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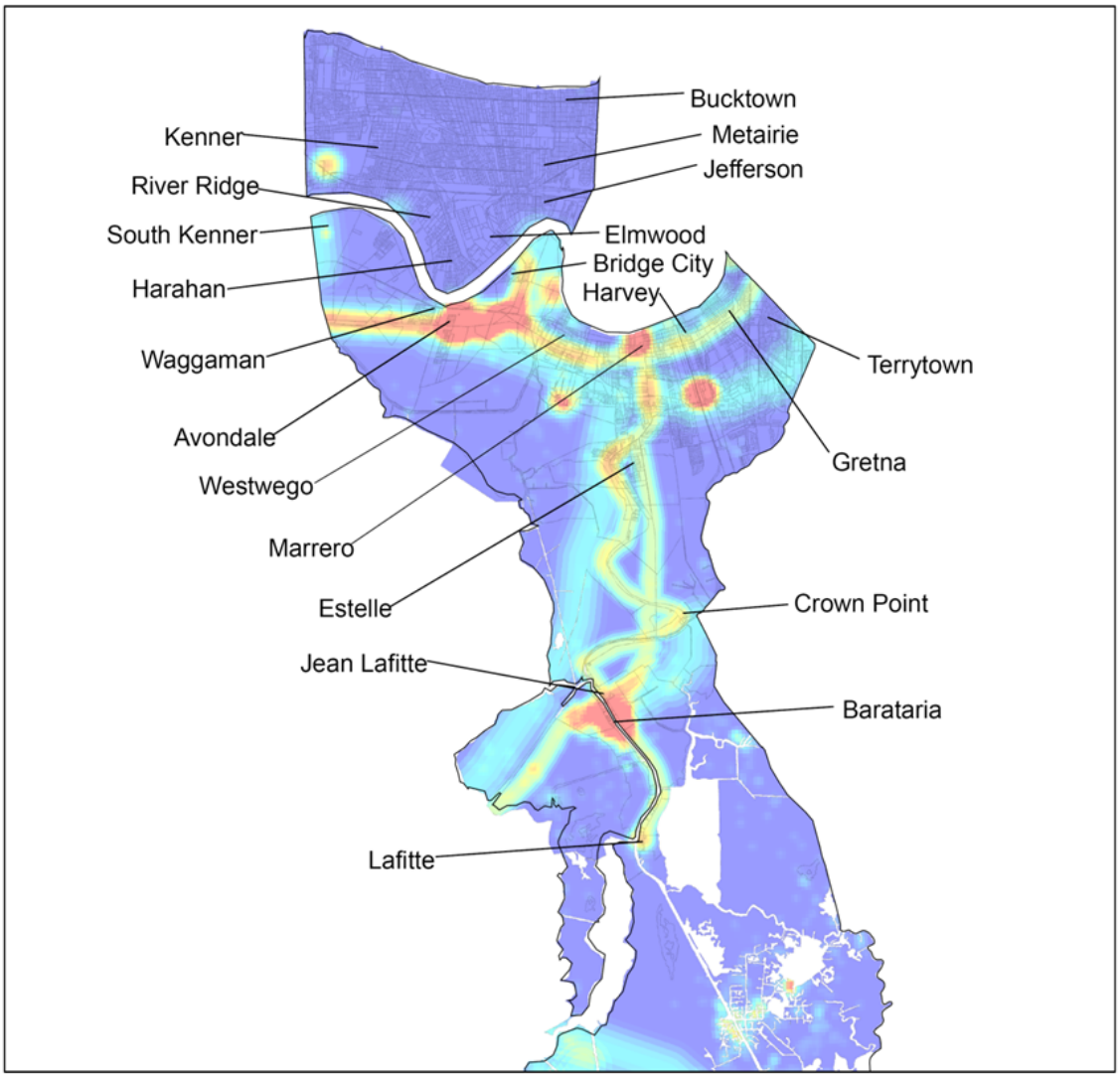
Environmental Justice: A Comparative Study in Louisiana



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Environmental Justice: A Comparative Study in Louisiana

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SUMMARY

The Bureau of Ocean Energy Management (BOEM) is charged with environmental stewardship and developing offshore energy and mineral resources in federal waters. BOEM has a legal mandate under both the National Environmental Policy Act of 1969 (NEPA) and the Outer Continental Shelf Lands Act (OCSLA) to consider the potential impacts of OCS oil and gas exploitation on the human environment. Executive Order 12898 (59 FR 7629) additionally specifies that this consideration must include attention to disproportionately high or adverse impacts of agency actions on minority and low-income groups. In the 1990s, the Minerals Management Service (now BOEM) was tasked with understanding environmental justice impacts of OCS activity. This study was part of that effort. Completed shortly before Hurricane Katrina made landfall, this study was not published in the aftermath of and upheaval from the storm. Today, it stands as an innovative methodology and historical snapshot of three Louisiana parishes in the years before Katrina.

This study provides a comparison of the relative degree of environmental justice impacts of multiple sectors of the oil extraction and processing industry as found in in Lafourche, Jefferson, and St. Bernard Parishes, Louisiana, in the early 2000s. At the time of the study, the three parishes were diverse in their level of urbanization and population characteristics but were all involved in oil extraction and processing. The study identifies potential geographic and demographic impacts of OCS-related hazards on minority and low-income populations using GIS techniques to integrate location of OCS-related activities, census data, and transportation data. The study considers locations of both residence and key subsistence resources. Historical analyses contextualize these findings.

Then, as now, the petroleum industry was a large, complex, varied, and unevenly distributed set of enterprises, activities, and infrastructure, and each sector of the industry had its own unique set of risks and hazards. The study developed risk-based analysis to compare the environmental justice impacts of three sectors of the petroleum industry: onshore production, offshore production, and petroleum refining. Quantitative measures were developed based on types of infrastructure and associated industrial processes to produce a geographic hazardousness model for the three parishes, allowing for direct comparison among sectors. Of the three sectors, offshore production was found to be the most geographically dispersed: hazards were distributed across a greater area, but at lower levels. Onshore production and petroleum refining, in contrast, were more tightly clustered, concentrating hazards in a smaller area. The refining district in St. Bernard Parish dominated the hazardscape for all three parishes, followed by points in Jefferson Parish around Marrero and the Barataria and Avondale fields, and the gas plants in rural St. Bernard Parish. The localized high hazard areas in Lafourche were significant, but were statistically much less significant than those in the other two parishes.

When the study considers the impacts of these industrial hazards across racial, ethnic, and income categories, it found no single pattern. At the time of the study, St. Bernard Parish was unique among the parishes studied as the only location where no minority groups were statistically more likely than whites to reside in the most hazardous areas. Across the study parishes, the Native American population was more likely to reside in the most hazardous areas than were other groups, while the African-American population was less likely to reside in

proximity to hazards. Residence of Asian and Hispanic populations in potentially hazardous areas varied across parishes, as did the relationship of household income to hazardousness of residence.

In recognition of the fact that populations are also exposed to risk through cultural practices outside their place of residence, this study also assesses impacts of oil-related development on commonly hunted, trapped, and fished species in each of three case study parishes in terms of environmental justice. It develops a quantitative assessment of these potential impacts on subsistence practices to create a geographic model and identify "hot-spots" where wildlife populations were most at risk from industrial development.

Though the above models examine areas of environmental justice concern at the time of the study, they do not inform on how these situations came to be. To contextualize these findings, the authors use statistical analysis of U.S. Census data and description, analysis, and comparison of the diverse historical processes involved in the development of the industrial and demographic landscape in these three parishes. The study finds that, over time, demographics in the impacted areas shifted in response to historical developments in each sector of the oil industry. Minority and low-income populations tended, with some exceptions, to migrate into areas with high percentages of their own minority population and either high or low house values. Of all the minority groups, only the Native American population migrated into areas where a large portion of the population worked in the oil industry.

This study concludes that there was very little evidence of systematic environmental injustice in the siting procedures of various oil-related industries, though certain individual facilities were sited in minority communities. In most cases, the demographic makeup of the community changed after the facilities were constructed, either increasing or reducing the percentage of minorities in the area. The authors note that environmental justice concerns remain: the fact that minority residents have moved into communities where potential hazards are already present does not lessen the responsibility of governmental agencies, under federal environmental justice guidelines, to assure that minority residents have access to accurate and up-to-date data about neighborhood and environmental health risks for informed decision-making about their residence and subsistence and cultural activities. The authors suggest that additional research would be necessary to understand how residents employ the ecosystem for subsistence, traditional, cultural, and religious purposes, and therefore how hazards inherent in the petroleum industry might impact these communities currently and in the future.

CHAPTER 1. INTRODUCTION

On February 11, 1994, President William Jefferson Clinton issued Executive Order 12898 (E.O. 12898), "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requiring federal agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations in the U.S. In a memorandum accompanying the order, the president emphasized that that existing laws, such as the National Environmental Policy Act of 1969 (NEPA), should provide opportunities for agencies to address environmental hazards in minority and low-income communities.

The Bureau of Ocean Energy Management (BOEM) (previously the Minerals Management Service [MMS], then the Bureau of Ocean Energy Management, Regulation and Enforcement [BOEMRE]), an agency of the U.S. Department of the Interior, is responsible for oversight of all oil and gas activity occurring on the Outer Continental Shelf (OCS) of the Gulf of Mexico. BOEM has a legal mandate under both NEPA and the Outer Continental Shelf Lands Act (OCSLA) to consider the potential impacts of oil and gas exploration on the human environment. The human environment is defined by OCSLA as the "physical, social, and economic components, conditions, and factors which interactively determine the state, condition, and quality of living conditions, employment, and health of those affected, directly or indirectly, by activities occurring on the Outer Continental Shelf" (Luton and Cluck 2000). E.O. 12898 extends this mandate by specifically requiring the agency to consider how these potential impacts are distributed among minority and low-income groups.

This project seeks to employ a geographic perspective to compare the relative degree of environmental justice impacts found in different sectors of the vertically integrated oil extraction and processing industry. It will build upon methods developed recently to investigate environmental justice concerns associated with outer continental shelf (OCS) oil and gas extraction (Hemmerling and Colten 2003). BOEM assesses upstream environmental impacts of OCS-related activities (e.g., from shipbuilding and fabrication) and operation environmental impacts (e.g., from transportation of supplies, air emissions from platforms, and oil spills), but it only assesses downstream impacts to the point where offshore product mixes with other product. Given its offshore location, the OCS presents few potential impacts at the extraction sites. Points of potential impacts are along transportation corridors (surface or pipeline) or proximate to service-related industries. The low population density in the Louisiana coastal zone where wetlands inhibit urbanization further reduces impacts. Many workers and their families live far from the actual embarkation sites. Likewise, minority and low-income families are not concentrated in great numbers near nodes of activity associated with the extraction industry. Conversely, refining requires a large labor force and is not found in offshore locations. Populations living nearby face a range of potential impacts–explosions, accidental releases on site, transportation related releases, or fires.

We develop a methodology that allows a comparison of findings across these different sectors and develop generalizations about levels of relative risk to low-income and minority populations. We incorporated toxicity values into hazardscape models and to develop a relative

comparison between the different types of facilities. Using a cumulative hazardscape weighted by toxicity enables a comparison of all facilities in our entire study area on a single sliding scale. This methodology allows researchers to effectively gauge, classify, and possibly ameliorate, instances of environmental injustice.

1.1 ENVIRONMENTAL JUSTICE

In southeast Louisiana, where oil and gas-related industries dominate the economy, substantial attention has been paid to environmental justice concerns in New Orleans (Colten 2001, Colten 2002, Colten 2005) and along the industrial corridor of the Mississippi River (Louisiana Advisory Committee 1993, Wright et al. 1994, Burby 1995, Allen 2001, Pine et al. 2002, Lerner 2005). These studies indicate that minority and low-income populations face a disproportionately greater risk than do higher income and non-minority residents due in part to public policy and its enforcement. Very little attention, however, has been paid to minority and low-income populations in the coastal parishes where much of the state's oil and gas is either brought ashore or produced. Studies that have examined these areas have found that minority residents residing on the wetland fringe, such as members of the United Houma Nation, tend to face disproportionately greater risks than do non-minority residents (Roberts and Toffolon-Weiss 2001, Hemmerling and Colten 2003, Hemmerling and Colten 2004, Hemmerling 2007).

Though there is a visible relationship among race, class, and environmental burden factors, the specifics are debated under the associated approaches of environmental justice, environmental equity, and environmental racism. All three approaches refer to the same basic issues, but there are nuanced differences among them, and their relative utility is also under debate. "Environmental equity" implies no bias or presumptions, but rather refers to whether the distribution of environmental hazards is equitable across the population, or with regard to race, ethnicity, or income (Burke 1993). Despite the claim that environmental equity studies are bias-free, in actuality, there are two different approaches to evaluating the distribution of environmental hazards. One view is akin to the relative deprivation hypothesis and would suggest that people are concerned about their standing in a community relative to their neighbors rather than about their absolute standard of living (Helfand and Peyton 1999).

The second view of environmental equity implies the achievement of safe minimum standards everywhere but does not require the same environmental quality in all communities. According to Cutter (1995), environmental equity involves an equal sharing of risk burdens, not an overall reduction in the burdens themselves. Environmental justice focuses the notion of environmental equity within the realm of public policy and environmental protection. It is often seen as a political movement aimed at achieving environmental equity, by addressing environmental enforcement, compliance, policy formation, and decision making (Bullard 1994). "Environmental justice" is a term that connotes "some remedial action to correct an injustice imposed on a specific group of people" (Cutter 1995). In the broadest view, this would require that everyone, through the equitable implementation and enforcement of public policy, have access to safe, clean neighborhoods, adequate jobs, good quality schools, and sustainable communities (Helfand and Peyton 1999).

The third related term, environmental racism, is based upon the premise that environmental inequities do in fact exist and that institutional racism has created these patterns of disproportionate exposure. A portion of this study will provide a snapshot in time of the oil and gas industry in southeast Louisiana, and thereby will focus on environmental equity, in relation to the overall distribution of hazards. BOEM, a federal agency operating within the Department of Interior, oversees energy-related activity on the OCS and evaluates OCS-related activities to the point where this product mixes with other product. For this reason, OCS-related activity meets the federal definition of environmental justice and falls under the rubric of Executive Order 12898.

1.1.1 Proximity- and Risk-Based Analyses

Most equity and justice analyses are either proximity-based or risk-based. "Proximity-based analysis" refers to the question of whether the distance-related impacts of one or more facilities are distributed evenly among the social groups in the local population (Glickman and Hersh 1995). These impacts are not only health or safety related, but may also include unmeasurable effects that may have negative impacts on the overall quality of life, including unsightliness, noise, and odor. If these impacts are strong enough, they will diminish the collective self-esteem and reputation of a community and the property values within it (Glickman and Hersh 1995). In conducting a proximity-based analysis, the geographical unit of analysis is a uniform buffer created around each facility or structure in question. These buffers are not modeled on any specific release; therefore weather conditions and wind direction are not included in the model and the buffers are uniform in all directions.

"Risk-based analysis" refers more specifically to the health and safety-related factors associated with particular facilities. Often, this may involve complex modeling of hazardous releases and are dependent upon environmental factors such as weather conditions and prevailing winds. Generally, mathematical processes modeling the distribution of contaminants in the environment are used to estimate potential environmental effects (Batterman and Huang 1996). In this type of analysis, risk is based on not only the distance from a facility, but upon the magnitude of the hazards and the size, shape, and orientation of the associated impact areas (Glickman and Hersh 1995). Risk assessments combine exposure assessment information with chemical toxicity and demographic information to estimate the potential health threats from the manufacture, use and disposal of chemicals and have been extensively employed in the last decade, especially at hazardous waste sites, due to U.S. Environmental Protection Agency (USEPA) requirements (Batterman and Huang 1996). Risk-based evaluations can often lead to different conclusions about environmental justice than proximity-based evaluations. The differences can be attributed to the fact that the size of the impact areas in risk-based evaluations vary and are generally much larger than the circles used in proximity-based evaluations (Maantay 2002).

Proximity- and risk-based analyses are both valuable tools used to evaluate environmental justice. Though risk-based estimates tend to take much more information into account than proximity-based measures, the amount of information available to researchers is limited to specific recorded releases, presenting an incomplete view of the potential hazardousness to the

community as a whole (Hemmerling 2007). An earlier study prepared for MMS developed a methodology that, though largely proximity-based, was modified to include some risk-based elements (Hemmerling and Colten 2003, Hemmerling and Colten 2004). For the current study, we created proximity-based buffers that are dependent on the specific potential hazard associated with each activity. In other words, the hazardousness of the industrial processes was taken into account, although environmental conditions and diffusion were not (Hemmerling and Colten 2004).

1.1.2 Comparative Risk Analysis

Comparative risk analysis is a recently developed subtopic of environmental risk analysis. Generally, comparative risk analysis is the comparison of different environmental problems to determine their relative risk to human health and quality of life, as well as risks to the natural environment (Jones 1997). This type of risk assessment is used to rank environmental problems by their seriousness or relative risk, unlike a quantitative risk assessment, which quantifies any given risk (Rechtschaffen and Gauna 2002).

The question of comparative risk analysis came to the fore in 1987 when the USEPA published "Unfinished Business: A Comparative Assessment of Environmental Problems" (USEPA 1987). This project, which arose out of a concern that the agency's resources were not being allocated to areas with the greatest environmental problems, was the first to directly address the question of relative risk and resource allocation. Indeed, the results of that project showed that the highest-ranked risks were not the focus of the greatest agency expenditures (Jones and Klein 1999). In 1989, the USEPA commissioned its Scientific Advisory Board (SAB) to review the findings of the report. The resulting report, "Relative Risk: Setting Priorities and Strategies for Environmental Protection," concluded that, although the data used to measure risk was often of poor quality and that qualitative factors are not easily indexed for comparison, comparative risk analysis represents an important development in national environmental policy (Hornstein 1992). USEPA also suggested that any comparative risk assessment take into account ecological risk and the protection of natural resources, noting the strong linkages between human health and the health of wetlands, forests, oceans, and estuaries (USEPA 1990).

Neither of these early USEPA reports discussed the importance of gauging comparative risk levels to minority or low-income individuals, though it noted that the agency must be attuned to the concerns of people who are closest to the real-world health, ecological, and welfare risks posed by different environmental problems (USEPA 1990). It was not until 1993, months before the issuance of E.O.12898, that federal comparative risk guidelines included environmental justice consideration. In these guidelines, USEPA notes that low-income and minority groups often live in polluted industrial areas where they may be exposed to multiple sources of risk, resulting in dramatic differences in the death rates, life expectancy, and disease rates of African Americans, Asians, and Native Americans compared to rates for white Americans (USEPA 1993). According to USEPA guidelines, analysts should address these issues in all phases of the comparative risk analysis.

In theory, comparative risk analysis allows federal agencies to evaluate two or more risks simultaneously and juxtapose the results for the purpose of examining whether the relative effort devoted to each risk should be changed (Cura et al. 2004). However, in examining present-day risks, comparative risk analysis tends to establish a baseline among existing risks, and so may accept rather than eliminate economically inefficient risks (Hornstein 1992). The ultimate goal of comparative risk analysis is to reduce the fragmentary nature of U.S. environmental policy and foster the evolution of an integrated and targeted national policy (USEPA 1990). Despite the overall importance USEPA has placed on comparative risk analysis, caution must be exercised when interpreting the results. Baseline levels of risk should not be interpreted as being acceptable levels of risk, given the ultimate goals of the USEPA.

1.1.3 Process- and Outcome-Based Analyses

Two distinctive fields of inquiry have developed in environmental justice research: process based and outcome based. The first seeks to determine present day levels of environmental inequity in low-income and minority communities. For example, many empirical environmental justice studies have demonstrated that minorities bear a disproportionate share of the burden of the effects of hazardous facilities. We refer to environmental justice studies that seek to determine whether there is an association between racial demographics and the location of environmentally undesirable sites as outcome-based analyses (Talih and Fricker 2002). Analyses that determine how such an association may have developed are referred to as process-based studies.

Outcome-based analysis may result in a determination of environmental inequity but not environmental racism, which is a conclusion of causation and not simply association (Talih and Fricker 2002). In other words, these studies present a "snapshot in time" of potential residential exposure levels. Recognizing where hazards are and who they might affect is of immediate concern to federal agencies seeking to estimate the potential impacts of their activities, as well as to those public officials calculating health risks, planning emergency measures, or seeking to redevelop contaminated land (Pastor et al. 2001).

A process-based analysis is the natural extension of finding inequity in an outcome-based analysis (Talih and Fricker 2002). If, for instance, there are existing inequities, a process-based analysis could determine whether the hazards were disproportionately sited in minority communities or whether minority residents moved in after the potentially hazardous facilities arrived. This determination is of central concern to policy makers and analysts. If the observed inequity is due to disproportionate siting, then it would be appropriate for planners and policy makers to revise permitting procedures to eliminate any elements of discrimination (Pastor et al. 2001). If, on the other hand, market responses to the facilities led the neighborhood to become disproportionately populated by low-income and minority residents through time, then policy makers would need a different set of tools with which to approach the problem. In these cases, the role of policy might be confined to ensuring that residents have access to data about neighborhood health risks so that individuals who choose to trade risk for affordable housing are not acting on incomplete data. In addition, policy makers would need to continually enforce

existing statutes that limit the steering of minority house-seekers to particular neighborhoods (Pastor et al. 2001).

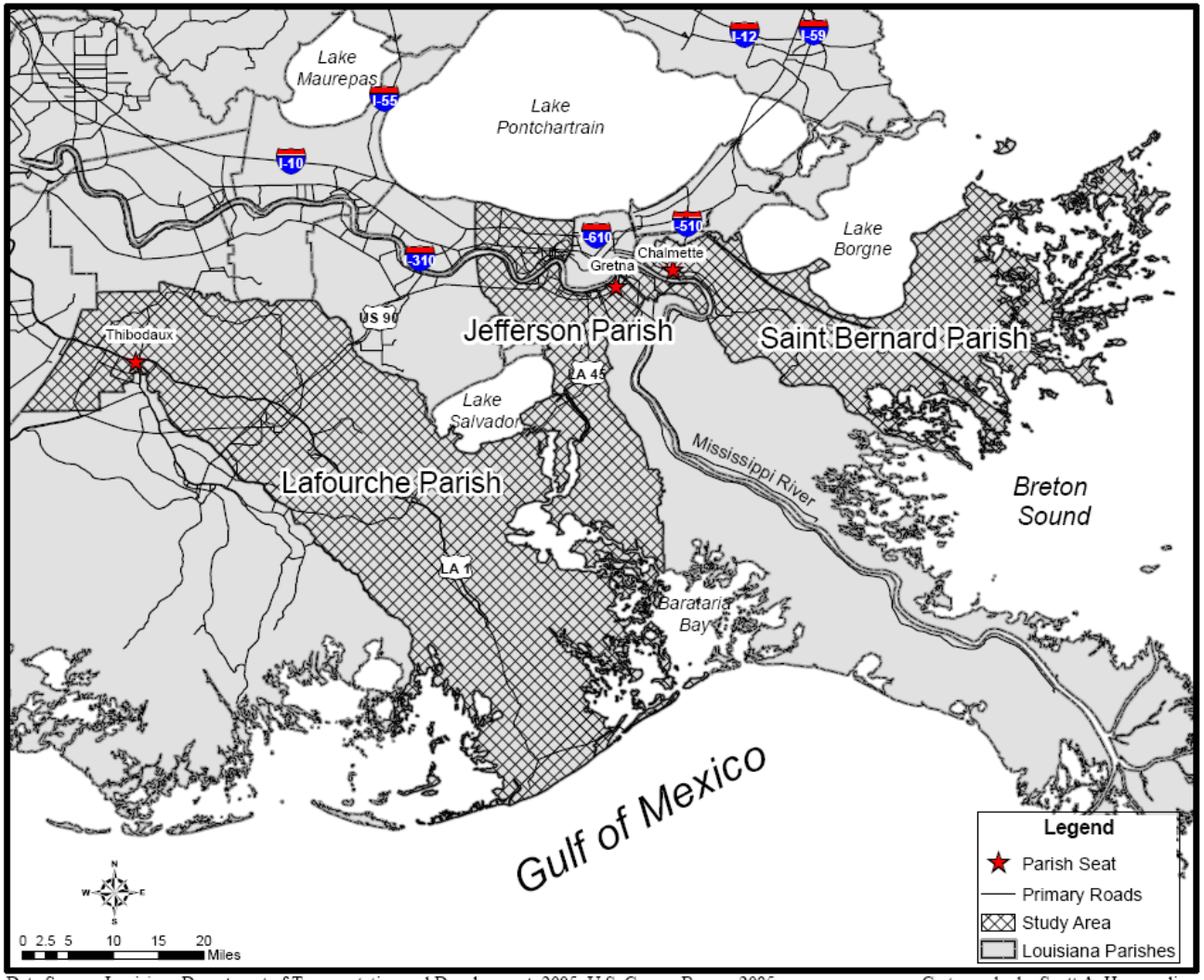
The most common process-based methodology involves examining the demographic makeup of the community at the time of the facility's siting. This methodology allows researchers to determine whether the facility was initially sited in a low-income or minority community or if low-income and minority populations came to live around the facility over time (Mitchell et al. 1999). This approach fails to examine the population changes that had been occurring in the community before the facility was sited. Without examining these preconditions and controlling for other confounding factors, it remains difficult for researchers to identify any type of process-based causal relationship (Liu 1997).

1.2 STUDY AREA

The current research explores the environmental justice implications in three individual case study parishes, each focusing on one particular aspect of the petroleum industry. The intent is to compare the environmental impacts of extensive onshore and offshore oil and gas development in three Louisiana coastal parishes and to examine any socioeconomic inequality patterns in their distributions. The parishes are chosen to represent different stages of historical petroleum development in Louisiana.

1.2.1 Lafourche Parish

Lafourche Parish is a coastal Louisiana parish that serves as the primary land-based supply center for the majority of the OCS oil and gas activity occurring in the Gulf of Mexico. Because of its role in OCS activity, the industry uniquely impacts Lafourche Parish. Located south-southwest of New Orleans (Figure 1), U.S. Highway 90 traverses the parish from east to west. Louisiana Highways 1 and 308 provide the only major north-south motor routes. Bayou Lafourche provides north-south waterway transportation to the Gulf of Mexico. The Intracoastal Waterway serves Lafourche Parish as an east-west waterway and is accessible from Bayou Lafourche. The largest volume of shipping traffic takes place on the portion of Bayou Lafourche between the Gulf of Mexico and the Intracoastal Waterway, which is in Larose. Principal goods shipped include shells, sulfur, water, drilling mud, crude oil, cement, and steel. Shrimp and oyster tonnage is smaller but has a higher value.



Data Source: Louisiana Department of Transportation and Development, 2005; U.S. Census Bureau 2005

Cartography by Scott A. Hemmerling

Figure 1. Study area.

Three incorporated towns are located in Lafourche Parish: Thibodaux, Lockport, and Golden Meadow. Thibodaux, Lafourche Parish's largest town, is the parish seat. Other communities in the study area include the unincorporated towns of Raceland, Larose, Cut Off, and Galliano (Figure 2). Port Fourchon, a deep-draft port at the mouth of Bayou Lafourche on the Gulf of Mexico, is a major onshore staging area for OCS oil and gas activities in the Central and Western Gulf of Mexico and the land fall for the Louisiana Offshore Oil Port (LOOP). Currently, the South Lafourche Airport in Galliano serves the southern portion of the parish and the Thibodaux Municipal Airport in Thibodaux provides similar service to the north.

Nearly 90,000 residents live in Lafourche Parish; the majority reside along the Bayou Lafourche levee. The parish is home to a sizable Native American population (2.3 percent), an African-American population (12.6 percent), and a small Asian-American population (0.7 percent). In total, nearly 15 percent of the parish population is minority. For the parish as a whole, 14.7 percent of the population is below the U.S. Census Bureau's definition of poverty and 19.7 percent of the children in the parish live below the poverty level. Though these figures are below the state average, they are significant. Tables 1 and 2 introduce general racial and economic characteristics of the Lafourche Parish study area and encompassed communities in 2000.

1.2.2 Jefferson Parish

Jefferson Parish is a highly urbanized parish with over 455,000 residents. Studies have generally shown a greater concentration of environmental inequity in urban locations. It is essential to consider one such parish in coastal Louisiana for comparative purposes.

Jefferson Parish's total minority population of 152,636 (33.5 percent) closely mirrors the state proportion (35 percent; Table 3). Its population living in poverty in 2001 (18.9 percent) was nearly the same as the state's percentage (18.2 percent; Table 4). With a total of 236 active wells in 2002, there is considerable on-shore activity in Jefferson Parish. Thus, this is a parish with a much larger population that might be susceptible to exposure to impacts from the highly dispersed activity of oil extraction and the distribution of minorities and low-income residents is much higher.

Jefferson Parish is located west of and adjacent to New Orleans. The parish is divided into a northern portion (the East Bank) and a southern portion (the West Bank) by the Mississippi River. The East Bank is home for many commuters, but the West Bank is much more industrial. Further south are the fishing communities that rely on Barataria Bay and the Gulf of Mexico for their livelihoods. Interstate 10 is the primary east-west transportation route in and out of the parish, although U.S. Highways 61 and 90 also serve this purpose. The Louis Armstrong International Airport, an important regional hub, is in the western portion of the East Bank.

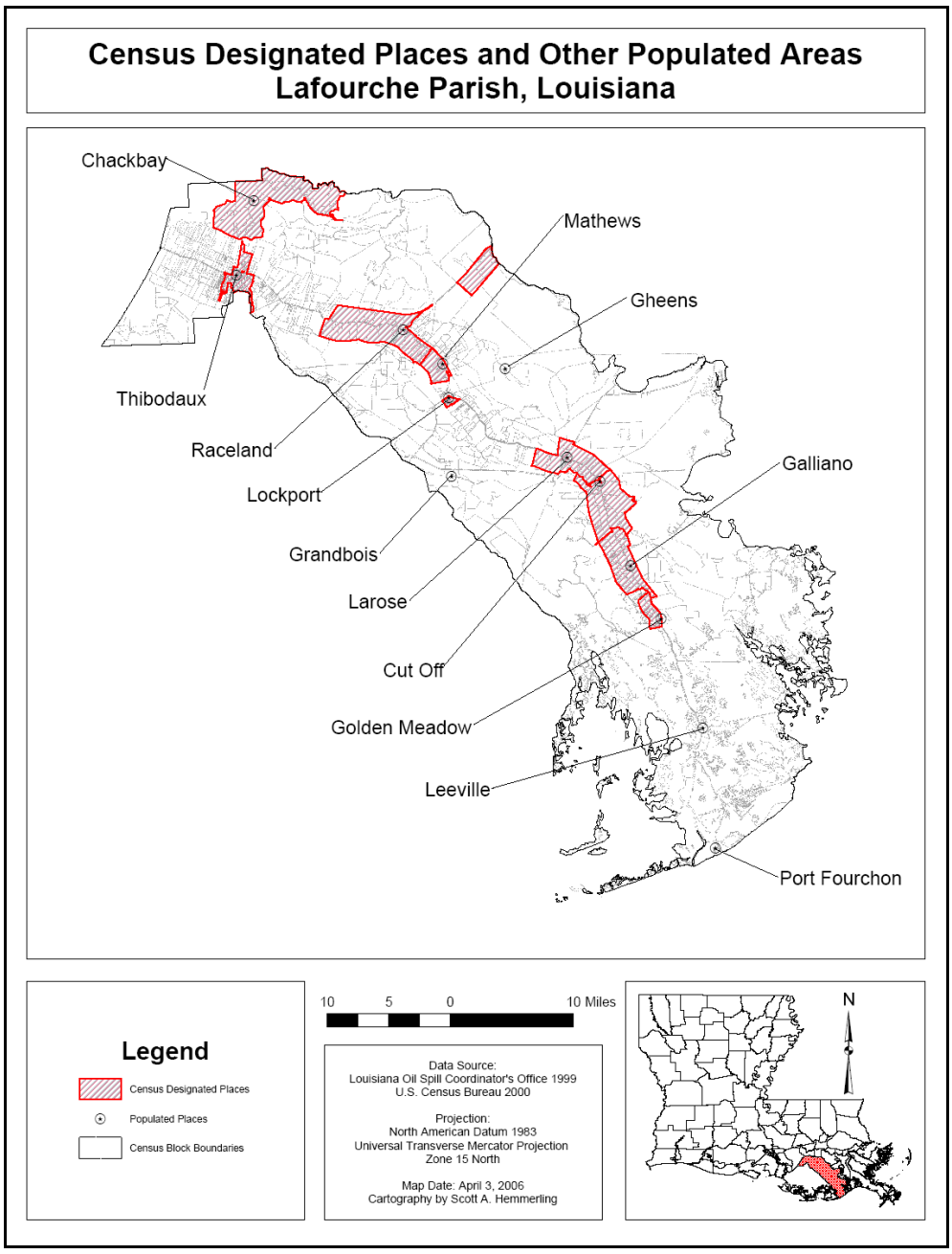


Figure 2. Census Designated Places and other populated areas, Lafourche Parish, Louisiana.

Table 1. Racial and Ethnic Characteristics of Selected Communities in Lafourche Parish, Louisiana

Area	Total Pop	White	African American	American Indian	Asian	Hispanic
Lafourche Parish	89,974	82.90%	12.60%	2.30%	0.70%	1.40%
Chackbay	4,018	94.50%	4.00%	0.70%	0.30%	0.70%
Cut Off	5,635	91.40%	1.10%	3.80%	1.30%	2.10%
Galliano	7,356	92.30%	0.70%	4.50%	0.80%	1.70%
Golden Meadow	2,193	92.50%	0.50%	4.80%	0.40%	1.50%
Larose	7,306	85.60%	5.70%	3.90%	2.40%	2.50%
Lockport	2,624	95.70%	1.00%	1.60%	0.40%	1.20%
Mathews	2,003	96.60%	1.50%	0.80%	0.30%	0.50%
Raceland	10,224	71.20%	26.20%	1.00%	0.30%	1.50%
Thibodaux	14,431	64.00%	33.80%	0.40%	0.60%	1.00%

Data Source: U.S. Census Bureau, 2000

Table 2. Economic Characteristics of Selected Communities in Lafourche Parish, Louisiana

Area	Annual Median Family Income ($)	Annual Per Capita Income ($)	Median House Value ($)	Median Monthly Contract Rent ($)
Lafourche Parish	40,504	15,809	78,900	310
Chackbay	41,934	15,389	87,800	175
Cut Off	42,986	16,353	79,500	343
Galliano	36,136	13,910	71,000	325
Golden Meadow	36,944	13,122	57,600	243
Larose	45,126	15,541	82,200	269
Lockport	40,288	15,769	65,500	306
Mathews	41,683	19,336	90,600	335
Raceland	35,460	15,539	73,800	266
Thibodaux	36,551	16,966	72,000	309

Data Source: U.S. Census Bureau, 2000

Table 3. Racial and Ethnic Characteristics of Selected Communities in Jefferson Parish, Louisiana

Area	Total Pop	White	African American	American Indian	Asian	Hispanic
Jefferson Parish	455, 466	69.80%	22.90%	0.40%	3.10%	7.10%
Avondale	5,442	64.90%	19.00%	0.80%	11.30%	4.80%
Barataria	1,390	85.30%	11.60%	1.00%	0.00%	1.40%
Bridge City	8,270	42.60%	49.80%	0.30%	4.30%	4.00%
Elmwood	4,432	80.40%	12.10%	0.00%	4.20%	4.90%
Estelle	15,983	75.50%	16.10%	0.80%	2.80%	7.70%
Grand Isle	1,541	96.70%	0.20%	1.90%	0.00%	1.20%
Gretna	17,338	56.70%	35.20%	0.50%	3.70%	6.10%
Harahan	9,861	97.50%	0.70%	0.20%	0.60%	2.00%
Harvey	22,259	49.10%	41.30%	0.50%	5.20%	5.50%
Jean Lafitte	2,136	94.20%	0.20%	2.70%	1.60%	1.10%
Jefferson	11,873	71.70%	24.60%	0.30%	0.70%	4.80%
Kenner	70,517	67.90%	22.90%	0.20%	2.60%	13.80%
Lafitte	1,650	96.20%	0.00%	1.90%	0.50%	2.00%
Marrero	36,073	47.40%	47.70%	0.50%	2.80%	2.50%
Metairie	145,852	86.60%	6.60%	0.30%	2.80%	7.20%
River Ridge	14,601	85.60%	10.90%	0.30%	0.70%	3.50%
Terrytown	25,397	56.70%	35.70%	0.30%	2.70%	8.70%
Timberlane	11,460	65.00%	23.30%	0.50%	5.60%	7.20%
Waggaman	9,403	41.70%	54.50%	0.60%	1.20%	4.10%
Westwego	10,841	76.70%	18.50%	1.10%	1.40%	3.30%
Woodmere	13,102	24.80%	64.80%	0.70%	5.40%	5.90%

Data Source: U.S. Census Bureau, 2000

Table 4. Economic Characteristics of Selected Communities in Jefferson Parish, Louisiana

Area	Annual Median Family Income ($)	Annual Per Capita Income ($)	Median House Value ($)	Median Monthly Contract Rent ($)
Jefferson Parish	45,834	19,953	105,300	455
Avondale	37,250	13,518	58,600	436
Barataria	29,913	12,890	104,700	247
Bridge City	25,620	10,333	58,800	289
Elmwood	61,176	34,329	120,000	706
Estelle	47,500	16,586	82,000	396
Grand Isle	35,517	18,330	69,500	316
Gretna	31,881	15,735	75,400	362
Harahan	55,319	23,448	135,200	474
Harvey	34,221	14,885	86,500	396
Jean Lafitte	40,163	14,209	102,800	338
Jefferson	40,408	19,245	98,100	407
Kenner	45,866	19,615	111,900	476
Lafitte	43,816	14,839	103,900	283
Marrero	37,287	13,933	73,900	336
Metairie	52,555	24,771	139,100	482
River Ridge	58,139	27,088	153,100	450
Terrytown	41,963	16,725	93,600	445
Timberlane	55,573	20,674	95,300	530
Waggaman	34,639	12,078	64,100	440
Westwego	31,187	13,160	68,400	335
Woodmere	45,378	14,494	85,400	471

Data Source: U.S. Census Bureau, 2000

There are six incorporated communities in Jefferson Parish: Harahan and Kenner, on the East Bank, and on the West Bank, Gretna (the parish seat), Grand Isle, Jean Lafitte, and Westwego (Figure 3). In total, the U.S. Census Bureau recognizes some twenty-one incorporated and unincorporated places in Jefferson Parish. Two important unincorporated communities are Metairie and Harvey. With a 2000 population of over 146,000, Metairie is a densely-populated residential community, though a number of commercial industries are located there. Harvey, on the other hand, is a densely-populated industrialized community located on the West Bank. Other unincorporated communities of interest include Avondale, Barataria, Lafitte, Marrero, and Waggaman.

