News, September 11, 2012, accessed January 26, 2015, http://www.usgs.gov/newsroom/article_pf.asp?ID=3398.

[504] On Point Radio, "New Orleans: On Point Live! American Coastline — The View From Louisiana," *On Point*, January 24, 2014, http://onpoint.wbur.org/2014/01/24/on-point-live-new-orleans; Stephanie Garlock, "Louisiana's Coastline Is Disappearing Too Quickly for Mappers to Keep Up," *CityLab*, March 4, 2014, http://www.theatlanticcities.com/technology/2014/03/louisianas-coastline-disappearing-too-quickly-mappers-keep/8544/; Bob Marshall, Brian Jacobs, and Al Shaw, "Losing Ground," *ProPublica*, accessed January 29, 2015, http://projects.propublica.org/louisiana/; Bob Marshall, Al Shaw, and Brian Jacobs, "Louisiana's Moon Shot," *ProPublica*, accessed January 29, 2015, https://projects.propublica.org/larestoration/; Anderson, "Louisiana Loses Its Boot"; Nathaniel Rich, "Louisiana Has a Wild Plan to Save Itself from Global Warming," *The New Republic*, September 30, 2014, http://www.newrepublic.com/article/119585/plaquemines-louisiana-environmental-disaster-land-vanishing; Nathaniel Rich, "The Most Ambitious Environmental Lawsuit Ever"; Suzanne Goldenberg, "Lost Louisiana: The Race to Reclaim Vanished Land Back from the Sea," *The Guardian*, October 14, 2014, http://www.theguardian.com/environment/2014/oct/14/lost-louisiana-the-race-to-reclaim-vanished-land-back-from-the-sea; Omar El Akkad, "That Sinking Feeling: Louisiana Is Embroiled in a Battle between Prosperity and the Planet's Well-Being," *The Globe and Mail*, October 17, 2014, http://www.theglobeandmail.com/news/world/that-sinking-feeling-louisiana-is-embroiled-in-a-battle-between-prosperity-and-the-planets-well-being/article21153862/. Longtime New Orleans reporter Bob Marshall has been writing about land loss for thirty years, and yet only very recently has his work (and the work of others) gained much notice beyond the borders of the state. Marshall and his collaborators won the 2015 Edward R. Murrow award for "Losing Ground."

[505] Mike Tidwell, *Bayou Farewell: The Rich Life and Tragic Death of Louisiana's Cajun Coast* (New York: Pantheon Books, 2003).

example, that Tidwell's newspaper columns on the subject were usually relegated to the travel section. She interprets this invisibility as evidence that Louisiana has fallen out of the territorial imagination of the United States.[506] More precisely, however, I believe that the indistinct boundaries of southern Louisiana's amphibious terrain make a phenomenon like land loss especially difficult to grasp for anyone unfamiliar with (and perhaps uninterested in) the watery landscape. It is not so much that Louisiana has fallen out of the nation's territorial imagination, but rather that the nation imagines Louisiana as otherworldly.[507]

But the occlusion of land loss is not just spatial. I would also suggest that the strange temporalities produced by a dredged and ragged coast also contribute to the invisibility of Louisiana's coastal crisis. Dredgers effectively compressed geological time in their unraveling of the delta, and yet at the same time land loss has still unfolded at a vastly slower rate than the events we typically classify as natural disasters: flood, hurricane, earthquake, and so on. That combination of fast and slow creates a kind of temporal in-betweenness that thwarts perceptibility. Although it represents an acceleration of geologic time, the fragmentation of the delta proceeded quietly, displacing communities even as they were stranded in place. As

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[506] LeMenager, *Living Oil*, 108-109.

[507] The in-betweenness of both Louisiana's wetland environment and its cultural gumbo have often become romantic fodder for the rest of the country's exotic fantasies. For much of the United States, southern Louisiana thus becomes a place imagined out of space. Benh Zeitlin's 2012 film *Beasts of the Southern Wild* is one of the few cultural works depicting subsidence and land loss that has reached a wide audience. And yet, ironically, the story Zeitlin tells actually reproduces the geographical obscurity that makes land loss invisible in the first place. *Beasts* depicts a flooded community called "The Bathtub" that lies completely outside the society, institutions, and culture of the rest of coastal Louisiana, all of which happens to be safely tucked behind a levee. The film's aesthetic is a combination of vaudeville, Romany, and magical-realist tropes that caricature southern Louisiana's notoriously quirky place on the edge of the continental shelf. That visual style amplifies the ways that *Beasts* essentially romanticizes precarity. Squalor, inundation, and grief are depicted not as unalloyed tragedies, but as a way out of modernity and the awful future we have created for the planet. In Zeitlin's film, land loss—aestheticized and romanticized—happens somewhere "out there" in the realm of fantasy, rather than to the millions of people inhabiting New Orleans and the rest of the Gulf Coast. Note, however, that the film was met with substantial praise. Brief references to land loss also appear in HBO's 2014 crime drama *True Detective*. Here still, however, the landscape is represented as an exotic world apart, steeped in pagan criminality and sexual deviance.

described in the testimonies of Myrtle Phillips, Whitney Dardar, and countless others, people's homes and communities have become unrecognizable, unfamiliar, and—increasingly—uninhabitable. But with the disaster having unfolded on such slow, invisible terms, residents have also been robbed of the wealth that might once have been attached to their land and homes. Without property to sell, they have been left stranded in place, materially unequipped to relocate until perhaps the very last moment of destruction.[508] The cliché of a frog slowly boiling on the stove is thus particularly apt: society at large is only beginning to perceive land loss almost at the point at which it becomes too late to do anything about it.

Land loss also leaves the margins of the Gulf Coast in a strange kind of climate future that only serves to make the phenomenon even more unnoticeable. Since southern Louisiana is currently experiencing a world of watery risk that other, wealthier and more powerful areas of the United States are yet to confront, the region's troubles receive far less consideration. For example, the devastation Sandy visited on the American northeast in 2012, focused far more attention on coastal vulnerability than had decades of coastal erosion in Louisiana. As an imaginative category fraught with uncertainty, "the future" occludes Louisiana's environmental struggles at the vanguard of climate collapse. Land loss has in part gone unnoticed for so long by the rest of the country in part because of the kind of landscape in which it unfolded. The instability and uncertainty of amphibious terrain lends itself to a certain kind of invisibility. But

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[508] New Orleans journalist Bob Marshall observes that unless further land loss is arrested (and hopefully reversed), displacement from southern Louisiana's eroding margins could result in the largest permanent migration in the nation's history: WWNO, "Louisiana Last Call, Part 1." For statistics on outmigration—driven in part by increased vulnerability and the pressures of rising insurance premiums—see: George Hobor, Allison Plyer, and Ben Horwitz, *The Coastal Index, April 2014* (New Orleans: The Data Center, 2014), 17. My thoughts here have been importantly influenced by ecocritic Rob Nixon's *Slow Violence*. He asks, "What are the repercussions of having mineral belongings that literally undermine a community or society's capacity to belong? And what forces turn belongings…. into evil powers that alienate people from the very elements that have sustained them, environmentally and culturally, as all that seemed solid melts into liquid tailings, oil spills, and plumes of toxic air?" Or, in Louisiana's case: as all that seemed solid melts into open water. Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011), 69.

it also seems as if the temporal uncertainties of land loss also help obscure the phenomenon from view. The mixing of fast and slow, the uncannily gradual displacement of a people in place, and the cognitive dissonance of a distant climate future unfolding so immediately in the present altogether suggest that the invisibility of land loss is as much a temporal phenomenon as a spatial one. When time ceases to behave with as much linear predictability, it too lends itself to a certain kind of invisibility.

Humans have both occupied and transformed southern Louisiana's saturated deltaic landscapes for thousands of years, indeed, since those landscapes first began extending into the Gulf.[509] But as Europeans began colonizing the region in the early eighteenth century, the scale of that occupation and transformation increased dramatically. For almost three hundred years, most Euro-American settlers in the region constructed all sorts of deeply entangled physical and conceptual boundaries to inhabit, make sense of, and otherwise render productive an amphibious environment fundamentally defined by unpredictable flows of water, sediment, and muck.

Wetland oil was just one of the many categories to emerge from that history, a category that, in collaboration with human beings, resulted in widespread social and ecological consequences. Over more than two centuries, petroleum came into being in the Louisiana Gulf Coast in a variety of forms, from "stone pitch" and whale oil, to medicine, and ultimately to

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[509] On prehistoric inhabitation of deltas, see: J. Budel, "Deltas: Basis of Culture and Civilization," in *Scientific Problems of the Humid Tropical Zone Deltas and Their Implications* (Paris: UNESCO, 1966), 295–300; J. W. Day, Jr. et al., "Emergence of Complex Societies after Sea Level Stabilized," *Eos, Transactions, American Geophysical Union* 88, no. 15 (2007): 169–70; Douglas J. Kennett and James P. Kennett, "Early State Formation in Southern Mesopotamia: Sea Levels, Shorelines, and Climate Change," *Journal of Island and Coastal Archeology* 1, no. 1 (2006): 67–99; Daniel J. Stanley and Andrew G. Warne, "Holocene Sea-Level Change and Early Human Utilization of Deltas," *Geological Society of America Today* 7, no. 12 (1997): 1–7. On the Mississippi River Delta in particular, see: Mark A. Rees, *Archaeology of Louisiana* (Baton Rouge: LSU Press, 2010); Tristram R. Kidder, "Making the City Inevitable: Native Americans and the Geography of New Orleans," in *Transforming New Orleans and Its Environs: Centuries of Change* (Pittsburgh: University of Pittsburgh Press, 2001), 9–21.

wetland oil. Once oil had been discerned in the coastal marshes, the petroleum industry embarked on a geophysical quest to discover the invisible contours of wetland oil's geology amidst a relentlessly in-between landscape.

This coming-into-being of wetland oil spurred the opening of an entirely new resource frontier that, somewhat like the cypress frontier before it, saw industry convert wild nature into an extension of the resource-extraction apparatus. But where cypress logging was a generally short-lived process, oil and gas extraction depended on stable, durable infrastructure in the coastal marshes. Amphibious terrain and deltaic dynamism could hardly support such extractive infrastructure. Instead, petroleum companies would deploy dredgers to reconfigure and stabilize the environment into a vast network of rigid industrial waterways.

In perforating Louisiana's deltaic wetlands to produce an extractive nature-as-infrastructure on the resource frontier, dredgers subsumed watery nature into the workings of the petroleum industry. Imposing hard edges on the shifting deltaic environment, oil and gas companies dissolved the muddy coastal margins dividing dry land and open ocean. Wetland oil, geophysical surveys, and nature-as-infrastructure were all forms of bounding, categorizing, and ordering the seemingly disordered environment. Ultimately, however, the petroleum industry's efforts to rationalize and reform the delta resulted only in even more profound disorder.

By destabilizing the Mississippi River Delta, the interventions of the oil and gas industry dramatically accelerated geological time. What ensued was an environmental disaster that created a new experience of time on Louisiana's coast. Simultaneously rapid (from a geological standpoint) and slow (compared with other disasters), land loss in the Mississippi River Delta became a strangely imperceptible crisis affecting the Gulf Coast of the United States.

Though it has long gone unnoticed by much of the rest of the nation, the territory that has eroded into the Gulf of Mexico over the last eight decades was a significant portion of Louisiana's deltaic landscape. Today, the people, plants, and wildlife of southern Louisiana inhabit a world of accelerated and acute climate risk. Amphibious terrain has been rendered fully otherwise. The inhabitants of this sinking, eroding, soggy environment—whether human or not—are increasingly forced to straddle the hard boundary between land and sea where once they were cushioned by a shifting, soggy margin. This edgy hybrid space, fashioned partly by America's largest river, by levees, and by dredgers, lies somewhere between environment and technology, geologic past and apocalyptic future.[510]

As the petroleum industry evolved in the coastal wetlands, it soon began turning its attention to the next frontier off the continental shelf. Soon after the close of World War II, oil and gas companies began applying the knowledge gained and technologies developed in the deltaic margins to the problem of deep-water drilling on the open ocean. Around the same period, and all the way in the upper reaches of the delta, a new industrial corridor was developing by virtue of the region's abundant water and petroleum resources. Oil refineries established in Baton Rouge and New Orleans in the 1910s and 1920s were, by the 1950s, being joined by a string of new refineries and petrochemical facilities. Over the ensuing decades, this new chemical corridor in Louisiana would permeate both the environment and the bodies inhabiting it with toxic risk. Land loss would not be the only environmental catastrophe to emerge from the interplay of brittle human boundaries and a watery deltaic landscape.

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[510] Note that dredgers have also become an important piece of technology in *restoring* the coast. For more, see chapter 5. When standing in New Orleans, one is occupying a fossil landscape in the making, for it is the urban developments of subsiding deltaic and estuarine environments—Dhaka, Bangladesh; Amsterdam; Venice; Ho Chi Minh City—that are most likely to be found preserved in sediments for alien geologists arriving millions of years hence to ponder. On fossilized cities: Jan Zalaziewicz, *The Earth After Us* (New York: Oxford University Press, 2008), 165-172.

Chapter 4: The Leaking Landscape

Long before Interstate 10 connected Baton Rouge and New Orleans, one of the chief land-based thoroughfares in southern Louisiana was the river road that wound along the banks of the Mississippi. Offering an alternative to water transportation, the river road connected the region's sugar and rice plantations. Today, it is celebrated as an important part of Louisiana heritage with books, websites, and tours devoted to the striking mansions and grounds of famed sites like Oak Alley Plantation. Yet anyone who drives along the river road's hundred or so miles will find it hard to ignore some conspicuous features of the landscape looming alongside the remnants of Louisiana's "white-pillared past."[511] Imposing levees dozens of feet high completely hide the river from view. The sprawling sugarcane fields that once enriched the river road's mighty plantations are a good deal smaller and fewer than Louisiana history would suggest. Instead, they're often squeezed on two sides by the sprawling petrochemical complexes now lining the river, complete with belching stacks, tangled pipes, and mysterious towers. And, finally, amongst the sugar fields and the chemical plants, one will find small, predominantly African American hamlets marked by striking poverty. This is seemingly a landscape of contrasts. A road named for an invisible river connects the opulence and majesty of plantation heritage with unsightly industry and profound inequality. And yet these apparent contradictions are deeply intertwined, sharing a history that produced a landscape of raced and classed environmental exposure in Louisiana.

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[511] On the river road, see: Mary Ann Sternberg, *Along the River Road: Past and Present on Louisiana's Historic Byway* (Baton Rouge: Louisiana State University Press, 2001). "White-pillared past" is from: Steven Hoelscher, "The White-Pillared Past: Landscapes of Memory and Race in the American South," in *Landscape and Race in the United States*, edited by Richard Schein (New York: Routledge, 2006), 39–72

At first glance, the petrochemicals of Louisiana's industrial corridor might appear to have little in common with the rice flumes, pullboats, and floating dredgers that have been the technological protagonists of the story so far. Impermeable levees and a perforated coast both point toward the crisis of subsidence and erosion currently unraveling the fabric of the Mississippi River Delta. Even the hundred-year old scars of the pullboating industry at least gesture at some of the reconfigurations of the delta that have left the region fragmenting into the Gulf. Indeed, the values, practices, and technologies surrounding flood protection, pullboating, and petroleum extraction all figured directly in attempts to resolve and stabilize the ambiguities of Louisiana's wetland environment. The petrochemical landscape, by contrast, lies along a stretch of the Mississippi that begins just north of Baton Rouge, considerably inland of the canals that perforated Louisiana's disappearing coastal wetlands. The petrochemicals manufactured in Louisiana's riparian industrial corridor are neither a technology designed to negotiate the region's saturated landscapes, nor a resource to be extracted from the watery environment; altogether, they reveal comparatively little about the tragic land loss afflicting Louisiana's coast.

But if we were to focus *only* on land loss as a crisis of boundary-making in the Mississippi River Delta, we would miss some very important lessons about the ways nature often thwarts the brittleness of human categories. In fact, petrochemicals are a part of this story precisely because they remind us that the phenomena we have witnessed so far—struggles over perforated levees, efforts to reconfigure swamps, the consequences of transforming deltaic nature into hard infrastructure—can unfold not just out in the sodden landscapes of southern Louisiana, but also much closer to home. Petrochemicals, produced through hydrocarbon cracking processes arrayed in vast complexes lining the Mississippi River, put people's bodies at the center of this history of permeability.

The deltaic plain stretches all the way inland to just north of Baton Rouge, encompassing the entirety of the riparian industrial landscape. The residents of industrial corridor thus inhabit a remnant of the flat, flood-dependent environment. Though leveeing and reclamation had, by the mid-twentieth century, essentially stabilized this stretch of once-amphibious terrain, it remains a landscape that is highly saturated, built in part from highly porous sands, and often quite permeable to whatever might be flowing through, across, or under the surface.

Situated in this permeable environment is a vast array of petroleum refineries and petrochemical plants, all interconnected in a complex industrial network. Without too much effort, however, one can observe that this network, far from self-contained, is actually an enormous open system in which each facility is carefully managed to receive inputs and expel products and wastes. The petrochemical landscape is in fact managed for porosity. But it is a porosity that is only tenuously under careful control. Prone to accidents, negligence, and inconsistent regulation, the riparian industrial complex steadily leaks its materials throughout this remnant of amphibious terrain, permeating the environment with toxic risk.

The entanglements of the permeable landscape and a porous industry produce streams of flowing, wafting, and oozing hazards that spread out into the environment and people's communities. In the deltaic landscape of the industrial corridor, water surges from the river, through facility intakes, and back out into the region's air, soils, wetlands, and streams as contaminated liquid or vapor. These emanations can then pass through the skin, orifices, and mucous membranes of predominantly African-American residents, entangling inequality with exposure and transforming the ways people understand their bodily relationship to the environment. If watery landscapes are a very particular kind of borderland marked by fluid, permeable boundaries, then what of the permeability of the human body in those borderlands?[512]

The leaking landscapes of the chemical corridor reveal that even the edges of the human body can grow muddy in southern Louisiana. Woven into the fabric of the humid deltaic environment, people's bodies become nodes in the watershed—tiny distributaries in a delta of toxic risk that stretches tendrils not just into individuals, but whole generations. Ultimately, the blurred boundaries of Louisiana's industrial corridor—from facility and landscape to body and environment—reveal that both the space and time of the human body are neither as local, nor as finite as they might first appear. The overlooked porosities in each of those three categories—factory, landscape, and body—suggest still another crisis of brittle human boundary-making in the Mississippi River Delta.

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[512] For an extensive selection of literature on watery places, see the introduction to this dissertation. For two (of the very few) examples of permeable bodies intersecting with watery landscapes, see: Conevery Bolton Valenčius, *The Health of the Country: How American Settlers Understood Themselves and Their Land* (New York: Basic Books, 2002), 133-158 and the preface to Nancy Langston, *Toxic Bodies: Hormone Disruptors and the Legacy of DES* (New Haven: Yale University Press, 2010), vii-viii. The question of permeable, watery bodies in watery environments is especially pertinent to a place like Louisiana's industrial corridor; the environmental historian Linda Nash has observed that, it is ironically in our most industrialized landscapes that the most "ecological"—that is, the most environmentally permeable—understandings of human bodies emerge. Linda Nash, *Inescapable Ecologies: A History of Environment, Disease, and Knowledge* (Berkeley: University of California Press, 2006), 210. For other scholarship on the permeable body, see: Emily Martin, "Fluid Bodies, Managed Nature," in *Remaking Reality: Nature at the Millenium*, edited by Bruce Braun and Noel Castree (London: Routledge, 1998), 64–83; Gregg Mitman, Michelle Murphy, and Christopher Sellers, eds., *Landscapes of Exposure: Knowledge and Illness in Modern Environments* (Chicago: University of Chicago Press, 2004); Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty: Environmental Politics, Technoscience, and Women Workers* (Durham, NC: Duke University Press, 2006); Gregg Mitman, *Breathing Space: How Allergies Shape Our Lives and Landscapes* (New Haven: Yale University Press, 2007); Charles E. Rosenberg, "Epilogue: Airs, Waters, Places. A Status Report," *Bulletin of the History of Medicine* vol. 86, no. 4 (2012): 661–670. Ecocritic Rob Nixon explores the way novelist Indra Singha's fictional character Animal—disfigured in utero by the Bhopal chemical disaster—represents not only the blurred boundaries between human bodies and the environment, but also the porous boundaries between our conceptions of the human and nonhuman: Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA: Harvard University Press, 2011), 55-6.

The Making of a Porous Industry

Petrochemical[513] industrialization of the lower Mississippi River between Baton Rouge and New Orleans began in 1909 with the arrival of Standard Oil's refinery and an insecticide plant, both just outside Louisiana's state capital.[514] Development slowed during the Depression, but by the next decade, demand for wartime materials like aluminum oxide, synthetic rubbers, fuels, lubricants and other petrochemicals drove the expansion of existing plants as well as the creation of new facilities. Following World War II, several factors encouraged still more rapid industrial development along the river. Postwar consumer demand conspired with a steadily growing supply of petroleum, salt, and sulphur emanating from the Gulf coast to create a general boom in chemical production.[515] Labor unrest in the Texas petrochemical industry, meanwhile, frequently pushed companies to Louisiana just as tax exemptions and lax pollution regulations

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[513] As the word suggests, petrochemicals are produced today using chemicals refined from petroleum. But that was not always the case. Up until the first decades of the twentieth century, early plastics and other commercial chemicals were produced from coal tar or other feedstocks completely unrelated to petroleum, such as calcium carbide for the production of acetylene. Standard Oil in New Jersey produced the first propylene through petroleum refining in 1917. By the 1930s companies like Union Carbide, Shell, and Dow Chemical had begun producing a host of chemicals from petroleum instead of coal tar or calcium carbide: ethylene, ammonia, ketones, and styrenes. Petrochemicals were in fact a particularly American invention; it was not until the 1950s that European chemical companies at last made the decisive turn away from coal feedstocks. Louisiana's first oil refineries came on stream in an era when petroleum had just been used to produce fuels and lubricants. But as the American petrochemical industry developed into the 1940s, those first facilities became central nodes in the region's chemical production network. Peter Spitz, "The Rise of Petrochemicals," *Chemical Week*, August 2, 1989, 24-32.

[514] For more of the history recounted in this paragraph, see: Robert Nance McMichael, "Plant Location Factors in the Petrochemical Industry in Louisiana" (Ph.D. diss., Louisiana State University, 1961); Raymond Edgar Shanafelt, "The Baton Rouge - New Orleans Petrochemical Industrial Region: A Functional Region Study" (Ph.D. diss., Louisiana State University, 1977), 456-459; Craig Colten, "Making a Lemon Out of Lemonade: The Transformation of Louisiana's Petrochemical Corridor," in *Energy Capitals*, edited by Martin V. Melosi and Joseph Pratt (Pittsburgh, PA: University of Pittsburgh Press, 2014), 58–76; Craig Colten, "An Incomplete Solution: Oil and Water in Louisiana," *Journal of American History* vol. 99, no. 1 (2012): 91–99.

[515] Although oil and gas used in Louisiana's petrochemical industry comes from a variety of sources, a significant share comes from petroleum extracted on the Gulf Coast. Shanafelt, "The Baton Rouge - New Orleans Petrochemical Industrial Region," 177-180 describes pipeline connections between the corridor and Gulf Coast fields in the 1970s.

drew companies in.[516] By the early 1960s, Louisiana's industrial corridor had become part of a much larger petrochemical region—the "Golden Crescent"—that stretched in an arc along the entire Gulf Coast.[517] A 1957 article from *Chemical Week* noted (exaggerating some) that almost a hundred different petrochemical companies had migrated to this "bastion of the Mississippi," including petroleum refineries, chlorine-alkali plants, synthetic rubber works, acid producers, ethylene-based chemical manufactures, natural-gas-based chemical manufacturers, and aluminum plants.[518] In 1958, output had been valued at close to $600 million (or about $5 billion in today's dollars), a tenfold increase from prewar production.[519] Fifty years later, approximately 150 petrochemical plants would line the Mississippi between Baton Rouge and New Orleans.[520] Today, Louisiana is second in the nation for chemical production after Texas.[521]

But these political-economic factors contributing to the rise of Louisiana's petrochemical industry tell only half the story. The state's refining and chemical production capacity ultimately concentrated in the riparian corridor between Baton Rouge and New Orleans because of the river itself. For one, the river's geography also provided a key transportation amenity for refineries and chemical plants. Lying at the foot of a vast watershed, the Baton Rouge-New Orleans

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[516] On labor unrest: Gerald E. Markowitz and David Rosner, *Deceit and Denial: The Deadly Politics of Industrial Pollution* (Berkeley, CA: University of California Press, 2002), 239-240. On tax exemptions: Colten, "Making a Lemon," 87. On regulation: Colten, "An Incomplete Solution," 96-7. In 1940, Louisiana created the Stream Control Commission to oversee water pollution from spills and waste disposal, but often the office seemed to serve more as a rubber stamp for industry's self-regulation than as an actual enforcement agency. For example, after a 1960 accident that tainted New Orleans drinking water with phenols, the state placed the burden of safety on water-supply operators and refrained from penalizing those responsible for the spills.

[517] McMichael, "Plant Location Factors," 2.

[518] "Wellspring of Louisiana's Chemical Boom," *Chemical Week*, December 7, 1957, 59-68

[519] McMichael, "Plant Location Factors," 5.

[520] Randy Peterson, *Giants on the River: A Story of Chemistry and the Industrial Development on the Lower Mississippi River Corridor* (Baton Rouge, LA: Homesite Co., 2000).

[521] Ryan Noonan, "Made in America: Chemicals," US Department of Commerce, 2011, accessed July 30, 2015, http://www.esa.gov/sites/default/files/chemical-manufacturing-industry-profile.pdf.

industrial corridor was perfectly positioned to take advantage of the enormous water-based transportation network offered by the river and its tributaries. Even more important, however, was the immense flow of water that the Mississippi offered industry for both production and—at least for the first few decades after the war—waste disposal. Petroleum refining and chemical cracking are hugely water-intensive and the Mississippi provided an essentially unlimited source of process water. At the other end of production operations, the hundreds of thousands of cubic feet of water rushing past facilities each second seemed to offer a similarly unlimited waste sink. Essentially, the petrochemical industry functioned in large part by diverting water out of the Mississippi before returning it, albeit in a much-altered state, back to the river.[522] Central to the relationship between the petrochemical industry and the riparian environment was thus a carefully controlled exchange between river and chemical facility. Processing water flowed in, and both chemical products and chemical wastes flowed out. Products were shipped up or downstream, while wastes were disposed of in the Mississippi's turbid waters. Although petrochemical facilities and the river might superficially appear to have been distinct entities, the boundaries between the two were necessarily porous and were deliberately managed as such.

The river also indirectly attracted chemical companies to the region by having created the conditions for a prior riparian industry to flourish: plantation agriculture. Rice and sugar cultivation emerged along the river in the early eighteenth century specifically because of the water resources and transportation services the Mississippi provided. But as we saw in chapter one, sugar plantations only succeeded along these lowest stretches of the river south of Baton Rouge with considerable reorganization of the landscape. Initially undertaken by slaves and later

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[522] Barbara L. Allen, *Uneasy Alchemy: Citizens and Experts in Louisiana's Chemical Corridor Disputes* (Cambridge, MA: MIT Press, 2003); Colten, "Making a Lemon."

through state and federal investment, the leveeing and draining of the riparian corridor had made permanent settlement and agriculture along the river possible. By the early decades of the twentieth century, however, competition from both domestic sugar beets and international cane growers drove down sugar prices, sending the Louisiana sugar industry into a second decline. In the mid-nineteenth century, there had been almost 1,500 sugar mills along the river. By 1900, that number had plummeted to 300.[523] With each mill closure after World War II, a new site for industrial development became available. While spending comparatively little money, petrochemical companies could acquire large tracts of riverfront land—key for processing, waste disposal, and transportation— that had also been drained, embanked, and otherwise improved for over a century thanks to the sugar industry.[524] The new chemical industry developed in a riparian environment that had already been carefully reconfigured to prevent flood and other watery nuisances. In this stabilized corridor of the delta, chemical companies seemed almost completely in control of the timing, manner, and extent of the exchanges taking place between the Mississippi River and the production facilities that increasingly lined its banks.