1.2.3 St. Bernard Parish

Like the other two parishes, St. Bernard is a coastal parish. With two refining operations, employing over 500 workers, St. Bernard provides a good site for examining refining activity. Located east of and adjacent to New Orleans, the parish is accessible from a number of transportation routes. The two main east-west transportation arteries within St. Bernard Parish are State Highways 39 and 46. Another important road is State Highway 47, which has recently been connected to Interstate Highway 10 to the north. I-510, as this connection is designated, provides a north-south route in and out of St. Bernard Parish for industrial and residential transportation. The parish is bordered on the west by the Mississippi River and bisected by the Mississippi River Gulf Outlet (MRGO), which provides a short water route between the river and the Gulf of Mexico.

No incorporated communities are located within St. Bernard Parish, although the U.S. Census Bureau has identified six communities that contain a mixture of residential, commercial, and retail areas similar to those found in incorporated places of similar size (U.S. Census Bureau 2000). These include Chalmette (the parish seat), Arabi, Meraux, Poydras, and Violet (Figure 4). These census designated places (CDPs) all occupy sites on the Mississippi River. Other smaller communities, such as Delacroix, Reggio, St. Bernard, Toca, and Yscloskey, are spread throughout the rural portion of the parish.

St. Bernard Parish's population is distributed along the Mississippi River and Bayous La Loutre and Terre Aux Boeufs. Among its 67,000 residents, 14.5 percent represent a minority population and 13.2 percent live in poverty according to the census bureau's 2001 estimates (Tables 5 and 6). The minority and impoverished population for St. Bernard is similar to Lafourche and will enable a reasonable cross-sector comparison. The susceptible populations are highly concentrated in the areas along the natural levee so risk is ever present in the relatively small territory occupied by human settlements.

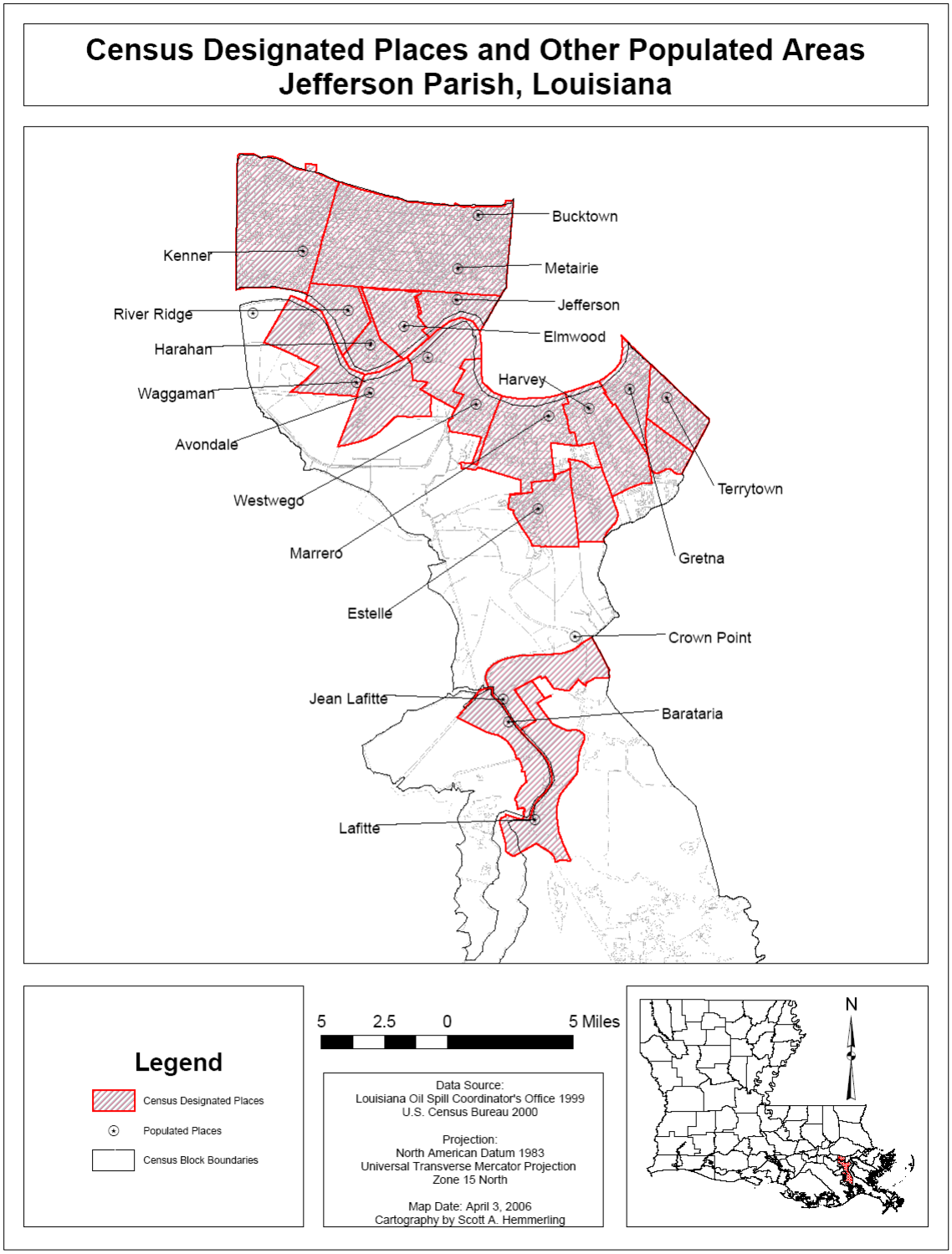


Figure 3. Census Designated Places and other populated areas, Jefferson Parish, Louisiana.

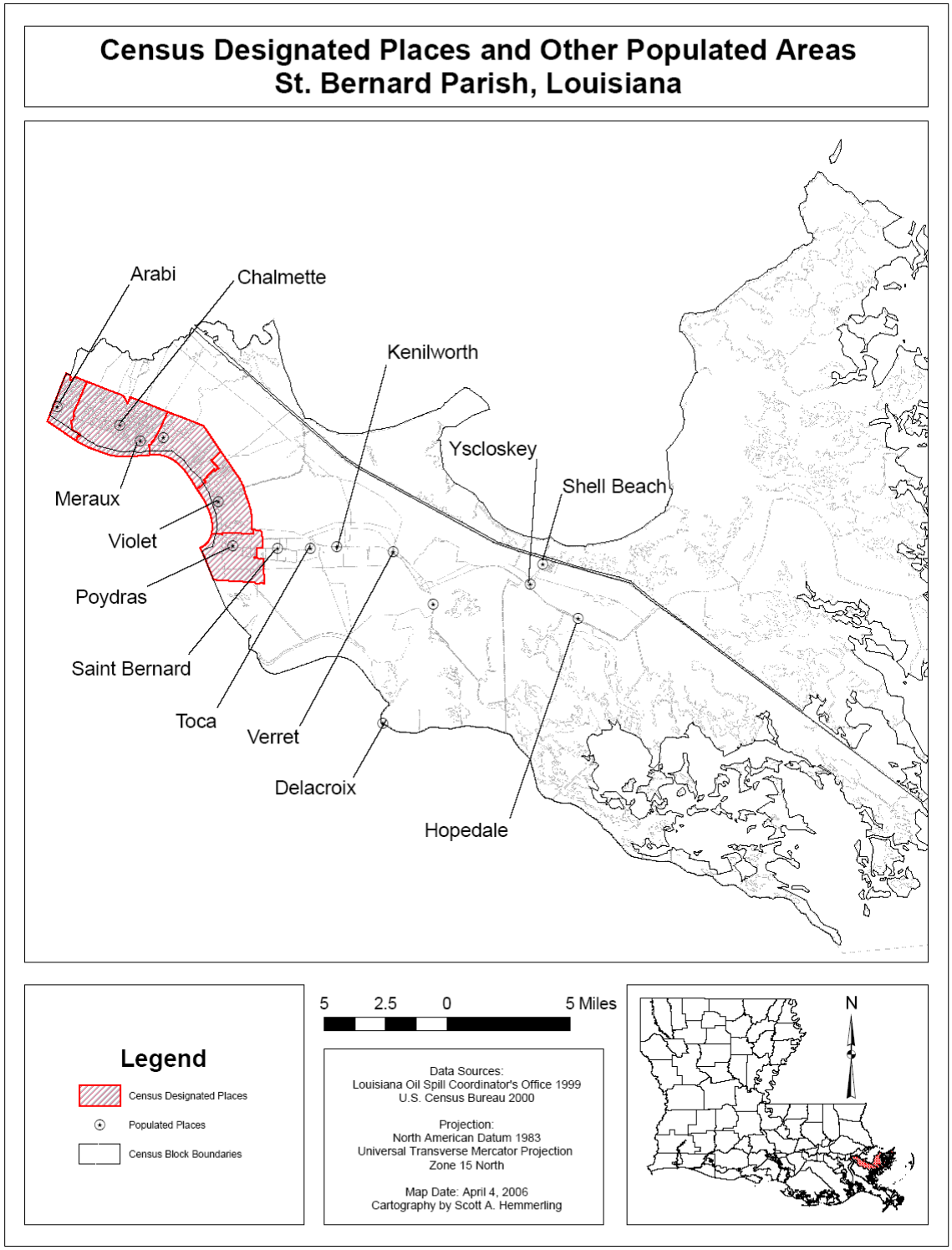


Figure 4. Census Designated Places and other populated areas, St. Bernard Parish, Louisiana.

Table 5. Racial and Ethnic Characteristics of Selected Communities in St. Bernard Parish, Louisiana

Area	Total Pop	White	African American	American Indian	Asian	Hispanic
St. Bernard Parish	67229	88.30%	7.60%	0.50%	1.30%	5.10%
Arabi	8,103	95.70%	1.00%	0.10%	1.10%	6.30%
Chalmette	32,080	93.20%	2.00%	0.30%	1.50%	4.90%
Meraux	10,264	92.10%	2.80%	0.50%	2.90%	3.70%
Poydras	3,672	84.40%	11.50%	1.70%	1.70%	3.50%
Violet	8,627	60.50%	34.60%	0.70%	1.80%	4.80%

Data Source: U.S. Census Bureau, 2000

Table 6. Economic Characteristics of Selected Communities in St. Bernard Parish, Louisiana

Area	Annual Median Family Income ($)	Annual Per Capita Income ($)	Median House Value ($)	Median Monthly Contract Rent ($)
St. Bernard Parish	42,785	16,718	85,200	374
Arabi	42,526	19,038	77,900	373
Chalmette	43,804	17,408	89,600	393
Meraux	52,408	17,951	93,100	311
Poydras	33,036	12,874	61,100	284
Violet	36,616	13,894	76,000	352

Data Source: U.S. Census Bureau, 2000

1.3 THE COMMUNITY

Any examination of environmental justice should begin with an analysis of the population of the potentially impacted area. It is important to recognize that, as Susan Cutter notes, a hazard is a threat to people and the things they value. Furthermore, hazards can be thought of as arising from the interaction between social, technological, and natural systems (Cutter 2001). Studies of environmental justice and equity expand this notion of environmental hazards from an examination of social systems in general to a more specific examination of minority and/or low-income populations. USEPA defines an environmental justice community as a location where residents are predominantly minorities or low-income; where residents have been excluded from the environmental policy setting or decision making process; where they are subject to a disproportionate impact from one or more environmental hazards; and where residents experience disparate implementation of environmental regulations, requirements, practices, and activities in their communities (USEPA 1999b).

The first step in identifying an environmental justice community is to examine the spatial distribution of low income or minority populations. To this end, we begin this analysis with a description of ethnic and racial groups found to some extent within southeast Louisiana, regardless of whether or not these groups are impacted by oil-related industries or activities.

1.3.1 Non-Hispanic White Ethnic Groups

The largest racial group in southeast Louisiana is white. This population is largely of French and French Canadian descent, known as Acadians. Others, not of Acadian descent, are locally known as Anglos. Between 1765 and 1785, most of the approximately 4,000 Acadians who migrated to south Louisiana settled along the lower Mississippi River and its tributaries (Estaville 2001). The Acadians, and their descendants the Cajuns, adapted their culture to the wetlands, borrowing readily from other groups such as the Native Americans, French Creoles, Spanish settlers, and African slaves (Estaville 2001). Still, their communities remained highly insular. This insularity combined with a high degree of community cohesiveness to create a culture unique to South Louisiana. In fact, some scholars have suggested that the Acadians were the first European immigrant group to develop a distinctly North American identity (Brasseaux 2005).

Throughout the nineteenth century most Acadian landowners became yeoman farmers, engaging in small scale farming and ranching. Antebellum land prices, however, forced many to seek employment in the burgeoning sugar industry as overseers, artisans, and laborers (Brasseaux 2005). Those Acadians who remained along the Mississippi River and Bayous Teche and Lafourche became even more socially and culturally isolated, with many seeking their livelihoods in the marshes as cypress lumberjacks, fishermen, and trappers (Brasseaux 2005).

This isolation was not to last, however, as technological innovations such as steamboats, railroads, mechanized agriculture, electricity, and telephones began to diffuse throughout the towns and villages of the Acadian homeland of south Louisiana (Estaville 2001). By the

twentieth century, many young Acadians, unable to make a living in agriculture, migrated to the towns and villages of the region, such as Lafayette, Plaquemine, and Thibodaux, where they emerged as a new professional class (Brasseaux 2005).

In the twentieth century, the discovery of oil would dramatically change the face of Acadian culture in south Louisiana in much the same way. Unprecedented employment opportunities were available to those Cajuns with a moderate proficiency in English. Work in the oil field, for example, paid over than four times more than traditional agricultural pursuits (Brasseaux 2005). The Acadian community has also been tremendously impacted by oil-related population migration, both into and out of traditional communities. Thousands of Anglos moved into Acadian south Louisiana to work in the oil fields. Conversely, the construction of many large petroleum refineries in Baton Rouge and Lake Charles drew a great many Acadian plant workers out of southeast Louisiana. The diffusion of the Acadian population and the intrusion of the Anglo population have resulted in a situation where, today, many Cajuns have developed lifestyles similar to mainstream urban Americans (Estaville 2001).

1.3.2 African Americans

For most of their history in North American, African Americans were a rural people largely confined to the southern plantation regions, where, historically, they were sold into the plantations as slaves. Northern Lafourche Parish was one of these major historic plantation regions (Aiken 2001). A number of sugar plantations were developed alongside Lower Bayou Lafourche in the late 1820s and the 1830s. In the antebellum period, dwellings of various sizes housed the planter's family, his overseers, and his slaves. The latter were housed on the premises in the "agglomerated village settlement" called the "quarters" (Rehder 1999). Even as the plantation economy changed from slave to wage labor following the Civil War, the settlement patterns in the quarters remained the same until the 1970s, when the quarters settlements were aggressively removed from the landscape (Rehder 1999). The compact settlement pattern of the sugar plantations continued in the post-Civil War period because sugar cane required teams of people working and housed together as wage-earning residential laborers (Rehder 1999). During this period, the region experienced a tremendous amount of African-American out-migration. Lane villages are residuals of the slave quarters lanes of the former sugar plantations. By the 1990s, however, the remaining sugar plantations had fewer quarter houses, fewer workers of both races, and many fewer if any whites living on plantation premises. Today, the former overseer's houses, almost all of the sugar factory workers' houses, and the storekeepers' houses are almost entirely inhabited by African Americans (Rehder 1999).

Other changes during the latter part of the twentieth century also began to affect African-American settlement patterns in the rural South. African Americans who remained in the plantation areas have begun to make significant social and economic advances, as a result of their severance from the plantation system and because of the civil rights movement. In 1960, farming was the leading occupation of African Americans in the plantation regions. However, by 1990, manufacturing and professional services were the two primary occupations. With these occupational changes came a substantial increase in home ownership for African-American

during the latter half of the twentieth century (Aiken 2001). Today, the majority of African Americans reside in urbanized areas of southeast Louisiana.

1.3.3 Native American

The Houma, a Native American tribe and the namesake for the southeast Louisiana city of Houma, were drawn to the marshlands of south Louisiana because of the area's remoteness (Wallace et al. 2001). After having already been driven out of central Louisiana by the Tunica tribe, the Houma, and remnants of other tribes that they absorbed, moved into the marshes and bayous of Terrebonne Parish when the white settlers came to south Louisiana nearly 300 years ago (Kniffen 1994). Since then, the Houma developed a number of small communities along the bayous of south Lafourche and Terrebonne parishes. Many of these settlements were the offspring of Native-American and non-Native unions, where the residents retained Native American identity (Austin 2001). The Houma's ready acceptance of members of other Native American tribes, and many non-tribal members as well, exacerbated their separation from white society (Austin 2001).

Today, the Houma are the largest Native American tribe in Louisiana, although they are not a federally-recognized tribe. Recent attempts to register all descendants of historical Houma people have swelled the current tribal rolls to around 17,000 members. The majority of the Houma reside along Highway 1 in south Lafourche, between Larose and Golden Meadow, and in the area around Houma, in neighboring Terrebonne Parish. Considered by some to be "the most conservative of all Louisiana French speakers," many Houma retained their traditional attitudes and practices at a time when many of their neighbors left fishing and trapping to work in the oilfields (Austin 2001). Many of the Houma who live along Bayou Lafourche continue to make a living from shrimping and to supplement their earnings with hunting, fishing, and gathering wild resources. Recent encroachment of salt water and loss of coastal marsh presently threaten to displace many Houma communities.

1.3.4 Southeast Asians

Some of the most recent immigrants to south Louisiana and Lafourche Parish are the Southeast Asians, particularly the Vietnamese. In the 1970s, following the American withdrawal from Vietnam, a number of Vietnamese immigrants fled to the U.S. The primary volunteer agency in charge of resettling Southeast Asian refugees was the Catholic Church. The involvement of the Catholic Church in resettlement has led Southeast Asians to locate disproportionately in predominantly Catholic areas. The Louisiana dioceses were particularly active in resettling refugees, especially the Houma-Thibodaux Diocese, which sought housing and sponsors in St. Mary, Terrebonne, and Lafourche Parishes (Bankston 1996).

Eighty-six percent of Louisiana Vietnamese reside in just seven parishes, each of which had around 500 or more Vietnamese residents: Orleans, Jefferson, East Baton Rouge, St. Mary, Vermillion, Terrebonne, and Lafourche (Bankston 1996). A number of institutional and economic forces drew the Vietnamese to rural parishes in south Louisiana. The oil boom,

together with federal funding for job training at oil-related skills, created job opportunities in south Louisiana. Furthermore, fishing in the Gulf of Mexico, an occupation appealing to many Vietnamese because it did not require advanced English-language skills, began drawing Southeast Asians in the 1970s.

The number of Southeast Asians employed in both shrimping and fishing expanded greatly in the 1980s as the oil industry in Louisiana contracted (Bankston 1996). Since many of the immigrants come from fishing families, many Southeast Asians have specialized in the seafood industry. By 1990, more than one in every twenty Louisiana fishers and shrimpers had roots in Southeast Asia, even though the Southeast Asians made up less than half a percent of the state's workforce (Bankston 1996). They have progressively dominated the shrimping industry, running large, modern steel-hulled shrimp boats along the Gulf Coast. In many cases, they have displaced Cajun workers in the crawfish industry (Brassieur et al. 2000). Many Southeast Asians have begun to achieve upward mobility, operating a number of small businesses (Donato et al. 2001).

1.3.5 Hispanics

Since the 1980s, the U.S. has experienced rising levels of new Hispanic immigrants in rural areas. Especially in the southern U.S., the single largest group of new immigrants is Mexican. This immigration is characterized by a growing economy dependent on abundant, inexpensive labor and a population willing to fill such positions (Duchon and Murphy 2001). This is especially true in the coastal parishes of southern Louisiana, where many Mexican and Hispanic migrants are now working in the shipbuilding and fabrication yards in the coastal areas of the state (Donato et al. 2001).

After the drop in oil prices and the resultant economic downturn in the 1980s, many highly skilled workers moved away from Louisiana in search of new job markets, leaving behind many unskilled workers. When the offshore oil industry expanded in the 1990s, some employers began to import skilled Mexican labor from the Rio Grande Valley (Donato et al. 2001). Even though these welders, fitters, and carpenters were relatively well paid, they performed some of the dirtiest jobs possible (Donato et al. 2001). Hispanic workers are especially conspicuous as welders and fitters in the ship repair industry. Large employers that have the financial and organizational resources tend to be the biggest employers of Hispanic workers.

It has been suggested that, although they are becoming a major part of the labor force, Mexican migrant workers in the Louisiana oil industry are geographically, linguistically, and socially isolated, seldom mingling with others and sending much of their earnings home to Mexico or Texas (Donato et al. 2001). The migrant Hispanic population, for the most part, has settled in residential niches and, besides patronizing small stores and food establishments, is peripheral to the social life of the area (Donato et al. 2001).

In addition to recent Hispanic immigrants, there is a group of native-born Spanish-speaking residents residing in southeast Louisiana, the Isleños. They are descendants of Canary Islanders brought to Spanish-controlled Louisiana in the late eighteenth century. Though the descendants

of the original Isleño population have been in large part assimilated into the general population, an intact Isleño community still exists in St. Bernard Parish, and many of its members continue to earn a living fishing and trapping the surrounding waterways and wetlands (Wilds et al. 1996).

By the early nineteenth century, most of the Isleño population in St. Bernard Parish lived at a subsistence level in relative poverty. The majority engaged in agriculture; others began to gather fish, shrimp, oysters, and crabs from the local waters for a livelihood (Din 1986). Later in the century, as sugar became Louisiana's leading cash crop, sugar planters began buying up much of the Isleño land in St. Bernard Parish. After selling their land, many Isleños worked on the sugar plantations. Others resettled in eastern St. Bernard Parish, where fishing and trapping became important livelihoods for Isleños in the late nineteenth century (Garvey and Widmer 2001). Many Isleños believe that the fishermen, hunters, and trappers residing around Delacroix Island, Shell Beach, and Yscloskey are genuine Isleños; those who have farmed or taken up other occupations are not (Din 1988).

During the twentieth century, the mechanization of agriculture reduced the demand for labor, driving many Isleños from agriculture into the towns and cities where they found employment in the petroleum, natural gas, lumbering, manufacturing, salt, and sulfur industries (Din 1988). The construction of the MRGO and other smaller channels destroyed thousands of acres of wetlands in eastern St. Bernard Parish and facilitated salt-water intrusion, negatively impacting traditional occupations, such as trapping, fishing, and oystering, and significantly reducing income from these occupations (Din 1988). These factors among others have had a profound impact on the Isleño community, particularly in St. Bernard Parish. Though the settlements at Delacroix Island, Shell Beach, and Yscloskey survive today as Isleño fishing communities, much of the population has migrated to the metropolitan New Orleans area.

1.4 OUTLINE OF THE STUDY

In this chapter, we have identified the major concepts that will frame the remainder of the study. We have introduced each of the three case study parishes as well as the minority populations that reside therein. The remainder of the report is divided into four chapters. Chapter 2 uses a risk-based analysis to compare the environmental justice impacts of three sectors of the petroleum industry: onshore production, offshore production, and petroleum refining. The petroleum industry is a large, complex, varied, and unevenly distributed set of enterprises, activities, and infrastructure, and each sector of the industry has its own unique set of risks and hazards. Quantitative measures are developed based on infrastructure and associated industrial processes. This allows for a direct comparison between the different sectors.

Chapter 3 explores the issue of environmental justice as it relates to hunting, fishing, and trapping in southeast Louisiana. According to the President's Council on Environmental Quality, where an agency action may affect fish, vegetation, or wildlife, that agency action may also affect subsistence patterns of consumption and indicate the potential for environmental injustice. This chapter provides a quantitative assessment of the potential impacts of oil-related development on commonly hunted, trapped, and fished species in each of three southeast Louisiana case study parishes.

Chapter 4 explores the historical processes involved in the development of environmental injustice. In this chapter, we explore how the demographics of the case study parishes have shifted in response to historical developments in each sector of the oil industry. We then use statistical analysis to determine some of the factors that are driving the migration of minority residents into potentially hazardous areas of the region.

Chapter 5, in closing, re-examines the notions of environmental justice and environmental equity as they relate to oil-related development in the coastal zone of southeast Louisiana. As we suggest, no one notion of environmental justice can account for all of the variability and demographic shifts in this region.

CHAPTER 2. COMPARATIVE ANALYSIS

One of the major problems encountered in conducting environmental justice analyses is the necessity to classify various waste streams according to their potential hazardousness to the environment and the community. This is especially important when conducting research that compares two or more types of facilities. In the vertically integrated petroleum industry, many large refiners are integrated backward into the exploration and extraction of crude oil and forward into marketing and distribution (Buehler and Schmutzler 2005). Each step along the supply chain possesses a unique potential for both risk and environmental injustice.

Previous research examined the environmental justice impacts of the offshore oil and gas industry and found that onshore support industries, such as shipyards and natural gas processing plants, clustered along the bayous and waterways of south Louisiana where much of Louisiana's Houma population reside (Hemmerling and Colten 2003, Hemmerling and Colten 2004). By focusing on a single sector of the petroleum industry, this earlier study focused exclusively on locational inequities in the distribution of offshore oil-related facilities. A potential exposure model classified multiple hazards sources for each census block level throughout the parish. Inverse distance weighting served to create a continuous hazard surface that covered the entire parish. This earlier model allowed the examination of the spatial variability in locational exposure based on proximity to multiple sources of environmental threats (Cutter et al. 2001).

2.1 METHODS

2.1.1 Potential Risk Exposures by Facility

This research extends the locational model used in previous research to incorporate relative measures of potential health threats based on the toxicity and the relative magnitude of potential hazardous emissions. The Toxic Release Inventory (TRI) provided state-level data for all reporting facilities for 1991-2000. A list of all chemicals released by facilities of specific oil-related Standard Industrial Codes (SIC) was gathered and analyzed. Due to TRI reporting the criteria in 2000, we remove several classes of toxins. Also, USEPA added seven chemicals and two chemical compound categories to the list of hazardous chemicals subject to reporting under EPCRA section 313. The following chemicals were not on the list previously and had not been included as part of the TRI before 2000 (Eck 2000):

- dioxin and dioxin-like compounds
- benzo (g,h,i) preylene
- benzo (j,k) fluorine or fluoranthene
- 3-methylcholanthrene
- octachlorostyrene
- pentachlorobenzene
- tetrabromobisphenol A
- vanadium (except in alloys, which is exempt)
- vanadium compounds

USEPA eliminated the *de minimis* exemption for the dioxin and dioxin-like compounds category, meaning that as of 2000, facilities must include all amounts of dioxin and dioxin-like compounds in threshold determinations and release and other waste management calculations regardless of the concentration of these in mixtures or trade name products (USEPA 1999c). Dioxin (2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin) is a Persistent, Bioaccumulative, Toxic (PBT) chemical that forms as a byproduct of the combustion of organic materials. Polychlorinated dibenzo-para(p)-dioxins (CDDs) and polychlorinated dibenzofurans (CDFs) constitute a group of PBT chemicals that are termed "dioxin-like," meaning that these compounds have similar physical-chemical properties and therefore have similar toxic responses (1999c). In total, the TRI now includes some 20 PBT chemicals and chemical categories.

Finally, in 2000, the USEPA lowered the reporting thresholds for 18 chemicals and chemical categories that meet the Emergency Planning and Community Right-to-Know Act (EPCRA) section 313 criteria for persistence and bioaccumulation, such as mercury and mercury compounds, polychlorinated biphenyls (PCBs), and polycyclic aromatic compounds. In many cases, the federal agency reduced reporting threshold for many of these toxins from 100 pounds of release to ten pounds. As a result, many of these toxins "appear" in the 2000 TRI. To maintain consistency in the data set across time, we examined data from the 2000 TRI and removed any PBT chemicals with a maximum release of fewer than 100 pounds.

Once adjusted, we could analyze all the TRI releases over the ten-year span from 1990 to 2000. The number of appearances on the TRI for each chemical was totaled, by SIC code. We examined chemicals where the frequency of release was less than the overall mean. This allows us to create an average hazard potential for each class of facility, where a specific set of chemicals had been commonly released in the past and are more than likely present.

Unlike manufacturing facilities (such as shipyards, storage facilities, and refineries), oil and gas extraction facilities are not required by EPCRA to report to the TRI. As a result, data for oil extraction and reinjection wells had to be obtained from other sources. The Aerometric Retrieval System (AIRS) is an air pollution data delivery system managed by USEPA's Office of Air Quality Planning and Standards (USEPA 2000a). Using its data, the amount of Hazardous Air Pollutants (HAPs) released by the oil fields could be determined and quantified in much the same way as the TRI-reporting facilities.

The air releases associated with oil and gas fields represent only part of the potential wastes released. As USEPA notes, produced water is the largest volume waste generated in oil and gas extraction operations (USEPA 2000b). To more accurately model the total releases from oil and gas extraction operations, we included those priority organic and metal pollutants listed by the USEPA Office of Water as contaminants in Gulf of Mexico produced water (see Table 7).

The combination of these two values gives us the total chemical releases for each oil field. In calculating the toxicity for the individual production and reinjection wells, we used the air releases that were associated with the entire oil field and the toxicity associated with the produced water. These values, summed and multiplied by the total number of oil fields located

within the parish, divided by the total number of wells in the parish provide a rough estimate of the releases associated with each individual well or waste pit.

Finally, we determined the potential releases associated with each of the line-based infrastructure types, the transportation corridors and pipelines. The USEPA has measured Hazardous Air Pollutants for roadways in each parish in both tons per year and tons per year per square mile (Table 8) and they provide a basis to model the total roadway releases. The roadways modeled in this study are the major oil-related transportation corridors in the region, which is a primary source of these hazardous releases. For the pipelines, two surrogates enable the modeling of the potential releases: the chemicals associated with the petroleum bulk storage facilities serve as a measure for crude oil pipelines and those associated with natural gas processing plants provide the basis for potential releases from natural gas pipelines.

The next step in the research was to determine the chemical toxicity of each chemical in the analysis. Previous research has shown that the Environmental Defense Fund Toxic Equivalent Potential (TEP) has indexed more chemicals than many of the other toxicity indices, such as Threshold Limit Values, the Pratt Index, and the USEPA Priority Chemical List. Yet, subtle differences between these toxicity indices have been shown to create statistical and spatial variations in the overall results of equity analyses (Cutter et al. 2002). For this research, we have chosen to use chemical toxicity measures developed by the Indiana Pollution Prevention and Safe Materials Institute (IPPI), who developed a quantitative method for measuring progress in pollution prevention. The IPPI used the University of Tennessee Total Hazard Value (Total UTN), supplemented by a score to quantify hazard to workers (Whaley 1996). One criticism made of the Total UTN is that it tends to focus on contaminants that tend to occur in aqueous natural systems because of its emphasis on the aquatic environment. Conversely, the worker score focuses on gases and vapors in the workplace environment, where the primary route of exposure is most commonly inhalation of airborne contaminants. Taken together in the Indiana Relative Comparative Hazard Score (IRCHS), the two scores tend to be complementary, emphasizing different routes of exposure, ranking chemicals by hazard to the environment as well as workers and neighboring residents (Whaley 1996).

We also use a standardized value to estimate the potential amount of chemical that may be released. By using a standard score in place of actual pounds, we are able to use this calculation for facilities not reporting on the TRI. In cases where the facility does not appear on the TRI, the base data is used. The multiplier used in these cases is one, which represents those releases of 0 to 99 pounds of chemical. Thus, we are assuming that a facility not reporting on the TRI has no releases, although there is the potential for release.

Table 7. Produced Water Effluent Concentrations: Gulf of Mexico (Coastal Waters)

Pollutant	Settling Effluent	Improved Gas Flotation Effluent
	Concentrations (Micrograms/L)	
Oil and Grease	26,600.00	23,500.00
Total Suspended Solids (TSS)	141,000.00	30,000.00
Priority Organic Pollutants		
2,4-Dimethylphenol	148.00	148.00
Benzene	5,200.00	1,226.00
Ethylbenzene	110.00	62.18
Naphthalene	184.00	92.02
Phenol	723.00	536.00
Toluene	4,310.00	827.80
Priority Metal Pollutants		
Cadmium	31.50	14.47
Chromium	180.00	180.00
Copper	236.00	236.00
Lead	726.00	124.86
Nickel	151.00	151.00
Silver	359.00	359.00
Zinc	462.00	133.85

Data Source: U.S. Environmental Protection Agency, 2000b

Table 8. List of Mobile Source Air Toxics (MSATs)

Acetaldehyde[4]	Diesel Particulate Matter & Diesel Exhaust Organic Gases	MTBE
Acrolein[4]	Ethylbenzene	Napthalene
Arsenic Compounds[1,4]	Formaldehyde[4]	Nickel Compounds[1,4]
Benzene[4]	n-Hexane	POM[3]
1,3-Butadiene[1,4]	Lead Compounds[1,4]	Styrene
Chromium Compounds[1,4]	Manganese Compounds[1,4]	Toluene
Dioxin/Furans[2,4]	Mercury Compounds[4]	Xylene

[1] Although the different metal compounds differ in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e. the sum of all forms)

[2] This entry refers to two large groups of chlorinated their cancer risks, their quantitative potencies are usually derived from that of the most toxic, 2,3,7,8-tetrachlorodibenzodioxin.

[3] Polycyclic Organic Matter includes organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 100 degrees centigrade. A group of seven polynuclear aromatic hydrocarbons, which have been identified by EPA as probable human carcinogens (benz(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, 7,12-dimethylbenz(a)anthracene, and indeno(1,2,3-cd)pyrene) are sometimes used as surrogates for the larger group of POM compounds

[4] Although the different metal compounds differ in their toxicity, the on-road mobile source inventory contains emissions estimates for total metal compounds (i.e. the sum of all forms)

Data Source: U.S. Environmental Protection Agency, 2000a

Using the toxicity measures obtained from the IRCHS and the relative amount of chemical releases, a relative potential risk exposure score was calculated for both class of facility and individual facilities:

$$RPRS_f = \sum_{c}^{n} (A_c \bullet T_c)$$

where: $RPRS_f$= relative potential risk score for a given facility, *f*; *n*= number of chemicals released by facility, *f*; A_c= standardized maximum amount of chemical *c*; T_c= toxicity measure of chemical *c* based on the Indiana Relative Comparative Hazard Score.

This computation is similar to the relative potential risk exposure model developed by Susan Cutter et al. (Cutter et al. 2001, Cutter et al. 2002). However, Cutter's model utilizes the amount of chemicals released by the facility in pounds. By using a standard score in place of actual pounds, we are able to use this calculation for all facilities, including those not reporting on the TRI (Tables 9-15).

2.1.2 Buffering

To begin to make sense of these complex industrial landscapes, we buffered each of the pertinent facilities. We examined Regional Management Plans (RMPs) for many facilities located within the study areas, using these to model worst case scenario chemical releases based on the facility type. The model helps determine the distance at which certain effects might occur to the public because of an accidental release (called the "endpoint" distance). In the case of flammable substances, at the endpoint distance, people could be injured by the force of the blast, by flying glass, or by falling objects. In the case of the release of a hazardous substance, people at the endpoint distance would be able to walk away from the exposure without any long-term health consequences, although some short-term consequences such as eye or throat irritation are likely.

The endpoint distances enable us to create a series of buffers around each of the facilities. In previous research, we used uniform buffers to test for the absence or presence of potential effects. In this research, we use a series of buffers to model the potential dispersion of hazards around various facilities and infrastructure types. A quartic function is applied to a limited area around each incident location defined by the radius of the buffer at the toxic endpoint.

$$g(x_j) = \Sigma \left\{ [W_i \bullet I_i] \bullet \left[\frac{3}{h^2 * \pi} \right] \bullet \left[1 - \frac{{d_{ij}}^2}{h^2} \right]^2 \right\}$$

where: $g(x_j)$= relative potential risk score at any given distance, *j*; W_i *and* I_j= relative potential risk score for a given facility at the point location, *i*; *h*= endpoint distance; d_{ij}= distance from the facility to any reference point within the buffer, *j*.

Table 9. Common Refinery Releases and Associated Toxicity Values

Refinery Releases	Value
Benzene	48
Toluene	29.1
ethyl benzene	24.3
Xylene	26.1
Cyclohexane	23.5
Trimethylbenzine	17.4
sulfuric acid	29.3
propylene glycol	14.2
Ammonia	21.8
Ethylene	19.3
Naphthalene	29.2
Chlorine	31.6
methyl tert-butyl ether	28.7
butadiene (1-3)	40.6
Methanol	24.7
hydrofluoric acid	50
Cumene	31.7
Phenol	30.6
Diethanolamine	20.3
phosphoric acid	17.2
molybdenum trioxide	6.8
Nickel	32.1
Zinc	10.6
Cobalt	19.9
Hexane	31
Nitrate compounds (ammonium nitrate solution)	18.1
polycyclic aromatic compounds (average of all pac)	28.1
TOTAL	**704.2**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 10. Common Shipyard Releases and Associated Toxicity Values

Shipyard Releases	Value
Xylene	26.1
butyl alcohol	19.4
Copper	29.4
Styrene	32.7
Zinc	10.6
zinc oxide fume and dust (ZnO)	11.6
Chromium	32.7
methyl ethyl ketone	27.9
Toluene	29.1
Nickel	32.1
Copper	29.4
Trimethylbenzine	17.4
Methanol	24.7
Manganese	21.3
manganese (II) oxide	22.8
TOTAL	**367.2**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 11. Common Petroleum Bulk Storage Releases and Associated Toxicity Values

Petroleum Bulk Storage Releases	Value
Benzene	48
Toluene	29.1
ethyl benzene	24.3
Xylene	26.1
Trimethylbenzine	17.4
Naphthalene	29.2
methyl tert-butyl ether	28.7
Hexane	31
TOTAL	**233.8**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 12. Common Natural Gas Liquids Releases and Associated Toxicity Values

Natural Gas Liquids Releases	Value
Trimethylpentane	20.1
Benzene	48
Toluene	29.1
ethyl benzene	24.3
ethylene glycol	16
Methanol	24.7
Xylene	26.1
Chlorine	31.6
Hexane	31
hydrosulfuric acid	34.5
TOTAL	**285.4**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 13. Common Oil and Gas Field Air Releases and Associated Toxicity Values

Oil and Gas Field Air Releases	Value
Trimethylpentane	20.1
Benzene	48
ethyl benzene	24.3
ethylene glycol	16
Hexane	31
Methanol	24.7
Toluene	29.1
Xylene	26.1
TOTAL	**219.3**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 14. Common Roadway Air Releases and Associated Toxicity Values

Roadway Air Releases	Value
butadiene (1-3)	40.6
Acetaldehyde	37.9
Acrolein	57
Benzene	48
Diesel	14.7
Formaldehyde	43.1
TOTAL	**241.3**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

Table 15. Common Oil and Gas Field Waste Pit Releases and Associated Toxicity Values

Oil and Gas Field Waste Pits	Value
dimethylphenol-2,4	15
Benzene	48
ethyl benzene	24.3
Naphthalene	29.2
Phenol	30.6
Toluene	29.1
PRIORITY ORGANIC POLLUTANTS	**176.2**
Cadmium	32.9
Chromium	32.7
Copper	29.4
Lead	33.3
Nickel	32.1
Silver	16.6
Zinc	10.6
PRIORITY METAL POLLUTANTS	**187.6**
TOTAL	**363.8**

Data Source: Indiana Clean Manufacturing Technology and Safe Materials Institute, 2004; U.S. Environmental Protection Agency 2004

This method operationalizes risk in terms of space. Using the quartic function, the relative potential risk score falls off gradually with distance until the radius is reached. Outside of the specified radius, the value of the potential risk score is assumed to be zero. For line data, such as transportation corridors and the various types of pipeline, the quartic formula enable the calculation of five equidistant buffers. For point locations, such as oil wells, waste pits, and pipeline crossings, where the number of locations may number in the hundreds, we employed CrimeStat II to create a kernel density surface. The CrimeStat program allows us to input the relative potential risk score and specify that the quartic function to calculate the density surface. Further analysis is possible through ArcView.

In order to scale our results, we calculated the quartic function twice. First, we used the actual endpoint distance to determine the potential risk score. We then used a distance of one as the endpoint for all facilities. By adjusting the potential relative risk score by the ratio of the two values, we are able to maintain accurate comparative ratios between different facilities.

2.1.3 Modeling

The standardized amount and toxicity of each chemical is incorporated into the riskscape, allowing us to create a toxicity surface for each facility. With this data, we model each parish's total risk surface. This is done by creating an arithmetic overlay model that incorporated all of our facilities into a single overarching hazardscape. Once the model integrates all the facilities, we used the resultant hazards value to classify each parish by a new weighted hazardousness of place rating.

In this analysis, a simple arithmetic overlay produced a conceptual model of the potential hazardscape related to the onshore impact of oil-related infrastructure in each of the three case study parishes (Hemmerling and Colten 2003, Hemmerling and Colten 2004). To accomplish this, we reclassified and overlaid our maps using a process termed "sieve mapping" (Kitchin and Tate 2000). Each facility, buffered to the toxic endpoint distance, receives a value based on the relative potential risk score. We next transformed all of the vector surfaces into a number of 30-meter resolution raster grid cells. Raster grid cells are significantly smaller than the original vector surfaces, and consequently we aggregated data to a variety of larger areal units (Mennis 2002). Using the model building capability of ArcView, all of the rasterized facilities and buffers were combined into a single composite of intersecting grid cells. This allowed us to classify all locations in the parish according to their cumulative hazards density, which was then broken down into quintiles, with one indicating the lowest hazard potential and five the highest. Those areas with no identified potential hazards were assigned a value of zero and classed separately. Finally, each census block and block group received a hazards rating, based on the relative potential risk score of the grid cell located at the centroid of the enumeration area. This allowed us to operationalize the model and analyze the potential environmental justice impacts of the entire network of oil- and gas-related infrastructure in the study area.

2.1.4 Statistical Analysis

Nonparametric procedures were used to analyze the racial and ethnic characteristics within specified hazardous areas relative to the characteristics of the portion of the parish outside of these areas. Odds ratios and the chi-square test of significance were used to demonstrate whether any observed differences were statistically meaningful or merely due to chance. Odds ratios allow us to make inferences about how much higher or lower are the odds of a minority individual (relative to a non-minority) living in proximity to a potentially hazardous facility (Pine et al. 2002). An odds ratio of 1, for example, implies that the two variables being compared are independent, and this serves as a baseline for comparison. Values of odds ratios further from 1 in a given direction imply stronger levels of association.

At the facility level, nonparametric procedures were used to analyze the racial and ethnic characteristics within each facility buffer relative to the characteristics of the portion of the parish outside of the buffer. To analyze the cumulative hazardscape in each parish, we used hazardousness deciles, with each decile containing roughly ten percent of the total census blocks in the parish. Odds ratios and the chi-square test were then used to analyze the racial and ethnic

characteristics in each decile relative to the characteristics of the census blocks outside of that decile.

Parametric regression analysis was also run on the data at varying spatial scales in order to test for the existence and strength of association between the socioeconomic variables and the hazardousness of place rating. In using regression analysis, we do not mean to imply that race, ethnicity, or income cause vulnerability. Indeed, as Buzelli et al. (2003) point out, we cannot infer causality on the basis of one study alone, regardless of the modeling framework. All data was tested for any obvious problems with multicollinearity and to determine whether some likelihood that linear relationships exist between the hazardousness ranking and each of the predictor variables. Residual plots were examined and any cases where the Studentized residuals exceeded two were removed from the model.

We regressed the hazardousness of place rating against race and ethnicity at the block level, and race, ethnicity, income, median house value, and median contract rent at the block group level. Because economic data was unavailable at the block level in the 2000 census, economic variables could not be included the block-level analysis. According to USEPA, mean house value as well as monthly rent can serve as proxies for income levels (USEPA 1998). This is important because before the 2000 census house values and monthly rent were counted at the block level, compared to income, which was only counted at the block group level and higher. Regression analysis allows us, specifically, to determine whether there is a positive, negative, or no correlation between the social and economic independent variables in the relationship with proximity to various oil-related facilities.

2.2 HAZARDOUSNESS OF PLACE MODEL

To operationalize our conceptual model, we focused on the following three elements: biophysical, social, and place vulnerability (Cutter et al. 2000). These three outcome indicators enabled measurement of the potential hazardousness of each parish relative to expanding oil-related activity. The delineation of oil-related hazard zones, provided the biophysical vulnerability and social and demographic characteristics yielded a measure of social vulnerability. The interchange of biophysical and social vulnerability provides the overall place vulnerability, the third outcome indicator.

2.2.1 Biophysical Vulnerability

Lafourche Parish

Examining the modeled hazard zones of Lafourche Parish, we see that offshore oil-related industry and activities are not equally distributed across the parish (Figure 5). As expected, industry has clustered along Highway 1, particularly in South Lafourche. Two areas stand out as sites where industry has concentrated, Port Fourchon and Larose. The geographical locations of these two areas play a large part in the concentration of industry found there.

Port Fourchon is one of the few ports on the Gulf of Mexico equipped to handle the needs of deepwater oil and gas development. It is considered to be the most efficient port for many offshore areas because it is closest to much of the deepwater development. Most of the other ports in Louisiana are located further inland, and other ports in the Gulf of Mexico region, such as Galveston and Mobile, are much more distant (Keithly 2001). Port Fourchon also contains the only facility in the world where deepwater supply vessels can take on fuel, water, deck cargo, barites, cements, liquid muds, and completion fluids efficiently at the same dock. This C-Port facility has cut vessel turnaround time by more than 50 percent (Keithly 2001).

As of May of 1999, more than 100 businesses were operating out of Port Fourchon, the vast majority of which are either directly or indirectly involved in supporting OCS-activity (Hughes et al. 2001). This includes petroleum production firms, oilfield pipeline laying companies, and independent drilling companies. Several shipbuilding firms are also located at Port Fourchon, including one major shipbuilding facility.

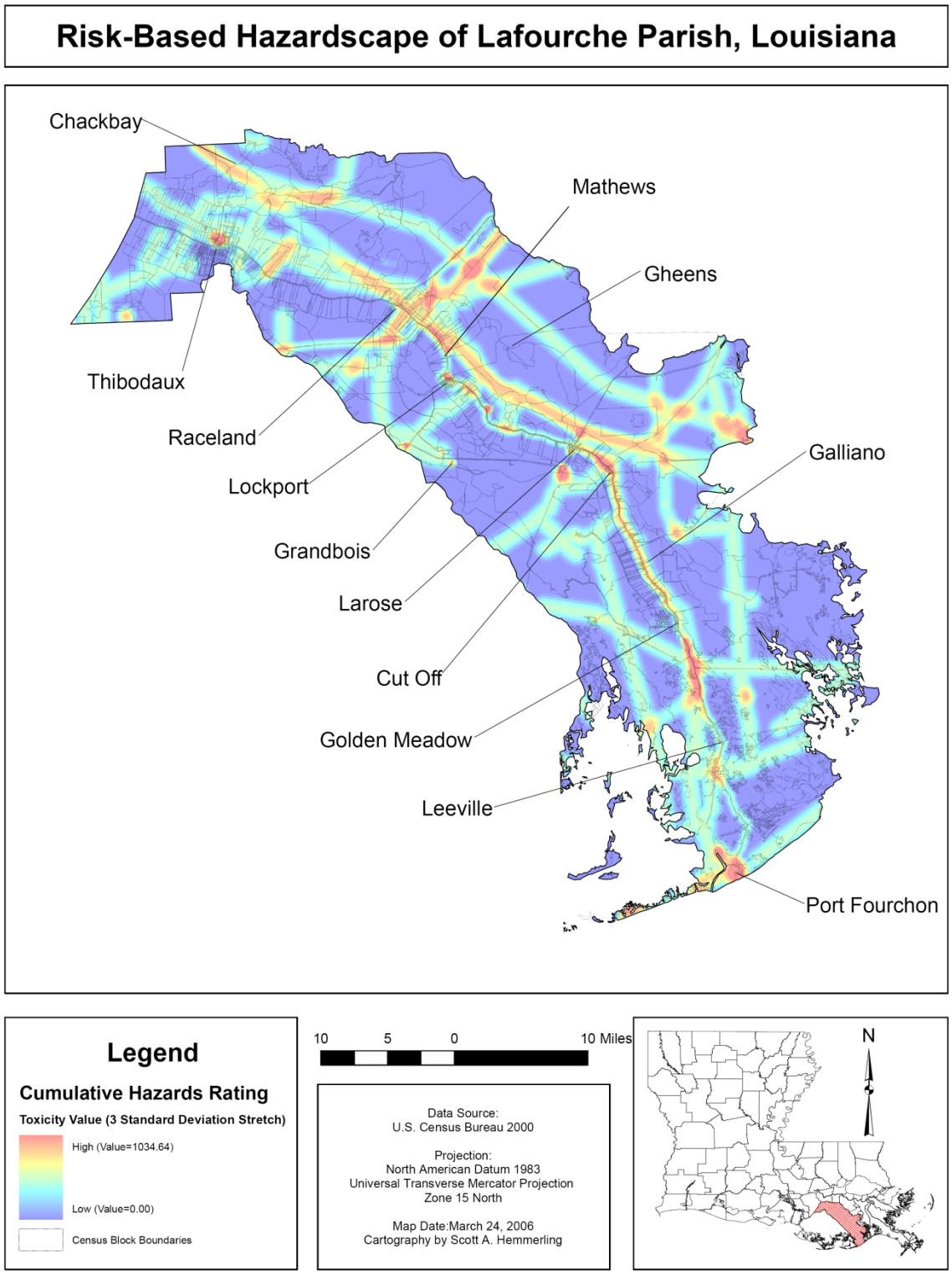


Figure 5. Risk-based hazardscape of Lafourche Parish, Louisiana.

Larose is an unincorporated community located at the junction of Bayou Lafourche and the Intracoastal Waterway sixteen miles south of U.S. Highway 90. This community of 7,306 residents is home to a number of shipbuilding and repairing industries, including two major shipbuilding facilities located along the Intracoastal Waterway, both of which USEPA identifies as large quantity generators as well as Toxic Release Inventory sites. In addition, there is a major gas processing plant located one-half mile to the west of Larose. The Larose Gas Processing Plant is capable of storing both propane and butane on site; methane, condensate and natural gas liquid products both move through the facility via pipelines.

Other communities identified by our model include the incorporated towns of Lockport and Golden Meadow, and the small community of Grand Bois. Lockport is located where Louisiana Highway 1 crosses a former channel of the Intracoastal Waterway about 5 miles south of U.S. Highway 90. Most of its 2,624 citizens find work in sugar cane farming, paper production, oil and gas exploration, shipbuilding, and fishing. The fishing town of Golden Meadow, the southernmost town in Lafourche Parish, is located at the edge of the levee system on land two feet above sea level. According to the Louisiana Department of Natural Resources (LDNR), there is a small Houma community on the northern shore of Catfish Lake, just to the west of Golden Meadow. This community consists of five families that hunt and trap the area for a living (LDNR 2002).

The community of Grand Bois is unique among the sites identified by our model in that it is not located along the Highway 1 corridor. The community of Grand Bois is located along the Intracoastal Waterway near the border of Lafourche and Terrebonne parishes. Most of the approximately 300 residents alternate between growing and harvesting food and working as laborers in the shipyards or on the oil rigs (Austin 2001). In addition to an oilfield waste facility, the community is also home to a large shipyard listed as a Toxic Release Inventory site. Grand Bois and the surrounding area are located within the Bayou Pointe-au-Chien Environmental Management Unit. The marshlands of this area are ideal for production of waterfowl food and waterfowl game species and fur-bearing animals both thrive throughout this area. In addition, both brackish and freshwater fishing are excellent throughout the unit. Wherever offshore oil-related activity has the potential to affect fish, vegetation, or wildlife, that activity may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Native American tribes (CEQ 1997).

Jefferson Parish

Oil fields and petroleum bulk terminals stand out in the hazardscape of Jefferson Parish, our case study of onshore oil extraction (Figure 6). Where onshore oil processing occurs, we see numerous wells, natural gas processing and separation plants, waste pits (where waste products are re-injected into the subsurface formation), and storage facilities. Many of these facilities are concentrated near the extraction points. Once processed the product is then piped off for storage, before being sent for further processing.

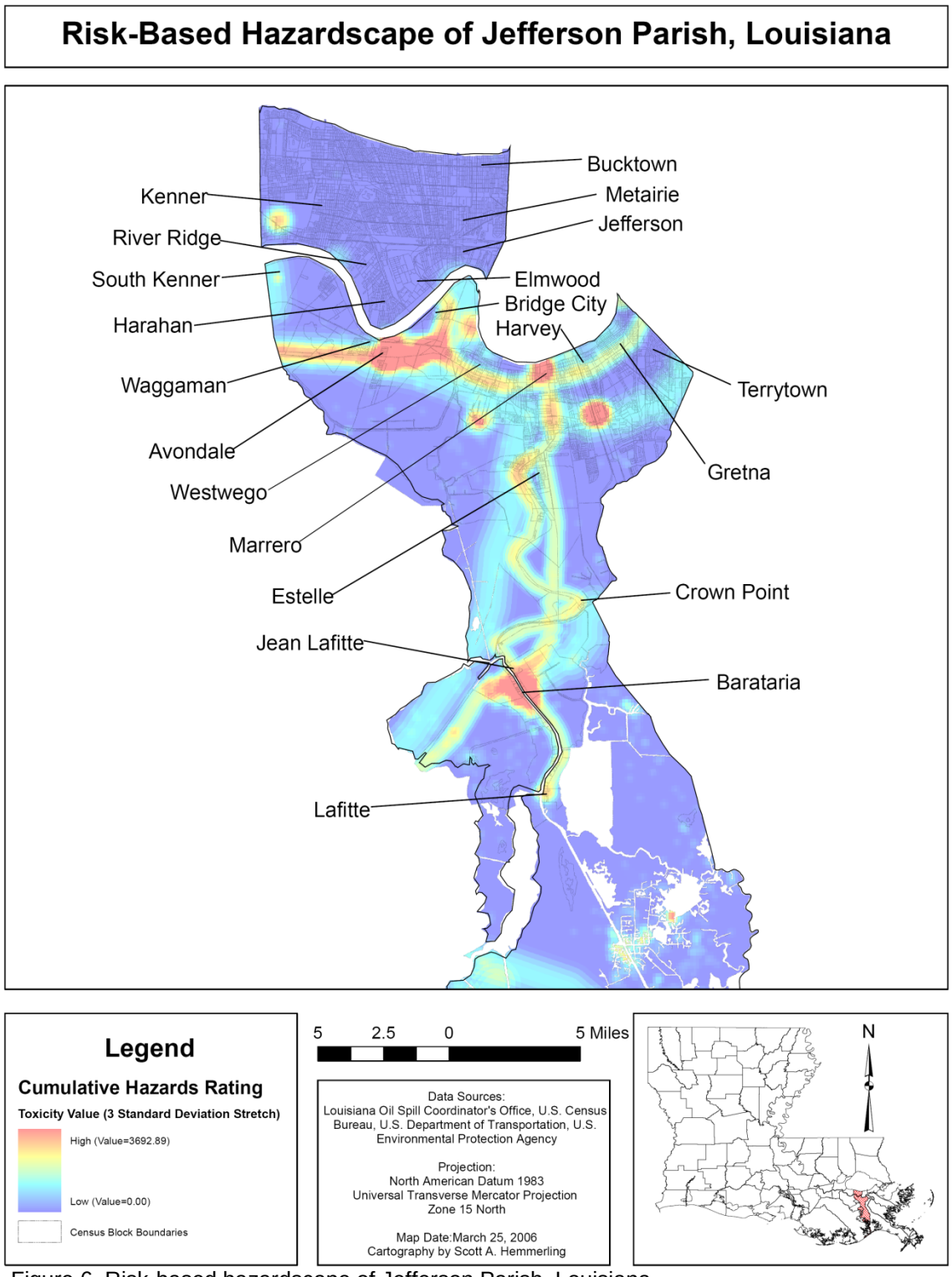


Figure 6. Risk-based hazardscape of Jefferson Parish, Louisiana.

As we saw in Lafourche Parish, many of the facilities in the parish tend to follow the waterways. The most significant portion of the parish impacted by onshore oil and gas is the area along the Mississippi River in Avondale, and to a lesser extent, Marrero. The hazardscape in this area is dominated by a number of Petroleum Bulk Terminals, including many that have been listed in the Toxic Release Inventory.

Avondale, an unincorporated community of 5,441 residents, is located in the urbanized northern portion of the parish on the Westbank of the Mississippi River. Although the largest employer in Avondale is the Avondale Shipyards, owned by Northrop Grumman, the town is still a major center for the onshore oil industry. There are some 91 wells located on the Avondale oil field, representing just about 9 percent of the total wells in the parish. However, there are forty-six waste pits associated with the Avondale Field, fully 25 percent of the total active waste pits in the parish. Avondale and the surrounding area represent a major petroleum storage area. There are two large tank farms located in Avondale and twelve smaller tank batteries.

This area consists of a mix of residential, commercial and industrial interests. The people from the larger region use the area for recreation and several water and overland transportation corridors including River Road, Lapalco, the West Bank Expressway and the Mississippi River traverse the area. There are six residential communities in this unit: Live Oak Manor, Avondale, Bridge City, Waggaman, Willswood, and South Kenner. These communities are largely minority, with higher than average numbers of African-Americans, Native Americans, Asians, and Hispanics.

Further to the south, along the bayous and waterways, we find the Barataria oil and gas field. Development in this area consists of a number of strip settlements that have developed along Louisiana Highway 45 on the East Bank of Bayou Barataria and along Louisiana Highway 301, including Barataria, which has higher than average proportions of Native Americans and Asians, and Lafitte, further to the south has a higher than average African-American population.

Barataria is a small unincorporated community located in the sparsely populated Barataria region of Jefferson Parish, the elongated central portion of the parish that includes many small communities scattered along the major bayous, principally Bayou Barataria and Bayou des Families. This community of 1,333 is located on the Bayou Barataria waterway, at the juncture of three large oil fields, the Barataria, Barataria West, and Barataria South. In total, these three fields have an estimated 174 wells, almost 17 percent of the total wells in the parish. Associated with these wells are some thirty-four active waste pits and seven storage tank batteries.

St. Bernard Parish

Finally, we turn to our refining district, St. Bernard Parish. Once the oil and gas are separated from impurities in the field, the product is ready for refining. Petroleum refineries engage in distillation, fractionation, and cracking of crude petroleum into refined petroleum products including reformulated unleaded gasoline, jet fuel, diesel, kerosene, liquefied petroleum gas, still oil, and sulfur. Additionally, aromatic chemicals such as ethylene may be produced, which are piped to petrochemical plants for further refining.

The areas of particular interest here are those areas in Chalmette and Meraux, a densely populated area that is home to two large oil refineries, one of which also has a gas fractionating plant (Figure 7). Both of these communities share a strategic location on the Mississippi River, close to the intermodal St. Bernard Port, Harbor and Terminal District, with terminals located at Chalmette and Arabi. We see an extremely dense hazardscape with some of the highest ratings across all of the case studies.

Chalmette is the unincorporated seat of St. Bernard Parish. Located within the New Orleans Metropolitan Region, Chalmette was home to 32,069 residents in 2000, a population density of nearly 4,370 persons per square mile. Chalmette is home to the largest employer in St. Bernard Parish, Mobil's Chalmette refinery, which employs approximately 665 persons. The refinery is listed as a USEPA TRI site, as well as a Large Quantity Generator of hazardous waste. In addition to the refinery, Chalmette is home to a gas processing plant and a calcining plant with the capacity to produce 230,000 tons of petroleum calcined coke. The nearby Chalmette Terminal and Business Park, part of the St. Bernard Port, Harbor and Terminal District, is home to over fifty businesses, including a 60-acre intermodal facility. A number of liquid bulk tanks are located at the port, including those storing petroleum and calcined coke.

Meraux, an unincorporated community adjacent to Chalmette on the east, is much less densely populated, with 10,192 residents residing on just over 4 square miles of land, a total density of almost 2,448 persons per square mile. This town is home to the Murphy Oil Refinery, a TRI reporter and Large Quantity Generator of hazardous waste.

Our model also identifies three other areas, the unincorporated towns of Toca, Ysclosky, and St. Bernard. Because of the gas processing plants located in these communities, they show localized highs in the hazardscape, though nowhere near the levels present in Chalmette and Meraux.

Three-Parish Comparison of Biophysical Vulnerability

Thus far, we have created a number of localized hazard models, geared specifically to the offshore industry, the onshore industry, and refining. The next step in the analysis is to examine the relative hazardousness of each sector of the oil industry. Because we incorporated toxicity values into the hazardscape models, we are able to show a relative comparison between the different types of facilities. When we use a cumulative hazardscape weighted by toxicity, we are able to examine all facilities in our entire study area on a single sliding scale. For example, as would be expected, the refining district in St. Bernard Parish dominates the overall hazardscape. Nonetheless, localized high points around Avondale and the Barataria Fields still stand out, despite much lower relative values. Other local high points that were located around individual gas processing plants in each of the individual parishes are significantly less important when compared to the other hazardous areas in the region. The areas around Larose in Lafourche Parish and Toca, St. Bernard, and Yscloskey in St. Bernard Parish, for example, all fall below the mean in terms of overall hazardousness.

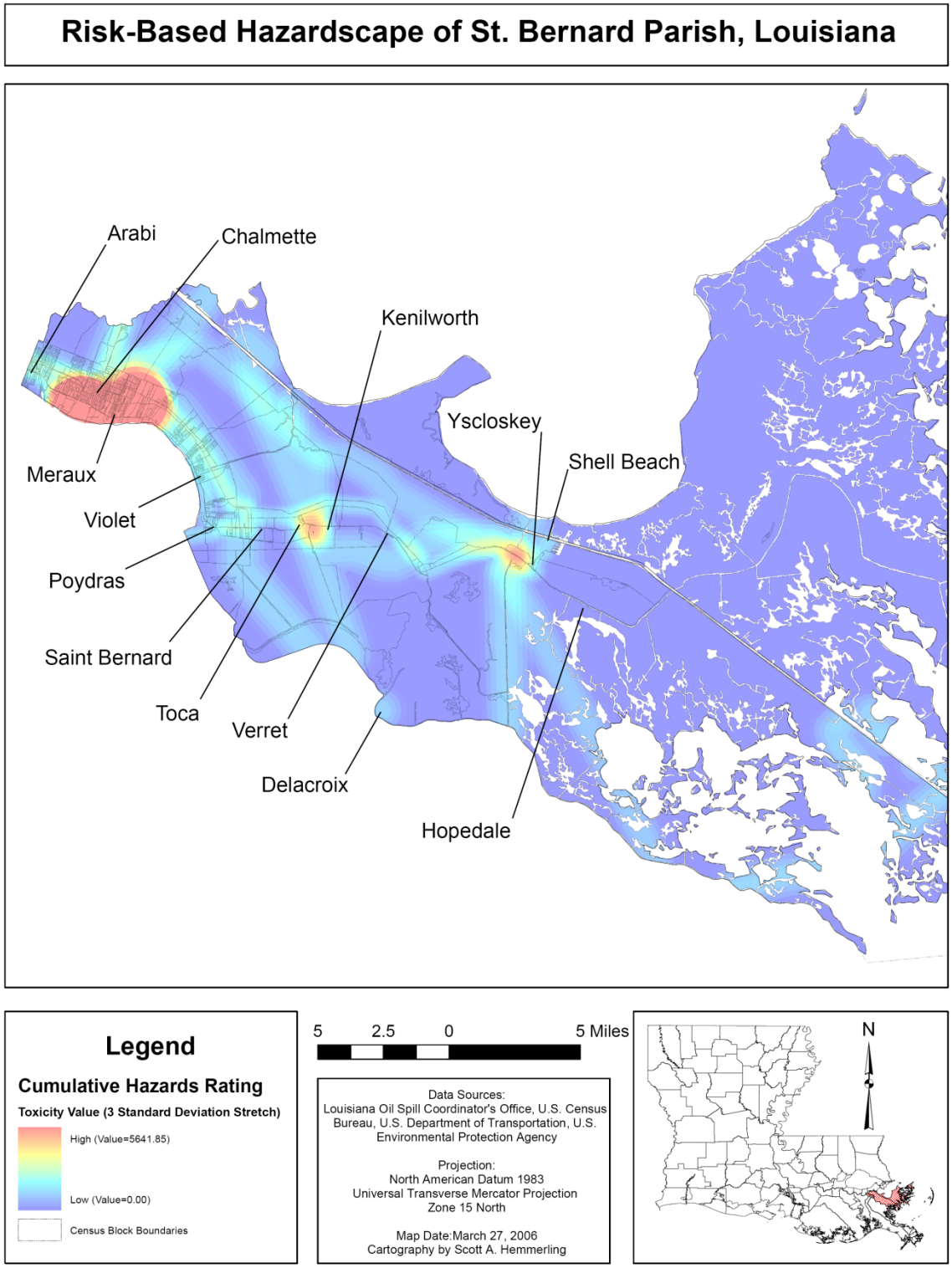


Figure 7. Risk-based hazardscape of St. Bernard Parish, Louisiana.

2.2.2 Social Vulnerability

Environmental justice concerns may arise if areas with high cumulative hazard ratings also have above-average minority populations or below-average economic conditions. To analyze this, we first present data on the geographic distributions of minority populations and economic conditions in Lafourche, Jefferson and St. Bernard Parishes. In particular, we present maps on the prevalence of African-American, Native American, Asian and Hispanic populations. We also present maps of three measures of economic conditions: per-capita income, median contract rent, and median house value. The following sections discuss the patterns observed in the maps for each county; subsequent sections analyze the correlations of the cumulative hazard ratings to the observed patterns of social vulnerability.

Lafourche Parish

Our model reveals some very clear minority population clustering in Lafourche Parish (Figure 8-11). For the most part, the African-American population clusters in North Lafourche, particularly around Thibodaux and Raceland. The Native American population is concentrated along Highway 1 in south Lafourche, between Larose and Golden Meadow. Also, some concentrations exist along the Lafourche-Terrebonne border, in the area of Houma and Bayou Pointe-Au-Chien. Both the Asian and Hispanic populations are geographically dispersed, living along the Highway 1 corridor, and into Thibodaux.

What this model reveals is that there is a great deal of minority clustering occurring in and around the area of Larose extending southward towards Cutoff. There are also a number of smaller minority clusters found in and around Thibodaux.

Low-income populations tend to be dispersed across the parish, at least at the block group level (Figure 12). Census block groups where residents earn, on average, 20 percent or more beneath the parish average are located in the marshlands of Lafourche south of Golden Meadow, as well as in and around Thibodaux. The population along the Louisiana Highway 1 corridor for the most part is not low-income, although Lockport does have areas of very low-income levels. Economic factors exhibit a similar dispersed pattern. Areas of low median contract rent, for example, exist in the marshlands of south Lafourche, along the Louisiana Highway 1 corridor, and around Thibodaux (Figure 13). The Census Bureau defines “contract rent” as the monthly payment agreed to or contracted for, regardless of furnishings, utilities, fees, meals, or services that may be included. Finally, median house values have a similar pattern, although house values tend to be higher in developed areas (Figure 14). The marshlands below Golden Meadow and the farmland along the U.S. 90 corridor to the east of Bayou Lafourche have the lowest median house values, with other smaller clusters located in Thibodaux, Raceland, and Lockport. It is important to recognize that the block group aggregation of data and lack of current information on income levels may fail to reveal certain relevant characteristics about the population, such as pockets of low-income individuals that exist among the larger general population (USEPA 1999a). In order to determine if block group low-income patterns hold at the block level, we examined 1990 median house value data, which was available at the block level. Although the growth of the oil industry throughout the 1990s would have altered much of the economic landscape of Lafourche Parish, this data reveals a similar pattern to that found at the block group

level in 2000. The marshlands below Golden Meadow and the area to the east of Thibodaux contain a number of census blocks with low-value housing. The area around Grand Bois appears in the 1990 census as an area with extremely low property values.

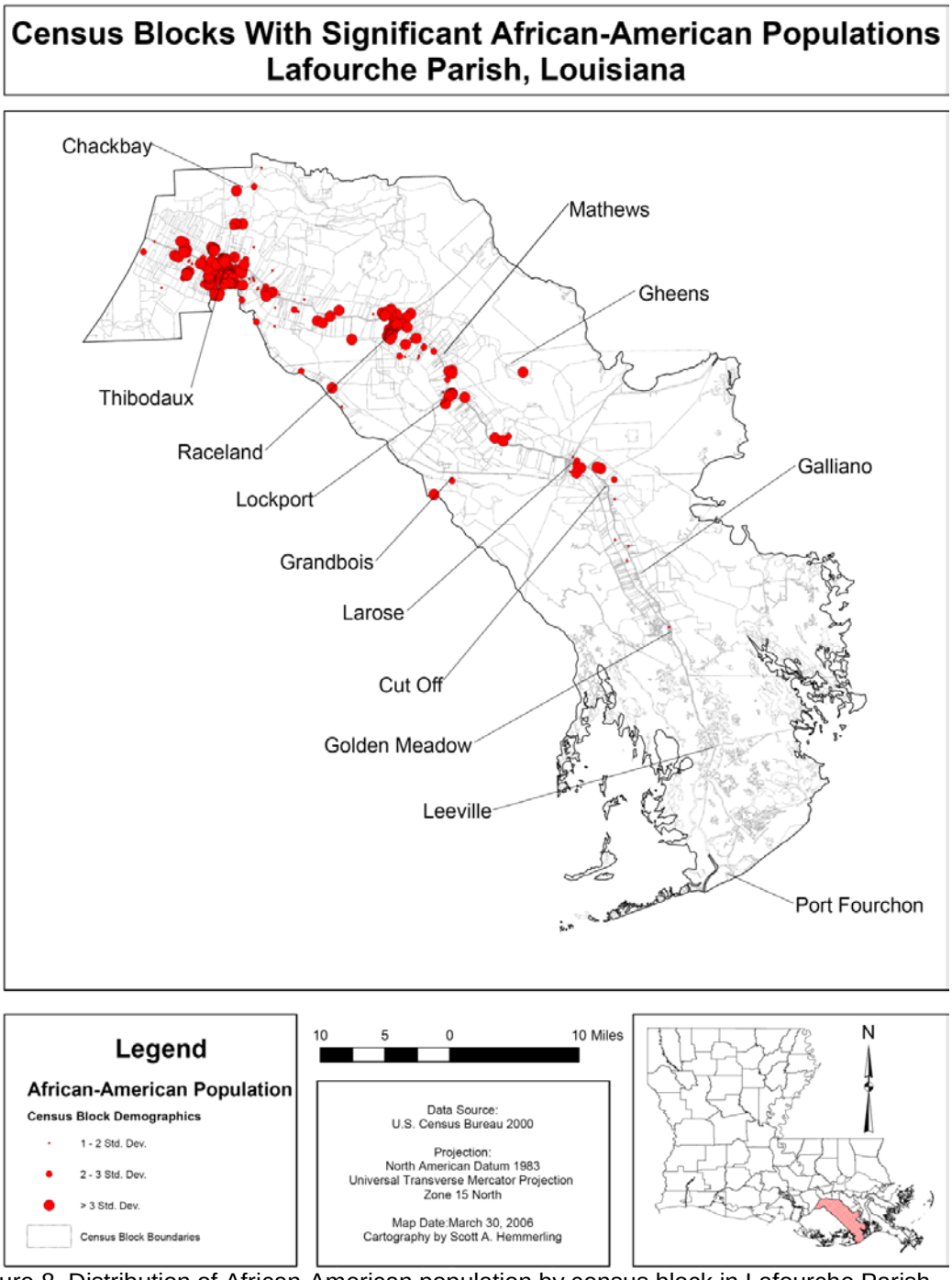


Figure 8. Distribution of African-American population by census block in Lafourche Parish, Louisiana, 2000.

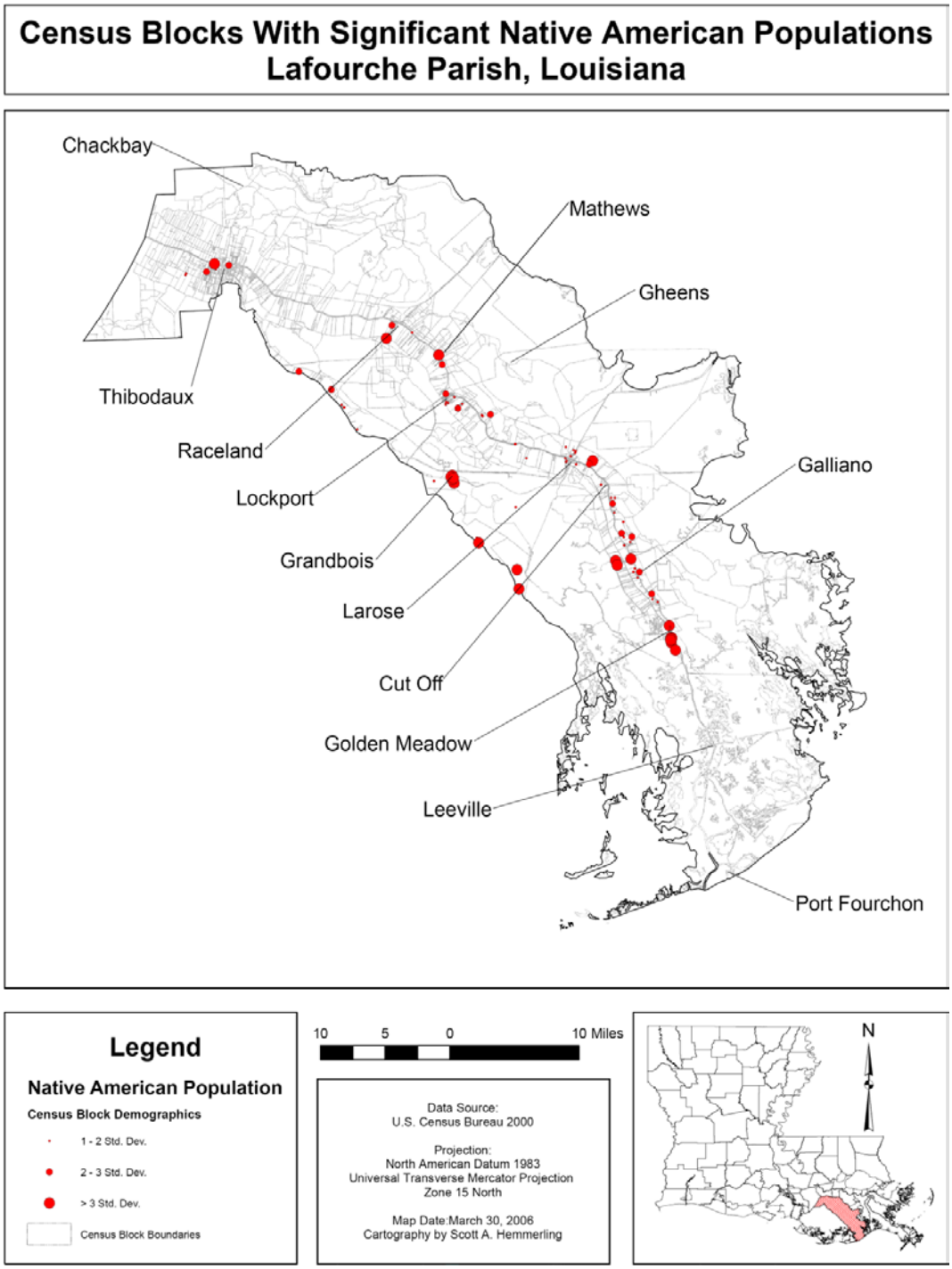


Figure 9. Distribution of Native American population by Census Block in Lafourche Parish, Louisiana, 2000.