Altogether, these political-economic and geographical forces led to the steady growth of industry along the river. As more facilities were built in the region, connections between plants served as still another magnet for further development, leading to marked clustering along the river. Petroleum refineries provided feedstocks—often produced as waste or byproducts—for

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[523] Technological improvements resulting in consolidation were also responsible for these declining numbers. Colten, "Making a Lemon," 59, 63-5, 67. For more on the decline of the sugar industry, see: John B. Rehder, *Delta Sugar: Louisiana's Vanishing Plantation Landscape* (Baltimore, Md.: Johns Hopkins University Press, 1999).

[524] Increasingly paid for by the federal government after the 1880s, such improvements eventually culminated in over $1.5 billion worth of flood-protection infrastructure undertaken in the three decades between the Great Flood of 1927 and 1960. On plantation economics and flood improvements, see: Colten, "Making a Lemon," 81-3. Colten also notes that while the petrochemical industry has pushed sugar cultivation away from the river and occupied many former sugar lands, sugar acreages in the region actually expanded between 1949 and 2007, suggesting that "sugarcane cultivation continues in the shadow of the petrochemical complex," p. 65.

other plants down the petrochemical production line. In addition to fuels and lubricants, refineries made the "building blocks" of chemical production, ethylene and propylene. These substances were in turn consumed by other facilities making butadiene for synthetic rubber manufacture or polyvinyl chloride (PVC) to produce plastics. Still other companies used these feedstocks to make acids for producing textiles or ammonia for producing fertilizers. This kind of interdependency would become so engrained in the industrial landscape that some companies would even purchase large tracts of land adjacent to their own plants to reserve for sale or lease to a future producer operating further down the manufacturing stream. By the late twentieth century, Louisiana's chemical corridor had developed into a network of sprawling riverside facilities, each almost guaranteed to have at least one component of its production process tied to another facility in the region.[525] These connections among petrochemical facilities embody still another genre of controlled permeability in Louisiana's industrial corridor. Connected to the river, to other facilities, to transportation infrastructure, and ultimately markets and waste disposal sites, chemical plants in Louisiana are riddled with intentionally porous boundaries.

As industry expanded in the riparian corridor, it intersected with the growing urban fringes of New Orleans and Baton Rouge and encroached well into the riparian sugar landscape. Where the original facilities established in the first decades after 1909 had been built with some kind of urban safety buffer in mind, unregulated industrial and urban development saw those safety zones begin to erode from both directions, putting facilities closer and closer to developing suburbs and preexisting rural communities in the years after World War II.[526] Those

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[525] On production chains in the industry, see: "Wellspring of Louisiana's Chemical Boom," *Chemical Week*, December 7, 1957, 59-68; Spitz, "The Rise of Petrochemicals." For details on actual linkages among plants in the 1960s, see: McMichael, "Plant Location Factors in the Petrochemical Industry in Louisiana," 77; Shanafelt, "The Baton Rouge - New Orleans Petrochemical Industrial Region," 277-364 (especially the diagrams on pp. 340-341).

[526] Colten, "An Incomplete Solution," 93.

eroding boundaries between residential communities and the chemical industrial complex would, in the ensuing decades, give rise to a growing sense of toxic risk, including increasing complaints about bad odors, water quality, and a growing unease about hazardous waste.[527] Those fears were made much more concrete on July 25th of 1978, just two weeks before President Carter declared Love Canal the first-ever national emergency caused by toxic chemicals.[528] Kirtley Jackson, a young waste worker, was dumping material at the Bayou Sorrel waste facility southwest of Baton Rouge when a chemical reaction took place. Hydrogen sulfide gas erupting out of the disposal pit swiftly killed Jackson, sparking the beginnings of a movement.[529] Residents of Louisiana's river road became increasingly concerned about the toxic threat posed by an industry that suddenly seemed to be most everyone's neighbor. When activists launched a series of high-profile actions against the BASF chemical company in the late 1980s, they had rechristened the river road's industrial corridor as "Cancer Alley."[530] With so many

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[527] On the history of early complaints concerning the petrochemical industry, including worries about major fish kills, see: Craig Colten, "Too Much of a Good Thing," in *Transforming New Orleans and Its Environs*, edited by Craig Colten (Pittsburgh: University of Pittsburgh Press, 2000), 141–159. Note that although community awareness around toxic hazards absolutely tend to be a postwar phenomenon, toxic landscapes themselves are anything but, with historical roots reaching back to the nineteenth century: Craig Colten, "Creating a Toxic Landscape: Chemical Waste Disposal Policy and Practice, 1900-1960," *Environmental History Review* vol. 18, no. 1 (1994): 85–116; Craig Colten, "Historical Hazards: The Geography of Relict Industrial Wastes," *The Professional Geographer* vol. 42, no. 2 (1990): 143–56.

[528] Clive Cookson, "The Spoiling of America," *New Scientist*, June 21, 1979, 1015-1017, 1016.

[529] Jackson's death is detailed in, among many other places: J. Timmons Roberts and Melissa M Toffolon-Weiss, *Chronicles from the Environmental Justice Frontline* (Cambridge: Cambridge University Press, 2001), 36. The story made national news through syndication as far as Florida and Chicago: D.J. Rosenbaum, "Threat of Industrial Waste Dumping Grows," *Sarasota Herald-Tribune*, August 23, 1979; D.J. Rosenbaum, "Dangers Seep into Awareness: Toxic Wastes Come Home to Roost," *Chicago Tribune*, September 9, 1979.

[530] Markowitz and Rosner, *Deceit and Denial*, 243-250. The phrase "Cancer Alley" is deeply loaded with politics, but they are more complex than might first appear: some community organizers prefer to refrain from using the label because of the ways it pathologizes the residents they are trying to assist. See: Gwen Ottinger, *Refining Expertise: How Responsible Engineers Subvert Environmental Justice Challenges* (New York: NYU Press, 2013).

apparently dangerous substances visibly entering and exiting Louisiana's chemical plants, how safe could neighboring communities possibly be?[531]

Porosity and Danger

As we have seen, the petrochemical industry is a fundamentally permeable enterprise. Far from being completely sealed off from the world, the refineries and chemical facilities of the region are constantly receiving streams of inputs and producing streams of outputs that, by nature, are almost impossible to fully contain. Indeed, petrochemical facilities are *designed* to have porous boundaries. First, plants transform the continuous stream of resource materials entering at one end into a flow of products that leaves at the other; without these flows of inputs and outputs, there would be no point to these immense plants. Second, because no chemical reaction is 100 percent efficient and because all petrochemical production involves undesired side reactions, wastes also necessarily emerge from production facilities. But there are also unintentional and uncontrolled porosities marking the industry. The reactions taking place in

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[531] Journalists, historians, sociologists, and geographers have all recounted numerous stories from Cancer Alley's front lines, including industry malfeasance, the strategies and victories of the region's environmental justice movement, and the distinctly raced politics of scientific knowledge and uncertainty around toxic exposure in Louisiana. Although conclusive evidence of harm has proved elusive in more traditional epidemiological studies, citizen science, popular epidemiology, and, at the very least, the testimonies of people's troubled bodies suggest that Louisiana's chemical corridor is, in fact, a landscape permeated with toxic risk. Robert D. Bullard, ed., *Unequal Protection: Environmental Justice and Communities of Color* (San Francisco: Sierra Club Books, 1994); James Schwab, *Deeper Shades of Green: The Rise of Blue-Collar and Minority Environmentalism in America* (San Francisco: Sierra Club Books, 1994); Roberts and Toffolon-Weiss, *Chronicles from the Environmental Justice Frontline*; Markowitz and Rosner, *Deceit and Denial*; Allen, *Uneasy Alchemy*; Hilda E. Kurtz, "Scale Frames and Counter-Scale Frames: Constructing the Problem of Environmental Injustice," *Political Geography* vol. 22, no. 8 (2003): 887–916; Steve Lerner, *Diamond: A Struggle for Environmental Justice in Louisiana's Chemical Corridor* (Cambridge, MA: MIT Press, 2005); Beverly Wright, "Living and Dying in Louisiana's 'Cancer Alley,'" in *The Quest for Environmental Justice: Human Rights and the Politics of Pollution*, edited by Robert D. Bullard (San Francisco: Sierra Club Books, 2005), 87–107; Hilda E. Kurtz, "Gender and Environmental Justice in Louisiana: Blurring the Boundaries of Public and Private Spheres," *Gender, Place & Culture* vol. 14, no. 4 (2007): 409–26; Ottinger, *Refining Expertise*. For a Cancer Alley skeptic, see: Frederic T. Billings, "Cancer Corridors and Toxic Terrors—is It Safe to Eat and Drink?," *Transactions of the American Clinical and Climatological Association* vol. 116 (2005): 115–125.

petrochemical facilities occur at extremely high temperatures and pressures, often with highly reactive substances. Even with the best efforts and intentions of industry, accidental leaks and explosions are an ever-present risk in the petrochemical landscape.[532] Feedstocks, products, wastes, and accidents define the porosities of the petrochemical facility. In each of these four categories, a plant becomes entangled with the landscape it occupies. By looking closely at a petrochemical plant, we can sometimes glean the suggestions of those entanglements.[533]

When driving past one of the many industrial complexes on Louisiana's river road, most casual observers are confronted with a bewildering maze of pipes, tanks, columns, stacks, towers, and fuming vents. But despite the overwhelming engineering complexity of the petrochemical landscape, it is still possible to read that landscape for clues about what transpires there. Where northern facilities were previously enclosed in building envelopes to moderate the effects of colder temperatures, plants in the South have, since the late 1930s, opted for something called open architecture (Figure 4-1). The milder climate of the Gulf Coast encouraged petrochemical operations in the region to "build without buildings," unveiling what had previously been the inner workings of refineries and chemical plants. While open architecture in no way makes those plants any more susceptible to leakage than a facility with a skin, it does offer outside observers some means of reading the porosities of the petrochemical industrial landscape—of seeing what goes in and, importantly, what comes out of a facility.[534]

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[532] And, as we shall see, it often seems as if those efforts and intentions are sorely lacking.

[533] The idea of "flow" here is important. As a "process" industry, petrochemical production takes place as a continuous stream, rather than in discrete batches. In fact, bringing a plant online is called bringing it "on stream."

[534] "Building *without a building*" formulation comes from Barbara Allen, "The Making of Cancer Alley: A Historical View of Louisiana's Chemical Corridor," in *Southern United States: An Environmental History*, edited by Donald Davis (Santa Barbara, CA: ABC-CLIO, 2006), 238.

Whether it is a refinery or a chemical plant further down the production line, a petrochemical facility always has a suite of infrastructures dedicated to receiving its feedstocks. Rail yards, tanker and barge docks, water intakes, and pipelines receive petroleum, sulphur, salt, minerals, petrochemical feedstocks, and, of course, water. Pipelines might be connected to either the Gulf Coast's vast petroleum extraction landscape or to other plants producing feedstocks like ethylene and benzene. Collectively this infrastructure serves as a kind of mouth for the complex metabolic process that is chemical production. And, importantly, it marks the petrochemical facility as a fundamentally permeable—albeit seemingly controlled—space.

Figure 4-1: Open architecture on display at the Baton Rouge Esso oil refinery c. 1945. Note the capsule-like reactor vessels of the cracking units at left. Photo courtesy of the National Archives and Records Administration, catalogued under identifier 535733.

A tangle of pipes, pumps, and valves then distribute petroleum or petrochemical feedstocks, water, and other minerals throughout the plant's open architecture. Although it is impossible for an observer—especially casual ones such as ourselves—to trace the flow of a particular molecule, the distinctive forms of three main kinds of processing equipment—sometimes repeated dozens of times across a single facility—offer an imperfect means of discerning the "uneasy alchemy" of petrochemical production.[535]

Feed heaters (or process heaters) bring feedstocks up to required temperatures—ranging from a few hundred degrees, Fahrenheit, to a few thousand—and have the same profile as an old stone fireplace and chimney. The hearth-like set of sloping shoulders at a feed heater's base contains a network of steel pipes through which feedstock is pumped, while the tall central stack burns off natural gas as the pipes surrounding it are heated to temperature (Figure 4-2).

Figure 4-2: A Shell refinery in Deer Park, Texas, March 16, 2012. The tallest stack with a flared base on the right is a feed heater. The two center stacks are fractional distillation columns. The white vertical capsule at the far right of the image is likely a reactor vessel of some sort. Also note the flare stack. Photo by Roy Luck, Creative Commons Attribution 2.0 Generic License.

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[535] The following tour of the petrochemical landscape comes from: Brian Hayes, *Infrastructure: A Field Guide to the Industrial Landscape* (New York: W.W. Norton, 2005), 165-177; Donald L. Burdick and William L. Leffler, *Petrochemicals in Nontechnical Language* (Tulsa: PennWell Corp., 2009).

Fractional distillation columns are perhaps the most distinctive architecture of a facility, often giving plants their characteristic skylines. These towers separate and purify chemical compounds according to differences in boiling point—the most volatile substances accumulate at the top, while the heaviest condense and trickle to the bottom (Figure 4-2).

Finally, high-pressure reactor vessels are used throughout a petrochemical facility to contain powerful chemical reactions. These structures are distinctive for their hemispherical ends—designed to withstand high pressures—that give the vessel a capsule-like appearance (Figure 4-1 and 4-2). Reactor vessels can often be seen arranged vertically in cracking and reforming units, two of the most important elements of a facility. Crackers use either extreme heat or chemical catalysts to break feedstocks into shorter-chain molecules. For example, ethane, one of the simple, light hydrocarbons produced in refining, is cracked down to ethylene, one of the basic building blocks of chemical production. Reformers use rare metals like platinum as a catalyst for re-arranging hydrocarbon chains into rings and branches—volatile high-octane liquids like benzene, toluene, and xylene.

All told, the chemical plants of Louisiana's riparian industrial corridor produce the raw materials for thousands of products, from plastics to fertilizers, textiles to food additives, insulation to tires. Each begins with a refined petroleum product that is cracked, reformed, re-cracked, and re-reformed to produce new molecules that serve as the basis for consumer society. As such, those molecules by definition must exit any given facility, sometimes only to be delivered to yet another plant down the line. The receiving infrastructure, pipes and valves, feed heaters, distillation columns, and reactor vessels of a petrochemical facility only operate because of streams of inputs and outputs. Porosity is built into the very fabric of chemical production, but industry (and regulators) will often also attest to the strict control with which those porosities are engineered, managed, and overseen.

Such tight control, however, is also frequently illusory, even when industry operates in good faith. Petroleum refining and chemical production involve, by nature, extremes of heat and pressure as well as chemical compounds that are often highly reactive and unstable. No matter how carefully managed, the intentionally porous walls of a facility—observed through flows of inputs and outputs—are intrinsically prone to accidental upheaval. Indeed, the storage infrastructure at a refinery or chemical plant suggests exactly these risks. Earthen berms from three to four feet high surround the cylindrical holding tanks used for liquid products. Often mounted with water cannons, the berms are designed to simultaneously prevent the spread of accidental fires and enclose an area calculated to hold the maximum storage volume of each tank in case of a spill. The spherical storage tanks that hold gas products under high pressure, meanwhile, are not surrounded by berms, but are instead sometimes fitted with windsocks that suggest which way to run in the event of a leak (Figure 4-3). Finally, valves and flare stacks dot a facility's landscape as testimony to a potential calamity (Figure 4-2). When plants need to be taken off-stream suddenly because of a leak, explosion, or other malfunction, this equipment allows the facility to release and burn off gases in a controlled manner. The highly unstable nature of petroleum chemistry renders the boundaries of the petrochemical landscape at constant risk of accidental rupture.

Figure 4-3: A butane tank farm at Karlsruhe refinery in Germany, June 2005. Note the windsock on the third tank from the left. Photo by Michael Kaufmann, cropped. Creative Commons Attribution 2.0 Germany License.

Reading petrochemical infrastructure for the risk of rupture does not, of course, equate to actual incidents. And yet, unfortunately, Louisiana's industrial corridor is plagued by a long history of major accidents occurring at chemical facilities. Explosions at Norco in 1979 and 1988 killed and injured several people.[536] On Christmas Eve of 1989, an Exxon refinery explosion near Baton Rouge killed one person and injured many more.[537] In 1996, an accidental release of 8,000 pounds of highly toxic ethylene dichloride, hydrogen chloride, and vinyl chloride injured several people in Geismar, Louisiana. Also in Geismar the following year, a 500,000-gallon PVC storage tank exploded, forcing the community to evacuate.[538] And in July of 2003, multiple accidents at Honeywell's Baton Rouge plant resulted in evacuations, hospitalizations, and one fatality.[539] And the list goes on. In the early 1990s, a study found that Louisiana's riparian industrial corridor had one of the highest rates of petrochemical facility explosions in the United

[536] Norco, an official place name, comes from "New Orleans Refining Company." Wright, "Living and Dying"; Colten, "Lemonade," 71.

[537] Colten, "Lemonade," 71.

[538] Allen, *Uneasy Alchemy*, 73-74.

[539] Richard Misrach and Kate Orff, *Petrochemical America* (New York: Aperture Foundation, 2012), 150.

States.[540] Two decades later, the Louisiana Bucket Brigade found that the state's seventeen refineries alone—that is, not including any chemical facilities—had reported a total of 327 accidental releases in just one year.[541] One of these, a June 2012 leak of almost 30,000 pounds of benzene at ExxonMobil's Baton Rouge plant, resulted in an EPA report that described corroded pipes, out-of-date inspections, inadequate emergency procedures, and failure to report other accidental releases.[542] A subsequent statement from the United Steelworkers union suggested these problems were not isolated just to the Baton Rouge facility, but were, in fact, industry-wide.[543] Even under the best of circumstances, the unstable flows of the petrochemical production stream are difficult to fully contain. But it appears that industry negligence also often exacerbates this risk of rupture and uncontrolled porosity.

These documents of the unstable petrochemical production metabolism suggest a particularly localized geography of risk in which accidental ruptures take place on-site at a facility. But uncontrolled and unintended porosity can also develop at any point along the production and distribution network. On September 28, 1982, a train derailed in the town of Livingston, Louisiana, about thirty miles west of Baton Rouge. Its 43 cars included tankers containing petroleum, vinyl chloride, metallic sodium, tetraethyl lead, phosphoric acid, methyl chloride, styrene, toluene diisocyanate and ethylene glycol. Almost 3,000 people were evacuated and a series of explosions, fires, and spills over succeeding days kept people from their homes

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[540] Susan Cutter and John Tiefenbacher, "Chemical Hazards in Urban America," *Urban Geography* vol. 12 (1991): 417-430.

[541] Louisiana Bucket Brigade, "Mission: Zero Accidents," November 12, 2013.

[542] Kristen Lombardi, "'Upset' Emissions: Flares in the Air, Worry on the Ground," *Center For Public Integrity*, May 21, 2013, accessed July 30, 2105, https://www.publicintegrity.org/2013/05/21/12654/upset-emissions-flares-air-worry-ground.

[543] Lauren McGaughy, "ExxonMobil Baton Rouge Safety Issues 'Prevalent Throughout Refining Sector': United Steelworkers," *Times-Picayune*, February 27, 2013.

for two weeks.[544] Similarly, on March 17, 1997, a barge carrying 400,000 gallons of pyrolysis gasoline overturned at the US 190 Mississippi River bridge in northern Baton Rouge. The pyrolysis gasoline, a byproduct of ethylene production, was on its way to be separated into aromatic hydrocarbons like benzene, toluene, and xylene. Although no one was seriously injured, fumes from the spill sickened students at nearby Southern University.[545] In these events, infrastructure designed to carefully manage the flow of petrochemicals in and out of facilities—a train and its enclosed tankers; a barge carrying sealed drums—broke down, allowing dangerous substances to breach the boundaries of the distribution network beyond any given plant.

Although a troubling number of accidents have plagued Louisiana's industrial corridor, those ruptures in the petrochemical production system are still relatively infrequent in comparison with industry's intentional, controlled (and legal) releases of hazardous substances into the environment. The branching distributaries of the refining and production stream necessarily include almost daily flows of waste—whether as trickles or floods—that must be disposed of somewhere in the landscape. Ranging from just a few percent of a facility's total output to substantially larger quantities, waste emerges from both the fundamentally imperfect nature of chemistry—undesirable side reactions, incomplete conversions—and the limited capacity of industry to make use of every single chemical it produces. Since its very beginnings along the Mississippi River, Louisiana's chemical industry has intentionally diverted streams of waste into the air, in pits and underground injection sites, and—at least historically—into the

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[544] Markowitz and Rosner, *Deceit and Denial*, 245; Reginald Stuart, "Derailment Keeps 1,500 Away From Town," *New York Times*, October 11, 1982.

[545] Peterson, *Giants on the River*, 186-7.

vast watery waste sink of the Mississippi River.[546] These embodied another set of intentional porosities built into the petrochemical production system that necessarily accompanied the streams of inputs entering facilities and the streams of products exiting them.

Although concern about water pollution in Louisiana reaches back to nineteenth-century debates over "nuisances," prior to the 1970s, regulators and citizens only rarely perceived waste in the Mississippi as an acute threat to public health.[547] The immensity of the river seemed to guarantee protection from any real harm while bad odors and unpleasant tastes in drinking water hardly seemed to pose a threat. There are two notable exceptions that prove the rule. First, in 1960, a Baton Rouge refinery spilled a large quantity of phenols—used to produce adhesives, resins, plastics, and the intermediary compounds for producing nylon—into the Mississippi, causing some panic over drinking water downstream in New Orleans. Second, poor waste disposal practices at the Velsicol chemical plant all the way upriver in Memphis, Tennessee, saw large quantities of the highly toxic chlorinated pesticide endrin cause massive fish kills downstream in Louisiana in 1963-4. Aside from these events, however, both industry and regulatory agencies put their faith in both the diluting capacity of the Mississippi and the innocuousness of chemicals so diluted.[548] It seemed for the most part as if the river could safely contain most quantities of the chemicals it received. And those chemicals only breached the river's disposal capacity to become poisons under extraordinary circumstances.[549]

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[546] The dilution power of the river was, after all, one of the primary amenities drawing industry to the corridor in the first place.

[547] On nuisances and the emergence of concern over hazardous water pollution in New Orleans, see: Craig Colten, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge: Louisiana State University Press, 2006), 47-48; 108-139.

[548] Colten, "Too Much of a Good Thing," 141–159.

[549] On people's shifting perceptions of waste and hazard, see: Mary Douglas, *Purity and Danger: An Analysis of Concepts of Pollution and Taboo* (New York: Praeger, 1966); Sarah A. Moore, "Garbage Matters Concepts in New Geographies of Waste," *Progress in Human Geography* vol. 36, no. 6 (2012): 780–799.

Passage of federal environmental legislation beginning in 1970 soon altered that arrangement. In 1972, the US Environmental Protection Agency produced a report raising grave concerns over dangerous pollution in the Mississippi River. The agency had found 42 industrial plants discharging at least five pounds of heavy metals (including lead, chromium, cadmium, and arsenic) daily into the river between St. Francisville and Venice. Seventeen plants were discharging ten or more pounds of phenols into the river each day. And another 46 organic chemicals were detectable in either the raw or treated water supplies of three water plants sampled between Baton Rouge and New Orleans. At least six of those substances were deemed capable of causing chronic toxicity in animal studies from the period.[550] Regulators at the EPA were especially anxious about the fact that just one Baton Rouge plant produced over forty different products, each with its own potential streams of byproducts and wastes: alcohols and glycols; olefins and polyolefins; chlorinated, fluorinated, and brominated hydrocarbons; synthetic rubbers and polymers; resins, plasticizers, and esters; surfactants; dyes; cyanides—the list goes on.[551] The EPA report also found that some waste streams could cause discernible odors in a flow of water *more than double* the average capacity of the Mississippi. Experimental fish placed downriver of some of the larger complexes, meanwhile, developed pronounced chemical flavors after just 72 hours of exposure to river water.[552] Finally, just two years after the EPA report, a national exposé reported the presence of carcinogenic chemicals in the New Orleans

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[550] U.S. Environmental Protection Agency, *Industrial Pollution of the Lower Mississippi River in Louisiana* (Dallas: United States Environmental Protection Agency, 1972).

[551] James Friloux, "Petrochemical Wastes as a Water Pollution Problem in the Lower Mississippi River" (Unpublished paper submitted to the Senate Subcommittee on Air and Water Pollution, April 5, 1971). Craig Colten generously shared this document with me.

[552] U.S. Environmental Protection Agency, *Industrial Pollution of the Lower Mississippi River*.

water supply, as well as a higher-than-average cancer rate for city residents.[553] The dilution potential of the river was seriously in doubt, raising anxieties that dozens upon dozens of chemical waste streams were breaching their watery confines.

Doubts about the river's ability to contain wastes would have important consequences as industry and regulators sought a new impermeable receptacle for hazardous pollution. As federal and state regulation in the 1970s increasingly restricted discharging pollution into waterways, the streams of waste pouring forth from the petrochemical corridor were diverted to land-based disposal sites. By 1987, Louisiana boasted 478 hazardous or potentially hazardous waste sites in the Superfund database.[554] Although that number has declined today to around 100, twenty-five of these are, or at one time were, listed on the Superfund National Priorities List (NPL) of sites containing the most serious pollutants.[555] Today, Louisiana is still ranked in the top five states in the nation with the highest number of land-based hazardous waste disposal sites.[556] Unfortunately, the earliest of the land-based facilities were hardly more impermeable, consisting of open pits and ponds just like the Bayou Sorrel site that killed Kirtley Jackson in July of 1978. Although regulations now require landfills like these to be capped and lined, many of the older open, and often unlined, disposal facilities persisted in the riparian landscape for decades.[557] Changing ideas about the diluting power of rivers and the nature of chemical risk had redirected Louisiana's petrochemical wastes from water to land in the hope of better containing those risks.

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[553] Colten, "An Incomplete Solution," 97-8.

[554] Joel Goldsteen, *Danger All Around: Waste Storage Crisis on the Texas and Louisiana Gulf Coast* (Austin: University of Texas Press, 1993), 121.

[555] State of Louisiana Department of Environmental Quality, "Superfund Sites," accessed July 30, 2015, http://www.deq.louisiana.gov/portal/DIVISIONS/UndergroundStorageTankandRemediationDivision/RemediationServices/SuperfundSitesinLouisiana.aspx.

[556] Goldsteen, *Danger All Around*, 122.

[557] Goldsteen, *Danger All Around*, 112-157.

Open and near-surface hazardous waste sites are but one genre of land-based toxic disposal that has taken place in Louisiana. Since the 1930s, both the petroleum extraction and refining industries have also used injection wells to dispose of wastes throughout the region. Beginning in the 1950s, chemical producers discovered that deep-well injection—at thousands of feet belowground—appeared to be a convenient way of isolating pollutants from the environment.[558] Deep-well injection is in fact generally regarded as safe because of the depths at which wastes are stored. Since the 1980s, the EPA has regulated injection wells in five classes, with a sixth for carbon dioxide sequestration added in 2010.[559] Of most concern are class I and II wells. Fifteen of Louisiana's class I wells are labeled for hazardous waste, ranking the state second to Texas's staggering 58 hazardous class I wells. Far more numerous in Louisiana are class II wells. As we saw in chapter three, the peculiarities of Gulf Coast geology have produced hundreds of salt domes throughout Louisiana. Today, those domes host about 4,000 class II wells. A dozen or so of these are used for "enhanced recovery" of oil and gas, also known as hydraulic fracturing. Mostly, though, Louisiana's class II wells bore into salt domes for either oil and natural gas storage or oil field waste disposal.[560] Reporting from *ProPublica* in 2012 revealed that disposal and storage in class II wells actually represent an enormous regulatory

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[558] Bob Kent, John Mikels, and Brad Hanson, "Hydrogeological Problems Associated with Siting Injection Wells in Southern Louisiana," *Proceedings of the Association of Ground Water Scientists and Engineers Southern Regional Ground Water Conference, September 18-19 1985, San Antonio, Texas* (1986): 129-144.

[559] United States Environmental Protection Agency, "Classes of Wells," accessed July 30, 2015, http://water.epa.gov/type/groundwater/uic/wells.cfm.