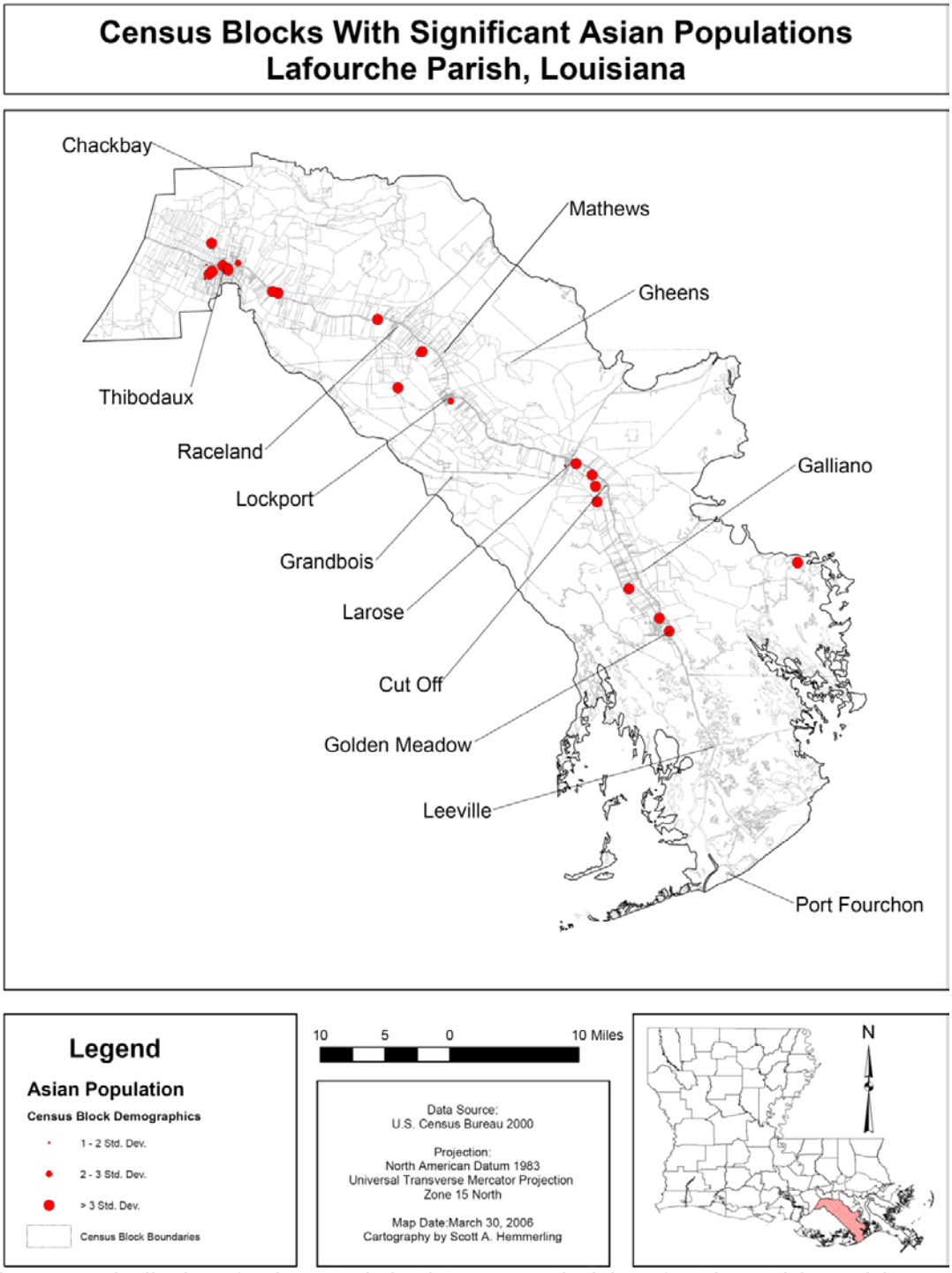


Figure 10. Distribution of Asian population by Census Block in Lafourche Parish, Louisiana, 2000.

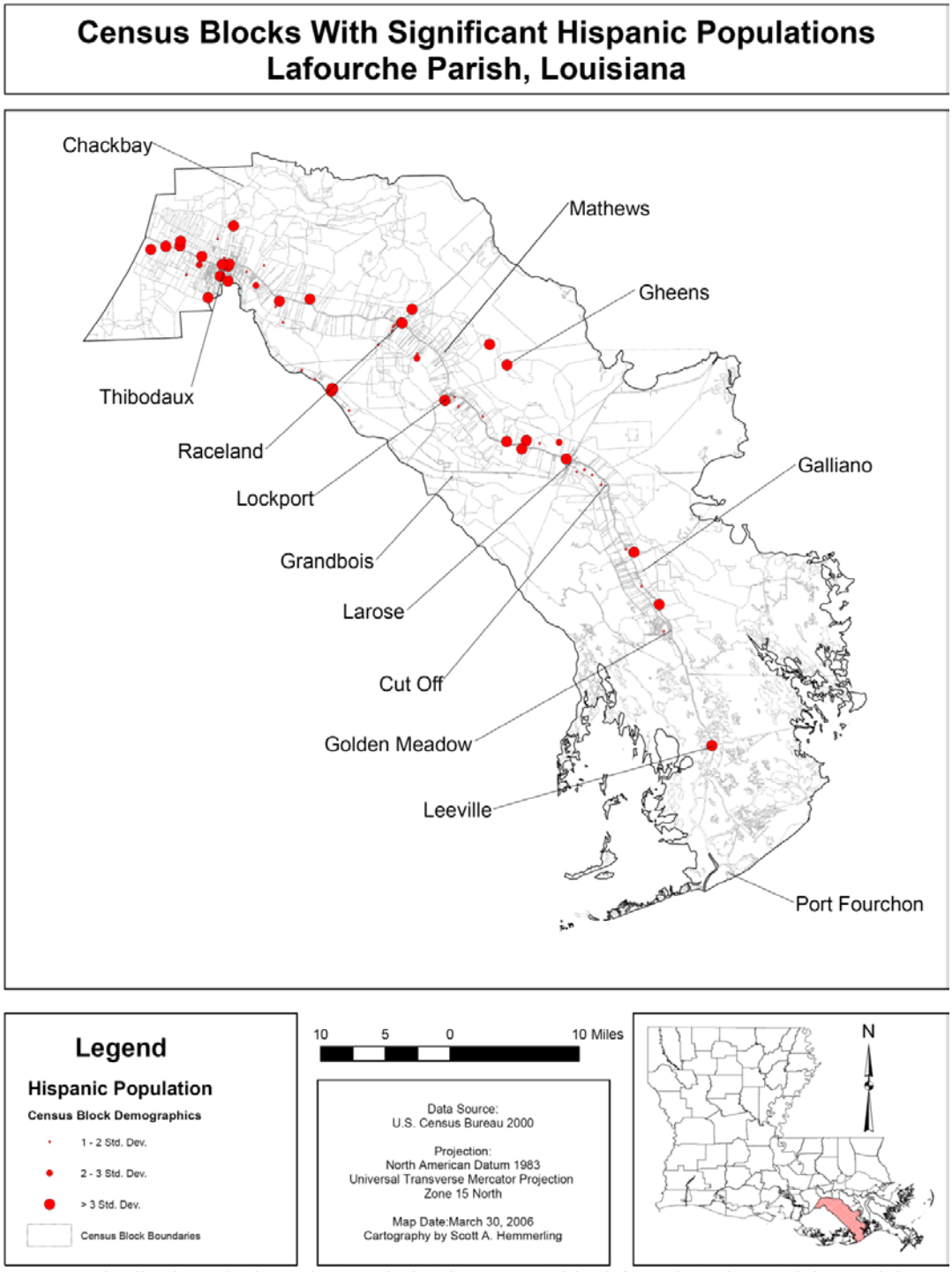


Figure 11. Distribution of Hispanic population by census block in Lafourche Parish, Louisiana, 2000.

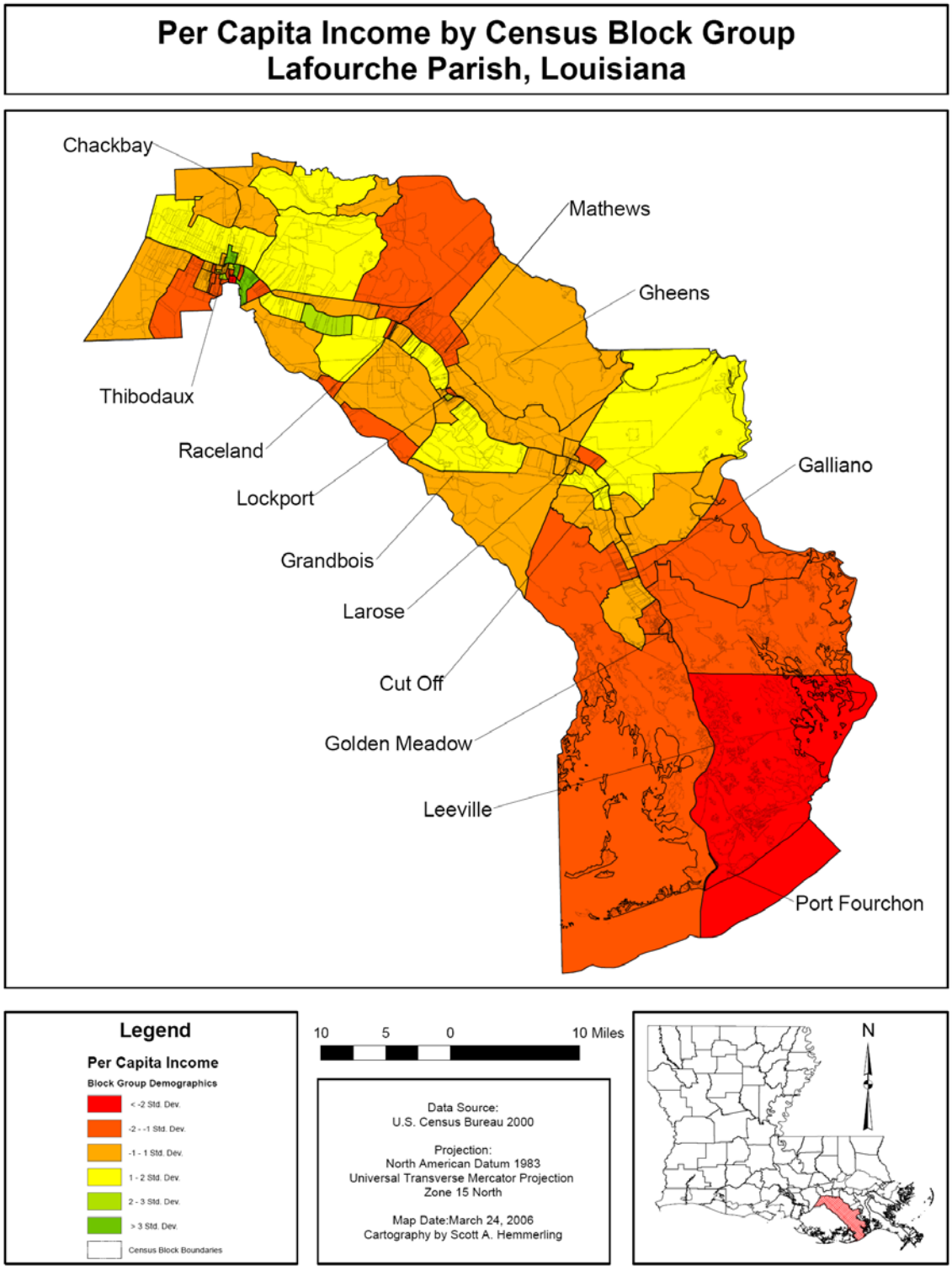


Figure 12. Per capita income by census block group in Lafourche Parish, Louisiana, 2000.

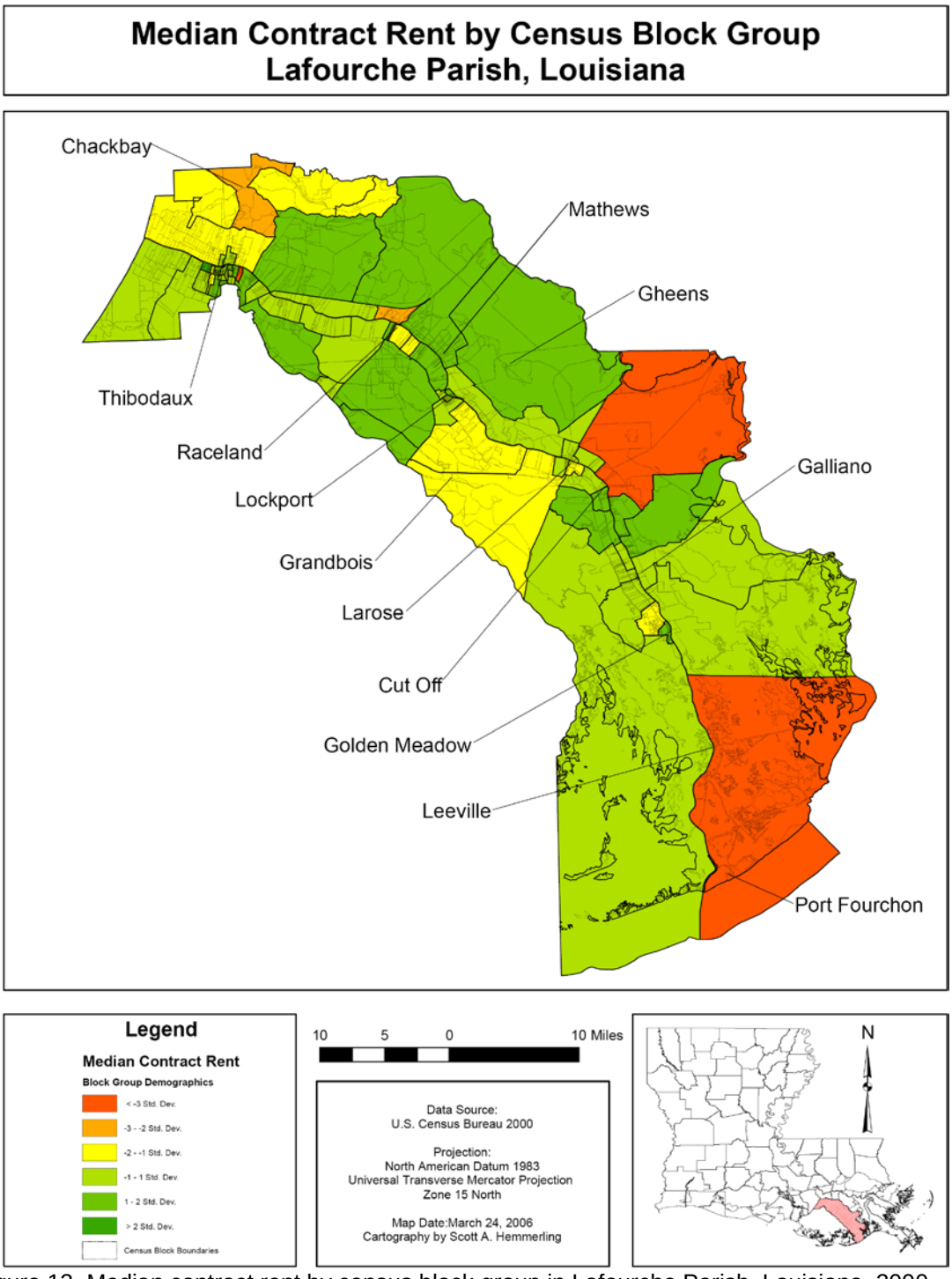


Figure 13. Median contract rent by census block group in Lafourche Parish, Louisiana, 2000.

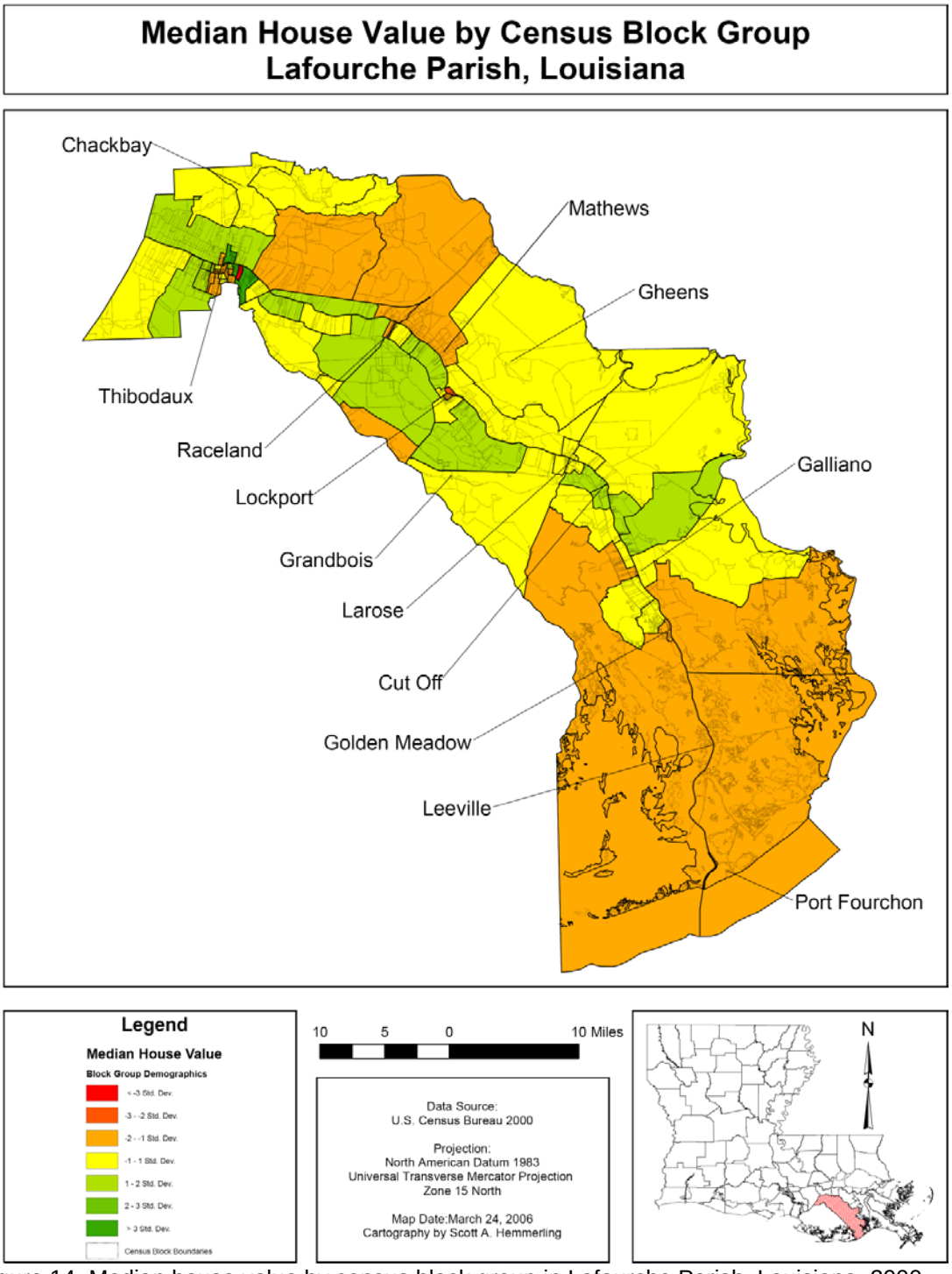


Figure 14. Median house value by census block group in Lafourche Parish, Louisiana, 2000.

Jefferson Parish

The African-American population in Jefferson Parish is the most clustered of all of the racial groups, with the majority of the population located in the more developed northern portion of the parish (Figures 15-18). On the East Bank of the Mississippi River, the African-American population can be found in two distinct areas. In Kenner, in the extreme northwest of the parish, statistically significant clusters of African-American residents can be found residing in close proximity to the Louis Armstrong International Airport, on the north, south, and east. This population extends eastward from the airport along US Highway 61, the Airline Highway, for the length of River Ridge. Another distinct cluster can be found south of the Airline Highway in the town of Jefferson, in the vicinity of Causeway Boulevard.

On the West Bank of the Mississippi River are a number of significant African-American population clusters. One is on the eastern edge of Waggaman between Highway 18, the River Road, and U.S. Highway 90. Further to the east, on the U.S. Highway 90 Business Loop, the Westbank Expressway, in Marrero there is another significant cluster of African-American population. Other clusters can be found along the Harvey Canal in Woodmere and Harvey, and in Gretna, close to the border with Orleans Parish.

The Native American, Asian, and Hispanic populations all tend to be much more dispersed across the parish, on both the east and west banks of the Mississippi River. The Native American population is the only minority group to be found in significant numbers in the relatively rural Barataria region of central Jefferson Parish, particularly in the towns of Crown Point, Jean Lafitte, Barataria, and Lafitte. The Asian population is the most dispersed of all of the racial and ethnic groups examined here, with clusters of Asian population found in virtually all towns in the developed northern portion of the parish. The Hispanic population is also quite dispersed, although the majority of the west bank population may be found to the east of the Harvey Canal. Significant Hispanic population clusters are also found in Kenner, on the East Bank, along Loyola and Williams Boulevards, north of Interstate 10.

Block groups with significant low-income are highly correlated with areas of high African-American population, including the neighborhoods around Louis Armstrong International Airport, the Airline Highway, and the town of Jefferson on the East Bank (Figure 19). On the west bank, this includes areas of Waggaman, Marrero, and Harvey. Of all of the areas with significantly high clustering of African-American population, only Woodmere is not significantly low-income.

Areas with significantly low house values (Figure 20) tend to be located around major transportation locations. This includes the Louis Armstrong International Airport, which is surrounded on all four sides by block groups with significantly low median house values. In addition, house values tend to be lower in proximity to U.S. Highway 90 (on both banks of the Mississippi River), the Westbank Expressway, and Airline Highway. Finally, house values tend to be significantly lower along the Harvey Canal stretching to the Intracoastal Waterway on the border of Jefferson and Plaquemines parishes.

The locations in the parish with significantly low median contract rent values tend to differ from areas with low incomes and low house values (Figure 21). For examples, rent values along

U.S. Highway 61, Airline Highway, are not significantly lower than the parish average, except around Causeway Boulevard near Jefferson. Similarly, rental costs around the airport do not differ significantly from the parish average. Marrero, on the west bank of the Mississippi River, does have block groups in which low-income, low house values, and low median contract rents are significantly correlated. The towns of Barataria and Lafitte, in the rural central portion of the parish, have significantly lower rental costs, although neither the house values nor the income levels are significantly lower than the parish average.

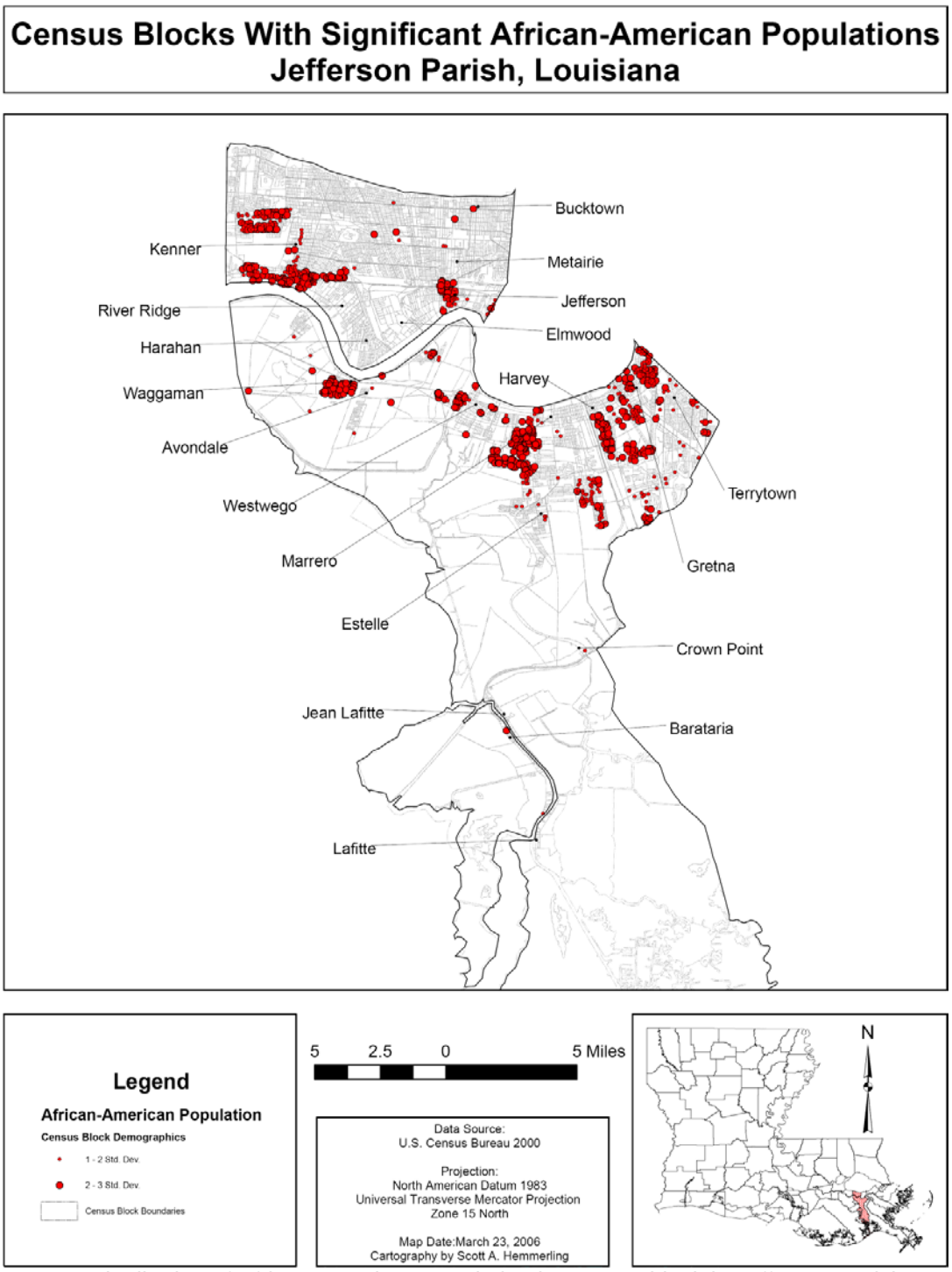


Figure 15. Distribution of African-American population by census block in Jefferson Parish, Louisiana, 2000.

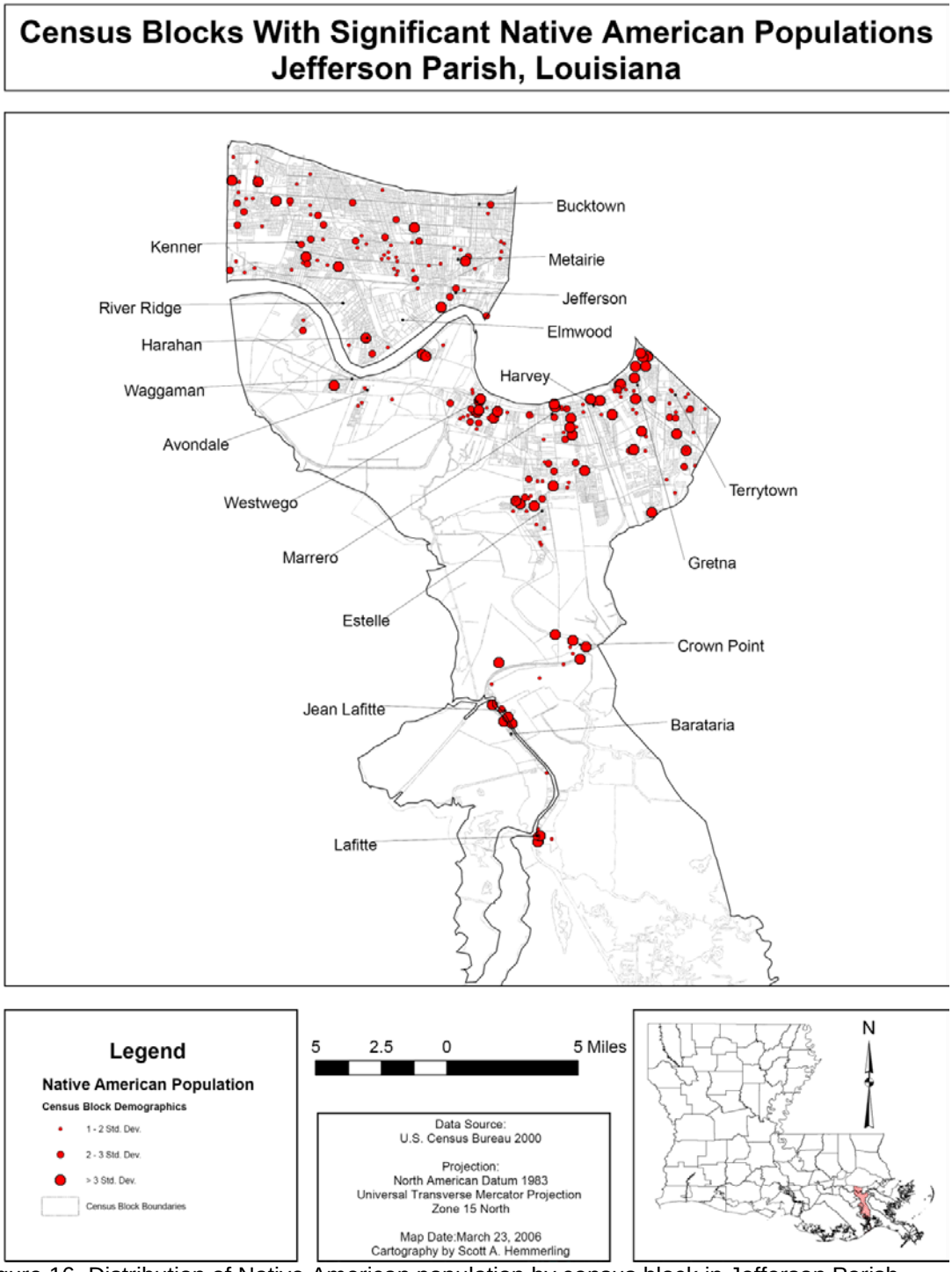


Figure 16. Distribution of Native American population by census block in Jefferson Parish, Louisiana, 2000.

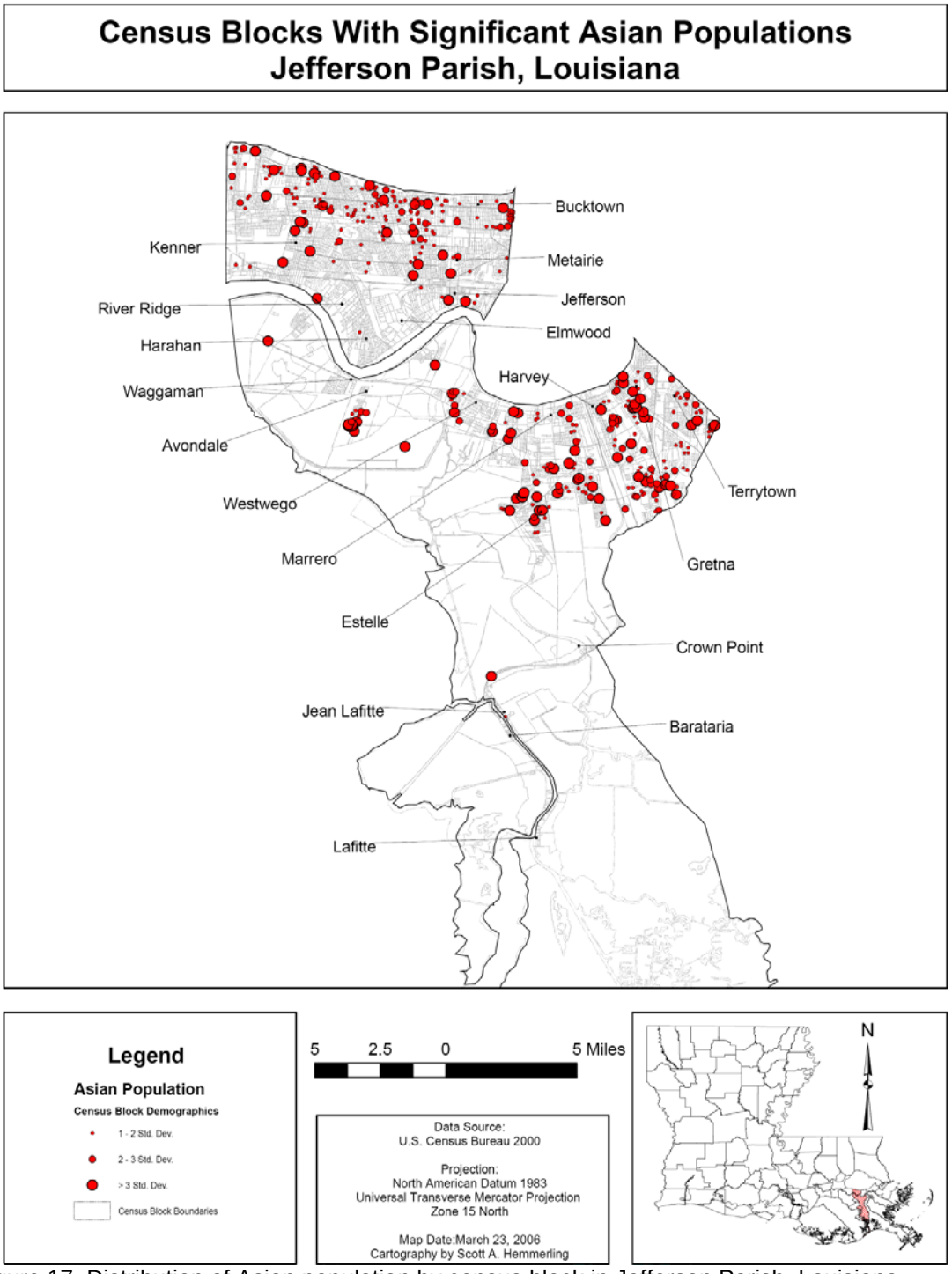


Figure 17. Distribution of Asian population by census block in Jefferson Parish, Louisiana, 2000.