[560] Abraham Lustgarten and Krista Kjellman Schmidt, "State-by-State: Underground Injection Wells," *ProPublica*, September 20, 2012, accessed July 30, 2015, http://projects.propublica.org/graphics/underground-injection-wells. Boring in salt domes can cause other dramatic environmental hazards. In 2012, the residents of Bayou Corne discovered that a nearby brine facility had caused a massive sinkhole threatening to engulf the town. Although not a toxic risk, the sinkhole at Bayou Corne suggests that other uncontrolled porosities can pose real danger in Louisiana's industrial landscape. Tim Murphy, "Meet the Town That's Being Swallowed by a Sinkhole," *Mother Jones*, August 7, 2013. Bayou Corne is not the first catastrophic salt-dome collapse in Louisiana: the Lake Peigneur sinkhole of 1980 was so striking the *History Channel* devoted a segment to it.

loophole.[561] Because of energy industry lobbying, wastes from oil and gas production—though they might involve some very toxic chemicals—are regulated as "non-hazardous" and can be disposed of in class II wells with very few permitting regulations.[562] Huge quantities of petroleum and oilfield waste—unavoidably entangled with the petrochemical industry's supply network—have thus been stored throughout Louisiana's class II wells, but with far less oversight and far greater risk of accidental release than their class I counterparts.[563] Here, the risk of uncontrolled leaks in the disposal system emerged not just from accidents or technological failures (though certainly they play a role), but—somewhat like the case of waste disposal in the Mississippi—also partly because of the ways waste gets defined and regulated.

In fact, these complicated—and often artificial—regulatory boundaries around what constitutes hazardous waste extends beyond injection wells to surface disposal sites as well. Since March of 1994, the few hundred residents of Grand Bois, Louisiana, have struggled to win compensation for a neighboring 140-acre disposal facility for oil field waste. Receiving millions of barrels annually of brines, spill wastes, drilling mud, and other contaminated petroleum production fluids, the site processes material in open-air pits (Figure 4-4). Grand Bois residents, some of whom live just hundreds of feet from the site, say those pits produce sickening noxious fumes.[564] The material disposed of at Grand Bois includes benzene and other hydrocarbons that,

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[561] Abrahm Lustgarten and Krista Kjellman Schmidt, "The Trillion-Gallon Loophole: Lax Rules for Drillers that Inject Pollutants Into the Earth," *ProPublica*, September 20, 2012, accessed July 30, 2015, http://www.propublica.org/article/trillion-gallon-loophole-lax-rules-for-drillers-that-inject-pollutants.

[562] United States Environmental Protection Agency, *Exemption of Oil and Gas Exploration and Production Wastes from Federal Hazardous Waste Regulations* (Washington, D.C.: EPA, 2002).

[563] At least some refineries have even tried to illegally dispose of petrochemical wastes in class II wells in part because more lax regulation meant that they could get away with it. Lustgarten and Schmidt, "The Trillion-Gallon Loophole."

[564] Kevin Sack, "Louisiana Town Goes to Trial Over Waste Pit," *New York Times*, July 13, 1998. Also see the clipping archives and accompanying story at: SoLa, "Clarice and Danny Friloux," accessed July 30, 2015, http://sola2050.org/stories/clarice-and-danny-friloux/.

had they been produced at a petrochemical facility instead of from an oil well, would have fallen under waste regulations that require far stricter containment. Though these substances originated far up the petrochemical production chain—before even a refinery gets involved—they document uncontrolled leaks in the system that result not from accident or failures of infrastructure, but rather from some unstable conceptual boundaries defining risk and waste.

Figure 4-4: Grand Bois, Louisiana (left) and the neighboring waste disposal facility (right). Image courtesy of Google Earth.

Besides leaking into the water and soils of the deltaic landscape, Louisiana's porous petrochemical industry has also long relied on the air for disposing of its wastes. At the turn of the twenty-first century, Louisiana ranked second in the nation for the volume of on-site chemical releases, with much of that material being released into the air. Six of the top ten emitting facilities and six of the top ten most afflicted parishes were in the riparian corridor.[565] Airborne releases are undoubtedly the single biggest source of petrochemical waste in Louisiana

565 Colten, "Lemonade," 72.

today. But although these releases are ostensibly regulated and controlled (and reported when not), their sheer frequency and enormity often leaves nearby residents feeling as if such disposal practices are in fact completely out of control. Flaring, for example, was a common problem at Diamond, a small African-American subdivision neighboring the Norco refinery complex and the site of one of the best-known environmental justice struggles in Cancer Alley. In the two years between 1996-1998 alone, a refinery there emitted 25 tons of sulfur dioxide in ten separate flaring incidents. During just one nine-day period in 1996, that same facility vented over 440,000 pounds of the gas. Flares at Diamond were sometimes so large and prolonged that they lit up the night sky well enough for neighboring residents to read by.[566] Such stories permeate the industrial corridor. Table 4-1 lists nine of the region's largest cumulative atmospheric releases of individual hazardous wastes from 1988 to 2013:

Facility	Chemical	Quantity
Shell, Norco	Benzene	2,278,600 lbs.
Shell, Geismar	Ethylene oxide	2,178,338 lbs.
Union Carbide, Taft	Ethylene oxide	570,143 lbs.
Westlake Vinyls, Geismar	Vinyl chloride	1,090,223 lbs.
Axiall,[567] Plaquemine	Vinyl chloride	564,141 lbs.
Formosa Plastics, Baton Rouge	Vinyl chloride	374,314 lbs
East West Copolymer, Baton Rouge	Styrene	3,704,418 lbs.
Cos-Mar Company, Carville	Styrene	2,949,571 lbs.
Dow Chemical, Plaquemine	Styrene	1,399,392 lbs.

Table 4-1: Just a handful of the cumulative atmospheric releases of some of the most hazardous substances produced in the industrial corridor between 1988-2013. All data from the US National Institute of Health's *Toxmap*, accessed July 23, 2015, http://toxmap.nlm.nih.gov/.

Altogether, these are just a fraction of the regulated airborne emissions reported in the EPA's Toxic Release Inventory. And note that these large releases are each just for a single substance. Dow's Plaquemine facility *alone* released over 150 different substances into the environment

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566 Lerner, *Diamond*, 49-50.

567 Formerly Georgia Gulf.

between 1988 and 2013; 26 of these releases surpassed 500,000 pounds, including carbon tetrachloride (571,000 pounds), benzene (1.3 million pounds), and asbestos (11.9 million pounds).[568] Although companies monitor and report these streams of airborne petrochemical wastes, the sheer volume and variety of substances disposed into the corridor's atmosphere suggest that industry's control over the porosity of its facilities might actually be quite tenuous, or even negligent. Certainly that is the suspicion within an environmental justice movement that has been growing in the region since the early 1980s.

But regardless of how activists might view such disposal practices today, it is also important to remember that part of what has created the landscape of toxic risk in the chemical corridor is not just the substances themselves, but also the history of our own understandings of pollution and hazard. It would be a mistake to presume the industry's intentional streams of waste universally point to carelessness and negligence. Though that might almost certainly true in some (or even many) cases, waste disposal has also been understood at other times throughout history to be a carefully bounded and controlled process. Whether piping chemicals into the Mississippi River, regulating injection wells, or siting disposal pits for oilfield waste, industry's environmental hazards of industry are also defined in part by the oft-overlooked porosity of the boundaries people have used to define both chemical waste and chemical risk.

For both industry and the people inhabiting industrial landscapes, the boundaries defining wastes, products, and risks have frequently shifted over time. In the early years of petroleum refining, companies simply burned off useless olefins like ethylene and propylene. But within a few decades, these olefins were being actively refined from petroleum as building blocks for petrochemical production. Benzene was also once just an undesirable byproduct from cracking

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[568] United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/.

naphtha and gas oil to make olefins. But today these streams account for a third of the benzene consumed in the United States.[569] For the residents of Cancer Alley, many of the categories of the petrochemical industry—inputs versus products, products versus wastes, intended versus accidental—are even more permeable. Benzene accumulating in the atmosphere by evaporating from an oilfield waste pit is no different than benzene flared from a stack. A tanker car full of vinyl chloride product can, quite swiftly, become a tanker car full of dangerous vinyl chloride pollution. Changing understandings of the nature of toxic pollution and shifting regulatory limits—or even definitions—suggest there are very unstable boundaries around categories like petrochemical feedstocks, products, and hazardous contaminants.[570]

And yet, unfortunately for most people living in places like Cancer Alley, it seems as if both industry and regulators have behaved otherwise, imagining not only that they can control and manage the physical porosities of the petrochemical production system, but also the conceptual ones. Over the last several decades, growing realization that many of the desired products of the petrochemical industry pose long-term risks of chronic toxicity suggest that these chemicals actually exist simultaneously as commodity and threat. The skinless open architecture of Louisiana's petrochemical industry is thus perhaps a valuable metaphor for the troubling instabilities that underlie the system. The fencelines separating a facility from a neighboring community suggest a completely misleading set of boundaries and enclosures in the petrochemical landscape. After a major benzene leak occurred at ExxonMobil's Baton Rouge chemical facility, for example, company tests along the fenceline recorded "no community

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[569] On the changing conceptions of products and byproducts in the petrochemical industry, see: Spitz, "The Rise of Petrochemicals," 28; Burdick and Leffler, *Petrochemicals*, 35.

[570] For a review of the shifting epistemologies and materialities of waste from a geographic perspective, see: Moore, "Garbage Matters."

impact." For nearby residents, however, these data are met with suspicion. Neighbor Shirley Bowman, for one, sarcastically observed that, "everything seems to stop at that magical gate, . . . but if you live here, you know. Chemicals are let out on you."[571] And, as we have seen, countless cases confirm Bowman's suspicions. Feedstocks, products, intended wastes, and accidental releases regularly flow across facility perimeters, whether in clouds of steam and gas, leakages through soil and groundwater, or in barrels, barges, and railcars always at risk of rupture as they move through, or store materials, in the landscape. Whether released in enormous quantities through a sudden explosion or spill, or gradually leaked into the environment over decades through regular emission and disposal, hazards have been permeating Louisiana's waterways, soils, and atmosphere since the very beginnings of the petrochemical industry. Regardless of engineering and regulatory attempts to control the porosities of the chemical production stream, the boundaries separating the corridor's chemistry and its environment are inevitably more unstable than production companies or regulatory agencies can account for.

That southern Louisiana's deltaic environment is itself marked by instability only serves to make the porosity of the chemical industry even more troubling. So far we have more or less taken for granted the distinctions between wastes emitted into *either* the river, *or*, the soil, *or* the atmosphere. But in southern Louisiana's deltaic environment, these distinctions often melt away. The people who live in Cancer Alley occupy an entire landscape composed simultaneously of air, earth, and water, a landscape where these elements mix promiscuously and often unpredictably. Once petrochemicals are released into Louisiana's humid, soggy environment, where do they go? And how do they find their way into human bodies?

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[571] Bowman quoted in: Lombardi, "'Upset' Emissions."

Toxic Hydrosphere, Lithosphere, Atmosphere

Eight current and former Superfund National Priorities List sites and a combined total of over 400 petrochemical production and disposal facilities sprawl across the soggy, flat terrain of southern Louisiana's deltaic plain. Perhaps 200 of those sites fall in Louisiana's riparian industrial corridor.[572] Additionally, numerous injection wells and waste sites used for oilfield wastes—like Grand Bois, for example—litter the landscape, but go under-noticed because they are not regulated as hazardous. Collectively, these sites occupy a humid, stormy, and saturated environment layered full of porous sands and other alluvial deposits. Water in the soil, streams, and atmosphere entangles the region's petrochemical production and disposal infrastructure with the soggy peculiarities of the deltaic, subtropical landscape. The region's hydrology, geology, and climate facilitate the migration of petrochemical hazards throughout the riparian corridor, undermining the perceived boundaries between industry and neighboring communities.

At Petro-Processors, Inc. (PPI), located near Baton Rouge just 1-2 miles outside the town of Alsen, toxicity and Mississippi hydrology are intimately connected. PPI is one of the most highly contaminated of Louisiana's current Superfund sites, while Alsen is well known for its environmental justice struggles with another hazardous waste processor: Rollins Environmental Services. In the 1980s, the town had a population of around 1,100 residents, 99 percent of whom were African American.[573] Between the early 1960s and late 1970s, PPI received around 300,000 tons of waste, including 63,000 tons of liquid chlorinated hydrocarbons.[574] The facility lies alongside Bayou Baton Rouge, a sluggish stream that ultimately empties into Devil's Swamp,

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[572] These figures come from: United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/.

[573] On Alsen: Allen, *Uneasy Alchemy*, 118-123; Bullard, *Unequal Protection*, 114-115.

[574] United States Environmental Protection Agency, "Petro-Processors of Louisiana, Inc.," January 15, 2015, accessed July 30, 2015, http://www.epa.gov/region6/6sf/pdffiles/petro-pro-la.pdf.

itself a slack-water wetland and lake occupying the Mississippi River floodplain. Concerns about PPI first began to emerge after a 1970 spill into Bayou Baton Rouge also contaminated neighboring Devil's Swamp.[575] Then, in June of 1983, the Mississippi overflowed one of PPI's liquid disposal pits, further dispersing contaminants throughout the wetland and, ultimately, back into the river to be sent downstream. The site, once imagined to be a stable container for toxic waste, had been breached by flood. The pit was so physically entangled with the floodplain, that EPA had to reroute Bayou Baton Rouge in order to remediate the site. Containment required imposing a new, less permeable hydrology on PPI's waste facility.[576]

Comparatively few sites in the corridor are so directly mediated by the flows of the Mississippi and its floodplain, however. In fact—and perhaps surprisingly—the river is sometimes the *least* important waterway for determining how contaminants spread across the landscape. Because Mississippi levees are so high and relatively impenetrable, the vast majority of water flowing through the river does not spread freely across lands occupied by the industrial landscape.[577] Which is not to say that the region's physical environment is any less mediated by flood and saturated soils. Although the Mississippi rarely influences the territory landward of the levees, five other United States Geological Survey-defined drainage basins encompass the

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[575] In fact, Devil's Swamp is currently a proposed Superfund site due to both the 1970 spill and contamination from PCBs that Rollins Environmental Services dumped into a nearby drainage canal. United States Environmental Protection Agency, "Devil's Swamp Lake," January 15, 2015, accessed July 30, 2015, http://www.epa.gov/region6/6sf/pdffiles/devils-swamp-la.pdf.

[576] United States Environmental Protection Agency, *First Five-Year Report for the Petro-Processors of Louisiana, Inc. Site*, (Dallas: US EPA, Region 6, 2005); United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Public Health Assessment: Petro-Processors of Louisiana, Incorporated* (Atlanta: ATSDR, 2009).

[577] The last floods to affect the land now occupied by the petrochemical industry would likely have occurred during the great crevasses of the late-nineteenth century, and—maybe for a few areas—the Great Flood of 1927.

industrial corridor.[578] The wetlands and more modest streams of these basins—former tributaries and distributaries of the Mississippi before levees severed their connections with the river—influence the spread of petrochemicals leaking from the industrial corridor. For example, most of East Baton Rouge Parish—home to several clusters of petrochemical facilities—drains not to the Mississippi, but off to the southeast into Bayou Manchac and beyond to the Gulf.[579] Where contaminants that reach the Mississippi might pose a threat to downstream drinking water, these smaller drainage basins can spread toxic risk throughout the soils, swamps, and canals of the territory behind the levees.[580]

Southern Louisiana's deltaic landscape is also full of invisible water circulating below the surface. If the Mississippi is not always a major determinant of *surface* flows of contamination, it still exerts a powerful hydrological force on flows of groundwater. Between 1997 and 2001, tests revealed that unsafe levels of vinyl chloride and 1,2 dichloroethylene had contaminated wells in a trailer-park community outside Plaquemine, Louisiana.[581] Subsequent investigation by the EPA suggested that the contaminant plume had originated at an old Dow Chemical hazardous waste facility just upriver on the banks of the Mississippi. Dow had also spilled over 760,000 pounds of tetrachloroethylene (which degrades to vinyl chloride) in 1993, with over 1,000 pounds reaching

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[578] The upper and lower bounds of watersheds are somewhat arbitrarily determined. See: United States Geological Survey, "Surf Your Watershed," accessed July 30, 2015, http://cfpub.epa.gov/surf/locate/index.cfm.

[579] Goldsteen, *Danger All Around*, 114-116.

[580] For evidence of canal and tidal influence on contaminant dispersal, see: Barney P. Popkin, "Guidelines for Ground-Water Quality Assessments for Hazardous Waste Facilities," *Groundwater Monitoring & Remediation* vol. 3, no. 2 (1983), 65-70, 66.

[581] Rick Bragg, "Toxic Water Numbers Days of a Trailer Park," *New York Times*, May 5, 2003; State of Louisiana Department of Environmental Quality, "AI 81438 - A. Wilbert and Sons Trailer Park," accessed July 30, 2015, http://www.deq.louisiana.gov/portal/DIVISIONS/UndergroundStorageTankandRemediationDivision/RemediationServices/RemediationHighProfileSites/AWilbertandSonsTrailerPark.aspx.

the river near the landfill.[582] Although Dow denied that the geology below its facilities communicated with the town's aquifer, the EPA found otherwise. Since the site was on the outside edge of a river meander, the Mississippi had driven contaminants into the riverbank. There, the vinyl chloride and other chemicals eventually made contact with the Plaquemine aquifer and migrated in a toxic plume south-southwest of Dow's operations to reach drinking water wells throughout the town and trailer park (Figure 4-6). The invisible movement of groundwater had unexpectedly connected the guts of industry with the guts of nearby residents.

Figure 4-5: Dow's Plaquemine hazardous waste site under flood. © Richard Misrach, "Hazardous Waste Containment Site, Dow Chemical Corporation, 1998," courtesy Fraenkel Gallery, San Francisco, California (used with permission).

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[582] United States Environmental Protection Agency, *Ground-Water Flow Directions and Contaminant Source Area Evaluation for the Plaquemine Aquifer* (Dallas: U.S. EPA Region 6, 2004).

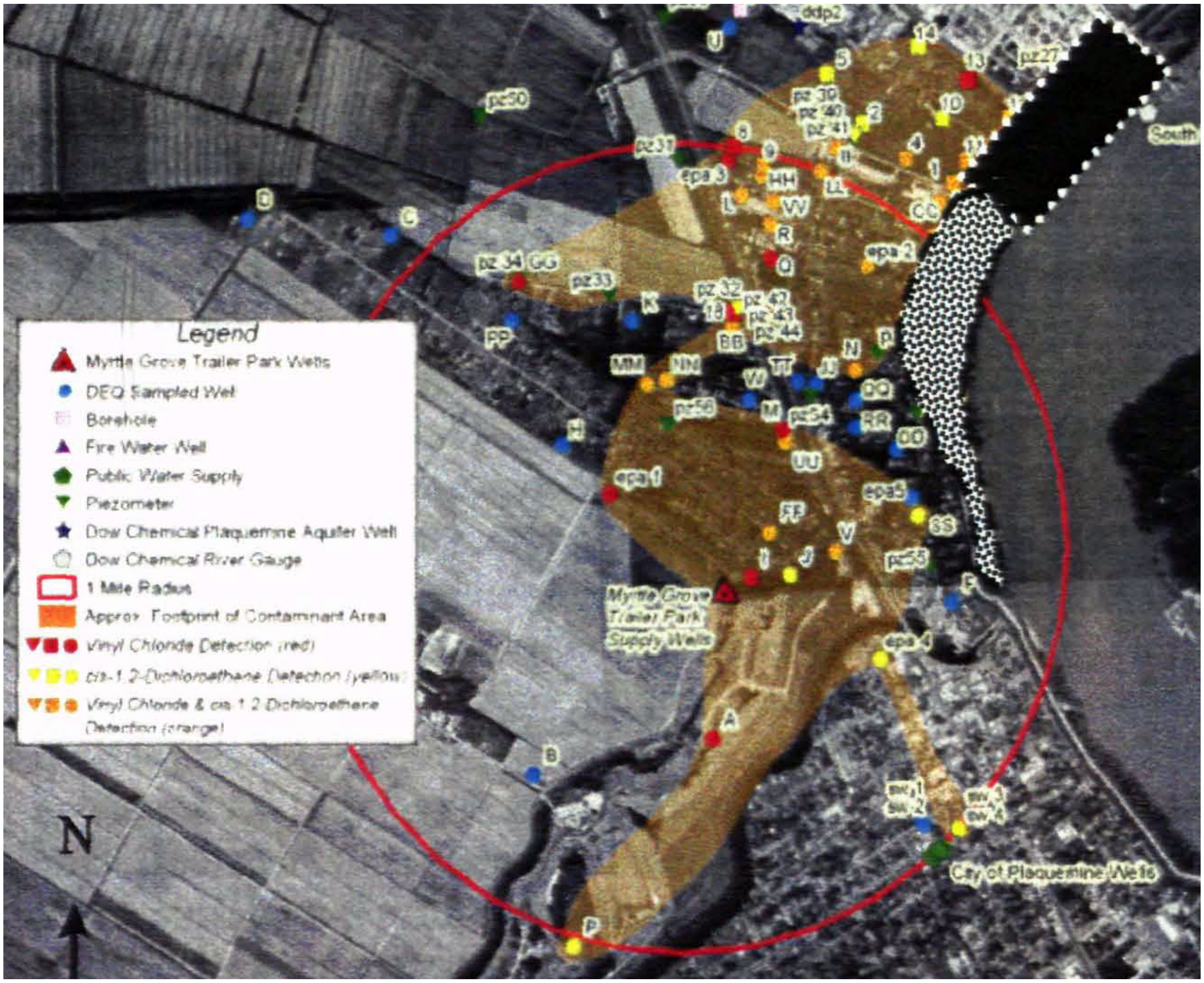

Figure 4-6: EPA map of vinyl chloride and 1,2 dichloroethylene plume at Plaquemine, Louisiana. Source area marked in black and initial contamination spread marked in dotted pattern. United States Environmental Protection Agency, *Ground-Water Flow Directions and Contaminant Source Area Evaluation for the Plaquemine Aquifer* (Dallas: U.S. EPA Region 6, 2004), 35.

Dow’s insistence that its facilities were not hydrologically connected with the town’s aquifer was not simply a product of poor corporate accountability. Rather, one major assumption about the region’s geology has long mitigated regulatory concern about groundwater contamination in Louisiana’s alluvial landscape. The only way contaminants can percolate into groundwater hundreds of feet below the surface is if the intervening strata are sufficiently permeable for a spill or landfill plume to communicate with the aquifer. The most porous geologies of the region are dominated by sand, a highly conductive medium that can see water move between fifty and one hundred feet per day. But even the thickest layers of sand in

Louisiana's soils are almost always accompanied by layers of clay. Composed of extremely small, tightly packed grains, clays are very imporous—so much so that it would take almost 60,000 years for contaminants to traverse even 100 feet of material.[583] Up until recently, risk assessments in Louisiana, upon finding layers of such impermeable clay at a site, assumed that a plume would automatically be contained.

Studies beginning in the 1990s, however, suggested that these supposedly impermeable layers of clay were not as confining as engineers and hydrologists had imagined. Geologist Jeff Hanor revealed that a layer of clay confining a Livingston, Louisiana, hazardous waste facility was both less spatially confining than presumed and up to four orders of magnitude more permeable than laboratory tests suggested.[584] First, although soil strata appear in more or less neat layers in cross-section, these formations—particularly in an alluvial, sedimentary environment such as southern Louisiana—are complex, three-dimensional structures. Inadequate surveying might lead risk assessments to imagine a clay layer completely confined a waste disposal site when a full survey would reveal unexpected discontinuities that could allow waste to communicate with an aquifer. Second, the material structures of clay beds spread throughout the region are full of internal fractures caused by alternate wetting and drying in the deltaic environment. These fractures render the clay more porous, allowing substances to permeate the soil and then communicate either directly with aquifers or with some adjacent conductive layers of sand that are in turn hydrologically connected with an aquifer.

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[583] Extrapolated from T. Prabhakar Clement, Michael J. Truex, and Peter Lee, "A Case Study for Demonstrating the Application of U.S. EPA's Monitored Natural Attenuation Screening Protocol at a Hazardous Waste Site," *Journal of Contaminant Hydrology* vol. 59 (2002): 133-162, 147-8.

[584] Jeffrey S. Hanor, "Effective Hydraulic Conductivity of Fractured Clay Beds at a Hazardous Waste Landfill, Louisiana Gulf Coast," *Water Resources Research* vol. 29, no. 11 (1993): 3691–98; Jeffrey S. Hanor, "Subsurface Geology of Louisiana Hazardous Waste Landfills: A Case Study," *Environmental Geology* vol. 26, no. 2 (1995): 97–106.

The irregularities and fractures of southern Louisiana's clay beds are not the only unexpected permeabilities arising from the region's deltaic geology. Exploration geophysicist Edward Zinni raised concerns that abandoned meanders of the Mississippi and its distributaries deposited layers of sand in such a way as to produce unexpected contacts between the sands of deep-well waste injection sites and aquifers in the region.[585] Southern Louisiana's deltaic geology is also prone to faulting, whether through subsidence or to accommodate the region's many protruding salt domes.[586] Much like the cracks in clay beds, these faults offer hydrological conduits between aquifers and hazardous waste disposal facilities, including deep-well injection sites.[587] Finally, while faults alone suggest there is some risk of unexpected hydrological conductivities in the region, the industrial corridor's tangled network of natural gas, petroleum, and feedstock pipelines amplify that risk. These sealed conduits carrying petrochemical resources and products span hundreds of miles of subterranean Louisiana. In so doing, they traverse permeable and impermeable soil formations throughout the region, offering potential pathways for contaminants to migrate *alongside* pipes for miles.[588]

Joining southern Louisiana's waterways, soils, and rocks, the subtropical climate also serves to compound the terrestrial conditions that unexpectedly distribute hazardous

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[585] E. Zinni, "Subsurface Fault Detection Using Seismic Data for Hazardous-waste-injection Well Permitting: An Example from St. John the Baptist Parish, Louisiana," *Geophysics* vol. 60, no. 2 (1995): 468–75.

[586] Thomas Mauduit and Jean Pierre Brun, "Growth Fault/rollover Systems: Birth, Growth, and Decay," *Journal of Geophysical Research: Solid Earth* vol. 103, no. B8 (1998): 18119–18136.

[587] George C. Flowers, Michael E. Barber, and Peikang Jin, "Subsurface Geology of Hazardous Waste Injection Sands near Geismar, Louisiana," *Environmental & Engineering Geoscience* vol. 4, no. 3 (1998): 341–60.

[588] United States Environmental Protection Agency, *Ground-Water Flow Directions and Contaminant Source Area Evaluation for the Plaquemine Aquifer* (Dallas: U.S. EPA Region 6, 2004), 33. In 1986, Kent et al. tried to suggest that southern Louisiana's geology is actually *less* prone to migration from injection wells: Kent, Mikels, and Hanson, "Hydrogeological Problems Associated with Siting Injection Wells in Southern Louisiana." Brad Hanson (an author on that study), however, was later asked in the early 1990s to cease his own research suggesting that waste might migrate from injection wells far sooner than companies projected: Bob Anderson, "Geologist's Well Work Stopped," *Baton Rouge Advocate*, November 12, 1991.

petrochemicals throughout the landscape. Prevailing winds from the south and southeast ensure the Gulf of Mexico's humid influence extends at least as far north as Baton Rouge; average annual humidity tends to hover at 75 percent. Long hot summers in Cancer Alley affect the chemistry of regional air pollution and pose particular risks for many poor residents who often do not have air conditioning.[589] Although the high humidity can serve to limit the concentrations of some pollutants in the air that people breathe, it also can accelerate deposition of contaminants onto the landscape, especially when it rains. High annual rainfall—averaging over sixty inches and one hundred rainy days per year in New Orleans—washes air pollution to ground even as it can lead to flooding in the saturated landscape.[590] It is perhaps no wonder that toxicologist and activist Wilma Subra found that in one Louisiana town neighboring a vinyl chloride complex, fruit trees, soils, and house dust contained levels of dioxin above acceptable federal limits.[591]

In this humid, rainy environment, hurricanes—notable for the profoundly destructive force with which they manipulate both atmospheric and terrestrial waters—exacerbate the geophysical conditions of toxic permeability. Less than a year after Hurricane Katrina, sociologist Scott Frickel speculated about the contaminants that storm surge might have spread across the New Orleans landscape. Included among his concerns were the petroleum and chemical contaminants that have been at the center of this chapter. Subsequent testing results from the EPA suggested that sediments deposited by Katrina's floodwaters posed no particular risk to human health. Critically, however, Frickel and some of his research colleagues observed that there was considerable lack of overlap in EPA sampling between industrial and residential

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[589] Goldsteen, *Danger All Around*, 117.