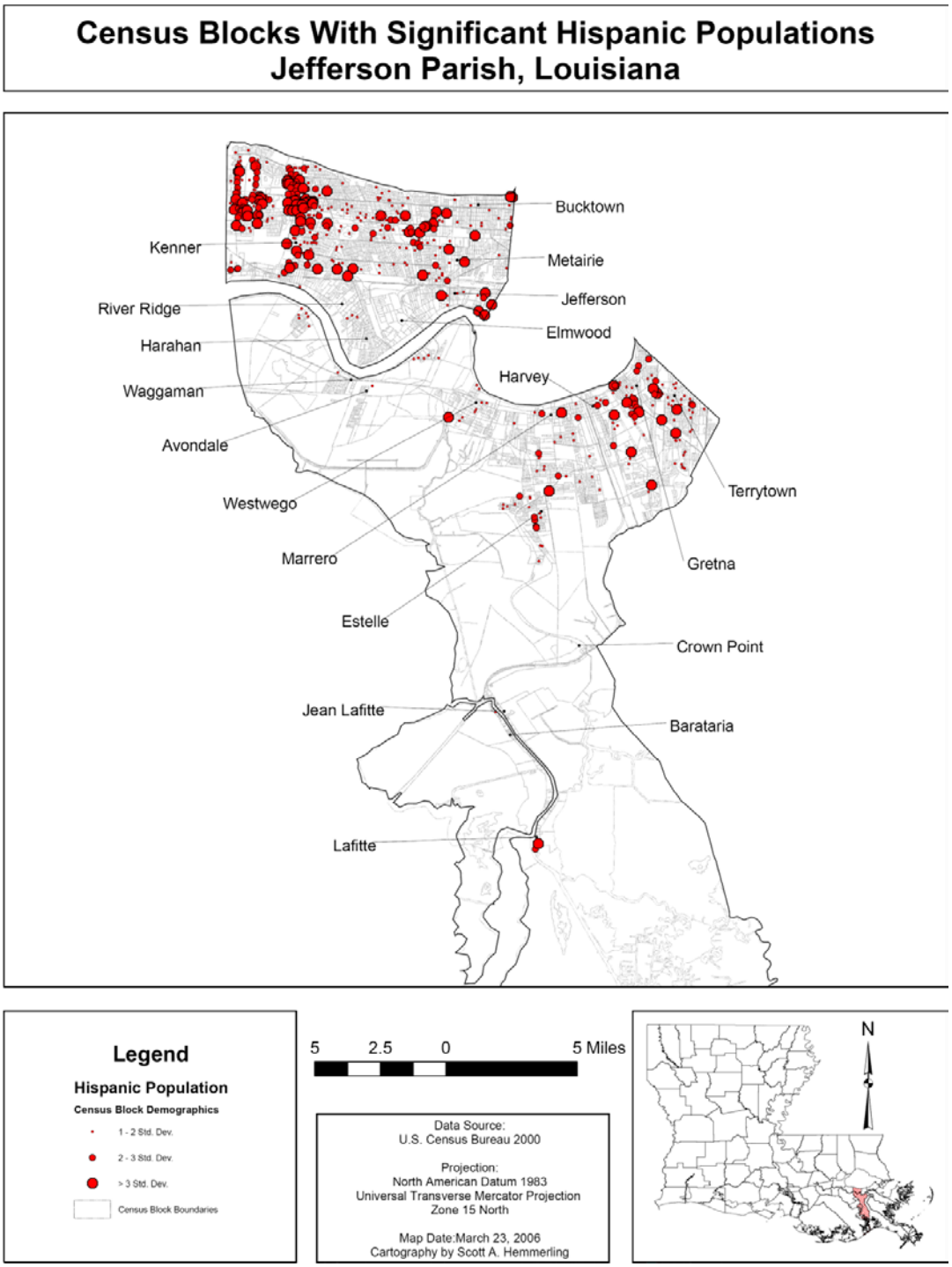


Figure 18. Distribution of Hispanic population by Census Block in Jefferson Parish, Louisiana, 2000.

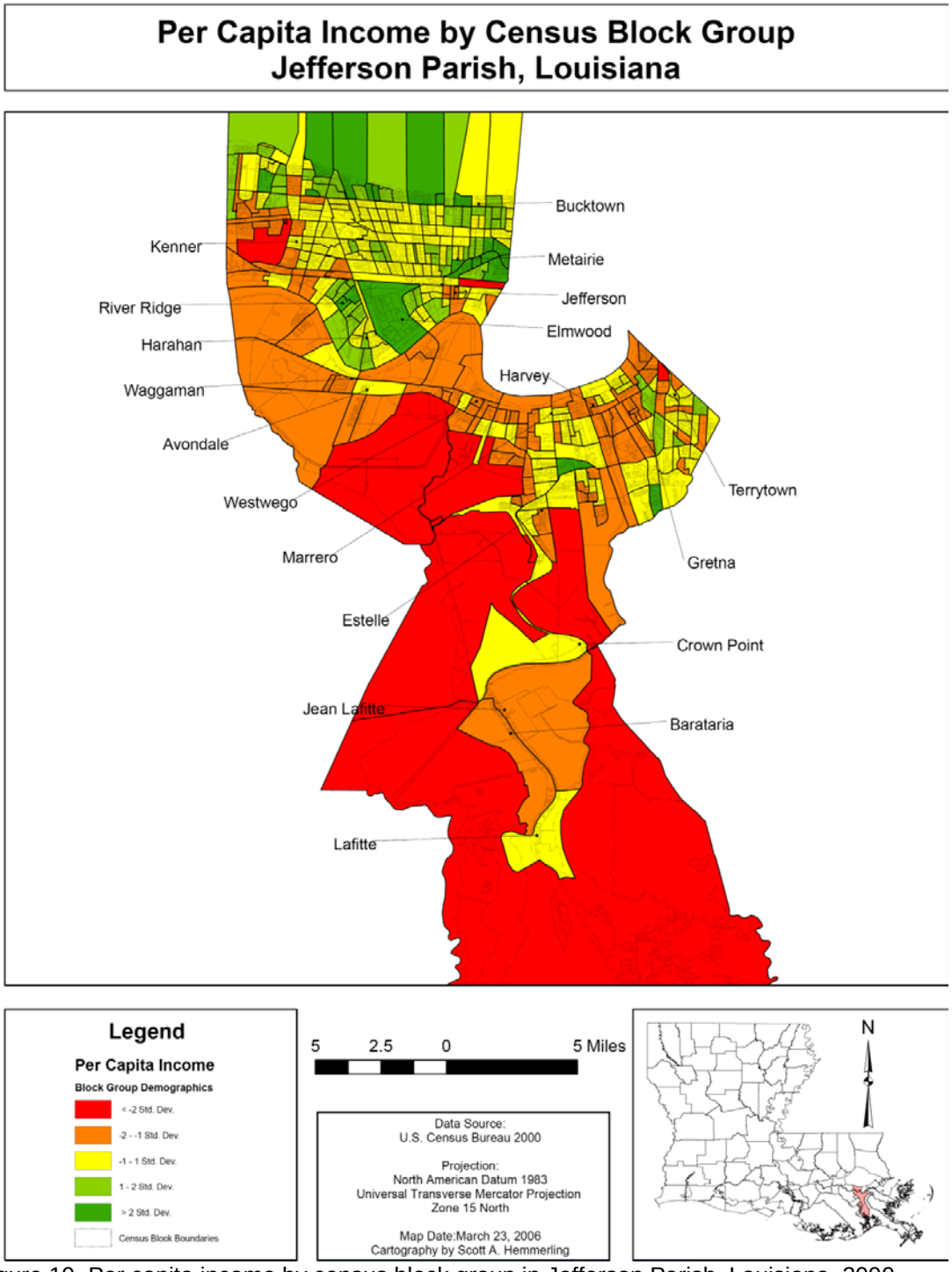


Figure 19. Per capita income by census block group in Jefferson Parish, Louisiana, 2000.

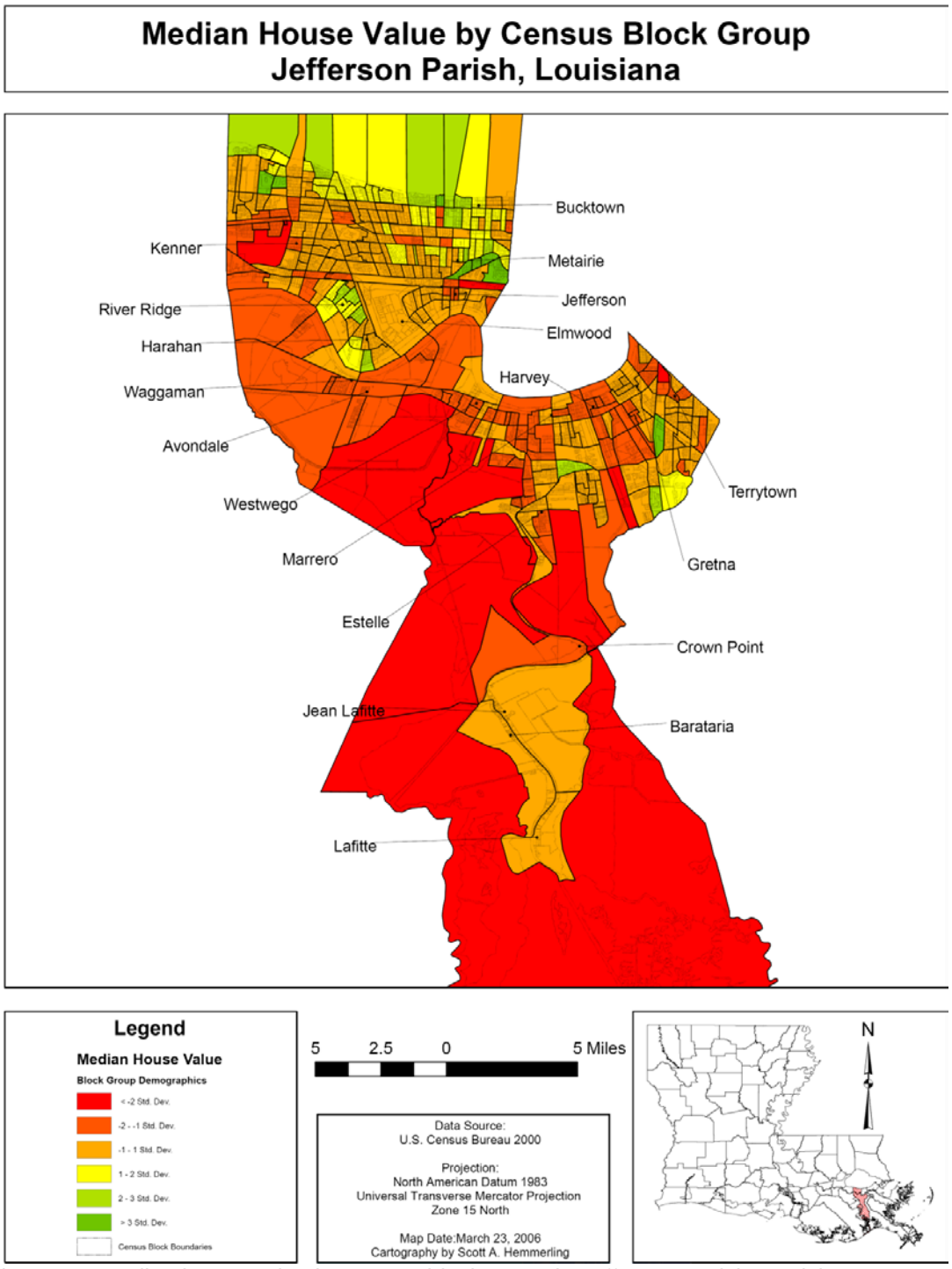


Figure 20. Median house value by census block group in Jefferson Parish, Louisiana, 2000.

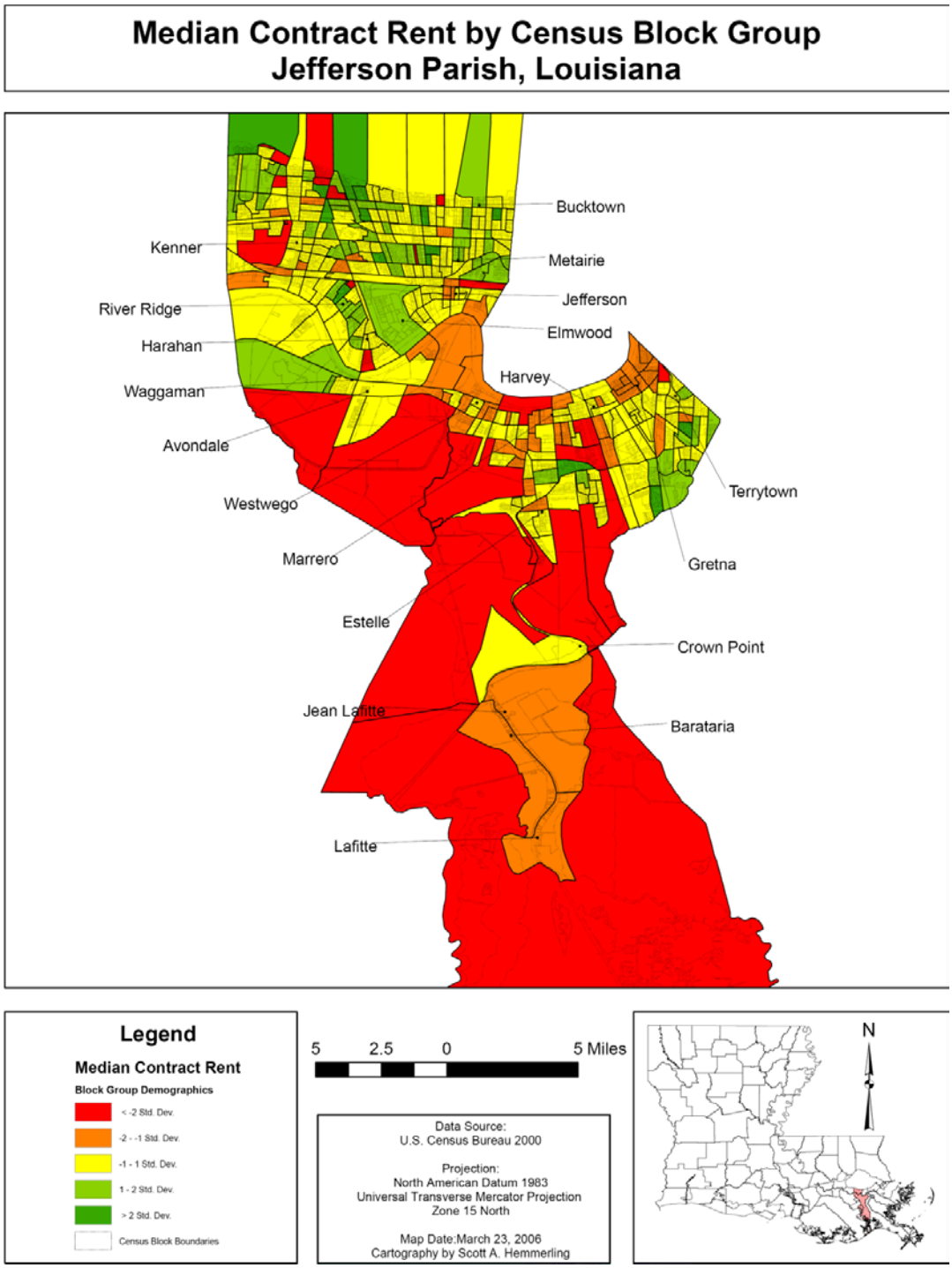


Figure 21. Median contract rent by census block group in Jefferson Parish, Louisiana, 2000.

St. Bernard Parish

With the exception of the African-American population, the minority populations in St. Bernard Parish are dispersed throughout the parish (Figures 22-25). The African-American population is unique in that the population does not reside in significant numbers in any of the three most populous locations in the parish: Arabi, Chalmette, and Meraux. Nearly all of the African-American population in St. Bernard Parish tends to cluster further to the west in Violet. Other African-American clusters are found in the rural area along Bayou Terre aux Boeufs toward the small community of Reggio.

In contrast, significantly high concentrations of Asians reside in the communities of Arabi, Chalmette, and Meruax, with very few blocks of high Asian population in Violet westward. The Native American population is much more dispersed, with significantly high clusters of population stretching from the Orleans Parish border at Arabi, out beyond Violet and Poydras to the smaller rural communities of Toca and Kenilworth. The Hispanic population is the most dispersed of all the minority groups in St. Bernard Parish, with significantly large concentrations in Arabi and Chalmette, but reaching out into the many rural communities toward Lake Borgne and the Mississippi River Gulf Outlet (MRGO) Canal.

There are relatively few areas with significantly low incomes or significantly low median house values and contract rents. The block groups with low incomes tend to be in areas with high proportions of African-Americans, particularly in Violet and Poydras. Interestingly, Violet does not appear to have either significantly lower rents or house values. These tend to be further downriver in Poydras, a community with significantly high levels of African-Americans, Native Americans, and Hispanics.

In the three largest communities in St. Bernard Parish, Arabi, Chalmette, and Meraux, there are very few areas that have low incomes, low house values, or low median contract rents (Figure 26–28). In Chalmette, the most populous of the three communities, there are three areas that are home to the only statistically significant concentrations of African Americans. These same areas are also the locations of the only low-income and low-value housing in the three communities.

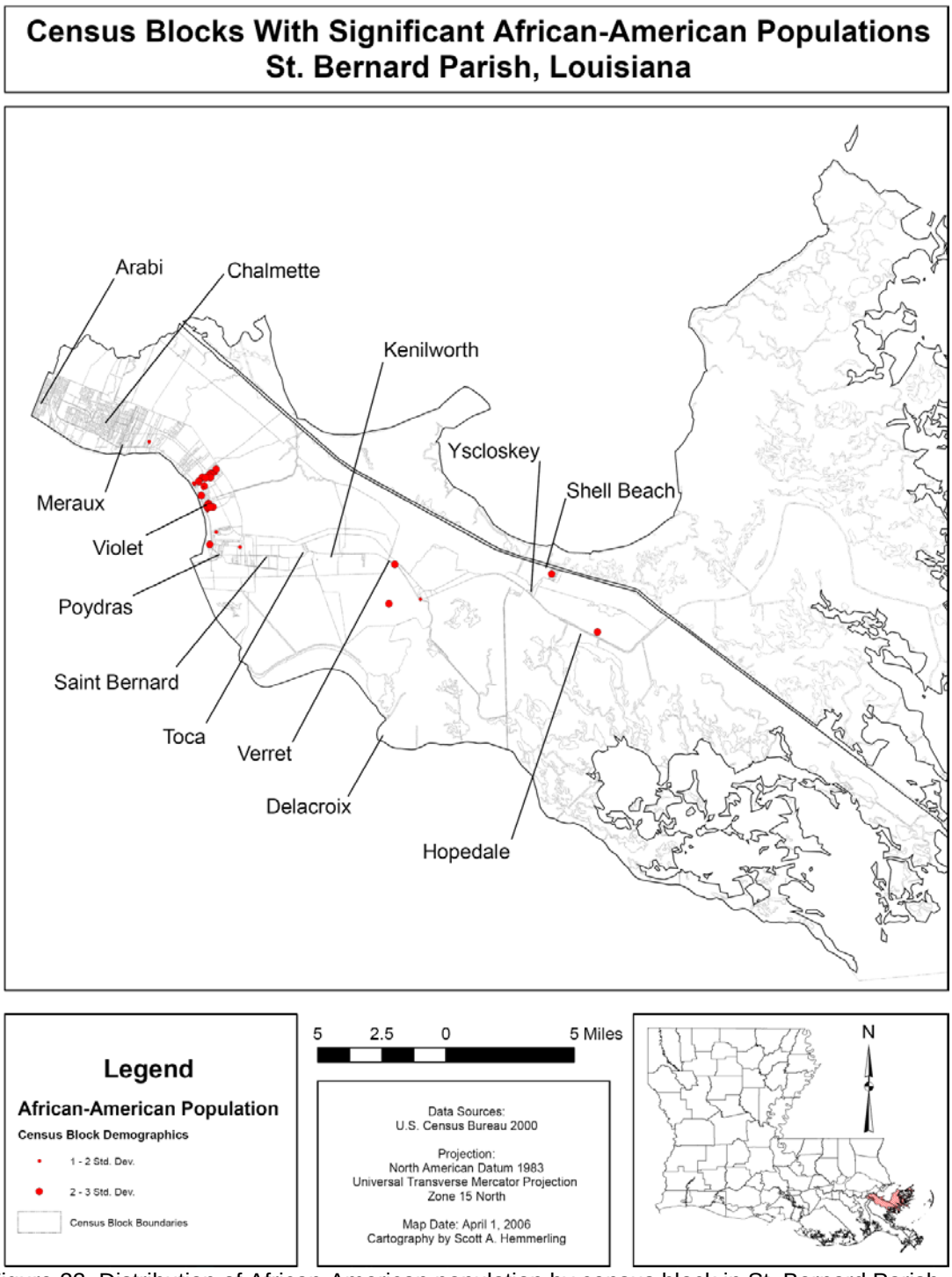


Figure 22. Distribution of African-American population by census block in St. Bernard Parish, Louisiana, 2000.

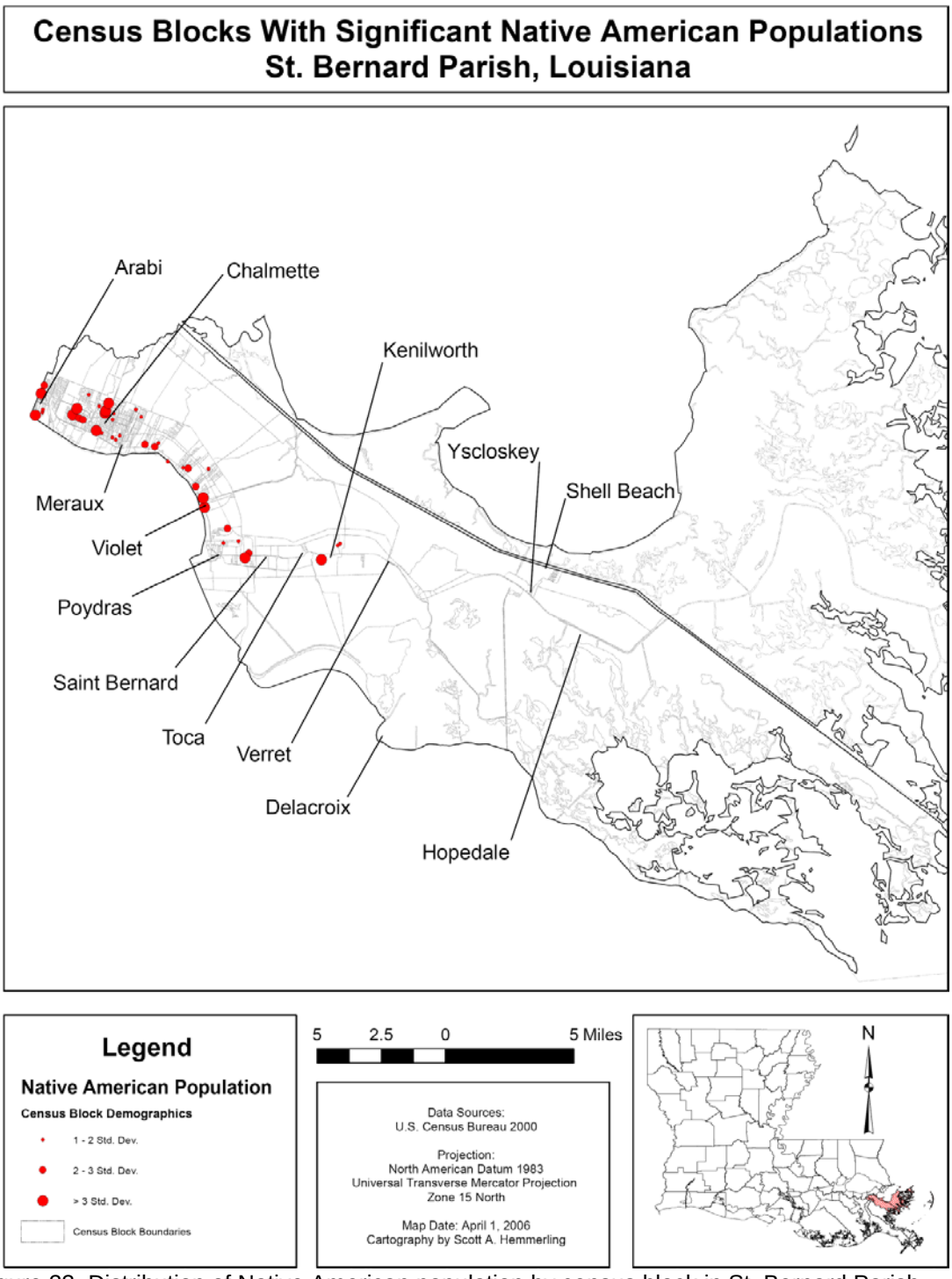


Figure 23. Distribution of Native American population by census block in St. Bernard Parish, Louisiana, 2000.

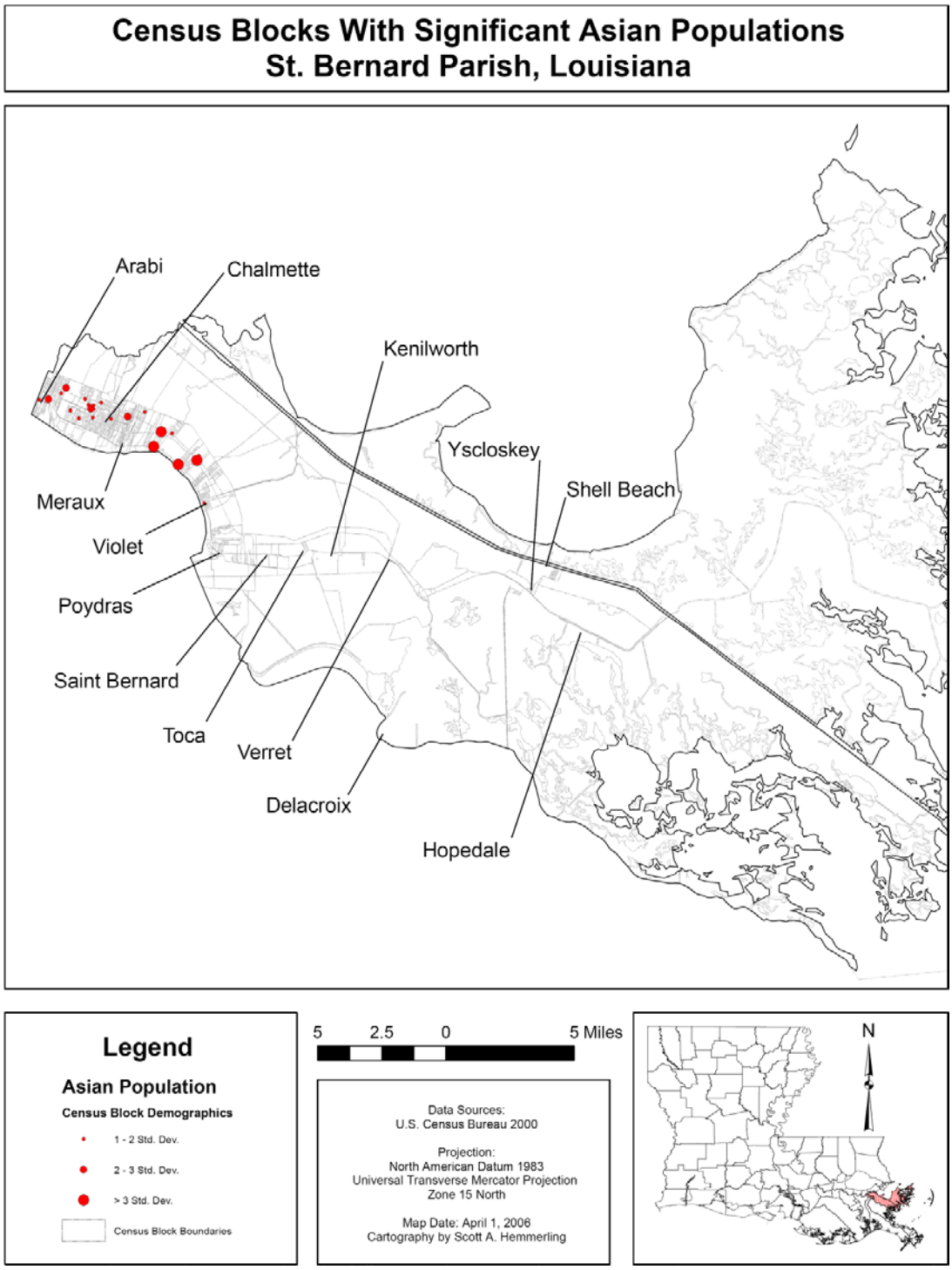


Figure 24. Distribution of Asian population by census block in St. Bernard Parish, Louisiana, 2000.

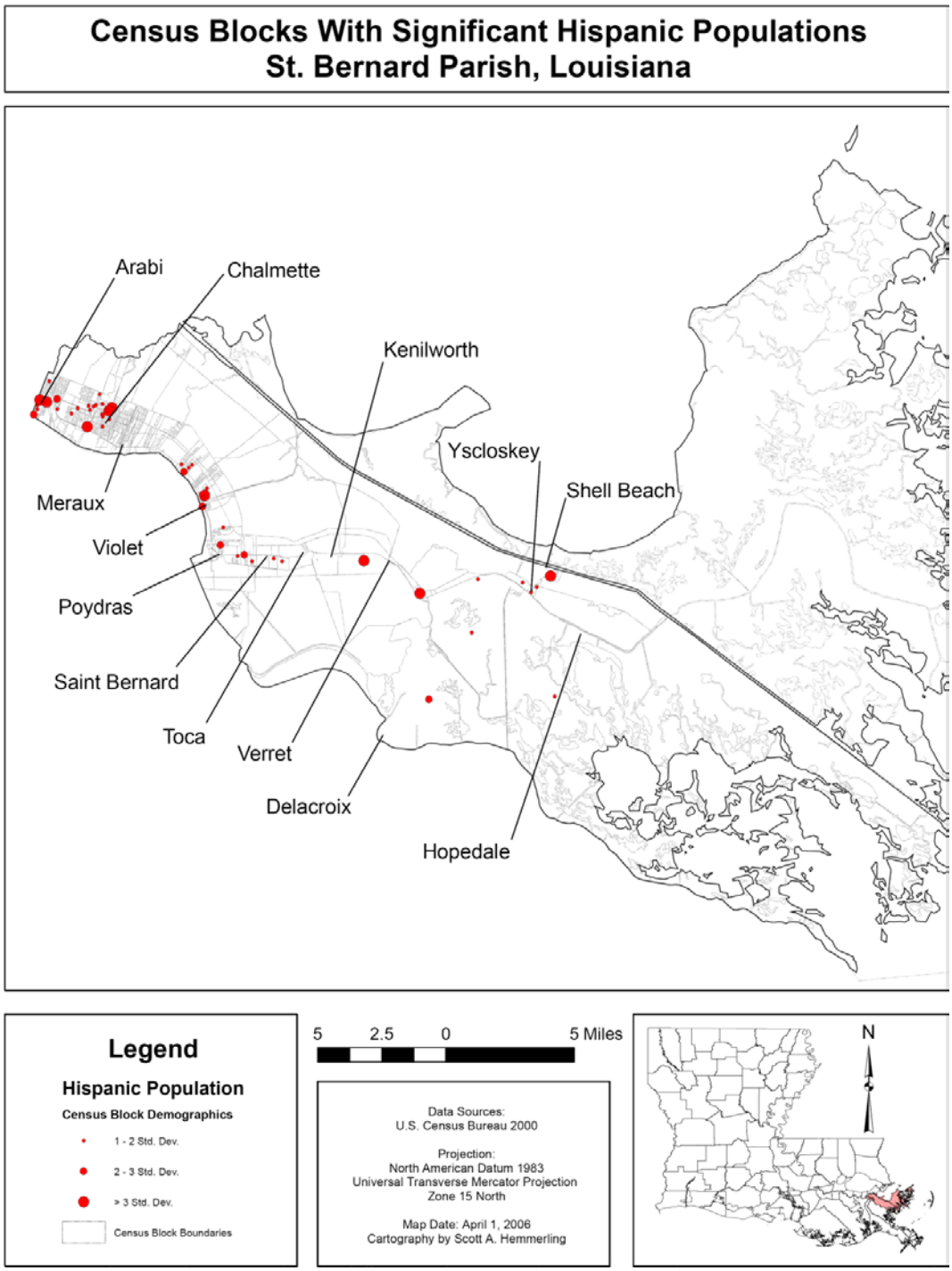


Figure 25. Distribution of Hispanic population by census block in St. Bernard Parish, Louisiana, 2000.

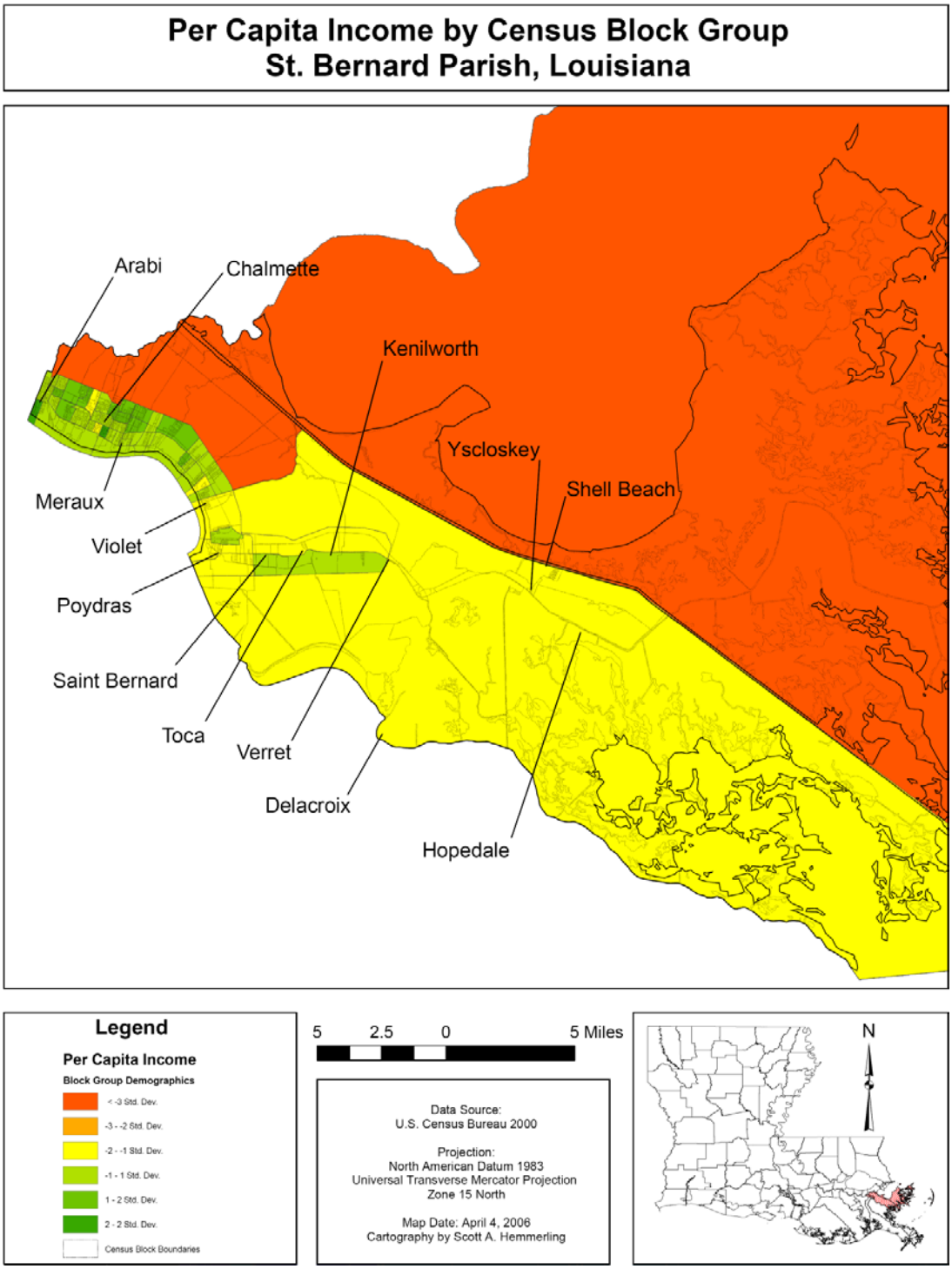


Figure 26. Per capita income by census block group in St. Bernard Parish, Louisiana, 2000.

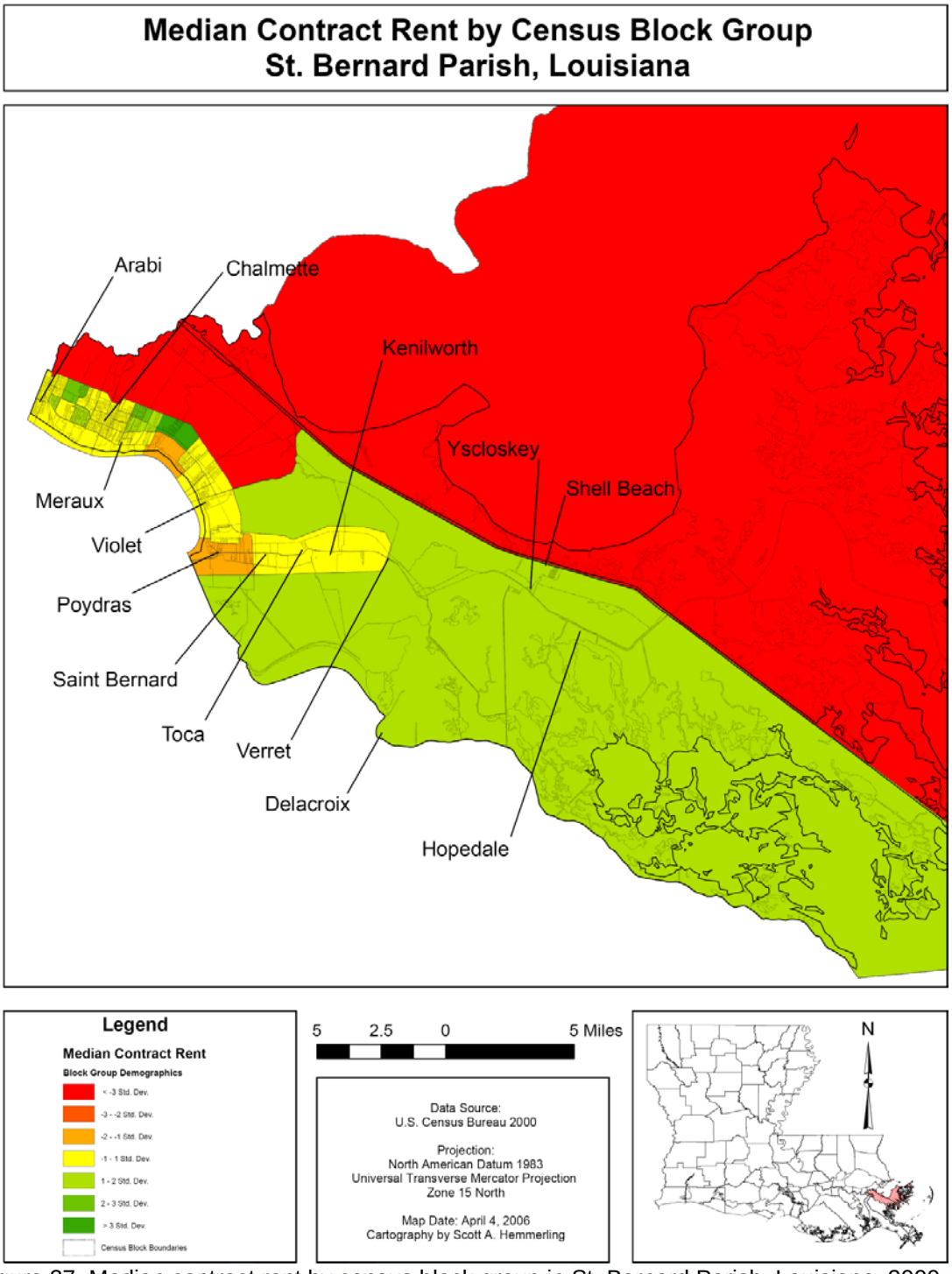


Figure 27. Median contract rent by census block group in St. Bernard Parish, Louisiana, 2000.