[590] Baton Rouge is somewhat, but not much, drier.

[591] Wilma Subra, *Industrial Sources of Dioxin Poisoning in Mossville, Louisiana* (New Iberia: Subra Company, 2007). Subra's claims, however, are contested. See the response from Louisiana's Department of Environmental Quality, accessed July 30, 2015, http://www.deq.louisiana.gov/portal/Portals/0/cnnvideo/signedsubraresponse.pdf.

sites. Granted, many of the industrial sites did not flood, but Frickel suggests that significant gaps still remained in our understanding of Katrina's "toxic gumbo."[592] Meanwhile, even just wind and rain from a comparatively smaller storm can also compound the leakiness of Louisiana's chemical corridor. Hurricane Isaac—a category 1 event—resulted in accidental releases at not less than two refineries in 2012. The Motiva-Shell facility at Norco released one ton of benzene on August 28th because the storm required an emergency shutdown. On the same day, the Marathon refinery at Garyville dumped 12.6 million gallons of untreated storm water from its processing facilities because Isaac's rains had overcome storage capacity.[593]

This humid, deltaic landscape of entangled air, earth, and water only serves to intensify and disperse the leaks emanating from the porous industrial corridor. Water suffuses the region in both liquid and gaseous forms. Steam inevitably accompanies the release of benzene, vinyl chloride, and countless other substances from the region's petrochemical facilities. Atmospheric waters blown in from the Gulf rain airborne pollutants down onto the region, flood waste facilities, or overwhelm chemical plants to produce toxic releases. The Mississippi—carrying water gathered from across the continent—breaches the barriers of waste containment facilities while deltaic waterways severed by levees can still spread contamination across the region. Ancient waters in the delta laid down porous sands and fractured, irregular clay beds that would

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[592] Scott Frickel, "Our Toxic Gumbo: Recipe for a Politics of Environmental Knowledge," Understanding Katrina, Social Sciences Research Council, June 11, 2006, accessed July 30, 2015, http://understandingkatrina.ssrc.org/Frickel/; United States Environmental Protection Agency, "Response to 2005 Hurricanes: Sediment and Soil," accessed July 30, 2015, http://www.epa.gov/katrina/testresults/index.html#sed; Scott Frickel, "On Missing New Orleans: Lost Knowledge and Knowledge Gaps in an Urban Hazardscape" *Environmental History* vol. 13 no. 4 (2008): 634-650; Scott Frickel and M. Bess Vincent, "Katrina's Contamination: Regulatory Knowledge Gaps in the Making an Unmaking of Environmental Contention," in *Dynamics of Disaster: Lessons in Risk, Response, and Recovery*, eds. Barbara Allen and Rachel A. Dowty (New York: Earthscan, 2011), 11-28.

[593] Louisiana Bucket Brigade, "Mission: Zero Accidents."

one day connect dumping grounds with aquifers. The permeable environment thus amplifies the porosities of the petrochemical industry.

Permeable Bodies

In an unfinished 1830s manuscript, Charles Dickens described the fictional English industrial town of Mudfog. Suffused with "thick damp mist" and "green and stagnant water," Mudfog's streets were stained and overrun with ooze, its atmosphere heavy with the scents of pitch, tar, and coal. "Water," wrote Dickens, "is a perverse sort of element at the best of times, and in Mudfog it is particularly so."[594] In Dickens's manuscript, Mudfog was not only the name of a town, but also a state of matter. As a slimy miasma and sludgy mist, it was a disconcerting mixture of air, soil, and water. Equal parts artifice and nature, mudfog was both swampy emanation and industrial pollution. It was matter that promiscuously crossed boundaries, not only among the elements, but also between nature and society, body and environment.

As a metaphor, mudfog is a useful shorthand for many of the boundary-breaching phenomena of the industrial corridor. Petrochemicals are both profoundly artificial and inescapably natural, derived as they are from ancient, fossil nature. Simultaneously, inputs, commodities, wastes, and hazards, these substances are also shifting objects that describe suggest multiple meanings and values. Leaking from a porous industry, petrochemicals—much like the original mudfog—effortlessly cross the boundaries between solid, liquid, and gas to permeate the earth, water, and air of the humid deltaic landscape. As matter that thwarts taken-for-granted categories, mudfog reminds us to look for the unexpected and troubling ways that petrochemicals escape people's physical and conceptual efforts to contain them.

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[594] Charles Dickens, *The Mudfog Papers, Etc.* (London: Richard Bentley & Son, 1880), 1-2, 24, 27.

But aside from facility infrastructure, waste-disposal practices, and industry regulation, perhaps one of the most important elements of people's efforts to contain toxic risk are their understandings of the vulnerability of the body. After all, if humans were universally understood to be impermeable to environmental contamination, then no one would be looking for cancer (at least of industrial origin) in Cancer Alley. Perhaps the most important question for the region then becomes: If leaky chemical plants and refineries have saturated Louisiana's industrial corridor with oozing mudfog, how does that ooze also find its way into people's bodies? Unfortunately, given the profound uncertainties of epidemiological research—which we will explore below—providing a definitive answer to that question is far beyond the scope of this project. Rather, this pursuit of mudfog attempts to suggest that risk in Cancer Alley emerges and recedes in some proportion to the boundaries we draw between people and their environment. As a category, mudfog helps us trouble the boundaries of the human body to illuminate the unnoticed porosities of our skin, orifices, and mucous membranes. Perhaps most importantly, mudfog suggests how risk itself is a boundary-defying category such that different bodies are differently permeable to poisoning in different places at different times.

As one of the premier narrators of the industrial revolution, Dickens was also writing at a time when most people's conceptions of health and illness meant they still lived in a world in which miasma and unhealthy environments left people sick. But by just four decades after Dickens's work on the *Mudfog Papers*, these ideas had begun to dramatically change. In the late nineteenth century, the germ theory of disease came to dominate European and American understandings of illness, challenging the notion that human health was dependent on the environment. Instead, health in this period came to be more narrowly defined as the absence of disease, while illness came to be understood as the result of specific pathogens in disordered flesh. Displaced by microbes, the environment no longer played a direct or independent role in causing sickness. The body was now imagined as self-contained, bounded by its skin, and vulnerable not to the complexities of the environment, but only to germs and acute poisons.[595]

It is in part because of this history that mudfog becomes so valuable a metaphor for thinking about bodies, health, and environment in Cancer Alley. Since the 1962 publication of Rachel Carson's *Silent Spring* and decades of subsequent research, we no longer live in a world in which the body is imagined to be so totally impermeable as it had been in the early twentieth century.[596] But nonetheless, the dogma of germ theory still maintains a powerful, often unnoticed grip on our understanding of human health and environmental illness such that the line between bodies and environment routinely wavers between rigidly impermeable and substantially less so. Indeed, even long before Carson, developments in the fields of industrial hygiene, toxicology, and sanitation illustrate just how shifting and unstable that boundary could be.

Working at a time when many public health officials were turning their back on the environmental dimensions of disease, experts in toxicology and industrial hygiene were describing the toxic hazards of workplace chemicals. These two fields understood pollution not just as a nuisance or destroyer of property, but also as a threat to human health. Unlike the bacteria that dominated conversations in public health, however, workplace chemicals were not reducible to contagion and instead operated in a world of contaminated air and surfaces—that is,

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[595] Nash, *Inescapable Ecologies*, 1-13.

[596] A beautifully written (if horrifying) text, Carson's book suggested that contrary to popular and expert medical wisdom of the time, our air, waters, and soils were actually full of invisible hazards to our health. Implicitly rejecting the model of an impermeable, self-contained body, Carson argued that humans were, in fact, inescapably entwined with their surrounding ecosystems. Rachel Carson, *Silent Spring* (Boston: Houghton Mifflin, 1962). Though Carson's work appeared groundbreaking—and even radical—at the time, environment historian Linda Nash reminds us that *Silent Spring* has a lineage reaching back beyond the nineteenth century all the way to Hippocrates. Nash, *Inescapable Ecologies*, 7-12. Also see: Alison Bashford and Sarah W. Tracy, eds., "Special Issue: Modern Airs, Waters, and Places," *Bulletin of the History of Medicine* vol. 86, no. 4 (2012).

toxic environments. But although industrial hygiene and workplace toxicology created empirical space for an environmental conception of health after germ theory, both fields remained deeply under the influence of modern bacteriology, and thus the new paradigm of impermeable bodies. By the 1920s, industrial hygiene, though attuned to the dangers of workplace environmental hazards, had begun to focus on quantifiable forms of exposure that could be measured in laboratories, signaling the rise of a reductionism similar to the germ-based model of infectious disease.[597] Although research into workplace exposures had for a time suggested the permeability of bodies in polluted conditions, that boundary between humans and their environment re-solidified by the second decade of the twentieth century.

In the first half of the twentieth century, sanitation engineers and water pollution scientists also witnessed similar shifts in the rigidity and porosity of the contained human body. Unlike their colleagues examining air pollution, these experts resisted adopting the insights of toxicology and industrial hygiene and increased their focus on bacterial contamination instead. This was partly due to difficulties in establishing causal connections between human illness and industrial water pollution, but also because water-borne infections like typhoid were perceived at the time as a far greater public health threat. In fact, industrial water pollution hardly registered as a concern: at the turn of the twentieth century, sanitary engineers often believed that chemical waste could act as a beneficial bactericide while posing almost not threat to humans. Taken together, these factors led water pollution scientists to only be concerned about the aesthetic

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[597] For more of this history, see: Christopher Sellers, “Factory as Environment: Industrial Hygiene, Professional Collaboration and the Modern Sciences of Pollution,” *Environmental History Review* vol. 18, no. 1 (1994): 55–83; Craig Colten and Peter Skinner, *The Road to Love Canal: Managing Industrial Waste Before EPA* (Austin: University of Texas Press, 1996), 18-31; Christopher Sellers, *Hazards of the Job: From Industrial Disease to Environmental Health Science* (University of North Carolina Press, 1997); Linda Nash, “Purity and Danger: Historical Reflections on the Regulation of Environmental Pollutants,” *Environmental History* vol. 13, no. 4 (2008): 651–658.

problems—smells and tastes—of chemical pollution in drinking water, rather than toxic risk. It was only in the early 1950s that the first studies emerged suggesting that people, and not just wildlife, might also be vulnerable to illness caused by industrial water pollution. A handful of water pollution scientists and sanitation engineers began to express concern that many of their colleagues had focused solely on microbial contamination of the water supply at the expense of examining prolonged exposure to chemical contaminants in drinking water. Incidentally, these expert conceptions of the permeable body appeared in the years just prior to *Silent Spring*.[598] Miasma, germ theory, industrial hygiene and toxicology, water sanitation, and Rachel Carson together all illustrate the shifting boundaries of the body as understood by different models of human health and the environment. Those boundaries have continued to shift in Cancer Alley—and elsewhere—right through the present.

As Louisiana's refining and petrochemical industry began to metastasize along the river in the decades after World War II, it began generating a trickle of mudfog, pollution that simultaneously flows, oozes, and wafts its way through the region's water, soils, and air. In turn, the humid and sodden deltaic environment facilitated and amplified those leaks and trickles throughout the landscape. Today, mudfog emanates from a riparian industrial complex composed of almost 150 facilities manufacturing hundreds upon hundreds of chemicals. Even when these facilities are functioning as planned, their inputs, products, and wastes percolate throughout the corridor, finding numerous opportunities to encounter resident human bodies. But how exactly might these streams of mudfog enter the body? What illnesses could result? And, in a region

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[598] On people's belief in industrial waste as bactericide see: Joel Tarr, "Industrial Wastes and Public Health: Some Historical Notes, Part I, 1876-1932," *American Journal of Public Health* vol. 75 (1985): 1059-1067. On water pollution science in the mid-1950s: E. J. Cleary, "Determining Risks of Toxic Substances in Water," *Sewage and Industrial Wastes* vol. 25 (1954): 203–210; Jules S. Cass, "The Potential Toxicity of Chemicals in Water for Man and Domestic Animals," in *Proceedings of the Tenth Industrial Waste Conference* (Lafayette, IN: Purdue University, 1955), 466–472.

marked by distinct inequalities of race and class, how might some bodies be more permeable to mudfog than others?

Occasionally, an accident—not unlike a crevasse—transformed industry's trickles of mudfog into a flood, leaving nearby residents sick with the acute symptoms of toxic exposure: headaches, itching and burning eyes, coughing, dizziness, nausea, vomiting, and even death. When 30,000 pounds of benzene swirled up from a massive stream of leaking naphtha at Exxon's Baton Rouge refinery in 2012, Shirley Bowman, a 61-year old neighbor commented to a reporter, "I live in fear up here. . . . I'm just sitting here waiting to get poisoned."[599] Although Bowman's comments at first glance seem to reflect the history of toxicology—of living in fear of the final poisonous dose—the phrase "waiting to get poisoned" also suggests a long-term experience of exposure. Bowman might not only be living in fear of a single explosive toxic accident, but also simply waiting for the symptoms of long-term, chronic exposure to finally manifest. [600] The trickles—in parts per million and parts per billion—of substances permeating Cancer Alley also represent a far more insidious form of toxic exposure. Although it was the fear of acute poisoning that first alarmed industrial corridor communities after Kirtley Jackson's death, the creeping, oozing threat of chronic illness has become the most sinister feature of the mudfog saturating Cancer Alley's permeable places and bodies. Although acute accidents and toxic releases punctuate everyday life in the industrial corridor, that geography of risk is also defined by the very fact of that everydayness. Immersion in the slowly leaking landscapes of

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[599] Lombardi, "'Upset' Emissions." A mixture of volatile hydrocarbons distilled from crude oil, naphtha is used as a feedstock to produce a variety of petrochemicals. Almost 60,000 people and forty schools and daycare centers are within two miles of Exxon's refinery and petrochemical complex. Residents half a mile away reported unusually harsh chemical odors, migraines, dizziness, and fainting

[600] I'm grateful to Jake Fleming for pointing out the dual meaning of Bowman's words.

Cancer Alley characterizes resident struggles for environmental justice as much as the regular "upsets" of violent explosions, overturned railcars, or sudden flares.

One expression of that immersion occurred in the late 1990s at Myrtle Grove trailer park, just outside Plaquemine, Louisiana. Tests first revealed the presence of vinyl chloride—used in the production of PVC pipes, siding, toys, housewares, and much, much more—in Myrtle Grove's water wells in 1997, but due to "human error," the Louisiana Department of Health and Hospitals that conducted the testing failed to alert anyone. For four years (and for who knows how many before that), around 300 residents would draw contaminated water out of their faucets, showerheads, and hoses to fill saucepans and drinking glasses, bathtubs and showers, mop buckets and kiddie pools. When residents were finally alerted in the spring of 2001, they connected the news with a host of strange health problems. Children complained of itching and burning after bathing, and as many as thirteen women in the trailer park had miscarried in the previous few years.[601] Dow's vinyl chloride water had permeated the lives of Myrtle Grove families, entering their alimentary canals and seeping through their skin.

Although vinyl chloride does not accumulate in plant or animal tissues, it can, as it did in Plaquemine, dissolve in water and migrate into aquifers, providing a source of long-term exposure.[602] Most people can begin to taste vinyl chloride at between 3 and 4 parts per million (ppm), but maximum contaminant limits for the chemical in drinking water supplies is

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[601] Rick Bragg, "Toxic Water Numbers Days of a Trailer Park," *New York Times*, May 5 2003; United States Environmental Protection Agency, *Ground-Water Flow Directions and Contaminant Source Area Evaluation for the Plaquemine Aquifer* (Dallas: U.S. EPA Region 6, 2004); State of Louisiana Department of Environmental Quality, "AI 81438 - A. Wilbert and Sons Trailer Park," accessed July 30, 2015, http://www.deq.louisiana.gov/portal/DIVISIONS/UndergroundStorageTankandRemediationDivision/RemediationServices/RemediationHighProfileSites/AWilbertandSonsTrailerPark.aspx. For an amusing and frightening look at PVC, see the 2002 documentary film *Blue Vinyl*.

[602] The information in this paragraph about vinyl chloride exposure and detection in humans comes from: United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Vinyl Chloride* (Atlanta: ATSDR, 2006), 2-5.

significantly below that taste threshold at 2 parts per *billion* (ppb). Without testing like that conducted on Myrtle Grove's wells, a community could ingest vinyl chloride at concentrations orders of magnitude higher than is deemed acceptable and never actually know it. The actual effects of drinking and bathing in vinyl-chloride-contaminated water, meanwhile, are largely unknown. Because the chemical is highly volatile, most research focuses on the more typical atmospheric exposures that occur in industrial worksites. According to the US Agency for Toxic Substances and Disease Registry, absorption of vinyl chloride through the skin is usually negligible, unless exposed to its pure liquid form. The questions Myrtle Grove trailer park residents asked about kiddie pools, bathing, and their children's complaints about rashes and burning were thus likely ignored. No matter what families residing in the trailer park might have experienced at the time, prevailing expertise would have rendered Myrtle Grove's children impermeable to bathing in tainted well water.

Meanwhile, because so little research exists about the effects of *ingesting* vinyl chloride in humans, its potential toxicity in drinking water must be extrapolated from animal and inhalation studies. The vinyl chloride that residents drank would have been absorbed through the walls of their stomachs and small intestines into their circulatory systems. The extremely small concentrations of vinyl chloride in the blood would likely have collected temporarily in the liver where they were metabolized into still other organochlorides. These metabolites would have eventually been excreted in urine, but not before possibly producing structural changes in liver tissue. Although attributing direct causality to chronic exposure is extremely challenging, long-term inhalation of vinyl chloride is associated with an extremely rare liver cancer called angiosarcoma.[603] Since it is impossible to know what other potential effects long-term ingestion of low doses of vinyl chloride might produce, we can only speculate on the potential risks Myrtle Grove residents faced by examining the hazards of vinyl chloride gas. Research has found that long-term chronic exposure to vinyl chloride in factory workers has resulted in brain, lung, and blood cancers; immunological and thyroid disorders; nerve damage; and miscarriage—a symptom of exposure with which the residents of Myrtle Grove were deeply familiar.[604]

Myrtle Grove trailer park residents drank, bathed in, and cooked with water tainted by vinyl chloride every day for at least four years. And contaminated groundwater was not their only encounter with vinyl chloride; they were also breathing air polluted with small measures of the substance as well. From 1988-2013, the same Dow Chemical facility responsible for poisoning Plaquemine's aquifer also released 118,000 pounds of vinyl chloride into the air. A neighboring plant owned by Polyone Corporation released 78,000 pounds of vinyl chloride in the same period. Just two miles away, the Shintech plants released over 250,000 pounds of the substance from 1988-2013.[605] In breathing air polluted with vinyl chloride and drinking water contaminated with the chemical, Myrtle Grove residents inhabited a boundary between liquid and gaseous chronic exposure, an experience common throughout the industrial corridor. We will never know conclusively what effect drinking Myrtle Grove water and breathing Myrtle Grove air had on Myrtle Grove bodies. Regulatory limits on workplace vinyl chloride exposure, however, offer at least some frame of reference for imagining just how vulnerable—just how permeable—these bodies were.

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[603] United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Vinyl Chloride* (Atlanta: ATSDR, 2006), 14-16.

[604] United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Vinyl Chloride* (Atlanta: ATSDR, 2006), 16-17.

[605] United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/.

The US Occupational Safety and Health Administration's maximum exposure limit for workers exposed to vinyl chloride gas is 1 ppm averaged over an eight-hour workday, and no more than 5 ppm in 15 minutes.[606] Those figures are significantly down from the pre-1975 exposure limit of 500 ppm.[607] But whether these newer exposure limits are in fact safe is not entirely certain. Historians David Rosner and Gerald Markowitz demonstrate that the notion of acceptable exposure limits—also called Threshold Limit Values, or TLVs—emerged less from medical data and more from a combination of economic compromise and engineering feasibility.[608] Indeed, the concept of the TLV emerged out of bacteriology's reductionist influence on industrial hygiene. But where bacteriology imagined the human body as a container vulnerable to contamination (rather than a permeable organism embedded in a disease environment), industrial hygiene's concept of threshold limits drew from physiology to propose a model of "homeostasis"—of bodies in balance. That model suggested the body could, within a range of exposure, self-regulate toxicity and absorb a certain quantity of hazardous material without suffering harm.[609] Homeostasis was, effectively, another model of the impermeable body. Still more suggestive of the problems with TLVs is evidence that industry has sometimes manipulated findings that would lead to lower threshold limits. A 2005 report published in *Environmental Health Perspectives* described industry's long history of suppressing data about the chronic toxicity of vinyl chloride. That report concluded by noting the longstanding trend at

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[606] United States Department of Labor Occupation Safety & Health Administration, "Vinyl Chloride," accessed July 31, 2015, https://www.osha.gov/dts/chemicalsampling/data/CH_275395.html.

[607] Jennifer Beth Sass, Barry Castleman, and David Wallinga, "Vinyl Chloride: A Case Study of Data Suppression and Misrepresentation," *Environmental Health Perspectives* vol. 113, no. 7 (2005): 809–812.

[608] David Rosner and Gerald Markowitz, "Industry Challenges to the Principle of Prevention in Public Health: The Precautionary Principle in Historical Perspective," *Public Health Reports* vol. 117, no. 6 (2002): 501–512.

[609] On threshold limit values, homeostasis, and impermeable bodies see: Seller, *Hazards of the Job*; Nash, "Purity and Danger"; Murphy, *Sick Building Syndrome*, 84-92.

the EPA of inviting industry participation in toxic risk assessment.[610] In 2012, molecular epidemiological research suggested that prolonged exposure to even smaller concentrations of vinyl chloride gas led to mutations in the liver associated with angiosarcoma risk. That study recommended a maximum exposure limit of 0.25 ppm—compared with the current limit of 1 ppm—over an eight-hour workday.[611] Given these shifting limits—and the distinct possibility that these limits are a fiction designed in part to accommodate industry, it becomes very unclear how safe Myrtle Grove residents (and other neighboring communities) could have been.

Indeed, it is not just the residents of Plaquemine that need worry. All told, the industrial corridor has witnessed the emission of almost 3 million pounds of vinyl chloride gas in twenty-five years. By far the worst offender for vinyl chloride emissions is Geismar's Westlake Vinyls, which emitted over 1 million pounds of vinyl chloride since reporting began in 1988. And although vinyl chloride gas only has an atmospheric half-life of 1-2 days, its reaction products include hydrochloric acid, formaldehyde, acetylene, and other chlorinated organics. While time-weighted maximum daily exposure limits should potentially be set as low 0.25 ppm, people can only detect the odor of vinyl chloride at more than 3,000 ppm.[612] Unlike the factory floor, the average homeowner in the industrial corridor has no access to chemical detection equipment other than their noses, leaving nearby residents almost no means of knowing whether they live with hazardous daily exposure to the region's polluted atmosphere.

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[610] Sass, Castleman, and Wallinga, "Vinyl Chloride: A Case Study of Data Suppression and Misrepresentation."

[611] Paul Wesley Brandt-Rauf et al., "Plastics and Carcinogenesis: The Example of Vinyl Chloride," *Journal of Carcinogenesis* 11, no. 5 (2012): published online, doi:10.4103/1477-3163.93700.

[612] Vinyl chloride emissions totals based on data available at: United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/. On both the half-life of vinyl chloride and the concentrations at which people smell the chemical, see: United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Vinyl Chloride* (Atlanta: ATSDR, 2006), 2, 169-171.

Like vinyl chloride, benzene is also ubiquitous throughout Cancer Alley's atmosphere. As a key refinery product and petrochemical feedstock, it is used to make gasoline, solvents, foams, plastics, pesticides, adhesives, lubricants, and dyes. It is produced, shipped, consumed, and released throughout the industrial corridor. In the twenty-five years after reporting began for the Toxic Release Inventory, Exxon's Baton Rouge facilities emitted over 2 million pounds of the substance. In the last eight years, Westlake Vinyls, that powerhouse of emissions in Geismar, has released 2.7 million pounds of benzene to accompany its 1 million pounds of vinyl chloride over the same period. Plaquemine's Dow Chemical facility has contributed 1.29 million pounds of benzene to Cancer Alley's atmosphere. Shell's Norco facility, infamous for flaring, released 2.28 million pounds. The list goes on.[613]

Like vinyl chloride, benzene has also long been recognized as a carcinogen and is, in the words of poet and biologist Sandra Steingraber, an "a-list contaminant."[614] Benzene inhaled in the air passes through the lining of the lungs into the circulatory system, which distributes it to the body's fatty tissues, including not just the liver, but also, very crucially, the bone marrow. Stored temporarily in the liver and marrow, benzene breaks down to metabolites that are themselves toxic.[615] Benzene and its metabolites are excreted within two days of exposure, but for the residents of Louisiana's industrial corridor, the air offers a constant source of replenishment for these substances. Long-term exposure to the chemical causes anemia and other blood disorders, immunological problems, and, because of benzene's affinity for bone marrow,

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[613] United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/.

[614] Sandra Steingraber, *Living Downstream: An Ecologist's Personal Investigation of Cancer and the Environment*, Second Edition (Philadelphia: Da Capo Press, 2010), 91, 95, 192.

[615] United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Benzene* (Atlanta: ATSDR, 2007), 4.

blood and lymph-related cancers including multiple myeloma, leukemia, and lymphoma.[616] In late 2014, a report from the Pulitzer-prizewinning Center for Public Integrity described the petrochemical industry's $36 million campaign to undermine independent scientific research on the dangers of benzene even as internal reports articulated those same dangers.[617] As early as 1948, an American Petroleum Institute toxicological review acknowledged that there was no safe exposure limit for benzene, suggesting that all bodies are always permeable to the chemical. In mid-2014, the state of California lowered its workplace time-weighted exposure limits from 20 parts per billion (ppb) to 1 ppb, three orders of magnitude below the US Occupational Safety and Health Administration limits of 1 ppm. Given those thresholds, it is perhaps especially troubling that, although the Louisiana Department of Environmental Quality has established an ambient air benzene standard for the state of 3.76 ppb, independent samples gathered by the Louisiana Bucket Brigade, suggest that limit is frequently breached, often without being reported.[618] If that is the case, then residents of Cancer Alley are regularly being permeated by atmospheric concentrations of benzene that not only transcend California's workplace exposure limits, but also the state's more lax regulations.

Unlike some of the pesticides that alarmed Rachel Carson, benzene, vinyl chloride and other chemicals emitted into the air, waterways, and soils of Cancer Alley don not tend to bio-accumulate. Where DDT, endrin, and dieldrin—or the PCBs and dioxins that have emerged as

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[616] United States Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Benzene* (Atlanta: ATSDR, 2007), 12-20.

[617] Kristen Lombardi, "Benzene and Worker Cancers: 'An American Tragedy,'" *Center For Public Integrity*, December 4, 2014, accessed July 30, 2105, https://www.publicintegrity.org/2014/12/04/16320/benzene-and-worker-cancers-american-tragedy; Kristen Lombardi, "New Battlefront for Petrochemical Industry: Benzene and Childhood Leukemia," *Center For Public Integrity*, December 8, 2014, accessed July 30, 2105, https://www.publicintegrity.org/2014/12/08/16356/new-battlefront-petrochemical-industry-benzene-and-childhood-leukemia.

[618] Louisiana Bucket Brigade (LABB) bucket sample data, acquired by email from LABB director Anne Rolfes on March 17, 2015; Louisiana Bucket Brigade, "Mission: Zero Accidents"; Lombardi, "'Upsets.'"

contaminants of concern since *Silent Spring*—gather in animal and human tissues to provide a source of toxic exposure from within the body, vinyl chloride, benzene, and many other atmospheric pollutants in Cancer Alley dissipate from the body within days or weeks. For the most part, residents need not speculate about which of their tissues—breasts, liver, bone marrow, or body fat—is betraying them as a biological fifth column slowly fomenting illness over decades. And yet, the geography of exposure in the industrial corridor ensures that the refineries, chemical plants, and hazardous waste sites provide a constant source of contaminants for communities interspersed throughout the industrial region. Whether in the constant flow of contaminated water from an aquifer soaked with vinyl chloride, or the regular atmospheric releases of benzene, Louisiana's industrial corridor sends a constant trickle of hazardous petrochemicals into the environment. This is chronic exposure without bioaccumulation. Water, air, and soil articulate the guts of chemical plants and human bodies alike; the boundaries between factory, landscape, and body grow blurry and indistinct. Petrochemical infrastructure thus serves as a kind of extended contaminated biology, a set toxic organs leaking chemicals into the lungs, digestive systems, and skin of area residents.[619]

The extended contaminated body that is Cancer Alley, however, is not home to just one leaking, poisoned organ. Rather, it is a choreography of toxic tissues all simultaneously oozing mudfog into local communities. As the long list of benzene and vinyl chloride released across the region since the 1980s suggests, residents of the industrial corridor do not contend with just one contaminant, nor with just one leaking source. Barbara Allen's research on citizen science in Cancer Alley describes one effort to more clearly reveal the cumulative effect of the leaking

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[619] My thinking here is influenced in part by geographer Nick Bauch's work in "The Extensible Digestive System: Biotechnology at the Battle Creek Sanatorium, 1890-1900," *Cultural Geographies* vol. 18 (2011): 209-229.

industrial landscape on resident communities. Permit applications for new petrochemical plants typically place the proposed facility at the center of risk assessment maps, with one, two, and three-mile rings arranged concentrically outward to indicate potential exposures. Those concerned about pollution, however, should place schools and neighborhoods at the centers of those maps. Only by seeing just how many potentially leaky facilities intersect with a community's one, two, and three-mile radii can concerned citizens begin to assess chemical risk.[620] The town of Geismar, for example, has witnessed countless hazardous chemical incidents over the years. Home to Westlake Vinyls, Momentive Specialty Chemicals, Rubicon, Praxair, Lion Copolymer, Occidental, a Shell chemical facility, two BASF plants, and four class I hazardous injection wells, the Geismar area is littered with toxic risk.[621] Chemicals produced, shipped, intentionally released, and accidentally leaked through this landscape include not just vinyl chloride and benzene, but also highly reactive, highly toxic substances like ethylene compounds, various toluenes, sulfuric acid, formaldehyde, phenols, and a handful of endocrine disrupting carcinogens like carbon tetrachloride and styrene.[622] These multiple streams of toxic emissions compound the boundary-crossing properties of mudfog, for what new porosities emerge when so many wastes are combined to form one giant toxic gumbo?[623]

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[620] Allen, *Uneasy Alchemy*, 146-148.

[621] Chemical facilities in and around Geismar were identified using: United States National Institute of Health, *Toxmap*, last accessed July 30, 2105, http://toxmap.nlm.nih.gov/. The number of injection wells near Geismar comes from: United States Environmental Protection Agency, "Underground Injection Control Program; Hazardous Waste Injection Restrictions; Petition for Exemption-Class I Hazardous Waste Injection Rubicon, LLC," *The Federal Register*, March 3, 2009, accessed July 31, 2015, https://www.federalregister.gov/articles/2009/03/03/E9-4464/underground-injection-control-program-hazardous-waste-injection-restrictions-petition-for.

[622] Note that much of the information about potential toxicity concerning these chemicals comes from summaries offered by federal agencies like the United States Department of Health and Human Services Agency for Toxic Substances and Disease Registry. By nature, these kinds of institutions can be conservative given the growing influence of industry on regulation in the US. See: Langston, *Toxic Bodies*; Sass, Castleman, and Wallinga, "Vinyl Chloride: A Case Study of Data Suppression and Misrepresentation."

[623] Toxic gumbo is from Frickell, "Our Toxic Gumbo."

Such a community-centered approach offers only the barest beginnings of making exposure visible and revealing the compounded vulnerabilities of Cancer Alley's permeable bodies. Activists and scientists undertaking this kind of work are all concerned about the shortcomings of modern toxicology when it comes to identifying the risks posed not just by multiple, but also potentially synergistic, chemical exposures. Sandra Steingraber observes that "air is a transmutational medium."[624] Chemicals like vinyl chloride gas can react with other emissions to produce still more harmful substances, or break down into reaction products like hydrochloric acid, which themselves might react with some other chemical in Cancer Alley's atmosphere. The synergies of multiple exposure can also take place in the body. Rachel Carson, for example, found that the relatively "safe" pesticide malathion could transform into an acute and deadly poison if someone was exposed to a second chemical that interfered with or destroyed certain liver enzymes.[625] Unfortunately, there are many unknowns about these kinds of reactions and synergies, especially when it comes to what might be happening in the body as opposed to in the air, soil, or water. As environmental historians Jody Roberts, Nancy Langston, and Frederick Rowe Davis have suggested, the five decades since *Silent Spring* have not been enough time for toxicology to assess the multiple, intersecting potentiations of the various streams of mudfog leaking throughout Cancer Alley's environment and into human bodies.[626]

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[624] Steingraber, *Living Downstream*, 176.

[625] Carson, *Silent Spring*, 30-31.

[626] Jody A. Roberts and Nancy Langston, "Toxic Bodies/Toxic Environments: An Interdisciplinary Forum," *Environmental History* vol. 13, no. 4 (2008): 629–635; Frederick Rowe Davis, "Unraveling the Complexities of Joint Toxicity of Multiple Chemicals at the Tox Lab and the FDA," *Environmental History* vol. 13, no. 4 (2008): 674–683. For more on concern about multiple exposures, particularly as they affect children, see: John Wargo, *Our Children's Toxic Legacy: How Science and Law Fail to Protect Us from Pesticides* (New Haven: Yale University Press, 1998).

But it is not just *any* body that faces the brunt of exposures in the industrial corridor. The residents of Geismar, like the town of Alsen near the Petro Processors, Inc. and Devil's Swamp Superfund sites, are largely African American, so much so that census blocks along chemical plant fencelines can be almost entirely black. The racial geography of exposure in Geismar and other communities in the industrial corridor suggests that some bodies in Cancer Alley are more permeable than others. The proximity of African American communities—including African American landowners—to petrochemical fencelines has its origins in the post-Civil War interventions of the Freedmen's Bureau. Allocating fragments of sugar plantation land to newly emancipated slaves, the Bureau facilitated the development of almost entirely African American towns with deep historic roots. These allocations did not replace the region's plantation geography. Rather, they accumulated at the edges and interstices of large plantation tracts that remained under white ownership. Once Louisiana began to shift from an agricultural to an industrial economy in the first decades of the twentieth century, it was these large, still-consolidated parcels that were the preferred sites for massive refineries, chemical facilities, and hazardous waste sites. A plantation-based geography of race and land-ownership was laid over by a new geography of industrial development and a particularly raced risk of exposure through proximity.[627] Eighty percent of the region's African American community live within three miles of a facility, if not closer.[628] And in some of the more tragic cases of environmental injustice in Louisiana, entire historically black communities reaching back to emancipation have been erased after corporate buyouts attempted to compensate for chemical exposures. Morrisonville, Sun,

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[627] Roberts and Toffolon-Weiss, *Chronicles from the Environmental Justice Frontline*, 34; Markowitz and Rosner, *Deceit and Denial*, 238-243.

[628] Wright, "Living and Dying," 95. Beverly Wright has also suggested that poor construction in some of these communities makes for more permeable homes, further increasing the vulnerability of resident bodies: Beverly Wright, "Environmental Racism and the siting of Toxic Release Inventory Facilities in Louisiana," a presentation at the 55th Session of the United Nations Consortium on Human Rights, Geneva, Switzerland, 1999.

Reveilletown were all swallowed up in the 1990s, while Diamond—adjacent to Norco—was bought out by Shell in the first few years of the twenty-first century.[629] The geographies of race in Cancer alley suggest that the color of a person's skin often marks an amplified degree of risk in the region. Blackness becomes an indicator of porosity, of the fact that some bodies are more vulnerable to environmental exposure than others.

The mudfog suffusing Cancer Alley is thus displacing the region's largely African American communities *in place*. Just as coastal erosion is destroying the deltaic landscape beneath the feet of residents, petrochemical development and environmental toxicity has made this segment of the Mississippi River unrecognizable, unfamiliar, and, in some places, uninhabitable. Poverty and depreciated property values—due largely to industry, no less—put relocation out of reach for most residents. For those that do receive offers of assistance for relocating, stories of decimated black communities like Reveilletown, Morrissonville, and Sunrise—all bought out by chemical corporations—make that option hardly appealing. For the people who have little choice but to remain, they are no less displaced by environmental risk: chronic illness in Cancer Alley, by disrupting formerly familiar, functional bodies, displaces residents from their corporeal selves.[630]

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[629] Allen, *Uneasy Alchemy*; Lerner, *Diamond*. For a study on raced and classed elevated risk of exposure to benzene and formaldehyde air pollution (among other carcinogens), see: Wesley James, Chunrong Jia, and Satish Kedia, "Uneven Magnitude of Disparities in Cancer Risks from Air Toxics," *International Journal of Environmental Research and Public Health* vol. 9, no. 12 (2012): 4365–4385. It is important to remember that although there have been several controversies over the siting of new chemical plants in politically marginalized communities—per the classic claims of the environmental justice movement—exposure in the region is also a result of complex historical geographies of race, property ownership, and community. Compare with: Andrew Hurley, *Environmental Inequalities: Class, Race, and Industrial Pollution in Gary, Indiana, 1945-1980* (Chapel Hill: University of North Carolina Press, 1995); Andrew Hurley, "Fiasco at Wagner Electric: Environmental Justice and Urban Geography in St. Louis," *Environmental History* vol. 2, no. 4 (1997): 460–481.

[630] My thoughts here have been inspired by: Nixon, *Slow Violence*, 69. Nixon also compares toxic exposure as a literally "foreign" body burden: as being invaded by alien occupying forces, p. 50.

And it is not only blackness that marks bodies as more vulnerable to displacement, more permeable to streams of mudfog in Cancer Alley. Certain bodies at certain times are more vulnerable to the influence of chemical exposure than others. The industrial corridor represents not just a geography of raced exposure, but also a life history of differently permeable bodies. Political scientist John Wargo observes that due to development and composition, children are far more at risk of chronic chemical exposures than adults. In proportion to their body weight, children eat three to four times more food, breathe twice as much air, and drink over twice as much water as adults do. Those higher proportions of consumption also reflect a higher rate of metabolism, which can put especially young bodies at greater risk of illness for those chemicals with more toxic metabolites.[631]

Young bodies—especially children and fetuses—can also be more permeable to chemical exposure because of the intricate and extremely sensitive workings of the endocrine system, particularly at crucial stages of development in utero or during, say, puberty.[632] Many of the chemicals produced in Cancer Alley—including benzene, styrene, carbon tetrachloride, hydroquinone, phenols, and the phthalates used to plasticize PVC—have been implicated as endocrine disruptors.[633] These substances mimic or otherwise interfere with the hormone signaling systems of the body that are key not just to human development, but also reproduction. Endocrine disruptors are major agents of breast cancers and other reproductive tumors as well as a host of immunological, reproductive, and developmental disorders. In fact, some chemicals

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[631] Wargo, *Our Children's Toxic Legacy*; Steingraber, *Living Downstream*, 46.

[632] Langston, *Toxic Bodies*, 6-12, 116; Steingraber, *Living Downstream*, ix-xx.

[633] Ali M. Tabish et al., "Epigenetic Factors in Cancer Risk: Effect of Chemical Carcinogens on Global DNA Methylation Pattern in Human TK6 Cells," *PLoS ONE* vol. 7, no. 4 (2012): e34674; Steingraber, *Living Downstream*, 113-114; Amy Ellis Nutt, "Phthalates, Found in Hundreds of Household Products, May Disrupt Sex Development of Male Fetus," *Washington Post*, March 6, 2015.

generally thought to be completely safe for adults at certain thresholds can pose dire long-term hazards for fetuses precisely because of these endocrine sensitivities. Additionally, toxicological studies assessing exposure risk can often over-emphasize the direct mutagenic properties of a chemical while ignoring the much more complex disruptions the substance might trigger in the endocrine system—disruptions that could lead to illness later in life.[634]

Considering that endocrine disruptors—and possibly other classes of chemicals—completely redefine the categories of dose and threshold, the floods and trickles of mudfog leaking from the industrial corridor's petrochemical infrastructure suggest even more complicated relationships of chronic toxicity. Historian Nancy Langston identifies four main properties of endocrine disruptors that result in unpredictable, nonlinear responses to exposure. First, physical harm is not always dose-dependent. Part of what makes the endocrine system so vulnerable to disturbance at particular times is that it becomes extremely sensitive to very small doses of hormone-mimicking substances. Second, there is often no threshold for these chemicals; even at parts per trillion some substances can produce long-term harm. Third, as we have seen, the age of exposure can be crucial, such that adults might experience no adverse effects, whereas fetuses or children undergoing puberty may experience profound hormonal disturbance. And fourth, it may be years or even decades before disruptions to the endocrine system actually result in illness.[635] Exposure in the womb, for example, may not result in cancer or reproductive disorders until adolescence. Thus, where a large dose of, say, phthalates, may produce few effects in most individuals, an almost undetectable quantity of these estrogenic chemicals introduced at a critical moment in fetal development could produce a cascade of harmful

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[634] Langston, *Toxic Bodies*, 6-12.

[635] Langston, *Toxic Bodies*, 5-9.

hormone signaling and feedback loops that could produce cancer at almost any point in the exposed fetus's future.

And it is not just children who are exceptionally vulnerable to endocrine disruption. The complex dance of hormones in the body can also leave adult women more or less permeable to chronic chemical exposure over time. For example, since female breasts undergo additional development in the final months of the first full-term pregnancy, having children may reduce the risk of breast cancer induced by chemical exposure. The resulting changes in breast tissue and hormone regulation add some measure of protection against carcinogenesis.[636] How much protection that might offer for women living their entire lives in Cancer Alley is deeply uncertain. And yet the facts of these pregnancy-related changes in breast tissue—along with the vulnerabilities associated with critical junctures of hormonal activity in human development—reveals that chemical hazards in Cancer Alley are not just a matter of the geography of exposure, but also the timing of those exposures. If toxicity was once conceived as "the dose makes the poison," today it must also be understood as "the place and time makes the poison."[637] In some scenarios, dosage seems to be of secondary, or even tertiary concern. Perhaps it would be better to understand vulnerability to toxic exposure not in terms of a given measure of a substance, but in terms of the changing permeability of an individual's body over the course of their life history.

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[636] Jose Russo et al., "The Protective Role of Pregnancy in Breast Cancer," *Breast Cancer Research* vol. 7, no. 3 (2005): 131–142; Kara Britt, Alan Ashworth, and Matthew Smalley, "Pregnancy and the Risk of Breast Cancer," *Endocrine-Related Cancer* vol. 14, no. 4 (2007): 907–933. I first came across this phenomenon in the 1998 edition of Sandra Steingraber's *Living Downstream* (p. 264). However, it only appears as an aside in the updated second edition on page xviii.

[637] On "the time makes the poison," see: Sarah A. Vogel, "From 'The Dose Makes the Poison' to 'The Timing Makes the Poison': Conceptualizing Risk in the Synthetic Age," *Environmental History* vol. 13, no. 4 (2008): 667–673. As a geographer (and given the particular nature of exposure in the Mississippi River Delta), I feel quite strongly that "place" also makes the poison.

Depending on race, gender, class, cultural practices, and, age (among other a factors), a body is rendered more or less permeable to potentially devastating physical transformations.

The politics of knowledge and uncertainty around environmental exposure, however, ensure that regulators and industry are often far from embracing such a perspective. In Cancer Alley—as in most landscapes of exposure—human bodies, particularly those of African Americans, are imagined to be generally *im*permeable to the leaking facilities of the chemical corridor in the region. The problem of establishing causality has long plagued communities like those in in the industrial corridor. Illnesses associated with chronic chemical exposures do not present bacteria or viruses that can be cultured and identified as culprits. While some rare cancers like mesothelioma tend to only develop after exposure to a particular substance (such as asbestos), most tumors emerge from a variety of causes, from genetic triggers to the almost infinite number of factors in a body's life history. The same goes for other symptoms of chronic exposure, ranging from respiratory illness to anemia, immune disorders to miscarriage. Since ill health arising from toxic exposure can often take years or even decades to emerge, and most people are exposed to thousands of chemicals—with all manner of joint toxicities—in a lifetime, complex biographies muddy the waters of causality even further. Given the enormous challenges of conclusively diagnosing individual victims of chronic toxic exposure, epidemiologists rely on spatial patterns of illness that might suggest statistical relationships of cause and effect. Even here, however, uncertainty still reigns. Statistical relationships, for one, are not conclusive lines of causal evidence. Designing studies capable of producing statistically meaningful results, meanwhile, often requires data or sample sizes that are simply unavailable. Finally, because most populations today have been exposed to an increasing number of synthetic chemicals in the environment since World War II, creating viable control groups for epidemiological research on toxic exposure has become increasingly difficult.[638] According to Sandra Steingraber, research on cancer clusters is so rife with uncertainty that many public health officials want nothing to do with it.[639] The challenges of uncertainty and statistical significance thus foreclose on the possibility that bodies might in fact be vulnerable to environmental illness even before residents can begin to ask whether their ill health could be the result of toxic exposure.

In Louisiana, such uncertainties about the body's permeability can lead to diverging ideas of place. Is the region Cancer Alley or merely an industrial corridor? In 1989, the Louisiana Chemical Association funded a project using Louisiana Tumor Registry (LTR) data to examine cancer rates in 34 parishes from 1983-1986. The study found that south Louisiana residents had, with the exception of lung cancer, a lower risk compared with national averages. Higher rates of lung cancer were blamed on smoking habits, while industry was given a clean bill of health.[640] Similarly, a 1993 *Chemical Week* headline crowed "Louisiana Is No 'Cancer Alley'" after another analysis of cancer incidence in the river parishes suggested that, again with the exception of lung cancer, rates were the same as, or lower than, the national average.[641] Finally, in 2005, medical doctor Frederic T. Billings III used LTR data to again show that the industrial corridor had no statistically significant difference in cancer rates, except for the elevated lung cancers in men across the state. "Smoking, not smokestacks, is to blame," wrote Billings.[642]

Scholars like Barbara Allen, Gerald Markowitz, and David Rosner, however, have recounted the various flaws plaguing the Louisiana Tumor Registry. LTR data aggregated cancer

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[638] This discussion of uncertainty and toxic environmental risk is based on: Michelle Murphy, *Sick Building Syndrome*; Langston, *Toxic Bodies*; Frickel, "Knowledge Gaps"; Nash, "Purity and Danger."

[639] Steingraber, *Living Downstream*, 72-76.

[640] Barbara Allen *Uneasy Alchemy*, 134-9; Markowitz and Rosner, *Deceit and Denial*, 255-262.

[641] Elisabeth Kirschner, "Louisiana is no 'Cancer Alley,'" *Chemical Week*, June 16, 1993, 21.

[642] Billings, "Cancer Corridors and Toxic Terrors."

rates across parishes and regions, thereby dampening statistical signals from those communities at the heart of the industrial corridor. Moreover, using an unusually extreme definition of patient privacy, the registry deleted single instances of cancers as too case-specific to be reported. Critics argued these deletions could hide many rare childhood and adult cancers from view. Finally, the LTR aggregated data across multi-year periods, ignoring annual totals. In contrast to the spatially aggregated, dampened data of the LTR, citizens and independent researchers requested far more fine-grained numbers, including incidences for 74 adult cancers and sixteen pediatric cancers tallied by parish and zip code. As of 2005, a court case had still failed to compel the Louisiana Tumor Registry to release cancer data by zip code.[643] Despite what industry and mainstream epidemiology might suggest, it is still far from conclusive whether resident bodies are impermeable enough to ensure "Louisiana is no 'Cancer Alley.'"[644]

Indeed, the studies that suggest as much represent a decades-long epidemiological discourse that connects ill health to habits and social circumstance, rather than a polluted environment. Such research has sought to rationalize "emotional" or unscientific belief in "toxic terrors" and shift the onus of public health onto individuals. By emphasizing factors like smoking and poor nutrition, these claims suggest people's bodies are not vulnerable to environmental illness, but are instead simply disordered by bad habits and poverty.[645] In Cancer Alley, those risk factors get substantially freighted with racial codes, such that the region's poor

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[643] Barbara L. Allen, "The Problem with Epidemiology Data in Assessing Environmental Health Impacts of Toxic Sites," in *Environmental Exposure and Health*, ed. M. M. Aral (Boston: WIT Press, 2005) 467-475; Markowitz and Rosner, *Deceit and Denial*, 255-262; Merrill Singer, "Down Cancer Alley: The Lived Experience of Health and Environmental Suffering in Louisiana's Chemical Corridor," *Medical Anthropology Quarterly* vol. 25, no. 2 (2011): 141–163;

[644] Elisabeth Kirschner, "Louisiana is no 'Cancer Alley.'"

[645] Becky Mansfield discusses similar phenomena through the lens of Foucault's biopolitics in: "Gendered Biopolitics of Public Health: Regulation and Discipline in Seafood Consumption Advisories," *Environment and Planning D: Society and Space* vol. 30 (2012): 588-602.

African American communities become geographies of inherent illness, not because of nearby chemical facilities, but because of the presence of raced and classed bodies.[646] Public health under such scenarios is enacted through social reform and policing the behaviors of individual (often raced) bodies, as opposed to remediating environments and regulating industry. The impermeable body that epidemiological uncertainty constructs, and the individuation of public health together are, of course, public-relations boons for industry.[647] Cancer Alley residents thus struggle to document the certainty and causality of chemical exposure within a medical paradigm so deeply influenced by modern toxicology that exposure is rarely (if ever) conceived as a phenomenon of permeable bodies in toxic environments.[648] Black residents of Cancer Alley are thus not only at risk of illness, but also of having that illness pathologized as a phenomenon correlated with the color of their skin instead of with the poisons saturating the environment.

Sociologist Barbara Allen, in recounting the methodological and epistemological shortcomings of mainstream epidemiology, follows the efforts of people she calls "feminist science workers." She suggests that understanding health and illness in the industrial corridor requires—in addition to acknowledging the permeability of human bodies—working across the

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[646] Linda Nash discusses the ways brown bodies have long been conceived of as being prone to illness in chapter 5 of *Inescapable Ecologies*.

[647] For a much broader look at the ways various industries have exploited uncertainty, see: Naomi Oreskes and Erik M. Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issues from Tobacco Smoke to Global Warming* (New York: Bloomsbury Press, 2010). Note that a 2010 case-control study modeling lung cancer incidence and proximity to petrochemical plants found no statistically significant odds ratios of lung cancer risk: Neal Simonsen et al., "Environmental Exposure to Emissions from Petrochemical Sites and Lung Cancer: The Lower Mississippi Interagency Cancer Study," *Journal of Environmental and Public Health* vol. 2010 (2014): e759645. Although this study was far more spatially nuanced than prior investigations and controlled for a variety of factors, including smoking, its inconclusiveness is unsurprising given the nature of statistical significance. Note also that it also only examined lung cancers.

[648] On the impermeabilities associated with the influence of modern toxicology, see Murphy, *Sick Building Syndrome*, 81-111.

artificial boundaries that distinguish laboratory and community, expert and citizen.[649] Troubling the "view from nowhere" that mainstream epidemiology inhabits, feminist critiques of science offer more partial ways of understanding the nature of exposure.[650] Such critiques create more room for popular epidemiology and citizen science to be taken seriously as they attempt to fill the gaps of "undone science"—those studies never funded or undertaken because they put community concerns before those of professional research.[651] Indeed, environmental historian Linda Nash suggests that scholars and scientists might consider how their rigid epistemological commitments might silence the voices of the exposed. "Rather than wringing our hands over the problem of scientific "uncertainty," we might grant that the modernist hope for perfect knowledge will always be unfulfilled."[652] In so doing, feminist approaches to epidemiology and community health not only leave room for new means of producing knowledge, but also provide still more space for acknowledging the permeable boundaries of the human body.

Leaking Bodies

Bodies, however, are not just permeable from the outside in, they also leak. Just as water, raw materials, products, and waste flow simultaneously in and out of facilities in the industrial corridor, the bodies living in Cancer Alley are permeable in both directions. In her preface to *Toxic Bodies*, environmental historian Nancy Langston recounts a visit from a guest speaker in her undergraduate seminar. Maria, a graduate student in the environmental sciences, grew up

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[649] Allen, *Uneasy Alchemy*, 148-150. Exposure risk assessments that place communities—as opposed to chemical facilities—at the center of the map would be one example of this kind of hybrid, community-based epidemiology.

[650] The classic text on this subject is: Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective," *Feminist Studies* vol. 14, no. 3 (1988): 575–599.

[651] "Undone science" is from: Allen, *Uneasy Alchemy*, 140.

[652] Nash, "Purity and Danger," 657. "

along Wisconsin's Fox River, now a Superfund site. Playing in its waters and consuming fish from the watershed, Maria's body accumulated PCBs over the course of her childhood. Many years later, with the birth of her daughter, she faced a choice: should she breastfeed? On the one hand, breast milk promised important health benefits for her child. But on the other, Maria's body had also become a toxic site. The milk she expressed would reduce her own body's concentration of PCBs, but could also pose serious endocrine and immunological hazards for her newborn daughter.[653] Environmentally persistent, lipophilic chemicals like PCBs and DDT flow in and out of human bodies because of the way the body stores and eliminates fat. But even substances that do not accumulate in fatty tissues can be excreted through breast milk. Benzene, for example, is excreted or metabolized within days, and yet women regularly exposed to atmospheric benzene yielded some amount of the substance in their breast milk.[654] Bodies thus leak into other bodies.

Maria's story and others like it are hardly new. Rachel Carson warned the public about the presence of environmentally persistent contaminants in breast milk in 1962. Almost a decade earlier Jules Cass—using the sexist language of his day—presented a schematic diagram of permeable, leaking bodies at the Tenth Industrial Waste Conference held at Purdue University in May of 1955 (Figure 4-7).[655] And yet, most people tend not to think about the ways they too are nodes within a variety of networks of flowing substances.

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[653] Langston, *Toxic Bodies*, vii-viii.

[654] U.S. Department of Health and Human Services Agency for Toxic Substances & Disease Registry, *Toxicological Profile for Benzene* (Atlanta: ATSDR, 2007), 176. Incidentally, these phenomena also make women's bodies particularly charged sites of permeability, especially given the cultural importance of breastfeeding. For a discussion of the ways women's bodies can become sites of discipline and regulation, see: Mansfield, "Gendered Biopolitics."

[655] Cass, "The Potential Toxicity of Chemicals in Water for Man and Domestic Animals," 466-472.

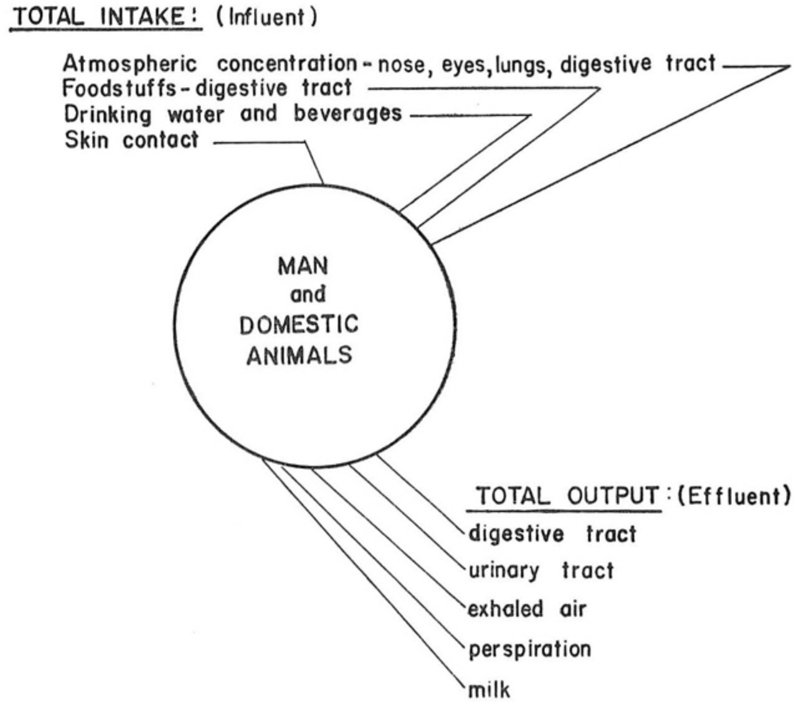

FIGURE 1.