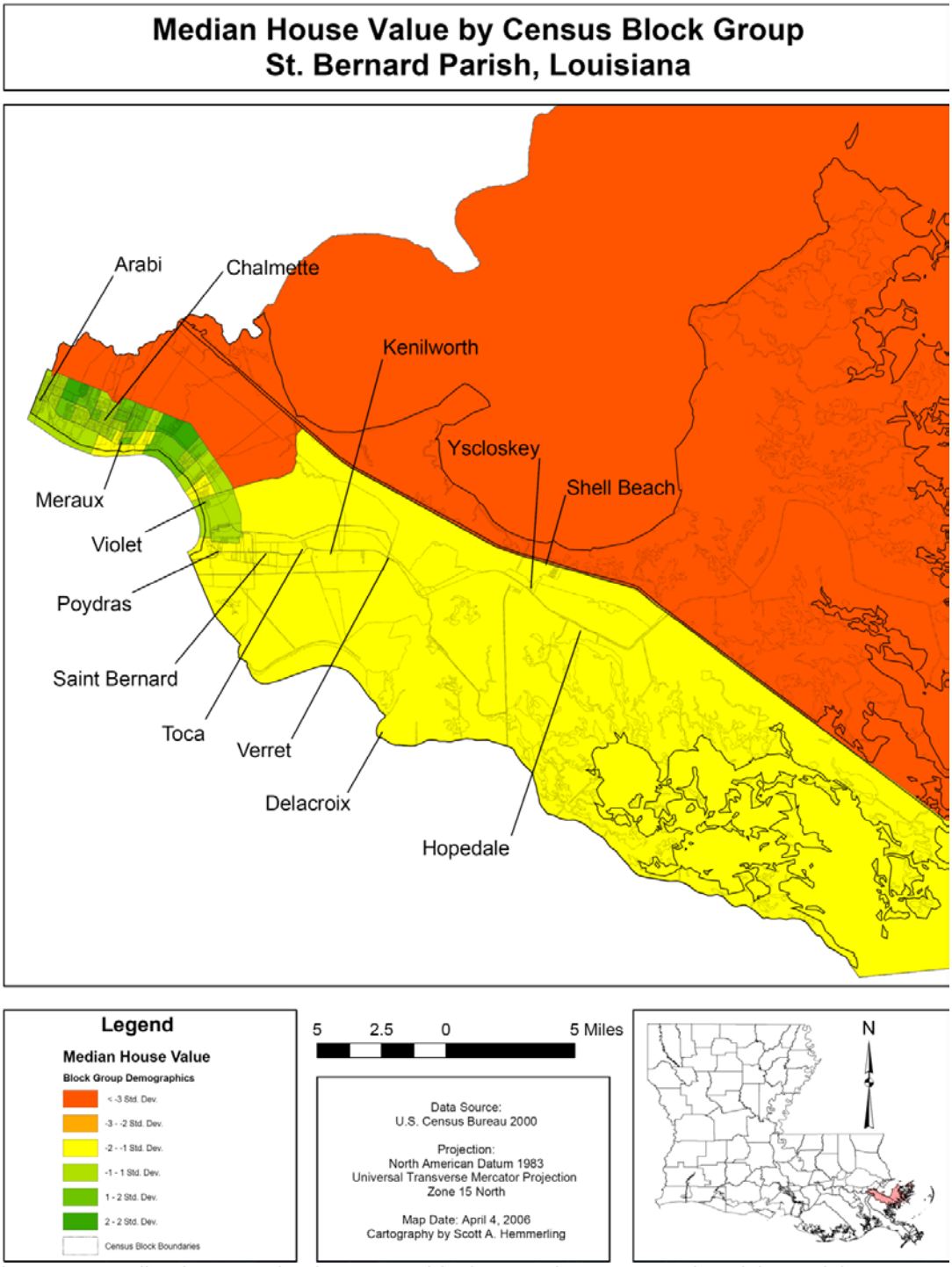


Figure 28. Median house value by census block group in St. Bernard Parish, Louisiana, 2000.

2.2.3Place Vulnerability

Areas of high potential hazardousness in combination with socio-economic vulnerability determine place vulnerability which makes it a useful composite indicator for potential environmental injustice. We assign each census block a hazardousness rating dependent on the hazardousness of place rating at its centroid. The centroid is the mathematically-derived center point of a geographical area. Census blocks are small enough that the value at the centroid serves as an effective surrogate for the value of the entire block. Once each block receives a hazardousness value, we are able to divide the parish into hazardousness deciles. An individual decile contains roughly 10 percent of the total number census blocks in the parish, allowing us to effectively compare population data.

Lafourche Parish

Nearly a quarter of Lafourche Parish's population resides in the least potentially hazardous offshore oil-related decile. As Figure 29 shows, these deciles contain the largest proportion of all minority groups, including 38.4 percent of the African-American population. In total, almost one third of the population reside in the 20 percent least hazardous census blocks (deciles 1 and 2), compared to just over 12 percent in the 20 percent most hazardous census blocks (deciles 9 and 10). The least hazardous census blocks seem to be either located entirely outside the Highway 1 corridor in sparsely populated marshland, or else in the less densely populated areas between the individual communities that line the high ground fronting Bayou Lafourche. In particular, much of the land along Highway 1 north of Raceland, including much of Thibodaux, is not impacted by offshore oil-related activity.

Despite the localized high potential hazardousness of areas identified by the biophysical vulnerability model, such as Larose and Port Fourchon, in terms of offshore oil-related development, the most potentially hazardous census blocks are dispersed across the parish. This reflects the fact that the wells themselves are located offshore, allowing the support industries more economic choice in where to site facilities onshore. As a result, census blocks with the most potential to be impacted by expanding offshore oil-related activity tend to cluster loosely along Louisiana Highway 1, particularly south of Larose, with some extension along the Intracoastal Waterway. Outside of this corridor, the primary potential for impact are from the pipelines crossing the sparsely populated wetland fringe.

Overall, large numbers of minority residents reside in and around Thibodaux, particularly African-American, Asian, and Hispanic. In addition, our social vulnerability model shows a large clustering of minorities around the junction of Bayou Lafourche and the Intracoastal Waterway in Larose. Our physical hazards model revealed two areas that are of particular concern for potential environmental hazards, Port Fourchon and Larose.

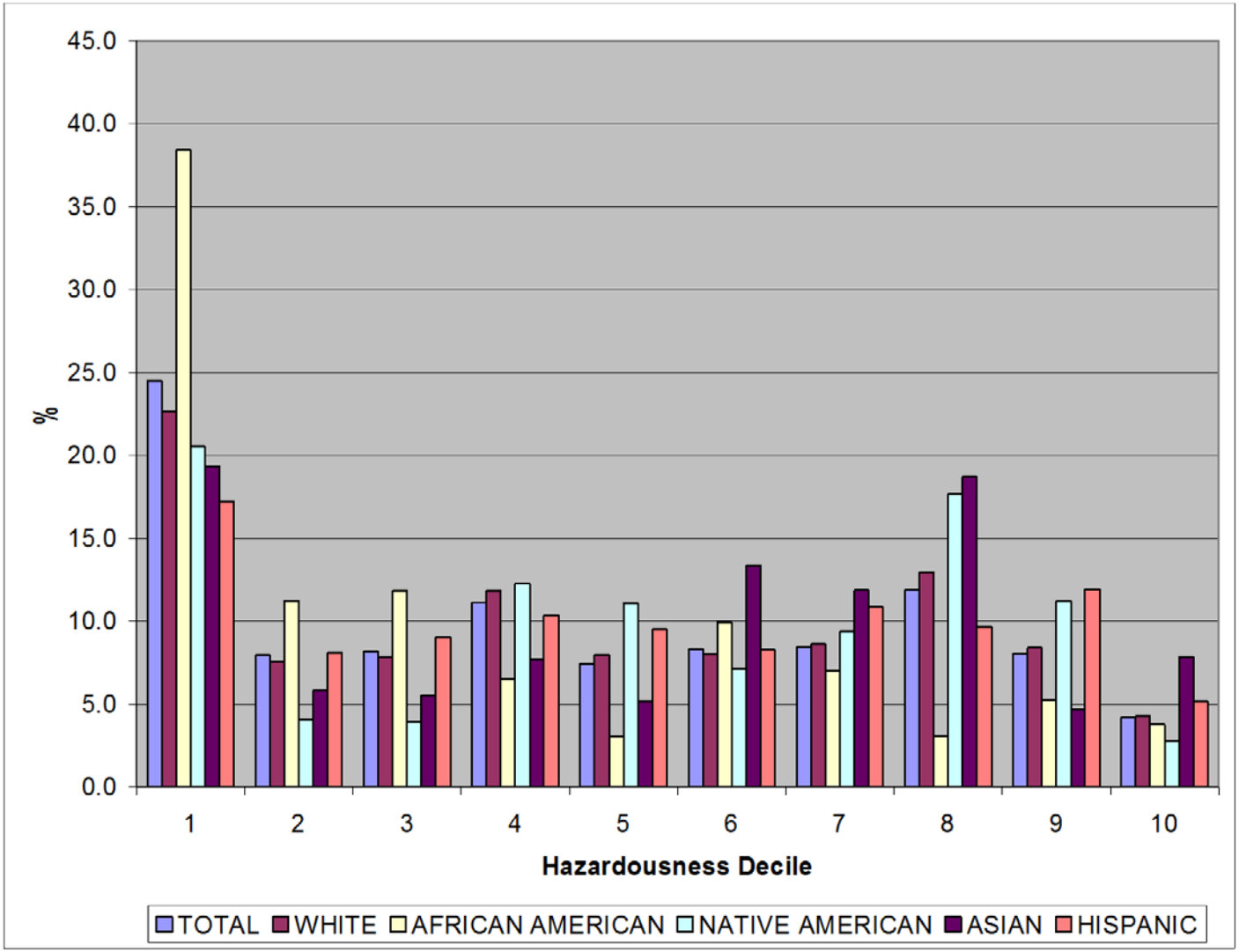


Figure 29. Proportion of the population residing in OCS-related hazardousness deciles in Lafourche Parish, Louisiana.

Most of the land surrounding Port Fourchon is in a semi-altered state, where developers have drained and filled the wetlands immediately around Port Fourchon and Fourchon Island for industrial and marine support facilities. There are very few permanent habitations found around Port Fourchon, and none of these areas are home to significant minority populations. This stands in stark contrast to the demographics of the population in and around Larose. Although at or above the parish average in terms of economic conditions, Larose is home to sizable concentrations of African-American, Native American, Asian, and Hispanic populations. In terms of the overall vulnerability of place in Lafourche Parish, Larose stands out as an area of particular interest.

When economic conditions are considered along with minority population, a different pattern emerges. Examining census blocks with a higher-than-average proportion of minority population in tandem with census block groups with incomes 20 percent or more below the parish level, the majority of the Louisiana Highway 1 corridor does not stand out. There are areas of concern located in and around Golden Meadow and in Lockport. Other locations are found along the Lafourche-Terrebonne border, and in Thibodaux. Other areas of high minority and low income population may be masked by the usage of the coarse block group level, such as the area around Grand Bois, which appeared as an area of concern based on the 1990 census data.

The areas examined and analyzed here are important for a number of reasons. Larose, for example is home to the largest concentration of oil-related facilities outside of Port Fourchon, and is also home to high proportions of all examined minority groups. Lockport and Golden Meadow both have multiple facilities as well, though not to the same scale as Larose. Both of these areas have a greater proportion of low-income residents than Larose, however, increasing the vulnerability of those populations residing there.

Jefferson Parish

Our physical hazards model revealed that the majority of the onshore oil-related infrastructure is sited on the west bank of the Mississippi River (i.e. the southern portion of the parish). With less than 1 percent of the total onshore oil wells located there, the influence of the East Bank on the overall hazardousness of place model is negligible. However, because the suburban communities of the East Bank contain over 4,000 census blocks, nearly 60 percent of the parish total, they would heavily skew the place vulnerability analysis. Therefore, in determining the onshore oil-related place vulnerability in Jefferson Parish, we focused exclusively on the West Bank communities, where the potential impacts would be greatest.

The onshore oil industry appears to have two distinct nodes that dominate the overall hazardscape: the oil fields and the bulk storage facilities. The census blocks in the most hazardous deciles are in proximity to both types of facility (Figure 30). The most potentially hazardous census blocks lie along the U.S. Highway 90 and the Westbank Expressway, extending toward the Mississippi River in Avondale and Marrero, where a number of bulk storage facilities exist. Other potentially impacted populations are found

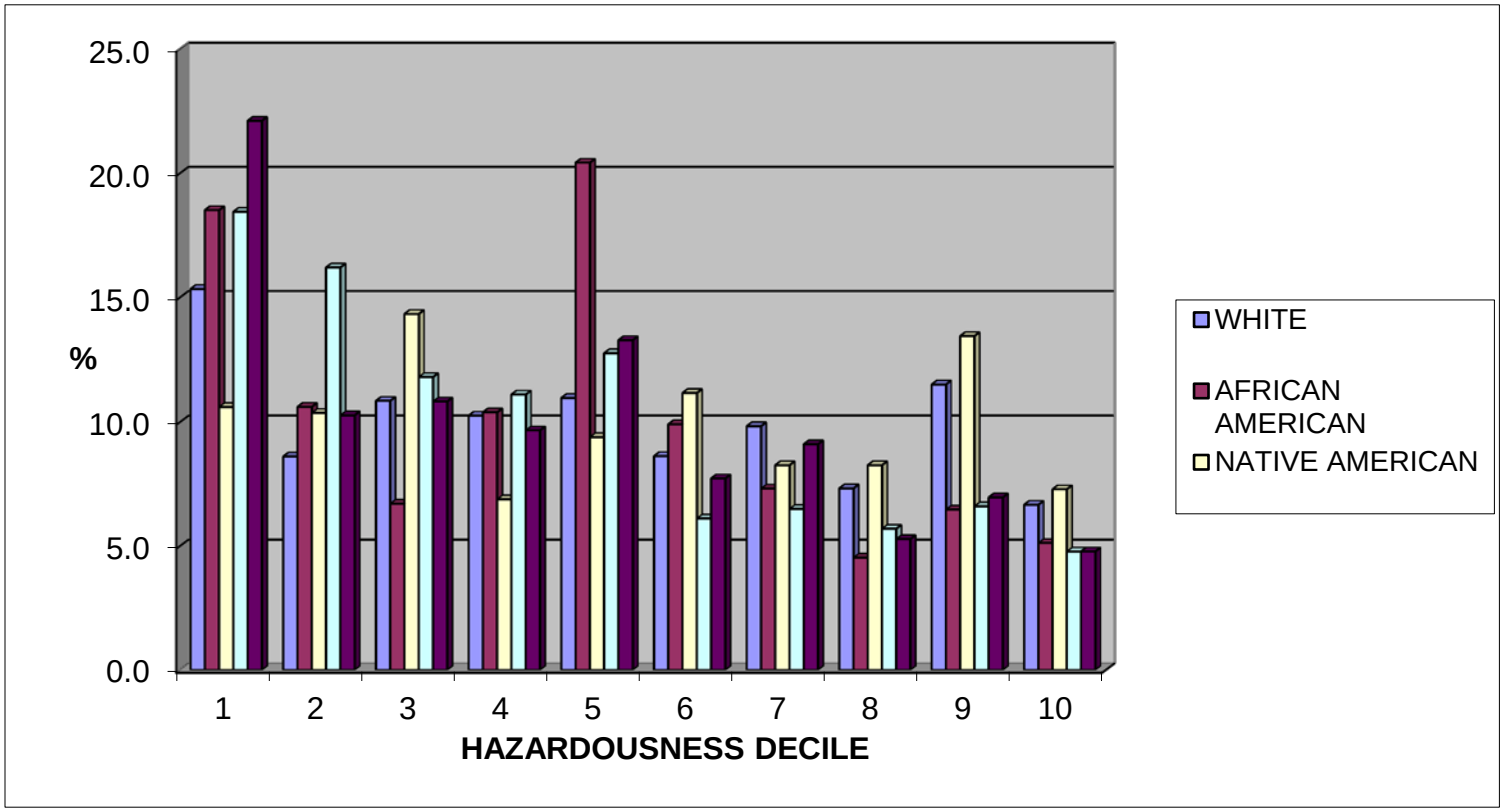


Figure 30. Proportion of the population residing in onshore oil-related hazardousness deciles in Jefferson Parish, Louisiana.

in proximity to the oil fields in Barataria and Lafitte. Only 15.3 percent of the population resides in the most hazardous census blocks (deciles 9 and 10).

On the other hand, fully 28.5 percent of the population resides in the 20 percent least hazardous census blocks on Jefferson Parish's west bank (deciles 1 and 2). Furthermore, 16.8 percent of residents reside in the least hazardous decile, including the majority of the parish's whites, Asians, and Hispanics. This includes areas in Terrytown, Harvey, and South Kenner, in the northern portion, as well as many less densely populated blocks bordering the marshes and wetlands in the Barataria region.

Examining census blocks with statistically significant proportions of minority residents in tandem with census block groups having median per capita incomes 20 percent or more below the parish mean reveal that most of the socially vulnerable populations remain significant, suggesting a high correlation between minority and low-income status in Jefferson Parish. High minority, low-income census blocks appear in clusters within all communities in Jefferson Parish, with the exception of River Ridge, Harahan, and Elmwood.

St. Bernard Parish

Some 12,820 persons reside in the 20 percent most potentially hazardous census blocks in St. Bernard Parish (deciles 9 and 10), compared to 9,011 in the 20 percent least hazardous blocks (deciles 1 and 2; Figure 31). The most potentially hazardous areas are clearly those areas surrounding the oil refineries in Chalmette and Meraux. Unlike the other sectors of the oil industry explored in Lafourche and Jefferson Parishes, the refining sector is highly concentrated. The refineries themselves serve as focal points for the entire oil-related infrastructure in the parish. Crude petroleum and natural gas pipelines bring raw materials into the refineries, and carry refined product out. Louisiana Highway 47, Paris Road, merges with Interstate 510, connecting the refineries with Interstate 10, Louisiana's primary interstate highway. The refineries each have bulk storage facilities in the St. Bernard Port, Harbor, and Terminal District. The two refineries are both Large Quantity Generators of hazardous waste as well as TRI facilities, and consequently the most potentially hazardous census block in the parish are in proximity to the refineries.

The least hazardous deciles in the parish are largely in the rural areas, where pipelines and pipeline crossing represent the most likely hazard to residents. Two vital links in the refinery-based infrastructure found in the rural areas of the parish are the large gas processing plants in Toca and Yscloskey. In much the same way that the refineries are focal points for the oil-related infrastructure on a large scale, the gas plants are focal points on a smaller scale. For this reason, the census blocks around the gas plants are potentially more hazardous than other census blocks in rural St. Bernard Parish, though not hazardous enough to be included in the most hazardous deciles with the refineries.

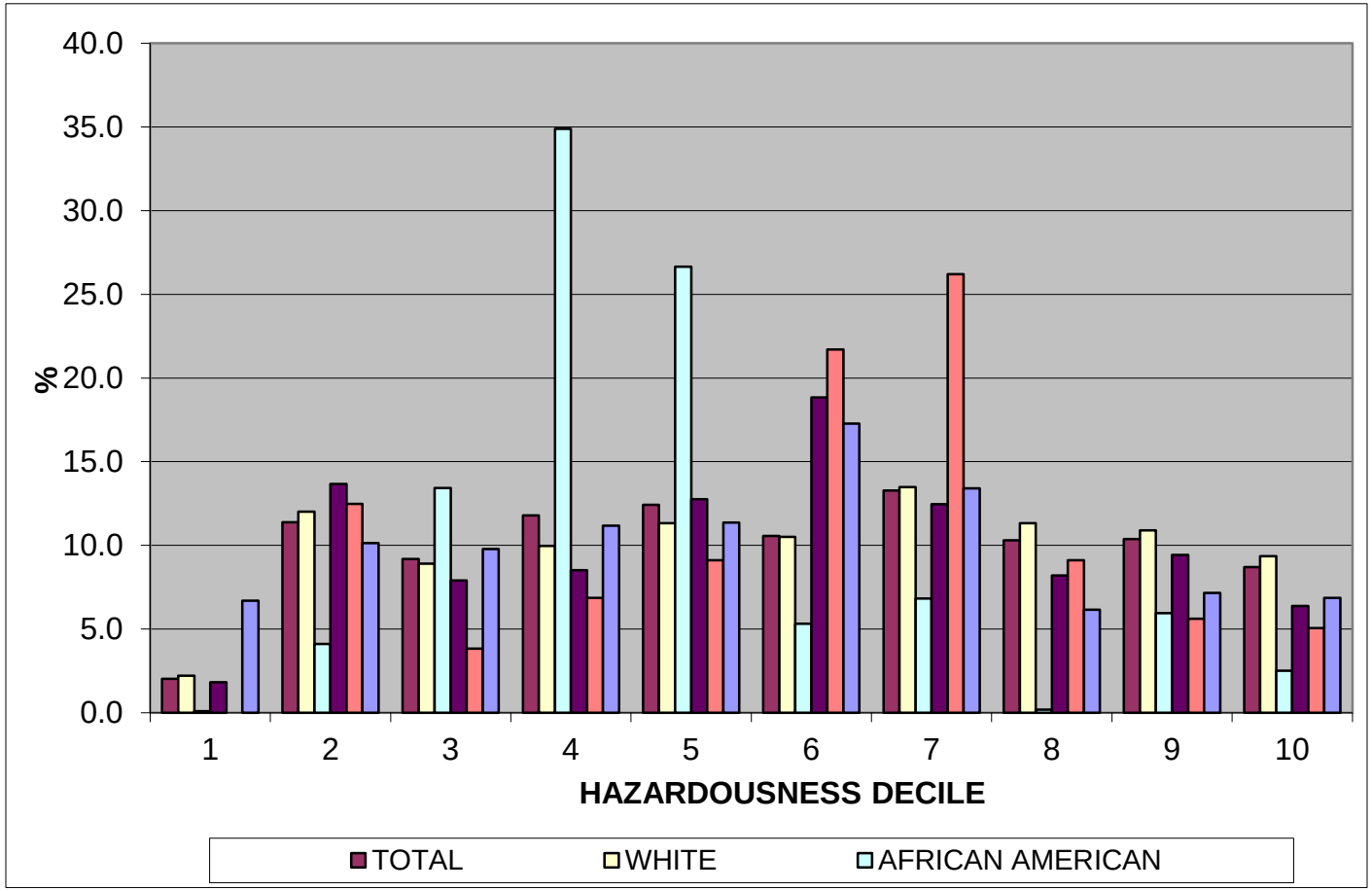


Figure 31. Proportion of the population residing in refining-related hazardousness deciles in St. Bernard Parish, Louisiana.

2.3 STATISTICAL ANALYSIS

Lafourche Parish

The patterns of racial and ethnic distributions around each of the offshore oil-related facilities all show a similar pattern (Figure 32). The closer the value of the odds ratio is to one, the more equitable the distribution of the population. The level of association between the minority population and the facility increases as the odds ratio value moves further from one (Pine et al. 2002). We use the Chi-Square test to determine if the odds ratio is significant (Table 16). The most equitable distribution is found around the pipelines. This is most likely due to the large geographical area that the pipelines cover in Lafourche Parish. Each of the other facilities shows particular patterns of racial and ethnic inequities. These patterns are most pronounced in the case of the Houma population around each facility. All of the facilities in south Lafourche show a statistically significant disproportionately high Native American population around them. For example, if we look at which populations are more or less likely to live around the shipyards, we see that Native Americans are 2.27 times as likely to live in proximity than elsewhere in the parish, and Asians are 1.96 times as likely. This stands in contrast to the white population, which is 0.61 times as likely and the African-American population, which is only 0.19 times as likely to be found living in proximity to a shipyard. The only exception to this is the distribution of minority population around the petroleum bulk storage facilities. Most of the bulk terminals are in unpopulated wetlands. There is, however, one large petroleum bulk terminal located in Thibodaux. Very few Houma live around this facility. In fact, this research shows that the Houma population clusters in south Lafourche, and the African-American population clusters in north Lafourche. With the majority of offshore oil-related infrastructure located in south Lafourche as well, the Houma population is exposed to a disproportionate amount of potential impacts.

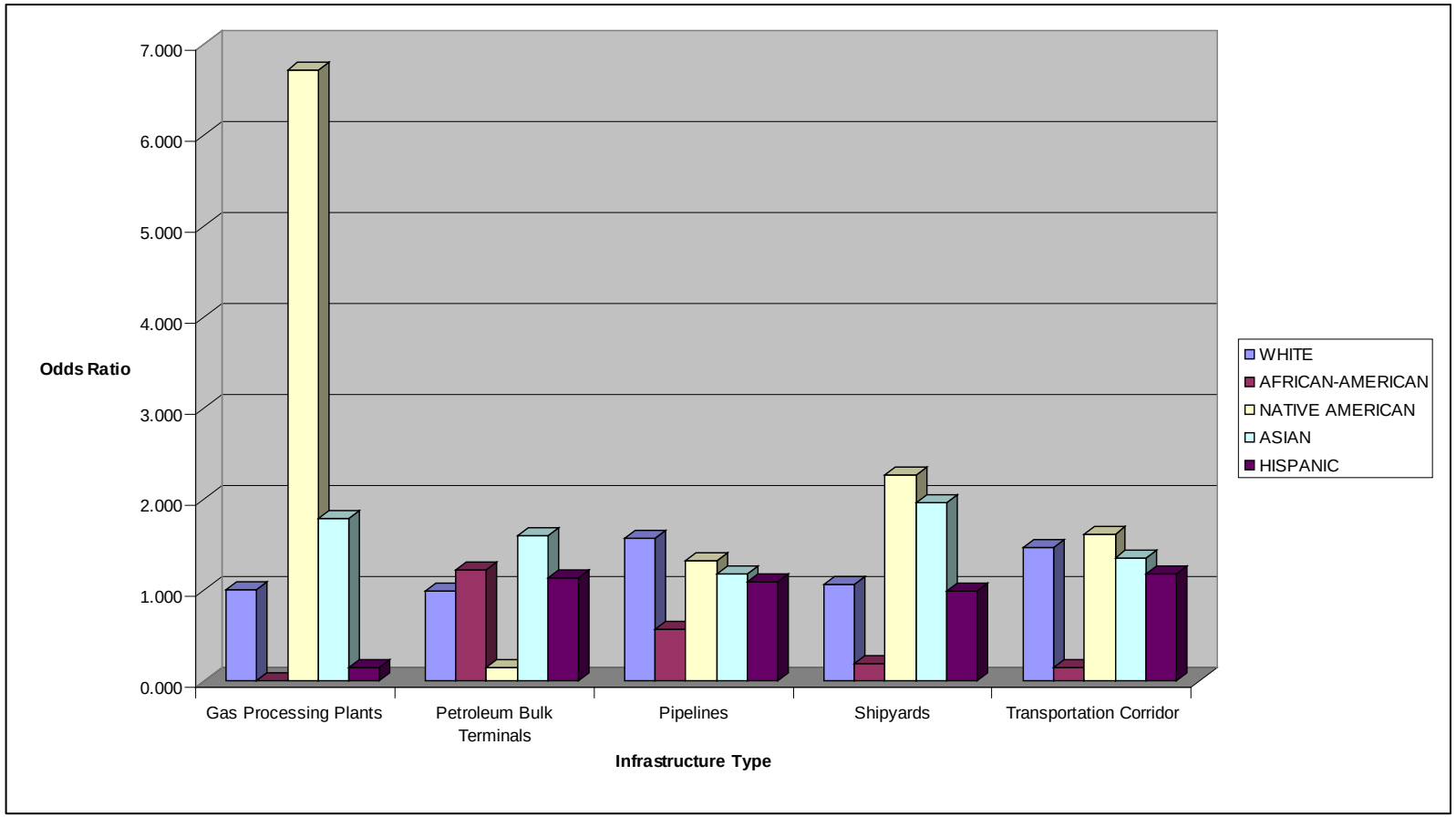


Figure 32. Odds ratios for Lafourche Parish, Louisiana OCS-related infrastructure.

Table 16. Comparison of Population for Selected OCS-Related Infrastructure in Lafourche Parish, Louisiana

Gas Processing Plants				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	82.8	82.9	83.0	0.952
African-American	0.0	12.7	12.6	0.000
Native American	12.9	2.2	2.3	0.000
Asian	1.2	0.7	0.7	0.094
Hispanic	2.1	1.4	1.4	0.152
Petroleum Bulk Terminals				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	82.5	82.9	83.0	0.671
African-American	15.1	12.6	12.6	0.001
Native American	0.4	2.3	2.3	0.009
Asian	1.1	0.7	0.7	0.022
Hispanic	1.6	1.4	1.4	0.455
Pipelines				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	86.7	75.5	83.0	0.000
African-American	7.7	22.0	12.6	0.000
Native American	3.0	0.9	2.3	0.000
Asian	0.8	0.4	0.7	0.000
Hispanic	1.6	1.2	1.4	0.000
Shipyards				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	88.8	82.0	83.0	0.000
African-American	2.7	14.0	12.6	0.000
Native American	5.0	1.9	2.3	0.000
Asian	1.3	0.6	0.7	0.000
Hispanic	1.4	1.4	1.4	0.926
Transportation Corridor				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	91.2	76.7	83.0	0.000
African-American	2.2	20.2	12.6	0.000
Native American	3.7	1.3	2.3	0.000
Asian	0.9	0.5	0.7	0.000
Hispanic	1.7	1.2	1.4	0.000

Data Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004

Contingency analysis of the weighted hazards model reveals that both the Native American and Hispanic populations are significantly more likely to reside in the most hazardous census blocks in the parish, and the African-American population is significantly less likely to reside in proximity (Figure 33, Table 17). Conversely, the Native American, Asian, and Hispanic populations are all significantly less likely to reside in the least hazardous census blocks than anywhere else in Lafourche Parish, and the African-American population is almost 1.7 times as likely to reside there.

These results were verified by an examination of the Pearson Product Moment Correlations between each independent variable and their individual effects upon the dependent variable at the block group level. The results reveal that the percentage Native Americans is most heavily correlated with the hazards-of-place model, with a positive linear correlation of 0.383. However, the analysis also reveals that there is a strong negative correlation of –0.384 between the percentage of African-Americans and the hazards-of-place model. Both of these correlations are significant at the .001 level. In addition, a slightly weaker positive correlation was detected between the hazardousness model and the percentage of Hispanics (.203) and median household income (.324). Both of these values are still significant however, with the percentage of Hispanics correlated at the .05 level and income at the .01 level. The Pearson Product Correlation Coefficient does not attempt to explain causality, but rather indicates the degree of correlations among the variables, whether positive, negative, or zero.

Further analysis reveals that minority population is a more important factor than income in predicting the degree of environmental inequity in Lafourche Parish. We used stepwise multiple regression to examine the significance of various minority categories, as well as economic factors, such as mean household income, median contract rent, and median house value (Table 18). We included the percentage of African-Americans and Native Americans in the final regression model, reflecting the clustering of these populations around infrastructure, in the case of Native Americans, or away from it, in the case of African-Americans. Both were significant at the 95 percent confidence level. Income tends to be marginally higher in potentially hazardous areas of the parish, significant at the 90 percent confidence level.

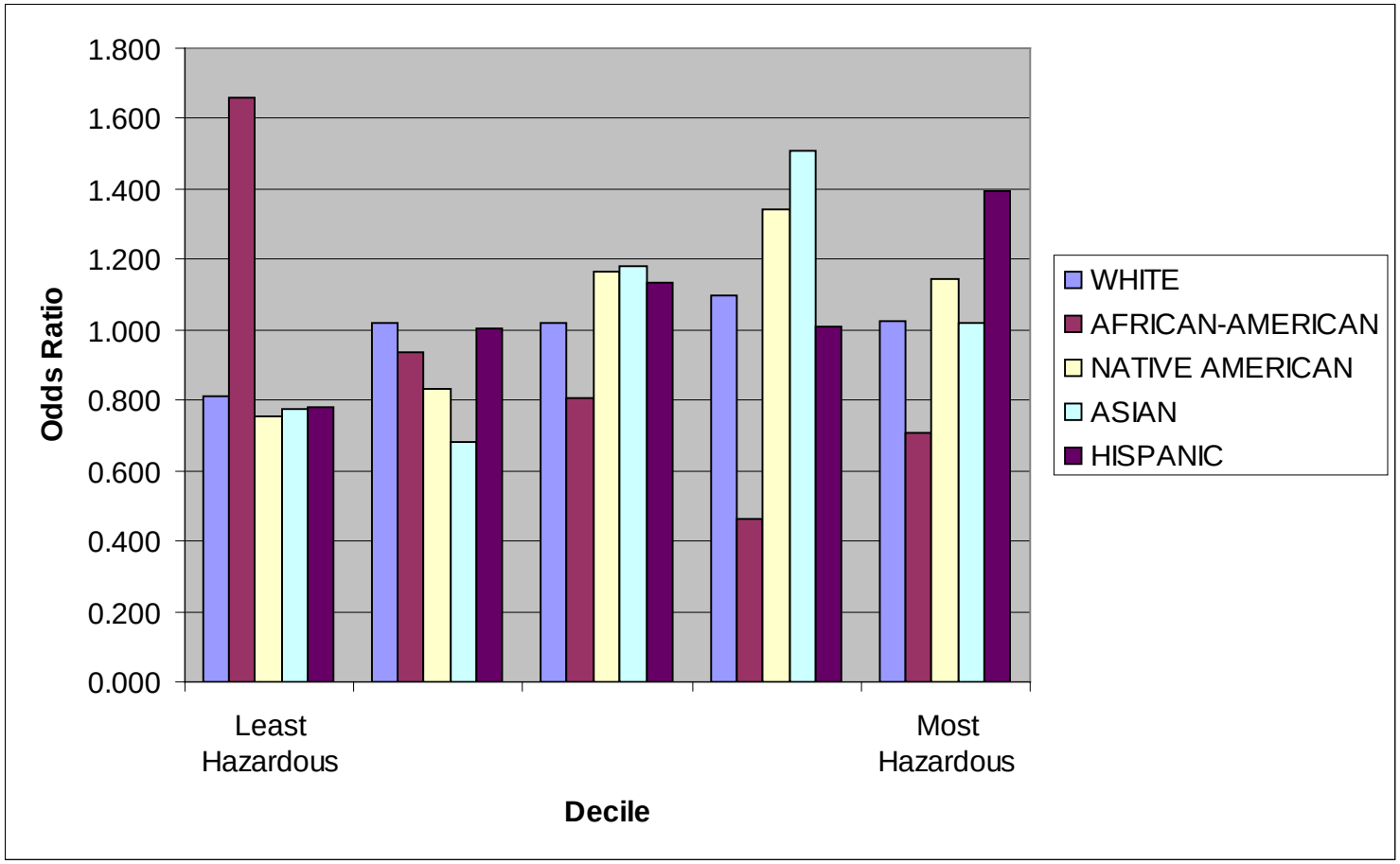


Figure 33. Odds ratios for Lafourche Parish, Louisiana. OCS –related hazardousness deciles

Table 17. Comparison of Population Proportions for OCS-Related Hazard Deciles in Lafourche Parish, Louisiana

Least Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	77.3	85.7	83.0	0.000
African-American	19.3	9.4	12.6	0.000
Native American	1.7	2.6	2.3	0.000
Asian	0.5	0.7	0.7	0.000
Hispanic	1.1	1.6	1.4	0.000
Deciles 3 & 4				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	84.2	82.7	83.0	0.000
African-American	12.0	12.8	12.6	0.003
Native American	1.9	2.4	2.3	0.000
Asian	0.5	0.7	0.7	0.000
Hispanic	1.4	1.4	1.4	0.966
Deciles 5 & 6				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	84.5	82.7	83.0	0.000
African-American	10.4	13.0	12.6	0.000
Native American	2.7	2.2	2.3	0.002
Asian	0.8	0.6	0.7	0.055
Hispanic	1.6	1.4	1.4	0.040
Deciles 7 & 8				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	88.2	88.6	83.0	0.000
African-American	6.3	14.2	12.6	0.000
Native American	3.1	2.1	2.3	0.000
Asian	1.0	0.6	0.7	0.000
Hispanic	1.4	1.4	1.4	0.859
Most Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	85.4	82.6	83.0	0.000
African-American	9.3	13.1	12.6	0.000
Native American	2.6	2.3	2.3	0.017
Asian	0.7	0.7	0.7	0.861
Hispanic	2.0	1.4	1.4	0.000

Data Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004

Table 18. Results of Stepwise Multiple Regression Analysis for Lafourche Parish, Louisiana with the Hazardousness of Place Rating as the Dependent Variable

Variable	Regression Coefficient	Student's t	Prob>t
Intercept	381.542	10.046	0.000
Percent African-American	-0.287	-2438.000	0.018
Percent Native American	0.285	2.427	0.018
Percent Asian	-0.023	-0.205	0.838
Percent Hispanic	0.156	1.006	0.318
Mean Household Income	0.230	1.668	0.100
Median Contract Rent	-0.097	-0.849	0.399
Median House Value	0.041	0.332	0.741

N = 66; R^2 = 0.219; Adjusted R^2 =0.195; F = 8.891 (0.000)

Jefferson Parish

The Native American population is the only minority group to be statistically more likely to reside in the most hazardous deciles in Jefferson Parish (Figure 34, Table 19). The Asian and Hispanic populations are, in fact, statistically more likely to found residing in the least hazardous census blocks than anywhere else on the west bank. The African-American population is statistically less likely to be found residing in both the most and least hazardous census block groups on the west bank. In fact, the African-American population is one and a half times more likely to be found residing in moderately hazardous deciles.

Regression analysis supports these results (Table 20). It would appear, however, that race and ethnicity are not as important as income is determining the potential hazardousness of the census block group in Jefferson Parish. Both the percentage African-American and Hispanic are, in fact, negatively correlated with the potential hazardousness of the census block group, at the 99 percent confidence interval; the percentage Asian is also negatively correlated with the hazard model, although not significantly. The percentage Native American is the only minority variable that is positively correlated with the hazards rating, although again not significantly. Low-income households, on the other hand, are significantly correlated with the cumulative hazardscape model, again at the 99 percent confidence interval. This suggests that economic factors are more important than racial factors in determining the degree of environmental inequity on the west bank of Jefferson Parish. The other economic factors, median contract rent and median house value, do not figure significantly in the regression model.

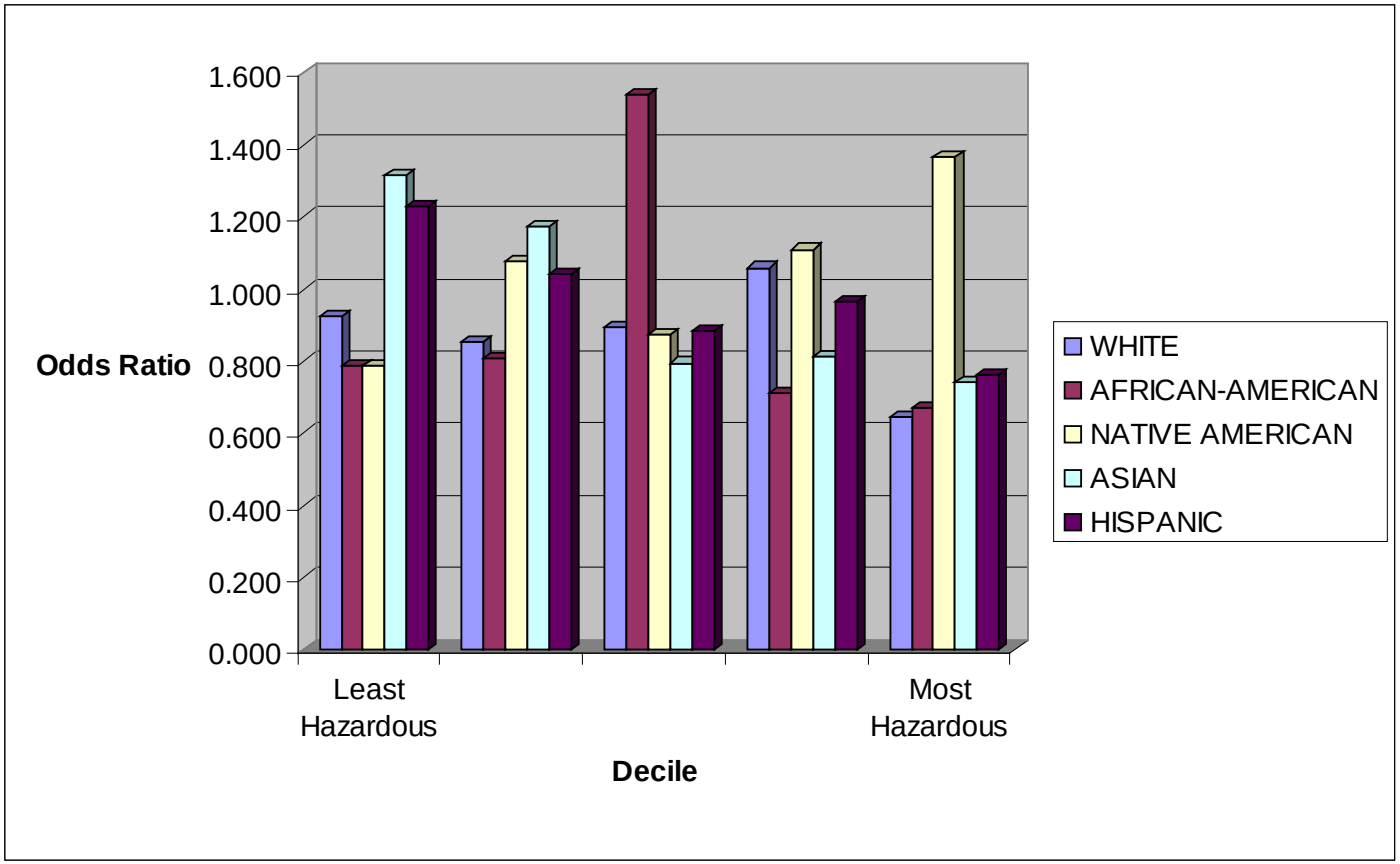


Figure 33. Odds ratios for Jefferson Parish, Louisiana onshore oil-related hazardousness deciles

Table 19. Comparison of Population Proportions for Onshore Oil-Related Hazard Deciles in Jefferson Parish, Louisiana

Least Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	48.5	56.0	54.0	0.000
African-American	39.7	35.1	36.3	0.000
Native American	0.5	0.7	0.6	0.000
Asian	4.8	3.3	3.7	0.000
Hispanic	6.5	4.9	5.3	0.000
Deciles 3 & 4				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	57.9	53.1	54.0	0.000
African-American	31.5	37.5	36.3	0.000
Native American	0.7	0.6	0.6	0.177
Asian	4.3	3.6	3.7	0.000
Hispanic	5.5	5.3	5.3	0.031
Deciles 5 & 6				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	45.0	56.8	54.0	0.000
African-American	46.8	33.1	36.3	0.000
Native American	0.5	0.6	0.6	0.013
Asian	3.0	3.9	3.7	0.000
Hispanic	4.7	5.5	5.3	0.000
Deciles 7 & 8				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	62.2	52.6	54.0	0.000
African-American	28.9	37.6	36.3	0.000
Native American	0.7	0.6	0.6	0.108
Asian	3.0	3.8	3.7	0.000
Hispanic	5.1	5.3	5.3	0.129
Most Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	35.4	47.9	54.0	0.000
African-American	27.7	37.9	36.3	0.000
Native American	0.8	0.6	0.6	0.000
Asian	2.8	3.9	3.7	0.000
Hispanic	4.1	5.5	5.3	0.000

Data Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004

Table 20. Results of Stepwise Multiple Regression Analysis for Jefferson Parish, Louisiana with the Hazardousness of Place Rating as the Dependent Variable

Variable	Regression Coefficient	Student's t	Prob>t
Intercept	948.383	9.177	0.000
Percent African-American	-0.267	-3.213	0.002
Percent Native American	0.061	0.706	0.260
Percent Asian	-0.020	-0.251	0.802
Percent Hispanic	-0.285	-3.483	0.001
Mean Household Income	-0.208	-2.485	0.014
Median Contract Rent	-0.040	-0.426	0.671
Median House Value	0.006	0.055	0.956

N = 145; R^2 = 0.153; Adjusted R^2 =0.135; F = 8.487 (0.000)

St. Bernard Parish

St. Bernard Parish is unique among the parishes in the study area, as it is the only location where no minority groups are statistically more likely to be found residing within the most hazardous census blocks (Figure 35, Table 21). In fact, the white population is the only group that is significantly more likely to reside in proximity to the refinery-related hazards. The Asian population is, however, one and a half times as likely to reside in the most hazardous 40 percent of the parish's census blocks. The Hispanic and Native American populations have residential patterns in St. Bernard Parish, with both groups being more likely to reside in the least hazardous census blocks, as well as the moderately hazardous central decile. The African-American population, on the other hand, is the least likely minority group to be found residing in both the highest and lowest deciles, as well as the second highest hazardousness decile. The extreme low odds ratios in these deciles suggest that the African-American population in St. Bernard Parish is highly concentrated in populated areas outside of Chalmette and Meraux, the areas impacted by the large oil refineries.

The contingency analysis of the individual facilities provides evidence of this (Figure 36, Table 22). The African-American population is the least likely minority group to be found in proximity to either the oil refineries in Chalmette and Meraux or the gas processing plants in rural Toca and Yscloskey. The analysis shows that the African-American population tends to cluster on the primary transportation corridors in St. Bernard Parish, though away from communities with refining-related facilities. Conversely, it is the white population that is more likely to reside near both the refineries and gas processing plants. As in each of the other parishes, facilities in the rural regions, such as the gas processing plants in St. Bernard Parish, tend to have statistically significant numbers of Native Americans residing in proximity.

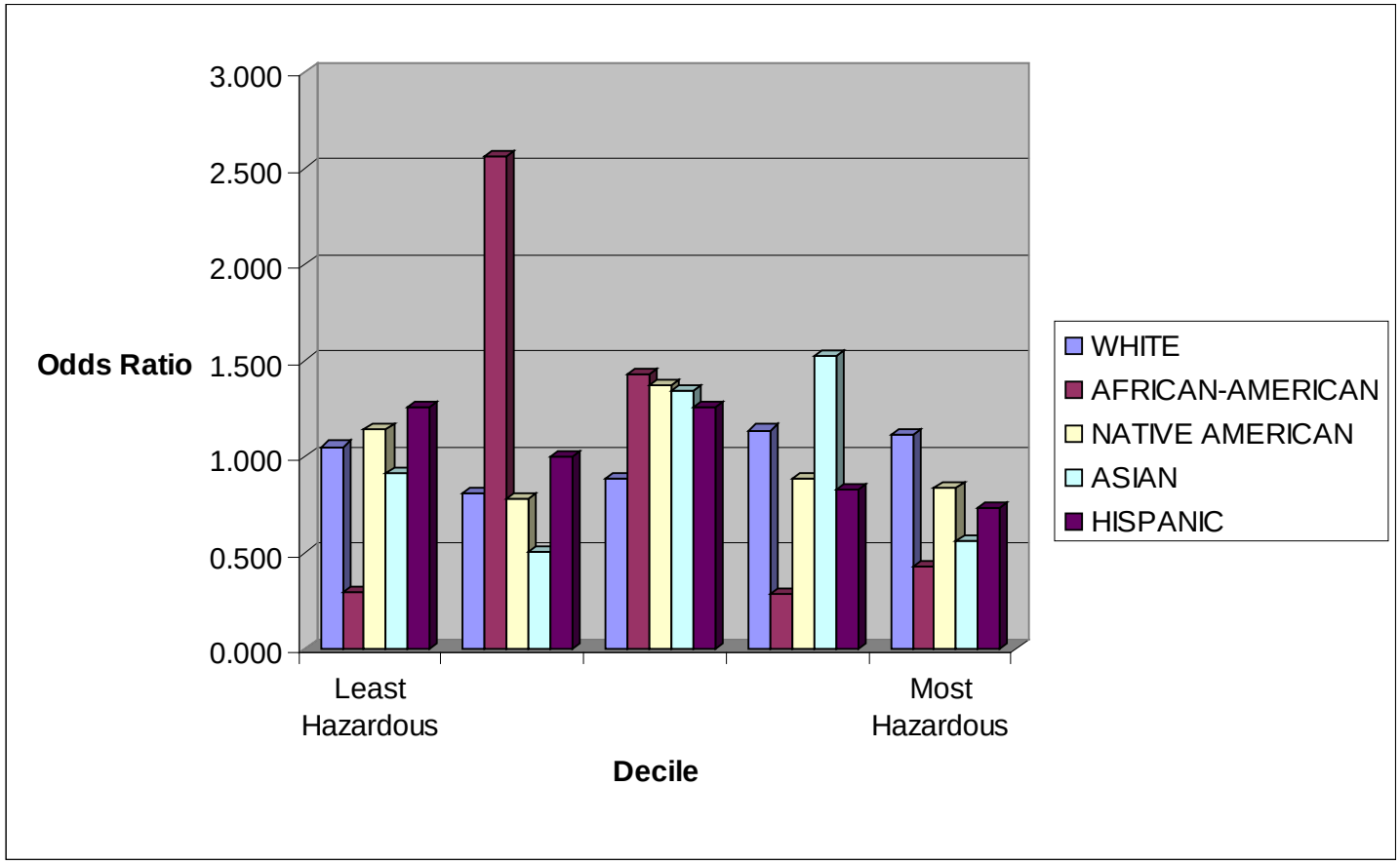


Figure 34. Odds ratios for St. Bernard Parish, Louisiana oil refining-related hazardousness deciles.

Table 21. Comparison of Population Proportions for Oil Refining-Related Hazard Deciles in St. Bernard Parish, Louisiana

Least Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	89.8	85.2	85.9	0.000
African-American	2.3	8.2	7.4	0.000
Native American	0.5	0.5	0.5	0.311
Asian	1.2	1.3	1.3	0.332
Hispanic	6.1	4.8	5.0	0.000
Deciles 3 & 4				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	77.0	88.2	85.9	0.000
African-American	17.0	7.4	7.4	0.000
Native American	0.4	0.5	0.5	0.039
Asian	0.7	1.3	1.3	0.000
Hispanic	4.9	5.0	5.0	0.895
Deciles 5 & 6				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	81.2	87.3	85.9	0.000
African-American	10.3	6.6	7.4	0.000
Native American	0.7	0.4	0.5	0.000
Asian	1.7	1.2	1.3	0.000
Hispanic	6.2	4.6	5.0	0.000
Deciles 7 & 8				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	91.3	84.2	85.9	0.000
African-American	2.2	9.0	7.4	0.000
Native American	0.4	0.5	0.5	0.248
Asian	1.9	1.1	1.3	0.000
Hispanic	4.1	5.2	5.0	0.000
Most Hazardous Deciles				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	91.9	84.5	85.9	0.000
African-American	3.3	8.4	7.4	0.000
Native American	0.4	0.5	0.5	0.148
Asian	0.7	1.4	1.3	0.000
Hispanic	3.7	5.3	5.0	0.000

Data Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004

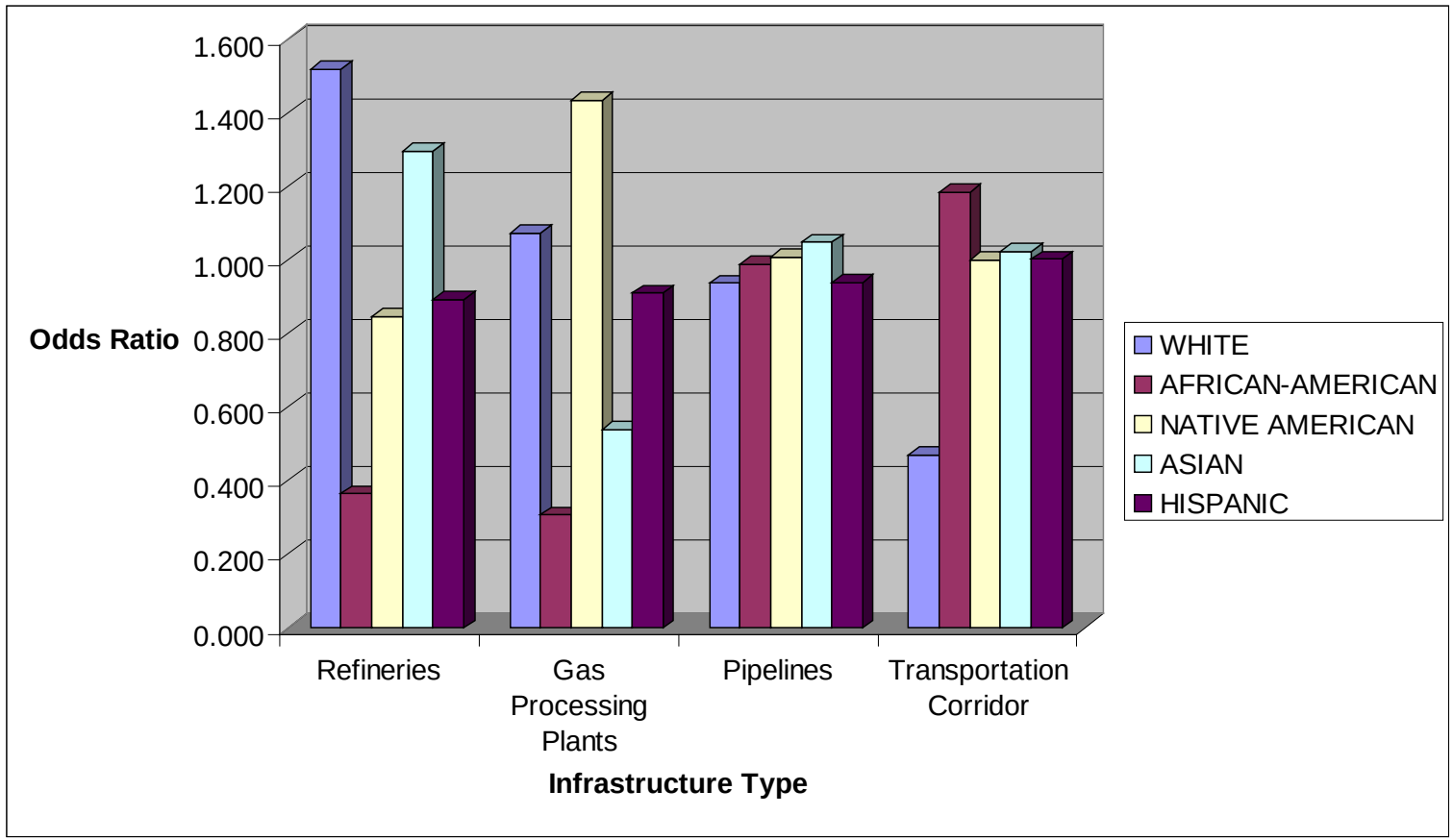


Figure 35. Odds ratios for St. Bernard Parish, Louisiana oil refining-related infrastructure.

Table 22. Comparison of Population for Selected Oil Refining-Related Infrastructure in St. Bernard Parish, Louisiana

Gas Processing Plants				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	94.9	89.2	85.9	0.000
African-American	2.1	7.0	7.4	0.000
Native American	0.7	0.4	0.5	0.018
Asian	0.7	1.3	1.3	0.000
Hispanic	4.6	5.1	5.0	0.110
Pipelines				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	90.5	80.4	85.9	0.000
African-American	6.4	7.7	7.4	0.006
Native American	0.5	0.4	0.5	0.677
Asian	1.3	0.3	1.3	0.000
Hispanic	4.7	10.0	5.0	0.000
Refineries				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	93.5	85.4	85.9	0.000
African-American	2.5	11.5	7.4	0.000
Native American	0.4	0.6	0.5	0.009
Asian	1.6	0.8	1.3	0.000
Hispanic	4.5	5.7	5.0	0.000
Transportation Corridor				
	Proximate	Not Proximate	Parish	Chi-Square Signif.
White	88.7	95.0	85.9	0.000
African-American	7.5	1.7	7.4	0.000
Native American	0.5	0.5	0.5	0.991
Asian	1.3	1.1	1.3	0.234
Hispanic	5.0	5.0	5.0	0.833

Data Source: U.S. Census Bureau, 2000; U.S. Environmental Protection Agency, 2004

Stepwise multiple regression analysis conducted at the block group level reinforces the findings of the contingency analysis (Table 23). All of the minority groups were negatively correlated with the hazardousness rating. The only significant factor in the regression model, however, was the percentage of African Americans, which was negatively correlated at a 95 percent confidence interval. The percentage of Hispanics was also negatively correlated with the overall hazardousness, though only significant at the 90 percent confidence interval. One of the economic variables proved to be significant in the model, though incomes showed a tendency to decrease as the hazardousness of the area increased. Rents and house values tended to rise in the more hazardous areas of Chalmette and Meraux, though not significantly.

Table 23. Results of Stepwise Multiple Regression Analysis for St. Bernard Parish, Louisiana with the Hazardousness of Place Rating as the Dependent Variable

Variable	Regression Coefficient	Student's t	Prob>t
Intercept	2364.545	9.374	0.000
Percent African-American	-0.336	-2.364	0.023
Percent Native American	-0.126	-0.886	0.380
Percent Asian	-0.027	-0.186	0.853
Percent Hispanic	-0.250	-1.805	0.078
Mean Household Income	-0.110	-0.737	0.465
Median Contract Rent	0.009	0.058	0.954
Median House Value	0.065	0.424	0.673

N = 45; R^2 = 0.113; Adjusted R^2 =0.093; F = 5.590 (0.023)

2.3.1 Summary of Findings

Of the three sectors of the oil industry explored in this study, we found that offshore oil-related hazards are the most dispersed, and thus the least overtly hazardous. This is due in large part to the fact that the actual extraction sites are located far offshore, away from the parish itself. As a result, industries have fewer constraints on where to locate their facilities. Though Port Fourchon, for example, is clearly the most convenient place for industry to locate, relative to proximity to the offshore wells, it is not economically unfeasible for facilities to be located further upstream. Thus we see shipyards located all along Bayou Lafourche, from Fourchon to Golden Meadow, up through Larose and Lockport. Petroleum bulk storage facilities are located in many communities across south Lafourche, with the largest facility located in north Lafourche. In the case of some industries, such as platform and pipeline fabrication, facilities exist in adjacent parishes, reducing the overall hazardousness of the region.

The other two sectors, onshore and petroleum refining, are much more constrained: economically, geographically, and politically. In Jefferson Parish, the onshore-related infrastructure must necessarily be placed in the immediate vicinity of the oil fields. Thus we see much greater facility clustering and, consequently, hazardousness. Petroleum refining requires large-scale facilities and a large labor force, as well as transportation infrastructure and easy access to large amounts of water for reactive and cooling purposes. In coastal Louisiana, the potential siting locations for large refineries are extremely limited, even before consideration of the political incentives and disincentives involved in siting such potentially hazardous facilities.

It is the flexibility in locating new facilities that results in offshore oil-related infrastructure being lower on the potential hazardousness scale than both the onshore extraction and petroleum refining industries. New facilities can be built on large tracts of land in sparsely populated areas that are often distant from the actual extraction or development site. The more dispersed the industries, the less the cumulative potential hazardousness of the region. We should be cautious in interpreting these results, however, so as not to assume that a more dispersed hazard surface is necessarily more or less equitable. Because the risk surface is more dispersed, more communities may in fact be exposed to potential hazards.

CHAPTER 3. ENVIRONMENTAL JUSTICE AND THE SPATIAL DISTRIBUTION OF WILDLIFE HABITAT

3.1 INTRODUCTION

Traditionally, when conducting environmental impact assessments, federal agencies have needed to consider and mitigate the impacts of development on threatened and endangered species. The Endangered Species Act, for example, recognizes that human actions can have impacts on certain species, and requires people to conform their behavior (Hill and Targ 2001). With the development and legal legitimization of the environmental justice movement, however, these agencies find themselves directed to also consider the effects that their programs and policies have on the natural and environmental resources upon which low-income or minority communities depend.

Such a mandate is explicitly stated in Executive Order 12898, issued by President Clinton on February 11, 1994. One of the priorities of E.O. 12898 is to collect and analyze information on the consumption patterns of people who rely principally on fish or wildlife for subsistence and to communicate to the public the risks of those consumption patterns. In fact, when the President's Council on Environmental Quality (CEQ) issued guidance to implement E.O. 12898, they directed that agencies determine whether there are inter-related cultural, social, occupational, historical, or economic factors that may amplify the physical environmental effects of the proposed action (Foster 2001). According to CEQ, where an agency action may affect fish, vegetation, or wildlife, that agency action may also affect subsistence patterns of consumption and indicate the potential for disproportionately high and adverse human health or environmental effects on low-income populations, minority populations, and Native American tribes (CEQ 1997).

The U.S. Environmental Protection Agency (USEPA) carries this mandate even further in its Environmental Justice Guidance by requiring consideration of both the cumulative and indirect impacts of agency action on vulnerable communities. The USEPA recognizes, for example, that certain natural resources may have both economic and cultural value to specific communities, and that analysts should consider the cumulative impacts from the perspective of these specific resources or ecosystems (Foster 2001). The USEPA guidance further recognizes that particular attention should be paid to the indirect effects of an action on minority and low-income communities. For example, USEPA notes that reduced access to fishing and farming locations may result from increased urbanization around a new facility due to increased employment or transportation system upgrades (Foster 2001). Such reduced access to natural resources resulting from policy actions, according to USEPA, would represent a potential source of environmental injustice.

Though most environmental justice studies have examined the spatial distribution of hazards and how they vary among different socio-economic groups as a result of policy, relatively few studies have considered how the spatial distribution of hazards impacts access to natural resources. Advocates have argued that it is the government's responsibility to protect natural

resources in a manner that encompasses the perspectives and needs of the most vulnerable individuals and species so that everyone can enjoy the benefit of healthy resources and environmental services (Hill and Targ 2001). Yet, this aspect of environmental justice research has not been widely explored.

The environmental justice regulations, however, are not designed to protect every piece of wildlife habitat for non-endangered or threatened species. In areas where natural resource collection is a viable economic and cultural activity, it should be possible to identify areas of land that offer the greatest potential to support a multitude of commonly hunted wildlife habitat. This approach would call for a place-based or resource-based analysis. Hill and Targ (2001) note that such resource protection would include "the protection of specific types of natural or environmental resources based on an ecological or place-specific basis." Further, regulation of specific natural or environmental resources can serve to protect ecosystems and the people whose lives are intertwined with them (Hill and Targ 2001).

This chapter seeks to extend previous environmental justice research methodologies to include natural resource issues raised by E.O. 12898 and the Federal environmental justice implementation guidelines. First, we establish a theoretical framework that relates locally based natural resource extraction activities to social vulnerability and environmental justice. Second, we examine the distribution of wildlife species that are important in the traditional livelihoods of local residents in southeast Louisiana, a largely rural region with a long history of hunting and trapping. Third, we attempt to identify the potential impacts of oil-related industries on wildlife habitat. Last, we discuss the importance of documenting diminishing local resource extraction and its implications for environmental justice policy.

3.2 Social Vulnerability and Natural Resource Collection

According to Susan Cutter, social vulnerability to risks and hazards derives from the activities and circumstances of everyday life (Cutter et al. 2000). Though researchers have focused on social vulnerability as a function of residential and occupational environments, for many people the activities and circumstances of everyday life extend well beyond these realms. Rural regions, for example, generally are less vulnerable to risk because of lower population and housing densities (Cutter et al. 2000). However, in many rural areas, residents obtain or supplement their food supplies by hunting or fishing. Researchers have demonstrated that the consumption and use of contaminated fish and wildlife is the primary route by which humans are exposed to many contaminants such as chlordane, dioxins, DDT, and toxaphene (O'Neill 2003). Thus, the risk to these rural communities is heightened beyond simple residential exposure levels when interactions with cultural and social processes are taken into account. This is what Kasperson et al. (1988) refer to as the "social amplification of risk."

This social amplification of the risk surface varies depending on the cultural and social values of the impacted communities. It is generally accepted that communities defined by common ethnicity, social ties, health conditions, or other factors may have unique susceptibilities or common cultural practices that, if closely examined, would demonstrate that they are in fact impacted (Warren 1999). Susan Cutter notes that certain social factors can contribute to greater

vulnerability on the part of some population subgroups (Cutter et al. 2000). For example, in addition to consuming fish and wildlife in greater quantities than does the general population, different ethnic or racial communities may consume and use different fish and wildlife species or employ different practices in preparing and consuming fish and wildlife (National Environmental Justice Advisory Council; NEJAC 2002). For example, we generally assume that people eat only the fillet of finfish, and that they do not eat the fat, head, skin, bones, eggs, or internal organs, and that people dispose of the drippings or cooking fluid (NEJAC 2002).

As Hill and Targ (2001) point out, "attention to minority and low-income communities and the natural resources upon which they depend is necessary because actions that adequately protect the general population may not always protect discrete segments of the population." In the case of natural resource collection and consumption, indigenous people, members of other non-dominant groups, and low-income individuals often rely on these resources as indispensable nutritional and economic goods and this reliance on natural resource collection sets the activities of these groups apart from the more recreation-based activities of other societal groups. Though there are important differences among various communities of color, low-income communities, and indigenous peoples, members of these groups often depend on fish and wildlife to a greater extent and in different ways than does the general population (NEJAC 2002).

As suggested above, there are two important ways that natural resource collection and consumption intersect with environmental justice. First, environmental justice research is concerned with the public health risks associated with the possible contamination and subsequent consumption of certain natural resources, particularly fish and wildlife. In addition, research needs to account for the role that natural resource collection plays in the economic life of potentially impacted communities. This is especially important in rural areas, where residents are generally more dependent on locally based resource extraction activities (Cutter et al. 2003).

3.2.1 Health Risks

Attention to minority and low-income communities and the natural resources on which they depend is necessary because actions that adequately protect the general population may not always protect discrete segments of the population (Hill and Targ 2001). By directing Federal agencies to collect, maintain, and analyze information on the consumption patterns of populations dependent upon fish and wildlife for subsistence, E.O. 12898 raises relevant questions concerning the degree of spatial coincidence between potential contamination sources and the distribution of fish and wildlife populations. The CEQ recommends that agencies determine whether their activities impact fish, vegetation, or wildlife. It is this determination that establishes whether or not the potential for environmental justice concern exists. If a contaminant is released and that contaminant persists in the environment and bioaccumulates in fish and wildlife, it may find its way into humans who consume or use these resources. In fact, the consumption and use of contaminated fish, wildlife, and other aquatic resources is the primary route by which humans are exposed to many different contaminants.

One of the most closely monitored environmental contaminants is mercury. When inorganic mercury enters the aquatic environment, it is readily converted to methyl mercury by aquatic microorganisms. Through biomagnification the level of mercury contamination tends to increase at higher trophic levels. When the rate of uptake exceeds the elimination rate, the mercury concentration in fish begins to increase. Ultimately, in Louisiana rivers and lakes, large predatory fish, such as adult largemouth bass and bowfin, tend to have much higher levels of mercury than juvenile fish and those lower on the food chain (LDEQ 2004). This risk is passed on to the consumers of fish. According to the Louisiana Department of Environmental Quality (LDEQ), the primary route of exposure to methylmercury in Louisiana is consumption of locally-caught fish. Therefore, according to LDEQ, individuals consuming a large quantity of fish are at a much higher risk than the general population.

Mercury also bioaccumulates in terrestrial wildlife. According to a study by LDEQ, top predators of the aquatic food chain tend to have the highest concentrations of mercury. This includes commonly-trapped mammalian species such as raccoons, mink, and otters. Waterfowl species are also susceptible to mercury contamination. A University of Georgia study found that female wood ducks and their eggs contain mercury at levels comparable to those in the environment where they are collected (Kennamer et al. 2005). According to the Michigan Department of Natural Resources, when waterfowl are exposed to chronic low levels of mercury contamination, mercury residue accumulates in the birds' pectoral muscles (Michigan DNR 1993).

Though mercury may be the most closely monitored environmental contaminant, it is not the only one. Lead, for example, is one of the most persistent pollutants in the environment. Once in the soils and sediments, lead persists and may migrate, contaminating not only surrounding areas but also sediments in rivers and marshes downstream. Plants, fish, waterfowl, and other birds then uptake the lead present in contaminated sediments (O'Neill 2003). Clearly then, all other factors being equal, a higher level of resource consumption results in a greater potential for exposure to many contaminants in the environment that the fish or wildlife take in, and the greater the risk of adverse health impacts.

3.2.2 Economic Risks

For many racial, ethnic, and low-income communities, environmental justice is rarely only about immediate health concerns or the distribution of hazards (Yamamato and Lyman 2001). For these communities, environmental justice is often about economic self-determination. The mainstream view of hunting and fishing is primarily as a recreational pursuit and only secondarily as an economic activity (O'Neill 2003). Analyses based on the use of these mainstream views may overlook important disproportionate burdens that may be experienced by particular populations and communities (Hill and Targ 2001). For rural communities, many of which are already economically challenged, the loss of valuable hunting and fishing grounds would represent a further economic blow to residents. For some communities, natural resource collection is a primarily economic and subsistence activity.

This highlights a shortcoming of using risk avoidance measures as a means to deal with environmental contamination. Fish and wildlife advisories generally focus on the problem of the contamination of fish and wildlife, and do not address the problem of the availability of fish, aquatic plants, and wildlife for consumption and use by local residents (NEJAC 2002). Clearly, risk avoidance strategies seek only to influence or require risk-bearers to alter their practices (O'Neill 2003). When issuing advisories and setting consumption limits, agencies have generally failed to consider which groups in society are likely to need to undertake avoidance. Restrictions on fishing often have the unanticipated effect of making it more difficult for indigenous people, minority groups, and low-income individuals to take advantage of a high-quality, low-priced food source (Lyall 1991). This places a disproportionate burden on these groups whose members must choose between their physical and economic well-being.

This highlights the differences in the ways in which researchers often view natural resource collection. For many evaluators, hunting and fishing are likely to be understood as pursuits that are not necessary for most practitioners, but important for recreational or economic reasons for some. Though recreational hunters and fishermen may recognize fish and game as palatable, efficient, and relatively inexpensive sources of protein and nutrients, these are not the primary sources for them. These resources are therefore likely to be valued, but not to be indispensable (O'Neill 2003). For subsistence hunters and fishermen, however, these resources are nutritional, economic, and cultural necessities.

This dependence on natural resources has been acknowledged by the U.S. Environmental Protection Agency when addressing environmental justice concerns. Many of the statutes that the USEPA implements provide the agency with the authority to support the integrity of the environment and the natural resources on which minority and low-income communities depend (Hill and Targ 2001). NEJAC, for example, has acknowledged that fish, aquatic plants, and wildlife are important food sources, and that "if someone can fish, gather, harvest, or hunt nearby, he or she can bypass altogether the need to get to a store and to purchase food" (NEJAC 2002: 3).

3.3 Determining Natural Resource Vulnerability

The process used to determine natural resource vulnerability is similar to the one used to create the hazards-of-place model of vulnerability. We focused once again on three elements: biophysical, natural resource, and place vulnerability. These three outcome indicators enabled measurement of the potential hazardousness of each parish as it relates to sectors of the oil industry. The biophysical vulnerability was measured by the delineation of OCS-specific hazard zones, and natural resource vulnerability was determined using habitat data for a number of indicator species. The interchange of the two gives us the overall place vulnerability, the third outcome indicator.

This analysis does not include data on actual harvesting locations and consumption patterns. Rather, two factors are analyzed and used as proxies for potential harvesting locations. The first, geographic areas of high species productivity, is used to identify locations where the potential harvest is highest. Questions of physical access to these locations are not addressed in this

analysis. Secondly, proximity to residence is used to measure intensity of use, which is not always the case. The function of the analysis is to highlight potential areas of environmental justice concerns and not to resolve questions related to specific communities. Given these caveats, this approach is an efficient way of identifying areas of potential concern, as well as areas that may warrant further exploration.

3.3.1 Pollution Potential

Pollution potential was measured using the weighted hazardscape model developed in Chapter 2. Again, this model enabled us to estimate the overall hazardousness of each sector of the oil industry by allowing us to incorporate multiple sources of potential risk into the hazardscape.

3.3.2 Modeling Wildlife Habitat

Aquatic wildlife resources were extracted from the Louisiana Gulf-Wide Information System (G-WIS), a database created for the MMS (now BOEM) to support environmental assessments associated with oil and gas exploration, production, and transportation activities in the Gulf of Mexico. One contains information on major crawfish and river shrimp concentrations in the coastal waterways of Louisiana, and the other describes freshwater (inland) fish resources in coastal Louisiana. Both data sets identify water-bodies and other aquatic habitats with similar species composition and relative abundance in various inland rivers, lakes, and, in some cases, adjacent wetlands.

Analysis of non-aquatic wildlife used U.S. Geological Survey (USGS) data to examine the habitats of those animals that are important in the more traditional livelihoods of local residents of Southeast Louisiana, particularly the Native American population. The Gap Analysis Program (GAP) is a state and national level endeavor whose purpose is to provide broad geographic information on the status of various animal species and their habitats in order to provide land managers, planners, scientists, and policy makers with the information they need to make better informed decisions. Sponsored and coordinated by the Biological Resources Division of the USGS, GAP is also supported at the national level by the Department of Defense, the U.S. Environmental Protection Agency, the National Mapping Division of the USGS, and The Nature Conservancy.

This analysis modeled the diversity of commonly hunted and trapped wildlife species. Species diversity has been shown to generally decline in response to disturbance for a variety of different stressors and ecosystems (Suter and Bartell 1993). This portion of the research involved mapping the zones of natural resources potentially collected and consumed by the local populations.