Flow diagram of chemical substances to and from the body of man and domestic animals.

Figure 4-7: Jules Cass's 1955 diagram of the permeable human body. Cass, "The Potential Toxicity of Chemicals in Water."

For over a decade, environmental toxicologists and other scientists have been observing the accumulation of pharmaceuticals and personal care products in the environment. Either excreted from or washed off of our bodies, these substances have begun to find their way into watersheds as treated effluent gets re-circulated in streams or is used agriculturally in the form of sewage-based fertilizers and reclaimed water. Some of these substances have even been shown to accumulate in the tissues of nonhuman organisms, including fish, earthworms, and soy plants, to say nothing of potential *re*-accumulation in people.[656] Contaminated humans do not just leak into

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[656] Christian G. Daughton and Thomas A. Ternes, "Pharmaceuticals and Personal Care Products in the Environment: Agents of Subtle Change?," *Environmental Health Perspectives* vol. 107 (1999): 907–938; Dana W. Kolpin et al., "Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999−2000: A National Reconnaissance," *Environmental Science & Technology* vol. 36, no. 6 (2002): 1202–1211; Oliver A. H. Jones, Nick Voulvoulis, and John N. Lester, "Human Pharmaceuticals in Wastewater Treatment Processes," *Critical Reviews in Environmental Science & Technology* vol. 35, no. 4 (2005): 401–427; Chad A. Kinney et al., "Presence and Distribution of Wastewater-Derived Pharmaceuticals in Soil Irrigated with Reclaimed Water," *Environmental Toxicology and Chemistry* vol. 25, no. 2 (2006): 317–26; Chad A. Kinney et al., "Bioaccumulation of

other bodies, but also into the environment as well. By examining the movement of water out of humans and into the environment at large, we might understand Maria's body, indeed, all of our bodies as tiny tributaries in the watersheds we inhabit.[657]

But chemical exposure leaks across time as well. Over the last two decades or so, researchers in environmental toxicology have begun looking at the science of epigenetics to find evidence of toxic exposure that might be passed down through generations. This idea would normally fly in the face of conventional understandings of genetics, in which only changes to an organism's DNA can be passed on to its descendants. The "epi" in epigenetics, though, refers to transformations happening *outside* the genetic code. These are not mutations. Rather, these are changes in the ways genes get expressed or suppressed ("switched on or off") over the life of an organism. And again, even though these changes in expression and suppression are not directly encoded in the parent's DNA, they can still actually get passed down to their offspring. Although epigenetics research is somewhat controversial since it demands reevaluating some of the core assumptions of genetics, scientists have managed to demonstrate actual mechanisms—such as DNA methylation—that produce epigenetic inheritance.[658]

So, for example, mice exposed to the endocrine disruptor diethystilbestrol (DES) developed abnormalities in genes associated with uterine cancer. Offspring born two generations

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Pharmaceuticals and Other Anthropogenic Waste Indicators in Earthworms from Agricultural Soil Amended With Biosolid or Swine Manure," *Environmental Science & Technology* vol. 42, no. 6 (2008): 1863–1870; Chris D. Metcalfe et al., "Antidepressants and Their Metabolites in Municipal Wastewater, and Downstream Exposure in an Urban Watershed," *Environmental Toxicology and Chemistry* vol. 29, no. 1 (2010): 79–89; Chenxi Wu et al., "Uptake of Pharmaceutical and Personal Care Products by Soybean Plants from Soils Applied with Biosolids and Irrigated with Contaminated Water," *Environmental Science & Technology* vol. 44, no. 16 (2010): 6157–6161.

[657] Nancy Langston observes how water crosses the boundaries among humans, ecosystems, and even generations in a brief paragraph on page 2 of *Toxic Bodies*.

[658] Julie Guthman and Becky Mansfield, "The Implications of Environmental Epigenetics: A New Direction for Geographic Inquiry on Health, Space, and Nature-Society Relations," *Progress in Human Geography* vol. 37, no. 4 (2012): 486–504.

later still presented those abnormalities.[659] Nancy Langston reveals the tragic history of DES consumption in humans where, between the 1940s and 1960s, women were prescribed the chemical as a drug that supposedly prevented miscarriage. Although it increased their risk of breast cancer to some degree, the most tragic aspects of DES exposure became apparent when these women's daughters, exposed in utero, saw dramatic increases in rare reproductive cancers much later in life.[660] These cancers do not necessarily require epigenetic explanations, but the fact that DES *grand*daughters are showing higher risk of ovarian cancer does.[661] Although the long time lag associated with these health effects means the epigenetic research is only just beginning, evidence suggests that DES daughters and granddaughters have to cope with chilling multi-generational transmission of toxic exposure.

DES is not the only substance that has displayed potential for transgenerational toxic exposure. An endocrine-disrupting fungicide used in wineries—vinclozolin—has also been shown to alter gene expression in succeeding generations of rats.[662] Epigenetics is an extremely young field of research and there may in fact be many different substances exhibiting similar potential. Some researchers are also examining—though not without controversy—whether poor nutrition or intense psychological trauma can produce epigenetic effects through DNA methylation, potentially passing echoes of starvation and violence through a line of

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[659] Retha R. Newbold, Elizabeth Padilla-Banks, and Wendy N. Jefferson, "Adverse Effects of the Model Environmental Estrogen Diethylstilbestrol Are Transmitted to Subsequent Generations," *Endocrinology* vol. 147, no. 6 Suppl (2006): S11–17.

[660] Langston, *Toxic Bodies*.

[661] Linda Titus-Ernstoff et al., "Offspring of Women Exposed In Utero to Diethylstilbestrol (DES): A Preliminary Report of Benign and Malignant Pathology in the Third Generation," *Epidemiology* vol. 19, no. 2 (2008): 251–257.

[662] Michael K. Skinner, "Endocrine Disruptors and Epigenetic Transgenerational Disease Etiology," *Pediatric Research* vol. 61, no. 5 Part 2 (2007): 48R – 50R.

descendants.[663] In Louisiana's industrial corridor, several chemicals permeating the region's air, soil, and water have revealed some epigenetic potential, including styrene, benzene, carbon tetrachloride, and hydroquinone.[664] Though much research remains to be done, it is very possible even if these substances may not directly accumulate in residents' bodies, long-term exposure in the region may see the toxic *effects* of these chemicals leaking down through generations.

And finally, bodies also leak across time and place through their labors in the environment. When Europeans arrived in the early 1700s, the landscape seemed fundamentally unsuitable for human habitation. The geologically dynamic, highly variable, watery, sludgy environment routinely frustrated attempts at permanent settlement and agriculture. Over the course of the eighteenth and nineteenth centuries, however, the region was transformed into a landscape not only habitable for sedentary communities, but also profitable. Enslaved African American labor made the first hundred and fifty years of that transformation possible. The ancestors of those who face the greatest risk of chemical exposure today built the levees, drainage canals, and other flood and reclamation infrastructure that allowed sugar plantations to flourish here. Race is embedded not just in Cancer Alley's geography of exposure, but also materially in the historical cultural landscape that paved the way for industry.

Of course, the flood protection and drainage infrastructure in place today, and on which the industrial corridor depends, was largely built by the state and the Army Corps of Engineers, not by slave labor. And yet it was tens of thousands of African Americans working the nineteenth-century landscape that resulted in the first substantial interventions against saturation

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[663] Gunnar Kaati et al., "Transgenerational Response to Nutrition, Early Life Circumstances and Longevity," *European Journal of Human Genetics* vol. 15, no. 7 (2007): 784–790; Brian G. Dias and Kerry J. Ressler, "Parental Olfactory Experience Influences Behavior and Neural Structure in Subsequent Generations," *Nature Neuroscience* vol. 17, no. 1 (2014): 89–96.

[664] Ali M. Tabish et al., "Epigenetic Factors in Cancer Risk."

and hydrological disturbance. By remaking the environment to suit the drier, drainage-dependent ecologies of sugar cane, enslaved blacks established the material conditions by which a plantation economy could reliably flourish in a sodden, flood-prone, constantly shifting watery environment. And that sugar economy further prepared the ground—both literally and metaphorically—for the emergence of a petrochemical industry in the twentieth century. By attracting ongoing investment in the reconfiguration of the sodden environment, sugar plantations ensured that one day chemical plants would find safe, high ground along the river on which to build.[665] By expanding their territory into massive parcels of agricultural land, sugar planters created ideal property conditions for later purchase. The legacy of those enslaved bodies intervening in this watery landscape lives on in ways that are intimately connected to the poisoned bodies of their descendants. Sugar slavery thus haunts today's exposed African Americans even in the physical arrangements of the petrochemical landscape.

Deltaic Bodies

In Louisiana's industrial corridor, the deltaic landscape, leaky petrochemical facilities, and permeable human bodies, are all entangled in a muddy choreography of permeability. Here, oozing, wafting flows of mudfog—itself straddling the boundaries not just between soil, water, and air, but also pristine and polluted nature—reveal that the categories differentiating nature, artifice, and human beings are far blurrier than often imagined. Few images more literally depict those blurred boundaries than an Arthur Lidov painting published in the December 1962 issue of *Life Magazine*. Accompanying an article about the "phenomenal digestive journey of a sandwich," the illustration portrays a body lying merged with a craggy landscape (Figure 4-8).

[665] On the importance of flood-control infrastructure to industry's development, see: Colten, "Lemonade."

Figure 4-8: Untitled painting by Arthur Lidov from "How Food Becomes Fuel: The Phenomenal Digestive Journey of a Sandwich," *LIFE*, December 7, 1962, 82-3. Image used with permission of the estate of Arthur Lidov.

The hands and forearms fade into two mountain ranges stretching up to meet the person's head gazing off to one side. In between the peaks, the tributaries of a vast watershed of organs—including the esophagus, stomach, liver and gall bladder, pancreas, and small intestine—eventually terminate in a delta-like network of blood vessels. The boundaries between body and environment are present, but indistinct. The tissues of the one bleed into the landscapes of the other. The edges of the person's skin are those of the drainage divide, outlined by the ridges, faults, and canyons of the mountainous terrain. The body's internal organs exposed and on display, are rendered completely open to the environment in which they are embedded. The hydrological cycle—implied by the dark thunderclouds at the top of the image—further integrates flesh and river valley as water flows from uplands to lowlands, cycling in and out of organs and landforms. This is the permeable body.

The fusing of an expansive regional watershed with the hyper local, minute ecologies of the human organism suggests just how mistaken conventional geographies of exposure can be, particularly wherever flowing water is involved. Watersheds create deep, but often overlooked, connections between far-flung places.[666] The inevitable flow of water collapses conventional, common-sense notions of distance, frequently breaking Tobler's first law of geography that suggests "near things are more related than distant things."[667] The spatial boundaries that concepts like distance and scale construct are revealed to be permeable, shifting, and unstable.[668] As I suggested we might think about Maria's breastfeeding body, the human in this image is reimagined as simultaneously a node in the drainage basin and a microcosm of that basin. By permeating the body with flowing water, the watershed is—at least partly—contained in that body. People, by occupying permeable human flesh, are tiny tributaries and distributaries of the watersheds we inhabit; we are deltaic bodies. In a landscape saturated not only with water, but also hundreds of substances ranging from benzene and vinyl chloride to endocrine disruptors like styrene and carbon tetrachloride, the space and time of the human body begins to appear neither as local, nor as finite as might first appear. The brittle boundaries that, since the late nineteenth

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[666] My thinking here has been influenced by a key passage by environmental historian Nancy Langston: "Moving water connects these places, weaving the threads of the landscape together. The places where water and land combine—the riparian zones—mediate these connections, and what happens in these zones affects areas far beyond their boundaries." Nancy Langston, *Where Land and Water Meet: A Western Landscape Transformed* (Seattle: University of Washington Press, 2003), 3.

[667] Waldo Tobler, "A Computer Movie Simulating Urban Growth In The Detroit Region," *Economic Geography*, vol. 46 (1970): 234-240.

[668] For an important rethinking of common-sense notions of scale—and implicitly, distance—in geography, see: Marston et al., "Human Geography Without Scale," *Transactions of the Institute of British Geographers*, vol. 30 (2005): 416-432.

century, have often shaped (if not sometimes defined) people's corporeal place in nature grow decidedly porous, fluid, and indistinct.

This metaphor becomes acutely consequential when we consider the broader regional geography of which the industrial corridor is a part. Lying at the foot of an enormous watershed, its facilities and communities are downstream of almost every thing and every person in the greater Mississippi Basin. So, for example, huge quantities of fertilizers applied throughout the upper Midwest accumulate in the Mississippi River Delta to produce a hypoxic dead zone in the Gulf. And while there is not as much research on the long-distance aquatic transport of hazardous waste, we *do* know that in the early 1960s poor management at Velsicol Chemical in West Memphis, Tennessee, left large quantities of the highly neurotoxic pesticide endrin flowing past New Orleans, over 600 river miles downstream.[669] Thanks to the inevitable flow of water through a watershed, the Mississippi River Delta and its watery inhabitants are more permeable to environmental pollution than most other places on the continent. Here we see how water redraws the ordinary boundaries defining distance and proximity, connection and isolation.

Perhaps more important, however, is the corollary to living downstream of everyone else's waste. By inhabiting the petrochemical headwaters of Cancer Alley, residents live upstream of everyone else's consumer products, and therefore in close proximity to their externalities. The coatings on our screens, the fibers in our clothing, the resins and plastics in our electronics and housewares, the fertilizers and pesticides on our fields, the cleaning products and food additives on store shelves—all of it (and so much more) comes from petrochemicals. While only about nine percent of the petrochemicals used in the United States come from Louisiana's industrial corridor, that is still nine percent of many of the synthetics pervading modern daily

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[669] Colten, "Too Much of a Good Thing," 141–159, 151-2.

life. As consumers, we all are complicit in producing the flows of mudfog leaking throughout the region, and are thus intimately connected with the cellular transformations that may be taking place in Cancer Alley's permeable bodies.[670]

That vulnerability is, in fact, captured in Lidov's painting. The figure lies prone with exposed, open organs, providing a powerful metaphor for the landscape of risk in Cancer Alley—or anywhere that large quantities of toxic substances saturate the environment. Acknowledging permeability is fundamentally to acknowledge vulnerability. Historians like Nancy Langston, David Rosner, and Gerald Markowitz have all recounted industry opposition to, and essentially complete failures of, precautionary approaches to chemical regulation, especially in the United States. Industry has worked assiduously to create standards based not on safety, but on harm, and to shift the burden of proof to the public, essentially transforming consumers—as well as bystanders and the environment—into a vast supply of experimental guinea pigs. The deep uncertainties associated with chemical exposure, from the variability of individual bodies, to the complexities of dosage and timing, to the largely untested interactions of multiple exposures, have all been used to justify (and even manipulate) the "retreat from precaution" in service to economic gain. But if, as Langston argues, regulatory victories need engaging stories in addition to data and empirical research, then striking images like this one may actually provide a useful role in communicating the vulnerability of permeable bodies.[671]

Vulnerability also raises some important questions about the ambiguities of this body's sex. Whether posted on Facebook or presented to a room full of over thirty scholars, not one

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[670] My thoughts here are deeply indebted to Richard Misrach and Kate Orff's *Petrochemical America* (New York: Aperture, 2012). In 2011, Louisiana produced $68 billion worth of chemicals, making it the second largest chemical economy in the nation after Texas: Ryan Noonan, "Made in America: Chemicals," US Department of Commerce, 2011, accessed July 30, 2015, http://www.esa.gov/sites/default/files/chemical-manufacturing-industry-profile.pdf.

[671] Langston, *Toxic Bodies*; Markowitz and Rosner, "Industry Challenges." On growing embrace of the precautionary principle among scientists and activists, see: Steingraber, *Living Downstream*.

person to whom I have shown this image has ever questioned that this was a female body. Most people viewing the image subsequently interpreted its vulnerability as a deeply disturbing visual rhetoric of sexual assault—she appears powerless, ripped open, even decapitated. Nothing in the image, however, explicitly suggests the sexual biologies of this particular person. No breasts, uterus, penis, nor vagina are depicted in the painting. The person's face is deeply androgynous while their hair—an inadequate, heteronormative marker of gender—disappears into a mass of thunderclouds. In fact, the *Life Magazine* copy describes a "surrealistic portrait of the teen-ager sprawled Gulliver-like on *his* back athwart a Lilliputian landscape." This body, aside from its glaring whiteness, can be almost any body (and anybody)—a man or woman, an adult or youth.

Those ambiguities are powerful, for they encourage the viewer to ask who this body is and why it is so vulnerable. How might particular landscapes—with particular histories, geographies, and ecologies—mark this body in terms of sex, time, and—if one is attentive—even race? We must ask how the boundaries securing bodies from their environments might break down in different ways for different people at different times in different places. Difference and permeability express unique geographies of unequal risk and unequal exposure. Bodies are deltas, but not always in the same way. Children bear disproportionate body burdens of environmental toxins. Teenagers, fetuses, and pregnant women, awash in hormones, are more acutely vulnerable to the disruptions of estrogenic chemicals. Cis-gender men and women live with markedly different risks for reproductive tumors, whether of the prostate or of breasts and ovaries. The permeable barrier of the placenta or the lipophilic toxins expressed in breast milk mark women's bodies as distinctly different sites of toxic transmission and inheritance. Raced bodies confront markedly different historical geographies of exposure. And the politics of scientific uncertainty become all the more freighted when those asking questions about exposure and illness are also marked by race and gender. The vulnerabilities of bodies-as-deltas, and the ambiguities of their bodily differences, together suggest the diversely tragic potential of Cancer Alleys all over the world.[672]

In Louisiana's Cancer Alley, people live on the porous edge between their corporeal selves and a soggy environment where chemical plants leak substances that have emerged somewhere in the space between fossil nature and industrial artifice. This permeable place is an assemblage of permeable bodies, leaking industrial infrastructure, and a humid, saturated landscape all promiscuously entangled through flows of water, ooze, and vapor. In Cancer Alley, the lines that separate people, technology, and environment grow indistinct. Indeed, where exactly are the boundaries that distinguish desirable products from hazardous wastes, ancient nature from petrochemical artifice, poisoned human cells from flaring stack or leaking tank, past from present and present from future? The overlooked porosities of factory, landscape, and body in the industrial corridor get entangled to produce a place saturated with toxic risk and uncertainty. Cancer Alley is yet one more crisis of brittle human boundary-making set amidst the dynamic natures of the Mississippi River Delta.

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[672] Note that differences of race and gender here are crucial. Women and people of color have done more—whether striving to bring attention to illness in the home and workplace, fighting against the sexist and racist production of knowledge, or launching environmental justice movements from the ground up—than anyone to shape the history of environmental health. Among the many individuals who have so contributed are: Robert Bullard, Rachel Carson, Ben Chavez, Lois Gibbs, Alice Hamilton, Nancy Langston, Michelle Murphy, Linda Nash, Florence Robinson, Sandra Steingraber, Wilma Subra, Patricia Williams, Beverly Wright—and many more.

Chapter 5: Living With Water

Coda: Deluge

On August 29th of 2005, Hurricane Katrina made landfall in southern Louisiana. Eventually taking 1,833 lives and causing $108 billion in property damage, the storm was one of the deadliest and costliest disasters in United States history.[673] But those statistics do little to illustrate the nightmare that unfolded long after Katrina's winds and punishing rains had calmed. The loss of life and property was compounded by a near total breakdown in physical and social infrastructure, with accompanying spikes in deprivation, disease, and even violence. Millions in the region were affected, but New Orleans saw the most hellish circumstances unfold, particularly as the city's ever-present divisions of race and class exacerbated already acute suffering. While certainly a powerful storm, the true extent of Katrina's brutality in southern Louisiana ultimately emerged not so much from the direct destructive power of hurricane-force winds, but instead from extensive and persistent inundation.

Although heavy rains certainly contributed to flooding in New Orleans, the disaster unfolded most acutely because of Katrina's enormous storm surge and subsequent failures in the levee system. Storm surge occurs when powerful winds and low atmospheric pressure pile water at elevations higher than normal sea level. Katrina's surge was especially devastating to the east of New Orleans on the Mississippi Gulf Coast, where the storm's onshore movement, prevailing winds, and extremely low pressure combined to pile water as much as 25 feet above sea level—

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[673] Damages in: National Weather Service Forecast Office, "Hurricane Katrina: A Look Back 10 Years Later," National Oceanic and Atmospheric Administration: Southern Region Headquarters, accessed May 22, 2016, http://www.srh.noaa.gov/lix/?n=katrina_anniversary. Deaths in: R. B. Seed et al., *Investigation of the Performance of the New Orleans Flood Protection Systems in Hurricane Katrina on August 29, 2005* (Berkeley: University of California, 2006), xix.

one of the highest recorded surges in US history.[674] Although the surge that reached New Orleans was not as high, the wall of water found its way to the city's levees along two routes: first, from the east, via Lake Borgne and the Mississippi River-Gulf Outlet Canal, or MRGO ("Mister Go"), and then second, from the north, via Lake Pontchartrain. The surge flowing through Lake Borgne was estimated at sixteen to eighteen feet above sea level. Subsequently funneled into MRGO, and ultimately the Inner Harbor Navigation Canal (aka, "the industrial canal"), that mass of water would overtop and breach multiple sections of the city's levees, flooding St. Bernard Parish and the Lower Ninth Ward. On the Lake Pontchartrain side, the surge would force its way into the city via breaches in the London Avenue and Seventeenth Street Canals.[675]

Once Katrina's surge entered the city, it combined with massive rainfall to leave eighty percent of New Orleans under anywhere from one to more than fifteen feet of water. Overcome, the city's stormwater pumping system ceased to function, ensuring that it would take weeks before the inundated parts of the city were dry again (and even after dozens of temporary pumps had been brought online). It would take years before those areas would be fully restored. Empty lots, abandoned buildings, and crumbled infrastructure still mark some parts of New Orleans a decade after the disaster.[676]

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[674] National Oceanic and Atmospheric Administration, National Hurricane Center, "Storm Surge Overview," accessed July 30, 2015, http://www.nhc.noaa.gov/surge/.

[675] Seed et al., *Investigation of the Performance of the New Orleans Flood Protection Systems in Hurricane Katrina on August 29, 2005*, 2-10.

[676] On inundation extent, depth, persistence: Jodie Smith and James Rowland, "Temporal Analysis of Floodwater Volumes in New Orleans After Hurricane Katrina," in *Science and the storms: The USGS response to the hurricanes of 2005*, ed. G.S. Farris, G.J. Smith, M.P. Crane, C.R. Demas, L.L. Robbins, and D.L. Lavoie (Reston, VA: U.S. Geological Survey circular 1306, 2007), 57-61.

Katrina marks a coda to this exploration of the interplay between rigid human boundaries and dynamic watery nature. Since the hurricane, Louisiana has moved to the front lines of an effort to redefine human relationships to watery nature. Designers, landscape architects, planners, and engineers have begun proposing new—or, given the history of river rice, perhaps remembered—strategies for inhabiting amphibious terrain. But while these efforts seem to readily embrace porosity and permeability in the Mississippi River Delta, they also remain fraught with challenges. Not everyone in southern Louisiana is in agreement about how best to live with water, and not everyone seems equally to gain. More importantly, there are real obstacles to bringing dynamism, flood, and sediment back into daily life in the region. Without paying careful attention to the often-unnoticed ways in which human boundaries rigidly intervene in wild nature, this embrace of permeability may, in the end, only be superficial.

The Sinking City

As the true extent of the disaster unfolded in the aftermath of the more immediately spectacular hurricane, the public became aware of issues scientists, conservationists, engineers, and planners had been struggling to spotlight for decades. Storm surge, once a comparatively arcane topic, became a matter of national consciousness,[677] while Louisianans acquired still more literacy in the particulars of New Orleans topography, deltaic geomorphology, and wetland erosion. Work by historical geographers long-focused on the intersections of an unequal society with a fundamentally dynamic environment gained new, almost uncannily predictive

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[677] A cursory search of the phrase “storm surge” yielded 35 hits in the *New York Times* archives for the period from August 1, 2000 through August 1, 2005. In comparison, the period from August 1, 2005 through August 1, 2010 yielded 216 hits, with 84 for the period between August of 2005 and August of 2006 alone. Similarly, a search on *LexisNexis* amongst “Major World Publications” in the “headline and lead” field yielded 270 hits for the five years between August 1, 2000 and August 1, 2005. In comparison, the same search for the period between August 1, 2005 and August 1, 2010 resulted in 841 hits.

relevance.[678] As social inequalities of race and class had come to trace the city's topographies of vulnerability, a host of historical interventions in the physical fabric of southern Louisiana's deltaic environment had dramatically intensified Katrina's horrific aftermath. Canals, wetland reclamation, and, ironically, even flood protection infrastructure itself had all conspired to create a sinking city amidst amphibious terrain.

Since Katrina, MRGO has been identified as one of the primary culprits behind the inundation of greater New Orleans. The canal had originally been dredged as a shipping channel to shorten the distance between the Port of New Orleans and the Gulf, but it ultimately performed essentially the same ecological devastation that onshore oil and gas development had since the 1920s. Originally excavated in 1963 at a width of 500 feet, the channel had expanded to over 2,500 feet wide by the twenty-first century.[679] But besides being a substantial conversion of the city's protective wetland buffer into open water in its own right, MRGO also invited saltwater intrusion from the Gulf, killing off surrounding areas of marsh and cypress swamp. Estimates of MRGO's wetland toll are in the tens of thousands of acres, with one some even claiming the total damage stands at a staggering 600,000 acres.[680] Coastal scientists have also suggested that if not for MRGO, levee overtopping during Katrina might have been reduced by as much as eighty percent. The canal has since been deauthorized and blocked with over 350,000 tons of rock. MRGO's role in facilitating Katrina's devastation is an example of the acute

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[678] For example, see the preface to the paperback edition of: Craig Colten, *An Unnatural Metropolis: Wresting Nature from New Orleans* (Baton Rouge: Louisiana State University Press, 2006).

[679] Mark Schleiftsein, "Louisiana Sues Corps of Engineers for $3 Billion Cost of Repairing MR-GO Damaged Wetlands," *Times-Picayune*, October 28, 2014.

[680] Gary Shaffer et al., "The MRGO Navigation Project: A Massive Human-Induced Environmental, Economic, and Storm Disaster, *Journal of Coastal Research* special issue no. 54 (2009): 206-224. The estimate of 600,000 acres is likely far too high, but it gets asserted by wetland restoration groups, e.g., Amanda Moore, "10 Years Post Katrina: Where Have You Gone, Mr. Go?," Restore the Mississippi Delta, accessed July 30, 2015, http://www.mississippiriverdelta.org/blog/2015/06/08/10-years-post-katrina-where-have-you-gone-mr-go/.

vulnerability of the coast in places where wetlands have eroded into open ocean due to erosion and subsidence. In fact, coastal scientists have called the land loss caused by MRGO as a "textbook example" of the fragmentation of Louisiana's coast associated with oil, gas, and other navigation canals.[681] Perforating the city's natural wetland defenses, MRGO and other infrastructure like it had made New Orleans vastly more permeable to disastrous storm surge.

But while phenomena like canal development and land loss help explain how water got into the city—as well as other coastal communities—they do not do much to explain why it stayed for so long, compounding and extending misery in the Big Easy for long after Katrina had dissipated. Historical geographer Richard Campanella remarks that in the aftermath of the hurricane, "pithy journalists" and "newly minted pundits" began declaring loudly, but very much incorrectly, that New Orleans lay entirely below sea level. In fact, for the majority of New Orleans's history, very little—if any—of the inhabited city had actually been at such a low elevation. Historically, almost all development had taken place on the high ground of the natural levees. Here, New Orleans was at about fourteen feet above sea level and then sloped downwards from there toward Lake Pontchartrain. For over 150 years, people had settled, developed, and urbanized New Orleans along those strips of high ground that guaranteed at least some measure of refuge from annual floods.[682] And while some slightly lower areas of the city saw expanding settlement, few dared to establish more than temporary encampments in the more perennially wet, high-risk lowlands in and adjacent to the backswamp.

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[681] On overtopping and "textbook example," see: Shaffer et al., "The MRGO Navigation Project." Despite being a "textbook example" of coastal erosion caused by canals, MRGO was also rather unique in the way it contributed to the inundation of New Orleans: it served to literally funnel storm surge against the city's flood protection infrastructure. For more on MRGO, see: William Freudenburg et al., *Catastrophe in the Making: The Engineering of Katrina and the Disasters of Tomorrow* (Washington, DC: Island Press, 2009).

[682] Richard Campanella, *Bienville's Dilemma: A Historical Geography of New Orleans* (Lafayette, LA: University of Louisiana at Lafayette, 2008), 79-80.

In the late nineteenth century, that development pattern rapidly changed as low-lying areas toward the swampy rear of the city were increasingly reclaimed for urban expansion. Armed with new drainage technologies, developers severed the backswamp from the area's hydrological system and set about transforming soggy muck into dry land. The process—also enabled by levees—was hailed as an engineering feat and a human triumph over decadent, wasteful nature. The city's former wetlands, once drained, however, would compact significantly over time as their alluvial soils settled and shrank in the absence of water and decaying organic matter. The weight of subsequent development only served to make these low areas sink even lower. Over the course of the twentieth century, New Orleans colonized areas at or slightly below sea level, only to see them slowly subside in the ensuing decades. By the year 2000, 49 percent of the city lay below sea level and only 39 percent of its residents still lived above it.[683] Imagining that urban development had fully reconfigured and stabilized the in-between landscape, New Orleanians took to inhabiting former wetlands, unaware that in reality the land had grown substantially *more* unstable, rather than less so.

Most residential expansion into these newly reclaimed wetlands took place on concrete slabs poured at grade-level, especially after World War II. In fact, according to geographer Richard Campanella, any neighborhood marked by an abundance of grade-level architecture is, ironically, almost guaranteed to be in the city's lowest elevations and most at risk of inundation. By comparison, older housing stock on some of the city's highest ground had been built at least a few feet above grade since the very founding of New Orleans. Building with such inattention to topography was not just a phenomenon restricted to New Orleans—due to the combined forces

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[683] 49 percent figure from: Campanella, *Bienville's Dilemma*, 80. Michelle Krupa, "More New Orleans Residents Lived Above Sea Level in 2010, Census Analysis Shows," *Times-Picayune*, February 6, 2011. Also see; Colten, *An Unnatural Metropolis*.

of cost and the homogenization of residential development, slab-on-grade architecture had also spread throughout communities in coastal Louisiana. By the time Hurricane Katrina struck, it seemed many Louisianans had also forgotten they lived in a dynamic deltaic environment. The engineering marvel of draining the backswamp, combined with apparently insurmountable levees throughout the region, had produced a kind of hubris in residents and developers. With nature seemingly subdued, Louisianans had largely abandoned the raised architectural traditions that had once arisen as adaptations to the deltaic landscape.[684]

The levees that suggested deltaic instability was being kept at bay are in fact another reason why parts of New Orleans are so vulnerable to prolonged inundation whenever those defenses get breached. Following the long tradition of impermeable engineering that emerged in the nineteenth century, the Army Corps of Engineers approach to flood-prevention in Louisiana continues to be focused on extremely large, powerful pieces of infrastructure: massive levees, spillways, floodgates, and so on. These hulking, costly interventions on the landscape often start to resemble military fortifications, as in a 2007 diagram of planned improvements in New Orleans following Katrina (Figure 5-1). Much like the attitudes of nineteenth-century engineers and sugar planters, such infrastructure frames water as an enemy to be kept out of the city at almost any cost. "Vast Defenses Now Shielding New Orleans," announced a *New York Times* headline in 2012. Reporter John Schwartz appeared to breathe a sigh of relief on behalf of New Orleans residents: "Finally, there is a wall around this city." He was referring to a "133-mile chain of levees, flood walls, gates and pumps too vast to take in at once, except perhaps from

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[684] On the history of building at grade-level in New Orleans, see: Campanella, *Bienville's Dilemma*, 146-158. On grade-level homes throughout the region: Interview with Bren Haase and Karim Belhadjali of the State of Louisiana Coastal Protection and Restoration Authority, April 21, 2015, conducted by Adam Mandelman. The classic work here is: Gilbert F. White, "Human Adjustment to Floods : A Geographical Approach to the Flood Problem in the United States" (Ph.D. diss., University of Chicago, 1945).

space," costing $14.5 billion. The most spectacular of these fortifications is probably the Lake Borgne Surge Barrier, a 26-foot high, 1.8-mile long wall—itself worth $1.1 billion—that protects the city from storm surges supplied from the eponymous lake.[685]

Figure 5-1: A 2008 US Army Corps of Engineers diagram of flood-protection defenses in New Orleans. Green lines represent Mississippi River levees, while orange and red lines indicate storm surge floodwalls, levees, and barriers. The Lake Borgne Surge Barrier is the red line at the eastern edge of the city.

But, as Manchac's pullboat scars and the accelerated erosion of the delta suggest, keeping water off the landscape actually comes at a very high price. Over three centuries of flood-protection infrastructure has cut the city's soils off from the river that built them. Without annual floods, even the high ground has subsided, although in no way near as catastrophically as the

[685] John Schwartz, "Vast Defenses Now Shielding New Orleans," *New York Times*, June 14, 2012; Rebecca Mowbray, "Lake Borgne Surge Barrier Closed for the First Time," *Times-Picayune*, August 28, 2012.

reclaimed backswamp.[686] Restoring floods and sediments to the city and its suburbs, however, is neither desirable nor even feasible. Instead we must recognize that leveeing has not only lulled residents into a false sense of security, but also compounded vulnerability.[687] By attempting to rigidly contain the unpredictability of a flood-dependent environment, levees ultimately amplified the risk of truly catastrophic inundation in the event those defenses would ever fail.

But levees are not the only intervention that, having been designed to banish water from the city, also invited disastrous watery consequences. As New Orleans developed and spread its impermeable urban surfaces across the landscape, removing stormwater from the city grew increasingly challenging. While New Orleans flood defenses are designed to prevent inundation from either the river in high water, or storm surges from Lake Pontchartrain, they also trap the region's torrential rains. Averaging sixty inches of precipitation each year, the city sometimes sees enough water fall from the sky to cause flash flooding on city streets. With nowhere to go thanks to the city's impermeable flood-protection defenses, all that rain must either evaporate or be pumped out. And in the humid conditions of the Gulf South, the former is not much of an option. By the 1940s, an aggressive drainage and pumping system could keep most of the city's built-up areas—including its newly reclaimed lower reaches—free of stormwater flooding even in rains in excess of three inches. Today, around 1,300 miles of underground pipes connected to 23 pumping stations—among the world's largest—can drain the city's flooded streets within thirty minutes after the last downpour and can handle up to nine inches of rain in 24 hours. Ironically, however, that drainage system has only served to put the Crescent City at further risk.

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[686] Note that the levees themselves are also subsiding: Bob Marshall and Thomas Thoren, "Sections of New, Best-Ever Levee System Are Sinking and Are Likely to be Raised," *The Lens*, May 20, 2015, accessed May 23, 2015, http://thelensnola.org/2015/05/20/sections-of-new-best-ever-levee-system-are-sinking-need-to-be-raised/.

[687] In fact, flood-protection infrastructure directly contributed to persistent inundation after Katrina by impounding rains and storm surge after the city's extensive pumping system had failed.

By pushing rain out of New Orleans, the pumps and pipes have significantly lowered the water table, exacerbating compaction and subsidence of the city's deltaic soils.[688] As we have seen elsewhere in the region, attempting to maintain rigid boundaries between land and water in the delta often seems to just invite calamity.

All told, the horrors of Hurricane Katrina, though they emerged from a variety of *immediate* causes like storm surge, subsidence, and breached levees, can largely be traced to a single *underlying* phenomenon: the nearly 300-year reign of a culture of impermeability devoted to drawing rigid distinctions between land and water. For centuries, a particular set of values guided the ways people settled and pursued livelihoods in this deltaic environment. Discomfort with the watery physical environment—not to mention with the muddy territory of uncertainty—inspired a prevailing body of engineering wisdom, a particular approach to permanent settlement, and a host of other choices that, over centuries, seemed to make this amphibious terrain much less so. Together, these choices sought—at least from a very particular Euro-American perspective—to make the in-between wetland environment profitable and inhabitable. This culture of impermeability is arguably the most significant underlying cause of subsidence and land loss in Louisiana. Hardly an abstraction, however, this culture—or what might be called an *ethic* of impermeability—is actually rooted in a deep human impulse to organize the world into clearly bounded categories. Levees, canals, and water pumps are all technologies devoted to

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[688] Bob Marshall, "Confronting the Enemy Below: Hydrologists Float Plan to Keep Water in the City," *The Lens*, March 2, 2015, accessed July 30, 2015, http://thelensnola.org/2015/03/02/confronting-the-enemy-below-hydrologists-float-plan-to-keep-water-inside-levees/. On the history of draining and pumping New Orleans, see: Colten, *Unnatural Metropolis*, 82-101; Ari Kelman, "Boundary Issues: Clarifying New Orleans's Murky Edges," *Journal of American History* vol. 94, no. 3 (2007): 695–703. In the spring of 2015, journalist Bob Marshall also revealed that the drainage system was only directly designed to handle a ten-year rainfall (about nine inches in 24 hours). The federal government approves the system as protection against 100-year rainfalls (thirteen inches in 24 hours) because streets and open spaces are assumed to store water in extreme events. Which is to say, New Orleans streets were designed to flood. Bob Marshall, "If You Like Your Flood-Insurance Rates, You Should Love It When Your Street Floods," *The Lens*, May 14, 2015, accessed July 30, 2015, http://thelensnola.org/2015/05/14/if-you-like-your-flood-insurance-rates-you-should-love-your-street-flooding/.

carving reliably separate categories of *terra firma* and *aqua liquida* out of the far more tangled, dynamic, and unpredictable mixture that is the deltaic landscape.

Establishing an impermeable order on the mucky terrain has had serious consequences. First, Louisianans increasingly forgot that they lived in an amphibious land that would not exist if not for a whole lot of water. And second, although Louisianans strived to eliminate from their lives the troublesome waters spilling from the Mississippi (or even falling from the sky), doing so invited another, far more catastrophic kind water into their lives—the vast Gulf of Mexico. While unchecked flooding from the Mississippi also once spread catastrophe across southern Louisiana, the disaster currently unfolding threatens to entirely eliminate much of the region's territory. Forgetting how to live with water has ensured that the water will just keep coming. Rita, Gustav, and Isaac followed Katrina, while many more nameless tempests lurk in the warming, rising waters of the Gulf—even as the deltaic environment sinks and fragments. Understanding the long history of human boundary-making in the Mississippi River Delta is to understand the values that animated a centuries-old culture of impermeability, an ethic that cleaved water and land from wetlands and ultimately engendered a drowning world. In the months and years after Hurricane Katrina, however, architects, planners, engineers, and other experts began proposing new visions for both the city and the coast that might re-incorporate some measure of water, sediment, and geological dynamism into the deltaic landscape. These new proposals, though sometimes technocratic and utopian, suggest a new (or perhaps remerging) ethic of living in amphibious terrain that could help avert the very worst of what twenty-first century deluge might hold in store.

Living With Water

At the largest, most ambitious, scale is Louisiana's Coastal Master Plan. Up until Hurricane Katrina, state coastal restoration and flood protection were fragmented among several agencies. In December of 2005, however, the Louisiana legislature created the Coastal Protection and Restoration Authority, or CPRA, to unify all of these efforts under one agency.[689] Within two years, CPRA had created the first Coastal Master Plan, a document that would be updated every five years. Its most recent iteration, released in 2012, calls for $50 billion to restore the coast on an unprecedented scale, including the creation and preservation of up to 800 square miles of wetlands and barrier islands.[690] Although those 800 square miles amount to less than half of what has been lost over the past eighty years, the plan explicitly does not advocate restoring exactly what has eroded into the Gulf, nor does it seek to save everything that currently remains of the delta. Rather, even despite the immensity of what it proposes, the Coastal Master Plan is a much more modest effort to buffer New Orleans and other coastal communities against inundation, to preserve fisheries, and to protect both the nation's largest port and some of its most important petroleum infrastructure.[691]

Those modest (given the scope of the problem) goals nonetheless define what is the most comprehensive and extensive effort to restore amphibious terrain to southern Louisiana. Although the plan includes proposals to build and maintain hundreds of miles of protection levees, it also radically reimagines what flood-protection infrastructure looks like in the twenty-

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[689] State of Louisiana and Coastal Protection and Restoration Authority, "History," accessed July 30, 2015, http://coastal.la.gov/about/history/; State of Louisiana and Coastal Protection and Restoration Authority, "Progress," accessed July 30, 2015, http://coastal.la.gov/a-common-vision/master-plan/progres/.

[690] State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Baton Rouge, LA: Coastal Protection and Restoration Authority of Louisiana, 2012).

[691] For coverage of the Coastal Master Plan, see: Bob Marshall, Al Shaw, and Brian Jacobs, "Louisiana's Moon Shot," *ProPublica*, accessed January 29, 2015, https://projects.propublica.org/larestoration/.

first century by embracing the power of deltaic sediment in the form of dredge-and-fill (aka "beneficial use of dredged material") and sediment diversions (compare with Figure 5-2). Dredge-and-fill reclaims the destructive power of the technology most responsible for accelerated land loss. Hydraulic dredgers scour and pump sediments—or slurry—from where they are needed least to build and restore protective wetlands land up to several miles from the source.[692] Terrebonne Parish is floating a formidable proposal for the 2017 Coastal Master Plan in which a billion-dollar pipeline will send dredged sediments from the Atchafalaya delta to as far as fifty miles west across the parish.[693] Ironically, the project might use an old oil and gas pipeline right of way to do this. For the most part, however, slurry pipelines are typically shorter, smaller affairs that cost tens of millions of dollars, as opposed to Terrebonne's billion-dollar proposal. Sediment diversions, meanwhile, always involve large structures costing hundreds of millions of dollars. Far more expensive than dredge-and-fill in the short term, these projects aim to recreate some of the delta's natural land-building tendencies by diverting sediment-laden waters from the Mississippi and Atchafalaya Rivers onto the subsiding and eroding coast. Where the work of dredge-and-fill begins to unravel almost as soon as it is begun, sediment diversions attempt to rebuild the coast by mimicking deltaic nature.[694]

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[692] State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Baton Rouge, LA: Coastal Protection and Restoration Authority of Louisiana, 2012).

[693] Xerxes Wilson, "Terrebonne Pitching Versions of Billion-Dollar Sediment Project," *Houma Courier*, August 9, 2014.

[694] Much, though not all, of the Coastal Master Plan is focused on fairly large-scale engineering solutions. Accompanying its levees, dredgers, pipelines, and diversions, however, are nonstructural proposals for protecting and maintaining communities in the dynamic environment. Amounting to fully one-fifth of the budget for the plan, these measures, although somewhat vague, involve land-use planning, elevating homes and flood-proofing homes, reducing community risk, and educating the public. Note that alongside the master plan's nonstructural approaches, passage of the federal Biggert-Waters Flood Insurance Reform Act of 2012 will curtail future development in vulnerable geographies along the Gulf Coast. The law mandates requires use of updated floodplain maps (which have changed dramatically on the eroding Louisiana coast) and replacement of subsidized national flood insurance rates with risk-based rates. Unfortunately, in addition to preventing future vulnerability, these insurance changes have also resulted in raising insurance premiums for many property owners from hundreds of dollars per year, to

In the aftermath of Katrina, both the CPRA and the master plan emerged as evidence that Louisiana was attempting to reassess how it protects the coast and its communities. Most remarkably, diversions and dredge-and-fill mark a new approach to the physical fabric of the delta, in which the environment's fluvial processes and mucky sediments are explicitly embraced as new forms of nature-as-infrastructure integral to sustaining life and community in the region. Diversions, in particular, interrupt the levee system that, for the last several hundred years, has created an impermeable landscape in southern Louisiana. Pouring sediment-rich waters from the Mississippi back into the coastal wetlands, these structures introduce permeability (albeit very controlled) back in the deltaic environment.

Figure 5-2: Davis Pond freshwater diversion sometime after completion in 2002. This structure was built to defend against saltwater intrusion by diverting freshwater from the Mississippi into the coastal marshes. Though similar in principle, sediment diversions are constructed differently in order to maximize the amount of suspended sediment in diverted waters. The Davis Pond structure (just downriver from the site of 1884 Davis Crevasse discussed in chapter one) has a maximum capacity of 11,000 cubic feet of water per second (cfs), an order of magnitude smaller than some of the 250,000 cfs sediment diversions proposed in the 2012 Coastal Master Plan. Photo courtesy of the US Army Corps of Engineers.

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tens of thousands—a painful, even impossible, burden. State of Louisiana and Coastal Protection and Restoration Authority, *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (Baton Rouge, LA: Coastal Protection and Restoration Authority of Louisiana, 2012).

But even though the master plan is in many ways a radical departure from previous approaches to coastal restoration and flood-protection, large-scale engineering projects still predominate in the document, suggesting the CPRA is not totally willing to abandon the status quo. And, as a state-sponsored plan, it is comparatively more conservative in its approach to coastal restoration. Far more radical and visionary have been the numerous independent planning and design proposals that have flourished since Katrina.

According to architectural historians and critics Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot, the hurricane was a critical event in the disciplinary evolution of fields like architecture, planning, and urban design. For Reese, Sorkin, and Fontenot, the deluge inspired "the greatest outpouring of disaster-response design efforts in the history of the United States, . . . ranging from the practical to the visionary," and targeted at all scales, from individual buildings, through the neighborhood, to the metropolitan region.[695] For architectural scholars Jacob Wagner and Michael Frisch, Katrina created a "design moment" for New Orleans in which some of the most basic assumptions about urban planning and architectural practice could be questioned while the city—in fact, even the region—could be envisioned and imagined anew.[696] For professor of architecture and former New Orleans resident Derek Hoeferlin, Katrina inspired him to reimagine the nature of his practice and to see the broader social and ecological potential of design-related expertise.[697] If the Coastal Master Plan offered a new engineering vision for restoring southern Louisiana's coast, the design moment suggested a flurry of new ways of

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[695] Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot, "Introduction," in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), xvi-xxix.

[696] Jacob Wagner and Michael Frisch, "Introduction: New Orleans and the Design Moment," *Journal of Urban Design* vol. 14, no. 3 (2009): 237-255.

[697] Interview with Derek Hoeferlin, April 30, 2015, conducted by Adam Mandelman.

inhabiting the deltaic environment. Key to these reimaginations of New Orleans and other coastal communities was a commitment to exploring watery dynamism and uncertainty. Writing for Reese et al.'s 2014 edited volume about reconstructing the city, designers Anuradha Mathur and Dilip da Cunha asked, "So how do we rebuild a New Orleans without the image and imagination of a line, a New Orleans that does not have its beginnings on a piece of ground between river and backswamps but rather in a liquid terrain."[698] For these designers, architects, and planners, engaging directly with the amphibious environment—as opposed to disentangling and rigidly stabilizing its in-betweenness—suggested (perhaps counterintuitively) the promise of a more adaptable human relationship with the delta.

One of the most important figures in this movement is the firm Waggonner & Ball Architects, led by principal David Waggonner. The son of a segregationist Democratic U.S. Representative from Louisiana, Waggonner is one of the more simultaneously innovative and practical designers working to reimagine New Orleans. The firm's influence on watery matters in the city began when it organized "Dutch Dialogues," a series of workshop collaborations between planners, architects, engineers, and other experts from the Netherlands and their Louisiana counterparts. The Dutch collaboration was inspired in part by a comparatively recent turn in the Netherlands toward environmentally oriented engineering guided by the slogan "Building with Nature"—now an official national program.[699] This new Dutch approach to "soft" engineering has created plans like Room for the River, an effort to lower dikes, create

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[698] Anurada Mathur and Dilip da Cunha, "Beyond the Line," in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), 470-473, 473. Mathur and da Cunha are well-known in design circles for their evocative maps and figures exploring the Mississippi River and estuarine Mumbai: Anuradha Mathur and Dilip da Cunha, *Soak: Mumbai in an Estuary* (New Delhi: Rupa & Co., 2009).

[699] The "Building With Nature" national program is administered by the EcoShape consortium: EcoShape, "Welcome to Building With Nature," accessed July 30, 2015, http://www.ecoshape.nl/.

spillways for high water, and restore drained land as marsh and floodplain.[700] Perhaps following the pithy "Building with Nature" of the Netherlands, Waggonner has gone on to promote—and in fact trademark—the slogan "living with water" for New Orleans and the region.[701] Much like Mathur and da Cunha, Waggonner's practice emerges from a conviction that the region's coastal struggles are largely the result of mistaken assumptions and values about living in a dynamic, amphibious landscape. He even describes the sorting and classification of land and water in the deltaic environment as a "fundamental problem of the human mind." Waggonner continues, "If I'm always sorting, I'm not really open to investigation and intuition."[702] On occasion, "living with water," in its ambitions to reorient people's values and reincorporate dynamic water into people's lives and communities, almost looks like an amphibious adaptation of Aldo Leopold's Land Ethic.[703] The work of Waggonner & Ball, following the Dutch, is the most explicit and sustained embrace of permeability in the urbanized landscapes of the Mississippi River Delta.

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[700] Michael Kimmelman, "Going With the Flow," *New York Times*, February 13, 2013; Tracy McVeigh, "The Dutch Solution to Floods: Live With Water, Don't Fight It," *The Guardian*, February 15, 2014. For the history of Dutch water management, see: Salvatore Ciriacono, *Building on Water: Venice, Holland, and the Construction of the European Landscape in Early Modern Times* (New York: Berghahn Books, 2006); Erik van der Vleuten and Cornelis Disco, "Water Wizards: Reshaping Wet Nature and Society," *History and Technology* vol. 20, no. 3 (2004): 291-309.

[701] The trademarking of "living with water" was, according to Waggonner, a response to larger firms supported by entities like the Rand Corporation repeatedly using Waggonner & Ball's vocabulary to outcompete the firm on design bids. But compared with asserting intellectual property on a product like the Dutch Dialogues workshops (also trademarked), doing so on a phrase as commonplace as "living with water" seems to also suggest the neoliberal potential of the post-Katrina New Orleans design moment. Interview with David Waggonner, April 22, 2015, conducted by Adam Mandelman. Note that this kind of engineering and design imaginary has been embraced not just in Louisiana, but also the northeastern United States after Sandy, as well as in deltaic and estuarine environments globally, from London to Southeast Asia: Piet Dircke, Jeroen Aerts, Arnoud Molenaar, *Connecting Delta Cities* (Rotterdam: City of Rotterdam, 2010); Ewan Willars, ed. *Living With Water: Visions of a Flooded Future* (London: Building Futures, 2007).

[702] Interview with David Waggonner, April 22, 2015, conducted by Adam Mandelman.

[703] Aldo Leopold, *A Sand County Almanac, and Sketches Here and There* (New York: Oxford University Press, 1949). A water ethic (and not just concerning water as a drinking resource, but also a part of totality of the environment) is the subject of another dissertation.

The first two Dutch Dialogues that Waggonner & Ball convened took place in March and October of 2008, with the second workshop resulting in a book: *Dutch Dialogues, New Orleans/Netherlands: Common Challenges in Urbanized Deltas*. The third workshop took place in conjunction with the American Planning Association's 2010 meeting held in New Orleans and devoted largely to the concept of "delta urbanism."[704] Proposals emerging from the Dutch Dialogues series advocate for water as an ecological, economic, and infrastructural amenity, and envision permeable urban environments in which flowing water is integrated into daily lives and livelihoods, as well as into the physical fabric of flood protection and mitigation. These projects aim to better store and circulate urban water (especially stormwater), reconnect impounded waterways, restore wetlands and wildlife habitat, recharge groundwater to combat subsidence, and much more.[705] The third Dutch Dialogues workshop, meanwhile, elaborated an image of the deltaic city as a vast circulatory system in which visible flows of water offer new urban services.[706] Altogether, this Dutch-inspired—but deeply New Orleanian—design moment seeks to promote a visible, working presence for water in direct contrast to the existing impermeable city where water has been either banished or hidden from the landscape through leveeing, draining, channelizing, and pumping. Ultimately, Waggonner & Ball's "living with water" attempts to transform not just the physical fabric of the city, but also a prevailing set of cultural

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[704] On the phrase "delta urbanism," see: Richard Campanella, *Delta Urbanism: New Orleans* (Chicago: Planners Press, 2010). Note that this is largely a synthesis and digest of his previous books on New Orleans, particularly *Bienville's Dilemma*.

[705] Han Meyer, Dale Morris, and David Waggonner, eds., *Dutch Dialogues, New Orleans/Netherlands: Common Challenges in Urbanized Deltas* (Amsterdam: SUN, 2009); P. Hermens, J. N. van der Salm, and C. van der Zwet, "A Working Landscape for New Orleans" (Thesis, Wageningen University, 2010). Note that these kinds of design principles go back at least to Ian McHarg's 1969 landmark text, *Design with Nature*, and the philosophy of water management developed in the 1950s-1970s by Luna Leopold. It might be said that Luna Leopold's work sought to conceive of an explicitly water-oriented set of values to accompany his father Aldo's land ethic. Ian McHarg, *Design With Nature* (Garden City: Natural History Press, 1969).

[706] Interview with David Waggonner, April 22, 2015, conducted by Adam Mandelman.

and policy orthodoxies when it comes to human negotiations of the uncertain boundaries between land and water in the region's amphibious environment.

Waggonner & Ball's most significant effort to emerge out of the Dutch Dialogues series is the Greater New Orleans Urban Water Plan. Funded by a $2.5 million Department of Housing and Urban Development grant, the project complements the Coastal Master Plan and presents a long-term strategy for urban water management, including proposals for mitigating subsidence and stormwater flooding. The Greater New Orleans Urban Water Plan—including three reports clocking in at about 600 pages—is the first document of its kind for any city in the United States and won the American Planning Association's 2014 Excellence Award. Costing three to six billion dollars depending on implementation, the plan uses principles developed through Dutch Dialogues in the hope of confronting not just the ecological challenges of a sinking city in the midst of a threatened coast, but also the social economic challenges as well.[707] The document's most concrete and radical embrace of the permeable city lies in its plan to halt and even reverse some of the disastrous subsidence caused by pumping stormwater out of New Orleans. Instead of removing rainfall from the city, the Greater New Orleans Urban Water Plan will slow, store, and circulate stormwater, ultimately reducing dangerous street flooding and, more importantly, recharging the water table.

The plan's nine-million-dollar pilot project is the Lafitte Greenway (Figure 5-3).[708] Begun in spring of 2014, the greenway is a 2.6-mile bike path and pedestrian parkway built over

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[707] All three reports can be obtained at the projects website: Waggonner & Ball Architects, "Greater New Orleans Urban Water Plan," accessed July 30, 2015, http://livingwithwater.com/blog/urban_water_plan/reports/. On the cost of the plan: Waggonner & Ball Architects, *Greater New Orleans Urban Water Plan: Implementation* (New Orleans: Waggonner & Ball Architects, 2013), 48. For a slightly more realist look at the GNOUWP, see: Jessica Fisch, "Green Infrastructure and the Sustainability Concept: A Case Study of the Greater New Orleans Urban Water Plan" (MA thesis, University of New Orleans, 2014).

[708] Friends of Lafitte Corridor, "The Lafitte Greenway," accessed July 30, 2015, http://www.lafittegreenway.org/.

the former (and filled) Carondelet Canal. Trees and meadows will help absorb rainfall, while bioswales, water gardens, filtration ponds, and even a public swimming pool will help store and circulate excess stormwater. Ultimately, projects like the Lafitte Greenway would be replicated throughout the city, making New Orleans the "Amsterdam of North America" by transforming 82 miles of open drainage canals into a hybrid of urban amenities and more functional water-management infrastructure. Alongside these canals, empty lots abandoned since Katrina would be converted into rain gardens, streets and parking lots would be resurfaced with porous materials, and homes throughout the city would be fitted with rain barrels and other runoff-reduction measures.[709] All told, Waggonner & Ball estimate the plan would support from 44,000 to 100,000 jobs and $22 billion in positive economic impacts over fifty years.[710] If the project to restore some permeability to the city's stormwater system is not already ambitious enough, its supporters hope that, far from gentrifying New Orleans, the improvements in the plan will help mitigate some of the city's most entrenched social inequality. Indeed, a 2015 *Times-Picayune* article explored "How fixing flooding can also reduce crime."[711] While it may be easy to be skeptical about such utopian aspirations, it is important to recognize that projects like the Lafitte Greenway articulate a vision for the social potential of flowing water that has not been seen in Louisiana for a very long time—perhaps since nineteenth-century river rice. By dreaming of the ways permeability might solve not just physical problems like street flooding or subsidence, but also social problems like crime and poverty, these planners and designers are making claims

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[709] Marshall, "Confronting the Enemy Below." Although Marshall discusses the Greater New Orleans Urban Water Plan in general terms and does not mention the Lafitte Greenway directly, the corridor remains at the center of the urban water plan.

[710] Waggonner & Ball Architects, *Implementation*, 48.

[711] Robert McClendon, "Making New Orleans Resilient: How Fixing Flooding Can Also Reduce Crime," *Times-Picayune*, April 20, 2015.

about water and the urban landscape that are radically different from the values that have defined New Orleans since its founding.[712]

Figure 5-3: The Lafitte corridor (top) reimagined as a greenway (bottom). Images courtesy of Waggonner & Ball Architects.

[712] The Greater New Orleans Urban Water Plan is not the only kind of watery intervention taking place in the city. Ripple Effect is a project supported by Waggonner & Ball to create "water literacy" programs in New Orleans public schools. Operating at the intersection of design and education, the program simultaneously remediates school grounds to solve flooding problems while investing in teacher training, curriculum development, and outreach. Gutter to Gulf, meanwhile, is a collaboration between design students and faculty at the University of Toronto and Washington University in St. Louis. Led by Jane Wolff—a Dutch Dialogues participant—and Derek Hoeferlin—a former Waggonner &B Ball employee—Gutter to Gulf seeks to develop ideas for reimagining New Orleans and the region without the constraints of designing for conventional clients, whether in the private or public sector. Ripple Effect, "Water Literacy for New Orleans," accessed July 30, 2015, http://rippleeffectnola.com/; Gutter to Gulf, "Gutter to Gulf," accessed July 30, 2015, http://www.guttertogulf.com/.

Although Waggonner & Ball may seem like a pervasive influence in the city's watery design moment, other similar efforts abound, particularly when it comes to the coastal region as a whole.[713] Louisiana State University's Coastal Sustainability Studio is a trans-disciplinary program working in conjunction with the Coastal Master Plan. Led by Jeff Carney, the studio brings together students and faculty from a diverse array of disciplines to design alternative plans for restoring the coast, building community resilience, and reducing vulnerability. These plans, much like the Lafitte Greenway, try to imagine productive adaptations to watery dynamism in southern Louisiana communities. In fact, the Coastal Sustainability Studio is also a member of one of three finalist teams in Changing Course, a major international design competition supported by the state of Louisiana and the Army Corps of Engineers. Organized to generate new visions for a "self-sustaining delta ecosystem" that are both groundbreaking and practicable, Changing Course is one of the biggest arenas for reimagining life in the Mississippi River Delta. Winning designs are expected to form part of the 2017 Coastal Master Plan.[714] The post-Katrina design moment has thus begun to percolate upwards to affect even the more conservative state-sponsored approach to coastal restoration. Euro-American occupation of the Mississippi River Delta has, with only very few exceptions, involved a process of reordering and stabilizing the watery environment, with disastrous consequences. Now, almost exactly three hundred years after the founding of New Orleans, the state of Louisiana will be entertaining design proposals that seek to embrace at least some measure of deltaic variability.

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[713] Also see: Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot, eds. *New Orleans Under Reconstruction: The Crisis of Planning* (New York: Verso, 2014).

[714] The Coastal Sustainability Studio represents fields including: coastal science, engineering, architecture and design, history, geography, philosophy, law, and religious studies. Louisiana State University Coastal Sustainability Studio, "Coastal Sustainability Studio," accessed July 30, 2015, http://css.lsu.edu/. Changing Course, "Navigating the Future of the Lower Mississippi River Delta," accessed July 30, 2015, http://changingcourse.us/the-competition/about-the-competition/. Note that Waggonner & Ball were on a team that did not succeed to the second round of the competition.

For all of these new efforts to transform the ways people imagine, understand, and inhabit southern Louisiana's amphibious environment, however, "living with water" faces some significant obstacles. For one, in the absence of a major disaster, entrenched habits of living *without* water stubbornly persist. New Orleans is currently in the midst of an enormous real estate boom that, according to some observers, is in part the product of a kind of post-Katrina heedlessness. Gulf Restoration Network activist Scott Eustis calls the glib wave of investment enthusiasm "the new abnormal" for the ways it seems to ignore (or perhaps have forgotten) the region's acute climate precarity. But aside from these kinds of anecdotal observations, there are three very concrete challenges to implementing the visions of projects like Dutch Dialogues, Gutter to Gulf, and Changing Course. First, not everyone in southern Louisiana agrees on how to pursue coastal restoration and stem the tide of land loss. Second, entrenched inequality in New Orleans, combined with some distinctly neoliberal aspects of the city's character since Katrina, suggest some of the socio-economic aspirations of living with water are profoundly utopian, if not themselves vulnerable to neoliberal capture. And, finally, there are very real physical limits on the extent to which deltaic processes can be restored and water reincorporated into people's lives in southern Louisiana, particularly in New Orleans.[715]

Since publication of the Coastal Master Plan in 2012, contentious disagreement has emerged around its proposals to use sediment diversions to restore the delta's wetlands. Groups representing the fishing industry, from sport fishers to large commercial operations, vehemently oppose diversions because, among other reasons, the industry fears river water will disrupt existing salinity gradients along the coast, thereby damaging fisheries and wetland nurseries while also pushing catches further into the Gulf. Fishers also argue that diverting the nutrient-

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[715] Interview with Scott Eustis, March 18, 2015, conducted by Adam Mandelman.

rich Mississippi into the coastal wetlands will weaken marsh grasses which, doused with fertilizers, will not grow sufficient rootstock to remain anchored in delta sediments. That shifting edge between fresh and salt water is thus yet another of the many challenging boundaries people have had to negotiate in coastal Louisiana. Although too much saltwater rapidly accelerates Louisiana's fragmentation into the Gulf, compensating with too much freshwater from the river will threaten fisheries that are the life's blood of the region's culture and economy.[716] Much like the sugar planters and rice planters of late nineteenth-century Louisiana, coastal restoration scientists and fishers are in a struggle over permeability.[717]

Fishers have similarly opposed restoration efforts targeting the land loss resulting from MRGO. Complaining that salinity changes from the canal's closure will result in a precipitous decline in saltwater fisheries like trout, shrimp, and crabs, the industry wants to see restoration efforts that preserve the *current* balance of salt and fresh along the coast. As Robert Campo, born to a line of famous fishermen, complains, "We gotta get that salinity back up, or this fishing will never be like it was." And yet, maintaining the status quo is fundamentally unrealistic given the dynamic state of the delta, particularly since the oil and gas industry began dredging the coast in

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[716] These opponents of sediment diversions argue instead for a complete focus on dredge-and-fill for restoring coastal wetlands. But given the tendency for dredge-and-fill sites to erode and subside as quickly as they are created, such an approach would make coastal restoration nothing short of Sisyphean. Captain George Ricks, "Sediment Diversions Won't Save the Coast—and They'll Be Bad News for Fishermen," *The Lens*, February 24, 2014, accessed July 30, 2015, http://thelensnola.org/2014/02/24/sediment-diversions-wont-save-the-coast-and-theyll-be-bad-news-for-fishermen/; The Editors, "Opposing Opinions on River Diversion Show Contentious Nature of Coastal Master Plan," *The Lens*, March 26, 2015, accessed July 30, 2015, http://thelensnola.org/2015/03/26/opposing-opinions-on-river-diversions-show-contentious-nature-of-coastal-master-plan/.

[717] Fishers are not the only ones complicating plans to build sediment diversions. In the fall of 2014, author and essayist Nathaniel Rich revealed what seemed to be a cynical effort in Plaquemines Parish to invite energy development in the form of coal terminals and oil tank farms that, in one case, threatened to undermine the proposed Mid-Barataria Sediment Diversion. For parish president Billy Nungesser, bringing energy facilities on which the whole nation depends to Plaquemines Parish offers communities far more of "a fighting chance" than the Coastal Master Plan. After all, building critical energy infrastructure increases the likelihood that the federal government will help pick up the tab on coastal restoration and flood protection. Nathaniel Rich, "Louisiana Has a Wild Plan to Save Itself from Global Warming," *New Republic*, September 30, 2014; Benjamin Alexander-Bloch, "Plaquemines Judge Strikes State Permit to RAM Coal Export," *Times-Picayune*, December 30, 2014.

the late 1920s. Journalist Bob Marshall has reported that despite the memories of fishermen, the seeming status quo is actually a temporary product of the delta's recent instability. Prior to the completion of MRGO in 1963, the Pontchartrain Basin was considered a largely freshwater system; the abundant saltwater catches enjoyed in the canal's area over the last several decades do not at all match the historical record. Saltwater intrusion and coastal erosion brought new species to the area while rapid wetland decay fueled what has actually been an unprecedented level of productivity in the system. Ironically, then, the fishing industry refuses to embrace the transience and dynamism of the delta even when what seems to be a status quo of abundant fisheries is also just the temporary state of a system in rapid flux.[718]

Where disagreements over the best approach to coastal restoration threaten to undermine regional efforts to live with water, profound inequality in New Orleans raises concerns that utopian visions for a floating city will only just further deepen the city's rifts of race and class. Perhaps the loudest warning in this territory has been Naomi Klein's *The Shock Doctrine*, which argued that post-Katrina New Orleans was becoming a privatization free-for-all where reconstruction would enrich corporations over city residents.[719] Combine those concerns with the historic problems of transparency and mistrust in Louisiana government and it is no surprise that fiascos like the 2006 "green dot" controversy—in which whole neighborhoods appeared to be marked for abandonment following Katrina—ensued.[720] More critical perspectives would view

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[718] Bob Marshall, "Dam It: Fishers Frustrated by Closing of MRGO, but Some Catches Increase," *The Lens*, March 13, 2015, accessed July 30, 2015, http://thelensnola.org/2015/03/13/dam-it-fishers-frustrated-by-closing-of-mrgo-but-catches-are-up/.

[719] Naomi Klein, *The Shock Doctrine: The Rise of Disaster Capitalism* (New York: Metropolitan Books, 2007).

[720] M. Christine Boyer, "New Orleans Under Reconstruction: A Crisis in Planning and Human Security," in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), 121-153; Melissa Harris-Perry and William M. Harris, Sr., "Ethical Dilemmas in Post-Katrina New Orleans Planning," in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), 154-169.

the depoliticized utopianism of the “living with water” vision focuses too much on aesthetics and amenities—a form of economic development that is acutely vulnerable to the kinds of neoliberal capture that Klein both observed and forewarned.[721] Indeed, for as much as actors like Waggonner & Ball or Gutter to Gulf design systems that appear innovative in part because of their aspirations to social equity, their language not infrequently contains the rhetoric of the apolitical rationalist and technocrat. David Waggonner observes that “the role of the architect is to figure out what the problem is and to try to solve it.”[722] Problem-solving is of course an admirable goal, but framed in this way, it overlooks the ways power and privilege often obscure the fact that few planning problems have clear solutions that can benefit all stakeholders equally. “Ecological gentrification”—in which living with water not only fails to benefit the city’s most vulnerable residents, but also ultimately displaces them—is a real risk.[723]

These concerns remind us that permeability can be expressed with many different social outcomes. When negotiating the future of human life in the Mississippi River Delta, politics and values cannot be glossed or ignored. Imagining that New Orleans and other communities in the region can, with pure technocratic vision or clear engineering intention, cleanly and easily embrace permeability is to forget much of what we have seen so far. Nineteenth-century political struggles over rice flumes remind us that something like the Lafitte Greenway emerges amidst

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[721] Mike Davis, “Foreword: Sittin’ on the Porch with a Shotgun,” in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), ix-xv; Yates McKee, “Haunted Housing: Eco-Vanguardism and Eviction in New Orleans,” *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), 407-417. For a more measured critique involving the Greater New Orleans Urban Water Plan, see: Fisch, “Green Infrastructure.”

[722] David Waggonner, “Ground Zero,” in *New Orleans Under Reconstruction: The Crisis of Planning*, edited by Carol McMichael Reese, Michael Sorkin, and Anthony Fontenot (New York: Verso, 2014), 475-498, 478.

[723] Sarah Drooling, “Ecological Gentrification: A Research Agenda Exploring Justice in the City,” *International Journal of Urban and Regional Research* 33 (2009): 621-639; Jennifer Wolch, Jason Byrne, and Joshua Newell, “Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities ‘Just Green Enough,’” *Landscape and Urban Planning* 125 (2014): 234-44.

complex social values. The prodigious labors required to transform swamps into cypress logging territory should give us pause, for how much similarly herculean, messy, and capital-intensive labor might it take to rebuild a dying delta? The dire consequences of transforming wetlands into petroleum infrastructure, meanwhile, should serve as a warning that rarely can nature be so easily engineered to do what we expect of it. And finally, the shifting, permeable boundaries of different human bodies over time should suggest that there are in fact many different, often deeply uneven ways of restoring amphibious terrain back into delta communities.

Ultimately, there are also real physical limits to the extent that southern Louisiana can live with water, particularly in New Orleans. Jeff Carney, director of LSU's Coastal Sustainability Studio observes that there will always remain some sort of incompatibility between the deltaic system and urban settlement. "The French Quarter is a perfect grid. There's a decision to be urban. There's a decision to reject the natural system. And you're not going to change that. . . . Biomimicry is great, but there's a line." For Carney, the new design moment in New Orleans is in large part a kind of aestheticized urban infrastructure. Much like a Japanese garden, living with water is "a way to evoke something that's wild, but it's clearly an artifice." Living with water in New Orleans is not—nor should it ever be—a true reintroduction of deltaic hydrology: "It's not the real thing. The Mississippi River is not being allowed to flow back. We're not opening up crevasses into New Orleans and saying 'we're going to build land here with a crevasse.'" Outside New Orleans, of course, there is far more room to reintroduce deltaic hydrology, and yet, even in these less urbanized environments, there remain some unavoidable tensions between human habitation and watery dynamism. The challenge that the CPRA and the Coastal Master Plan must meet, Carney argues, is "how do you reintroduce the natural system, but at the same time do not take out navigation, or take out the oil industry in the process?

There's a point where we are an urban society and the idea of restoring the system becomes self-defeating to the whole reason we're here in the first place."[724] Indeed, without attending to the ways even human-engineered porosity can be rigid and inflexible in the face of amphibiousness, it seems it would be very easy for "living with water" to simply build new brittle structures in the dynamic environment.

There are, of course, countless reasons why humans have settled amphibious terrain, and not just in the Mississippi River Delta, but all over the globe. From the Netherlands to the Mekong, people have long strived to inhabit amphibious landscapes. Deltas in particular have seen human settlement almost since their very beginnings, when sea levels began stabilizing some eight thousand years ago in the wake of the last ice age. But although history offers many exceptions, modern settlers seem to have, for the most part, become increasingly uncomfortable with the uncertainties of muddy ground. Paradox marks the world's deltas and estuaries: as supremely productive ecologies at the meeting place of land and water, they have almost universally attracted various forms of human settlement. And yet, that human occupation of the landscape almost inevitably sought—particularly in the last several centuries—to stabilize the perceived disorder and in-betweenness of amphibious terrain. Whether for permanent dwellings, agriculture, resource extraction, or for some other industry, human communities have often felt increasingly compelled to sort and bound the watery terrain into rigid, brittle categories of land and water, fundamentally undermining the essence of what made *terra anfíbia* so full of promise and abundance to begin with. Today, deltas and estuaries all over the world are foundering and unraveling into their respective oceans. And in our present era of rising sea levels and

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[724] Interview with Jeff Carney, March 19, 2015, conducted by Adam Mandelman.

increasingly unpredictable (or unfamiliar) weather, this fragmentation renders coastal environments doubly threatened.[725]

But while levees, canals, and wetland reclamation are the immediate causes of land loss in the Mississippi River Delta—and of similar environmental change all over the world—I have tried to suggest that we can only truly understand the fragmentation of the in-between landscape by examining the broader underlying the values of impermeability and stability that animated levees, dredgers, and pumps. Cleaving the wet and the land from the region's wetlands was only just one expression of a whole host of boundary-making classifications and categories that humans brought to southern Louisiana's watery environment.

So, for example, most explanations of land loss—focusing in part on the lack of new deltaic sediments—blame Army Corps of Engineers flood protection infrastructure for arresting the Mississippi River's land-building machine. But the historical processes that would ultimately sever the Mississippi from its delta had already been set in motion over 150 years before the Army Corps would get involved in leveeing the region. Though it would at first grow haltingly and inconsistently, the seeds of an impermeable society had been planted in the rich deltaic soil at the very moment Bienville first founded New Orleans.

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[725] On histories of deltaic habitation see: J. Budel, "Deltas: Basis of Culture and Civilization," in *Scientific Problems of the Humid Tropical Zone Deltas and Their Implications* (Paris: UNESCO, 1966), 295–300; J. W. Day et al., "Emergence of Complex Societies after Sea Level Stabilized," *Eos, Transactions, American Geophysical Union* 88, no. 15 (2007): 169–70; Douglas J. Kennett and James P. Kennett, "Early State Formation in Southern Mesopotamia: Sea Levels, Shorelines, and Climate Change," *Journal of Island and Coastal Archeology* 1, no. 1 (2006): 67–99; Daniel J. Stanley and Andrew G. Warne, "Holocene Sea-Level Change and Early Human Utilization of Deltas," *Geological Society of America Today* 7, no. 12 (1997): 1–7; Mark A. Rees, *Archaeology of Louisiana* (Baton Rouge: LSU Press, 2010); Tristram R. Kidder, "Making the City Inevitable: Native Americans and the Geography of New Orleans," in *Transforming New Orleans and Its Environs: Centuries of Change* (Pittsburgh: University of Pittsburgh Press, 2001), 9–21. Exceptions to this story of domestication and rationalization, include the *crannog* settlements of the British Isles, the Marsh Arab communities of Iraq, the floating markets of Vietnam, and, of course, the Cajuns of Louisiana. Frequently, people's intimate relationships with watery landscapes have also a form of refuge or even outright resistance for marginalized peoples. On wetlands as environments of resistance, see: James C Scott, *The Art of Not Being Governed: An Anarchist History of Upland Southeast Asia* (New Haven: Yale University Press, 2009).

The history of dissenting rice planters in the nineteenth century reveals quite clearly that the project of leveeing southern Louisiana was not a value-free technocratic effort to solve a simple engineering problem. Rather, preventing flood in the delta was inextricably woven into an ideology of progress that imagined the best way to improve Louisiana was to barricade and drain its lands. Subsequent conflicts between rice planters on one side and engineers, sugar planters, and some lawmakers on the other revealed that the question of impermeable levees not only turned around visions of progress, but also reverberated outward through nineteenth-century Louisiana society to shape people's ideas of nature, health, and even freedom.

Indeed engineers were clamoring for impermeable levees at a time when slave bodies routinely leaked into the river and its backswamps and bayous in search of either escape or some measure of independence from their masters. And though it is likely only coincidence, the fiercest conflicts over flumes and permeability came in the decades after the Civil War when the boundaries separating blackness from whiteness in Louisiana were growing their most rigid. Ultimately, the recent turn toward living with water in Louisiana should put to rest any doubts that a broader moral universe underpinned debates over leveeing and flumes. Rice planters embracing permeability believed—not unlike the architects of the post-Katrina design moment—that whatever the actual risks, flowing water conferred ecological, economic, and health benefits that were in short supply in the impermeably leveed landscape.

The pullboat logging scars that testify to the arrested and subsiding Mississippi River Delta, meanwhile, are similarly not merely a record of an engineering solution to a wetland problem. The hubs and spokes of Manchac document the enormous effort and capital required to create value out of what was imagined to be wasted swampland, thus connecting an ever-greater slice of Louisiana's territory with the markets feeding the state's development.

The process of enclosing *Taxodium distichum*—abstracting the tree out of its ecosystem and into commodity markets—allowed lumber companies to create meaning out of an unruly, often inaccessible, and seemingly undifferentiated morass. In order to do so, cypress companies reorganized the amphibious swamps into distinct categories of water and land in the form of logging canals, pullboat runs, and skidding railways. By opening a resource frontier in Louisiana's cypress swamps, the lumber industry asserted boundaries around a commodity, defined the limits of a logging territory, differentiated between resource and waste, and even made distinctions among its workers as lumber companies defined the abilities of whites, blacks, and Cajuns to labor in the watery environment. Reconfiguring the forested swamps into a cypress frontier was an immense project not just of reordering the physical environment, but also of people's categories of nature.

When the cypress frontier gave way to a wetland oil and gas frontier in the late 1920s, a very similar set of boundary-making phenomena unfolded along Louisiana's coast. Just as cypress logging required some transformation of *Taxodium* into lumber, oil and gas companies needed to detect, assay, and map petroleum reserves beneath the coastal wetlands before extraction could begin. That process suggested a much longer history of boundary-making as a substance once confused with tree resin and ambergris slowly congealed into the profoundly twentieth-century energy resource we recognize today. Extracting that resource also resembled pullboating operations, but with one crucial difference. Although logging runs remain visibly etched into the present-day landscape, they were never intended to be durable infrastructure. Whether extracted by pullboat or rail skidder, cypress operations only lasted for the weeks or months it took to cut over a swampy tract. In Louisiana's wetland oilfields, by contrast, a far more intentionally durable resource frontier took shape.

Solving the problem of petroleum extraction in the watery environment transformed nature into (seemingly) long-lasting infrastructure by converting marsh and swamp to canals and spoil banks. Again, not just a value-free engineering solution, the practice of carving hard edges into the deltaic environment also emerged in part because of the daunting instability and otherworldliness of amphibious terrain. By dredging the coastal margin into a hard, perforated edge, the oil and gas industry's boundary-making ultimately accelerated the erosion of the sediment-starved delta, creating an entirely new experience of geologic time in the region. The creeping millennia of a deltaic lifetime punctured people's sense of place along the coast. Sedimentary geology is suddenly, tangibly, and visibly eroding beneath their very feet.

Land loss, however, is not the only acute crisis of boundary-making in the Mississippi River Delta. Cleaving water and land from amphibious terrain is not the only condition by which we can observe the (often disastrous) encounter between wild, unpredictable nature and people's demarcations of the physical world. In the mid-twentieth century, increasing quantities of the wetland oil harvested from Louisiana's coast would be diverted up to the region's riparian industrial corridor between Baton Rouge and New Orleans. There, a growing network of interconnected petrochemical facilities would transform oil, gas, salt, sulphur, and water into hundreds of different substances, fueling first the war effort, and then a modern consumer society. Producing streams of feedstocks, products, intentional wastes, and accidental releases, these chemical plants were not only necessarily permeable, but also engaged in the brittle practice of distinguishing between both desirable chemicals and hazardous wastes, and between petrochemical facilities and neighboring, predominantly African American communities.

For the people living in what came to be popularly known as Cancer Alley, those brittle boundaries were fundamentally porous and fractured. Fencelines around a plant could hardly constrain the geography of toxic risk in the region, especially considering the ways southern Louisiana's humid and watery deltaic landscape conspires to disperse chemical feedstocks, products, and wastes throughout the environment. And just as dredgers in Louisiana rearranged the time and space of the deltaic coast, petrochemicals regularly leaked into Cancer Alley's soils, water, and air to alter the time and space of people's bodies. Endocrine disruptors and a landscape poisoned across generations suggest that it is not just individuals who are at toxic risk in Cancer Alley, but whole communities strung through the past, present, and future. Meanwhile, lying both at the foot of the Mississippi River and the headwaters for thousands of streams of synthetic products, the cellular spaces of Cancer Alley bodies are intimately connected with the far-flung spaces of an enormous riparian and consumer watershed, troubling the taken-for-granted boundaries of the space and time of the human body.

Conflict over permeable levees and plantations, the struggle to extract bald cypress, the remaking of wetlands into petroleum infrastructure, and the unnoticed porosities of Cancer Alley have all pointed toward two key insights. First, the reorganization of amphibious terrain is at least as much the product of values and concepts as physical labor in the environment. From river levees to resource frontiers, artificial waterways to the walls of petrochemical facilities, the lines etched across southern Louisiana's watery terrain emerged as much from a moral and cultural universe that shunned uncertainty and in-betweenness as from the realm of concrete things and objects. The edges people imposed on the shifting waterscapes of the Mississippi River Delta always carried with them strict judgments about what lay on this side or that, about what must be kept in or out, about what must be made separate or whole. This kind of boundary-making was hardly inevitable or natural, and yet the deeply cultural, value-laden, historically situated character of these practices often went unnoticed.[726]

Second, the levees, canals, chemical plants, and human bodies in this dissertation are all examples of a more general set of phenomena in which the boundaries people have used to structure the world are often far more porous and prone to rupture than imagined. Those porosities and ruptures can sometimes arise when people have ignored or overlooked the hidden permeable order behind dynamic nature. On Louisiana's fragmenting coast, or in the toxic landscapes of Cancer Alley, people struggled to impose their own notions of order on the world, only to risk all manner of unforeseen consequences. Not limited to the physical rationalization of the muddy environment, this order manifested not only as levees, pullboat runs, and petroleum canals, but also as the boundaries between improved fields and waste wetlands, disordered swamp and precious timber, unruly marsh and dependable infrastructure, contained body and industrial environment, and so much more. But whatever the edge, water—as flood, seep, canal, process liquid, groundwater, vapor, humidity, storm surge, or rain—has revealed these boundaries to be almost inevitably prone to rupture.

Thus, land loss superficially emerged as the result of people's attempts to solve the problems that flood and unstable watery terrain posed to permanent settlement, agriculture, and

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[726] Indeed, when it comes to boundary-making, invisibility is not unusual. For example, in Luhrmann's account of prototyping, the exceptions tend to fade from view. Every successful act of classification eliminates outliers and naturalizes both the category and the process that created it. Bruno Latour, meanwhile, in describing modernity's division of society from nature (and vice versa), also describes an act of translation, or effectively, of erasure and simplification. This act of translation so stealthily sorts the world's inevitable hybrids into either the categories of the natural or the social that it—like most boundary-making—goes unnoticed. The dangers here, according to Geoffrey Bowker and Susan Star, are that these extremely powerful, but often invisible, values are so deeply embedded in the ways people inhabit the world that they come to seem as given. The positive feedback loops of prototyping, of "sorting things out," render the conditions of boundary-making—the choices it entails, the histories of its enactment, the values it promotes—invisible and natural. T. M. Luhrmann, *Of Two Minds: An Anthropologist Looks at American Psychiatry* (New York: Vintage Books, 2001), 41; Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993); Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999).

natural resource development. But understood as the encounter between amphibious terrain and a moral universe of brittle, impermeable categories, land loss becomes far more than the unintended consequence of leveeing and dredging. Rather, it suggests deep, general questions of humanity's relationship to nature at large, from the world beyond our doorsteps, to the cells of our bodies. Scratch the surface of land loss, and we see it is entangled with a variety of what first might appear to be unrelated phenomena, whether the bounds of a commodity like lumber or oil, the temporalities that separate a year from an epoch, the invisible boundaries that distinguish this place from that and one generation from the next, or the vast cultural apparatus that cleaves society from nature and body from environment. When people imagine dynamic nature as disordered, as places with no edge primed for human organization, they risk inviting conflict, struggle, and disaster into their lives.

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