The predicted distribution of game animals that are commonly hunted for direct consumption was extracted from the Louisiana GAP data. We extracted the habitat data for a number of different species of waterfowl, including the wood duck, mallard, mottled duck, blue-winged

teal, and both the fulvous and black-bellied whistling ducks, and the Canada goose. The only other bird species used in this analysis was the wild turkey, another common game bird. The only large game animal used in the model was the deer. These distributions were mapped in the GIS, and a model created, whereby an overall distribution of species diversity was calculated. Using this cumulative distribution map, the portions of the parish with the greatest diversity of commonly hunted game animals were identified.

In much the same way, we created a model of the cumulative distribution of animals vital to the fur harvest in Louisiana. The animal populations included the nutria, raccoon, muskrat, mink, otter, and bobcat, in that order. Again, these distributions were mapped and a model was created showing the overall distribution of species diversity in the fur trade. Using this cumulative distribution map, we identified those portions of each parish with the greatest diversity of animals vital to the fur harvest.

3.4 LOCATIONAL VULNERABILITY OF NATURAL RESOURCES

The objective of this portion of the study is to identify the potential oil-related hazards that may specifically impact wildlife communities. Using the species-specific habitat zones along with the hazardscape model, we were able to identify locations within the study area where wildlife habitats are most at risk from oil-related development.

Further analysis was conducted on the minority populations residing within a half-mile buffer of these potentially impacted natural resource areas. Odds ratios were used to examine the minority proportions of census blocks within these buffers compared to the proportions outside of them. As noted earlier, this research does not make a determination whether or not nearby residents hunt or fish these potentially impacted areas. Rather, this data is used to identify populations that are at heightened risk should they hunt or fish the wetlands surrounding their residences.

3.4.1 Oil-Related Degradation of Wildlife Habitat

The potential impacts of oil-related development on wildlife habitats are numerous, ranging from habitat fragmentation to complete habitat removal. For example, when marshland is converted to canals, there is a loss in overall primary or plant productivity, regardless of a partial compensation by aquatic plant productivity (Wicker et al. 1989). The construction of roads and pipeline canals bisects the area, potentially separating breeding populations, which could result in genetic isolation and the threat of local extinctions. In the case of pipeline canals, however, backfilling has allowed plants and animals to completely reinvade the pipeline transects. Complete habitat removal often results from the dredging of canals and channels, as well as resultant spoil deposition.

In addition to habitat degradation, faunal communities may be directly impacted by hazardous releases and spills. Studies have indicated, for example, that oil toxicity is a definite factor in the mortality of impacted birds. When a bird's plumage becomes fouled with oil, there is a loss of insulation, which may ultimately result in starvation or the bird may ingest the oil as

it preens, potentially resulting in gastrointestinal irritations and other health conditions (Bolen and Robinson 1995). One indirect effect of exposure to oil concerns reproduction. Ducks that have ingested oil may cease laying eggs and fertile eggs exposed to small amounts of oil experienced significantly less hatching success than unexposed eggs (Bolen and Robinson 1995).

Fauna may also be impacted directly by onshore petroleum-related facilities. Animals may become trapped in oil pits and sumps constructed near oil fields, refineries, and petrochemical plants. Most of the impacted animals are ducks and other waterfowl, which mistake the oil for water (Bolen and Robinson 1995). Though this is clearly more of a problem in arid and drought-prone regions, any oil pit or sump has the potential to harm wildlife.

3.4.2 Spatial Analysis of Potentially Impacted Habitat

Wildlife habitat zones were correlated with the hazardscape maps to identify locations with high oil-related hazard rates and high species diversity. In these locations, the hazardscape has the potential to affect species productivity, and, presumably, access and use by local residents. If the surrounding communities are minority or low-income, this reduced access would present a potential environmental justice concern, particularly if take could not be made up elsewhere.

We used a two-step process to analyze the potential impacts of the oil and gas industries on local communities. First, we identified clusters of wildlife habitat that have a high hazardousness rating (Standard Deviation >3) and a high species diversity (Standard Deviation >2), where wildlife faces the greatest potential risk from oil-related facilities. In St. Bernard Parish, where there is an extremely steep risk gradient, we looked at areas with both extremely and moderately high hazardousness ratings (Standard Deviation >2). Then, we examined the residential makeup of the communities surrounding these clusters, using nonparametric procedures to determine if certain minority groups are more likely to reside in proximity to potentially impacted wildlife habitat. These procedures, taken together, provide a means of prioritizing where to spend resources when considering the potential environmental justice impacts of their activities.

Lafourche Parish

We identified a total of forty clusters of potentially at-risk wildlife and fisheries habitat in Lafourche Parish. Given the overall distribution of commonly trapped mammal habitat in Lafourche Parish, it is not surprising that this habitat has the most acreage at risk by current oil-related activities. We identified seventeen locations of potentially at-risk trapping habitat totaling over 49,000 acres of land (Figure 37). Much of this acreage is found around communities located along the Highway 1 corridor, although the wetlands to the east of this corridor also has significant acreage. The greatest amount of clustering is found in the area stretching between Larose and Cutoff, although large clusters were found as far south as Golden Meadow and as far north as the community of Chackbay. Other communities of note include Lockport and Raceland, both located on the Highway 1 corridor, and Grand Bois, a small Cajun and Houma community located on the western edge of the parish. In total, some 546 census blocks are located within one half mile of potentially impacted trapping habitat. The population of these census blocks at the time of the last census was well over 19,000. The percentage of the

total population that traps in the wetlands is likely to be quite small, but it is still an important consideration given the numbers of Cajuns and Houmas residing in the area.

There were fewer locations of potentially impacted hunting habitat in Lafourche Parish. Though 14 areas were identified, these represented just over 27,000 acres of land (Figure 38). Far fewer areas were identified along the Highway 1 corridor, although locations just outside of Larose were again significant, as were the marshlands stretching between Larose and Little Lake. Also of note is the inclusion, once again, of the small community of Grand Bois. In all, only 126 census blocks are within one half mile of potentially impacted hunting ground, encompassing 4,342 persons. Noticeably fewer people live in proximity to potentially impacted hunting habitat than trapping habitat, likely due to the clustering of identified hunting habitat.

Finally, there were only nine areas of potentially impacted freshwater fish habitat; these encompassed only 13,000 acres (Figure 39). However, two-thirds of these areas are entirely within the Highway 1 corridor along Bayou Lafourche. The southern extent of these areas includes that portion of Bayou Lafourche stretching from Larose to Cutoff. The northernmost area is located in a portion of Bayou Lafourche that crosses through Thibodaux. Although these areas of land encompass far fewer acreage, the vast majority of this land runs through the most populous portions of the parish. 653 census blocks are located within one half mile of the potentially impacted fisheries, with a total population of almost 23,000 residents.

The southern portion of Lafourche Parish contains sixteen Environmental Management Units (Figure 40). Strip residential and commercial development are the dominant land uses along Bayou Lafourche, and the units outside of this area are almost exclusively marshland, grading from freshwater to saltwater. DNR has identified each of these south Lafourche units as being important fish, shellfish and wildlife propagation areas. Two units, however, are important areas for the United Houma Nation: the Bayou Pointe-au-Chien and Raccourci Environmental Management Units. These two units encompass all of the land along Bayou Pointe-au-Chien along the western boundary of Lafourche Parish.

Bayou Pointe-au-Chien

Bayou Pointe-au-Chien, the more northerly of the two Environmental Management Units, is mostly low-lying marshland, with higher natural ridges found along Bayou Blue and Bayou Pointe-au-Chien. The surrounding marshlands are ideal for the production of waterfowl food. Consequently, waterfowl and fur-bearing animals thrive throughout the unit. Commercial and sports fishing, primarily fresh and brackish water angling, are also widespread throughout the unit. Residential and commercial areas are small and cluster along Bayou Pointe-au-Chien near Grand Bois. Most of the unit is part of Pointe-au-Chien Wildlife Management Area and is fairly unique in that extensive channelization of the fresh marsh and swamp has not occurred, with the exception of the extreme southern portion, where it borders the Raccourci management unit.

Raccourci

The Raccourci Environmental Management Unit consists of low-lying marshland and shallow lakes and bays that open into the Gulf of Mexico. There are numerous bayous throughout the area, as well as a number of pipeline and navigation canals. The vegetation in the

unit grades from brackish to saline marsh. In addition to large amounts of oil and gas extraction, the major uses of this study unit are recreation, hunting, and fishing. Trapping lands are also found in the northern portion of the unit. One small Houma community remains on the northern shore of Catfish Lake, just to the west of the town of Golden Meadow. According to Louisiana Department of Natural Resources analysts, this settlement consists of five families who hunt and trap for a living (LDNR 2002).

Analysis of Human-Wildlife Proximity

We calculated odds ratios for the proportion of minority population in the blocks within a half-mile of potentially impacted wildlife habitat (Table 24). Our analysis indicates that there is an unequal social distribution of potentially impacted wildlife and fishery habitat in Lafourche Parish. The most equitable distribution is seen around the potentially impacted freshwater fisheries of the parish. With the exception of the Asian population, minority residents are no more likely to live in proximity to potentially impacted fisheries than anywhere else in the parish. The Asian population, however, are almost twice as likely to live in proximity to this habitat type. In fact, the Asian population shows a tendency to live in proximity to each type of impacted wildlife habitat. Similarly, Houma are also significantly more likely to live in proximity to potentially impacted hunting and trapping grounds. It is important to note that hunting and fishing are largely rural pursuits. Some populations, such as the Houma, are rural, regardless of their use of wildlife.

The African American population is much less likely to be found living in proximity to all potentially impacted wildlife and fisheries habitat. Given that 33 percent of the African-American population resides in Thibodaux, these results are hardly surprising. Thibodaux, the largest population center in the parish, has significantly fewer areas of wildlife habitat in general. Similarly, because most of the offshore oil-related industries in Lafourche Parish are concentrated in the southern portion of the parish, Thibodaux has far fewer industries and a less significant risk surface.

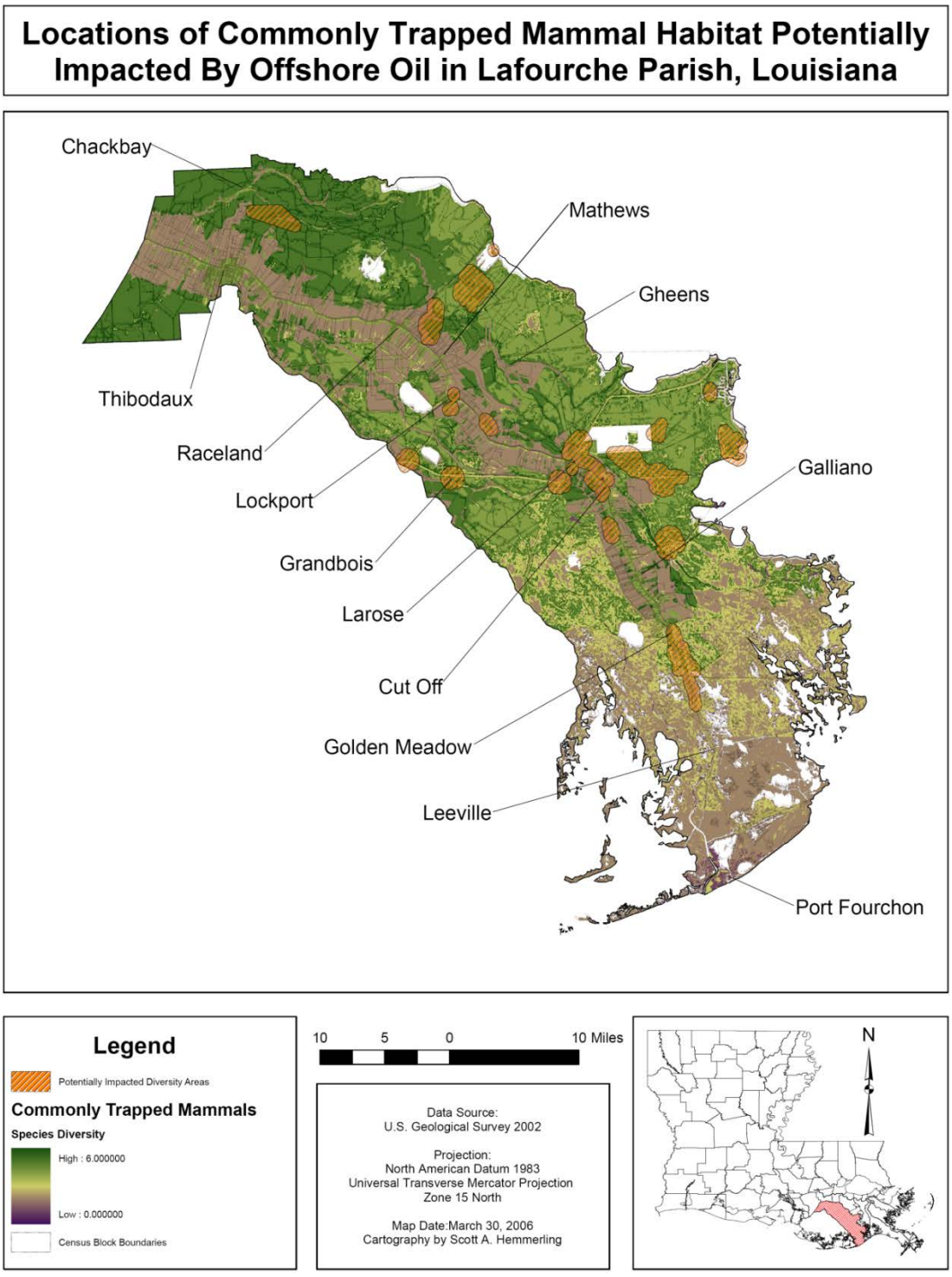


Figure 36. Locations of potentially impacted trapping zones in Lafourche Parish, Louisiana.

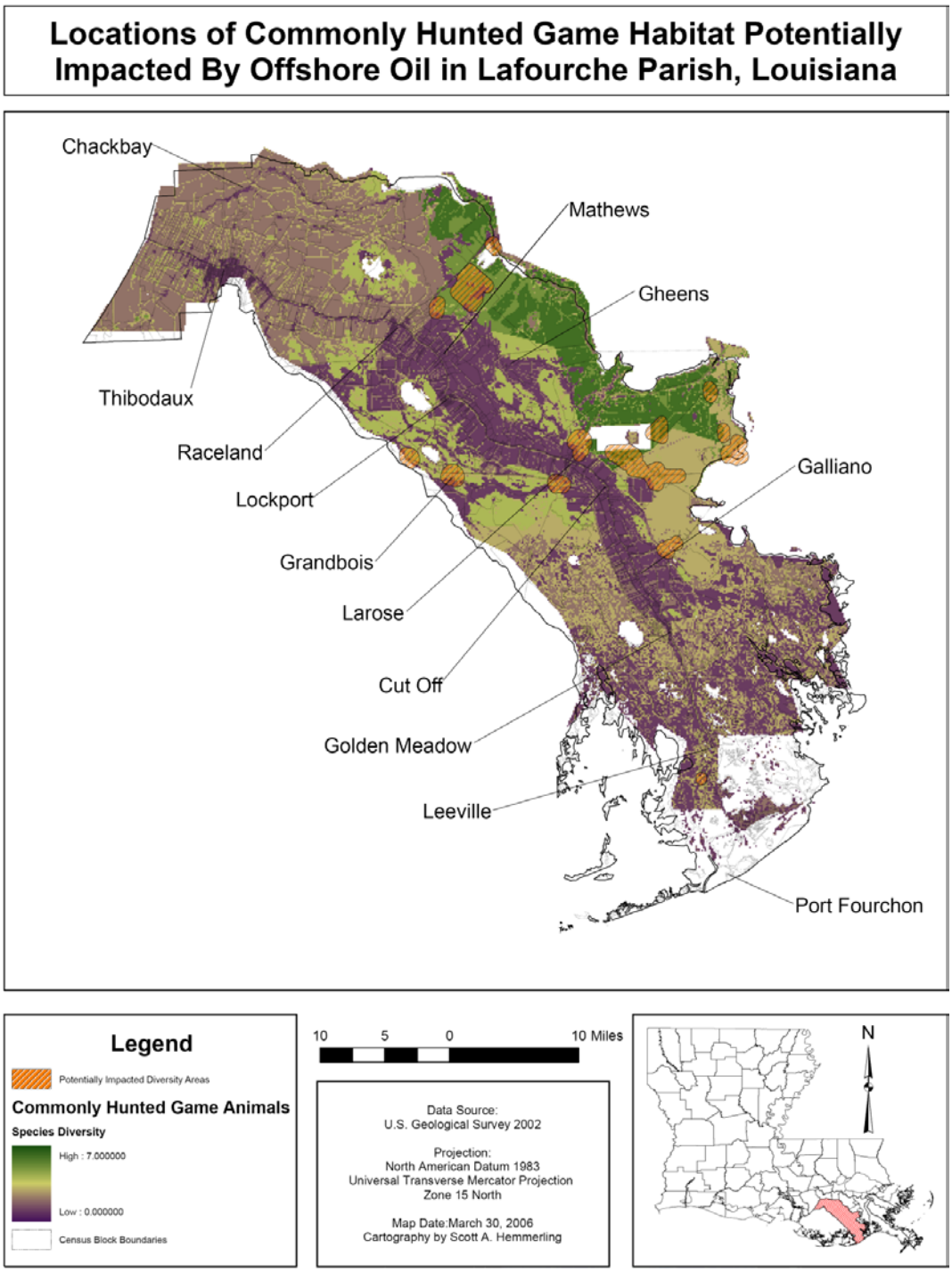


Figure 37. Locations of Potentially impacted hunting zones in Lafourche Parish, Louisiana.

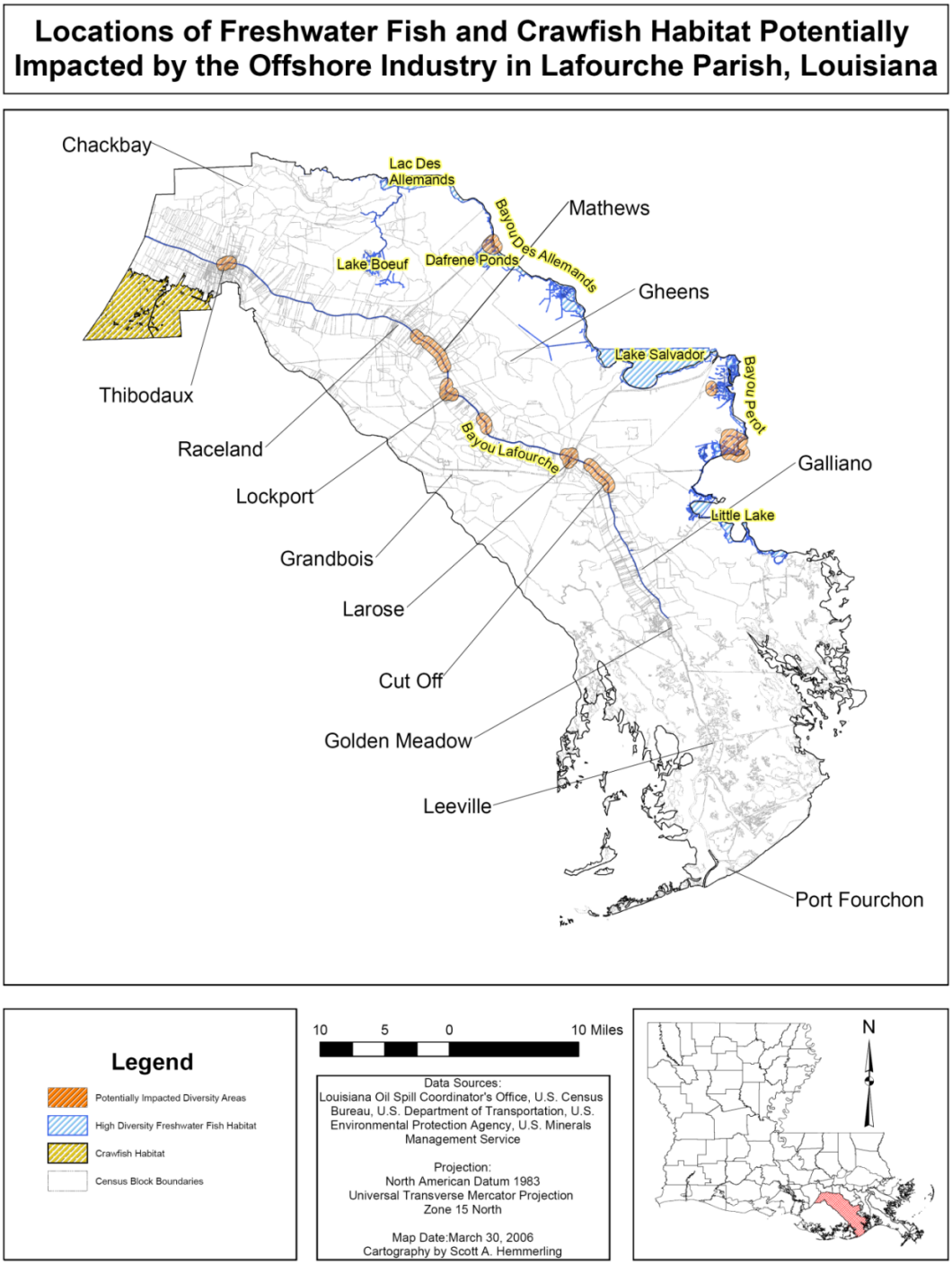


Figure 38. Locations of potentially impacted fishing zones in Lafourche Parish, Louisiana.

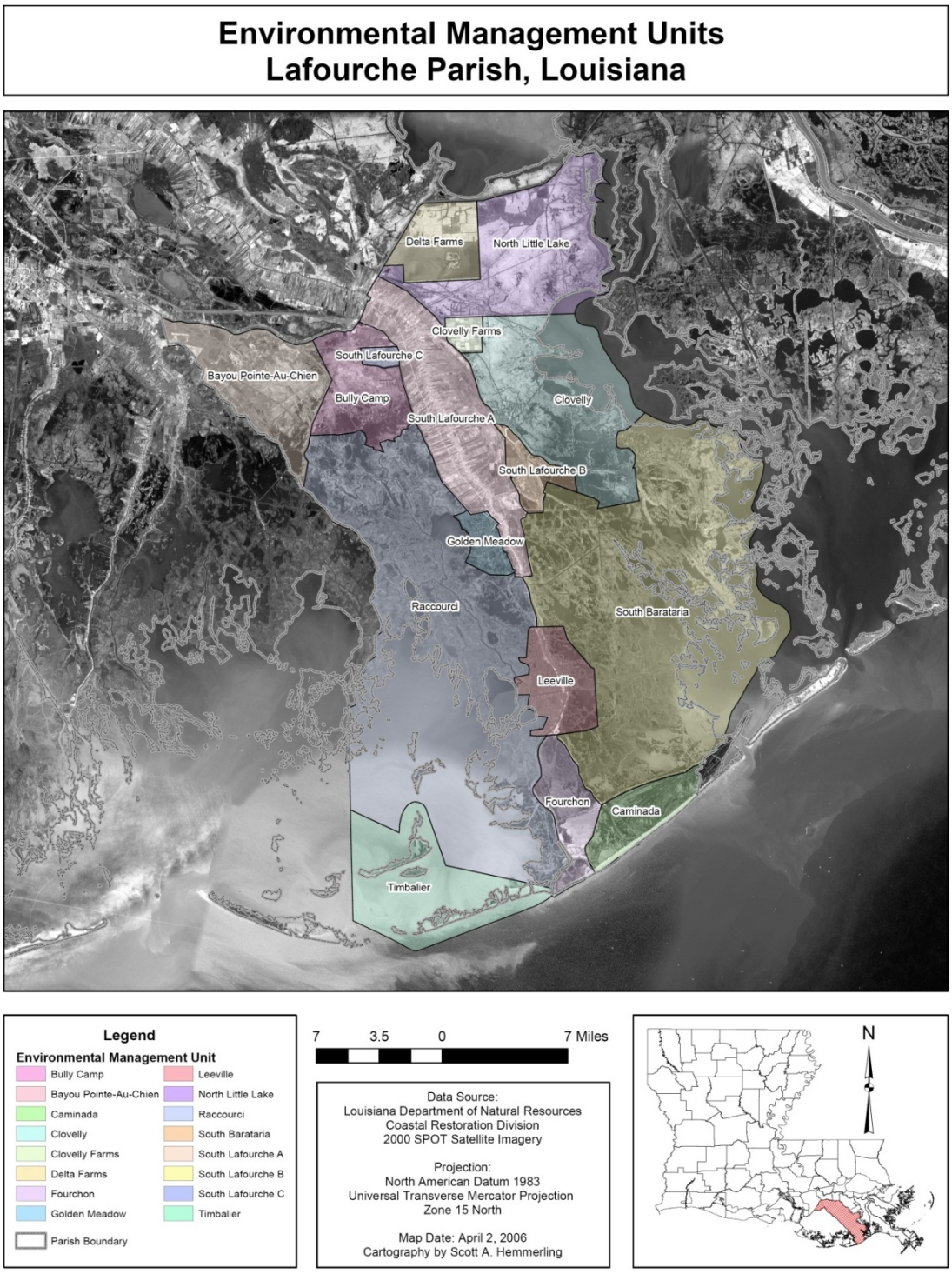


Figure 39. Environmental management units in Lafourche Parish, Louisiana.

Table 24. Odds Ratio Values of Potentially Impacted Wildlife Habitat in Lafourche Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

Habitat Type	Racial Variables									
	White		African American		Native American		Asian		Hispanic	
	Value	Significance	Value	Significance	Value	Significance	Value	Significance	Value	Significance
Hunting[1]	.723	.000*	.086	.000*	3.294	.000*	2.694	.000*	1.181	.148
Trapping[2]	.707	.000*	.281	.000*	2.232	.000*	2.060	.000*	1.388	.000*
Fishing[3]	.728	.000*	.612	.000*	.827	.007*	1.813	.000*	1.030	.537

* Statistically significant at 99% confidence level

[1]Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by OCS-related development (n = 126)

[2]Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by OCS-related development (n = 546)

[3]Sample consists all census blocks within 0.5 miles of freshwater fish habitat potentially impacted by OCS-related development (n = 653)

Jefferson Parish

In total, we identified one dozen areas where natural resources may be significantly impacted by onshore oil-related development. The potentially impacted areas are largely located in the developed northern portion of Jefferson Parish's west bank, an area included in the Avondale and West Bank Environmental Management Units (Figure 41). Other areas of potential concern are located in the south central portion of the parish, particularly the Lower West Bank and Bayou Segnette Environmental Management Units.

The habitat of commonly-hunted fauna is clustered in four locations, encompassing approximately 8,087 acres of land (Figure 42). Three of these clusters are in the northern portion of the west bank in the Avondale and West Bank management units; the fourth is in the Lower West Bank and Bayou Segnette management units. In total, 221 census blocks containing 12,475 persons are within one half mile of these potentially impacted habitat areas. These same areas are included in the 10,275 acres of identified potential trapping habitat, with one additional cluster located on an undeveloped area along the Mississippi River in Marrero (Figure 43). In total, 341 census blocks are located within a half mile of the potentially impacted trapping areas, containing some 19,909 persons.

Finally, of the three areas where freshwater fish and river shrimp may be potentially impacted, two are areas within the Mississippi River, along Avondale and Marrero (Figure 44). The third area is located south of Westwego at Six-Mile Lake, along the boundary of the Avondale and West Bank units.

Avondale

The potentially impacted wildlife habitat in Jefferson Parish are clustered in a few locations in the parish. Two of these clusters are within the Avondale Environmental Management Unit, bounded on the north by the Mississippi River, the south by the Lake Cataouatche Levee, the east by the corporate limits of Westwego, and the west by St. Charles Parish. Four major vegetative associations exist within this management unit. Modified forested wetlands are the principal vegetation type in the unit, along with the natural levee forests found along the Mississippi River. Cropland is found between the River Road and U.S. Highway 90 is pastureland and, to a lesser extent, tilled fields. The modified wetlands in the southern portion of the management area provide habitat for a variety of aquatic and terrestrial species, which support sporting and trapping activities. Avondale Oil and Gas Fields, the Waggaman Gas Field and the West Avondale Oil Field have been in production for many years. According to the Louisiana Department of Natural Resources, since this unit is entirely leveed, oil and gas development occurring outside of the levees has not exacerbated any saltwater intrusion or erosion problems in the unit (LDNR 2002).

West Bank

Located to the east of the Avondale unit is the West Bank Environmental Management Unit. This unit includes the land between the Westwego corporate limits and the Jefferson-Orleans Parish border. It is bounded on the north by the Mississippi River and on the south by the Estelle pumping canal and Bayou Segnette. The northern two-thirds of the unit includes two heavily developed, communities of Gretna and Westwego, as well as Marrero, Harvey, and Estelle.

With development, wildlife harvesting has declined in the area. However, in areas around Bayou Fatma, the Estelle pump station, and the V-shaped levee, there are thick stands of naturally occurring vegetation, which supports a large variety of wildlife. A number of gas pipelines traverse the area, which also contains three oil and gas fields: the Crown Point Oil Field, the Marrero Gas Field, and the Walkertown Gas Field.

Lower West Bank

Further to the south is the Lower West Bank Environmental Management Unit. This area includes the communities of Crown Point, Lafitte, and Barataria. Although oil field development in this unit is limited to just the Baratria Oil and Gas Filed, there are a number of oil and gas storage facilities, oil well access canals, and pipelines sited throughout the area.

Few animal species are harvested in the Lower West Bank Management Unit itself, which consists of a narrow corridor around the major transportation route. However, the management unit directly to the west, Bayou Segnette, contains natural levee forest, as well as forested wetlands and freshwater marsh fund within the Jean Lafitte National Historic Park. This habitat supports a variety of commercially and recreationally harvested aquatic and terrestrial species. A number of crude oil and natural gas pipelines traverse this area, which also contains the Bayou Segnette and Crown Point Oil Fields, and the Barataria Salt Dome.

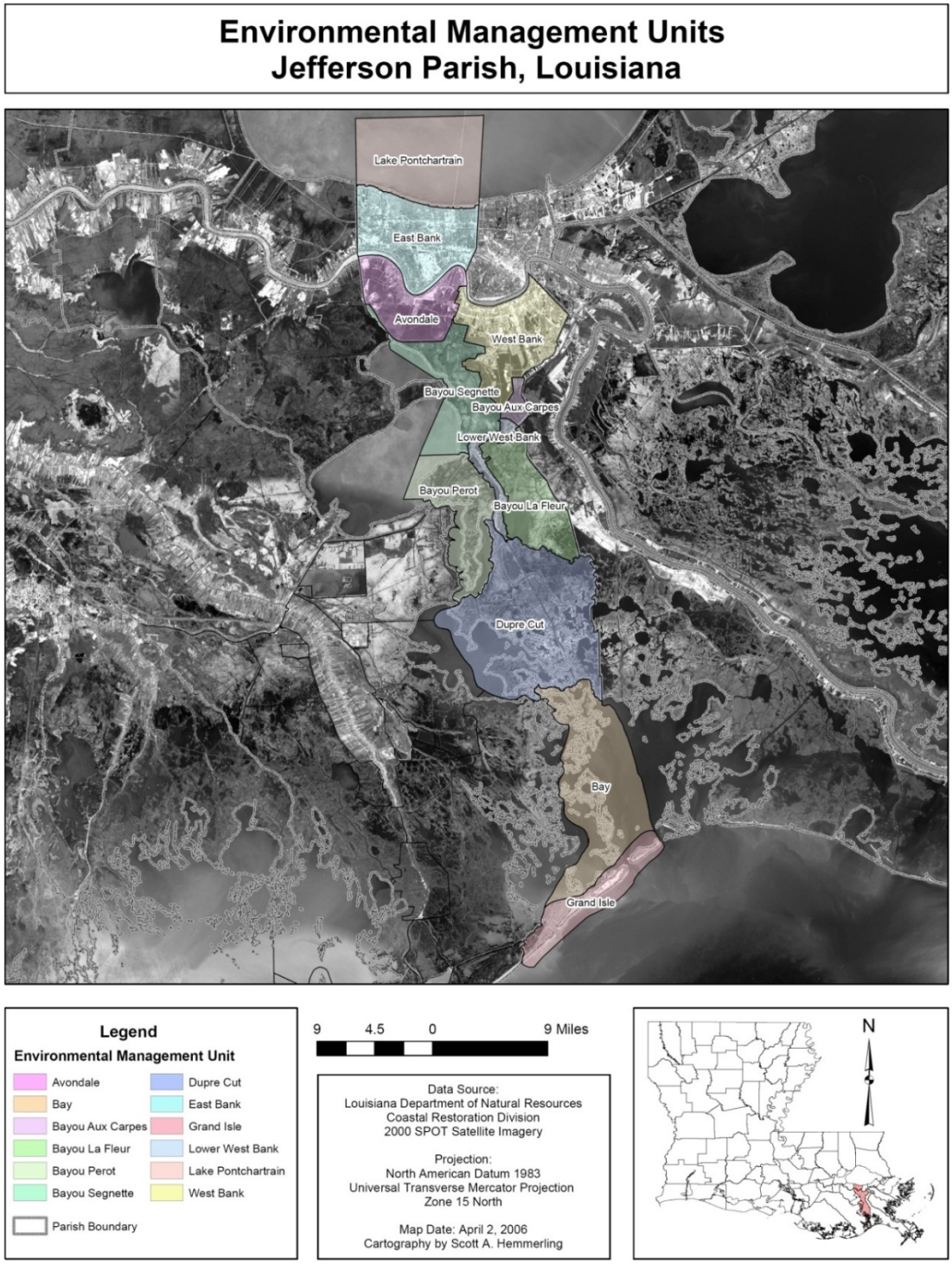


Figure 40. Environmental management units in Jefferson Parish, Louisiana.

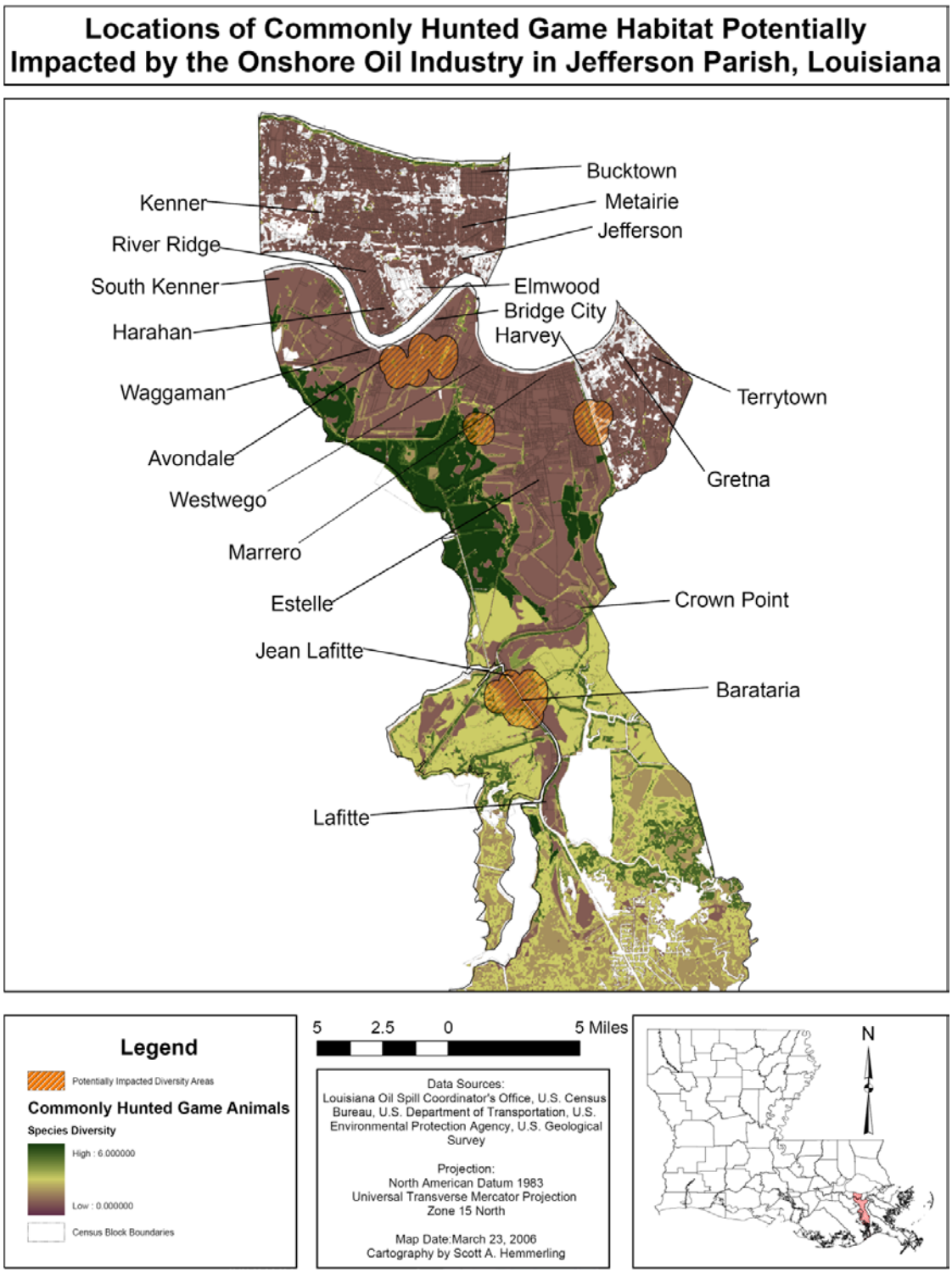


Figure 41. Locations of potentially impacted hunting zones in Jefferson Parish, Louisiana.

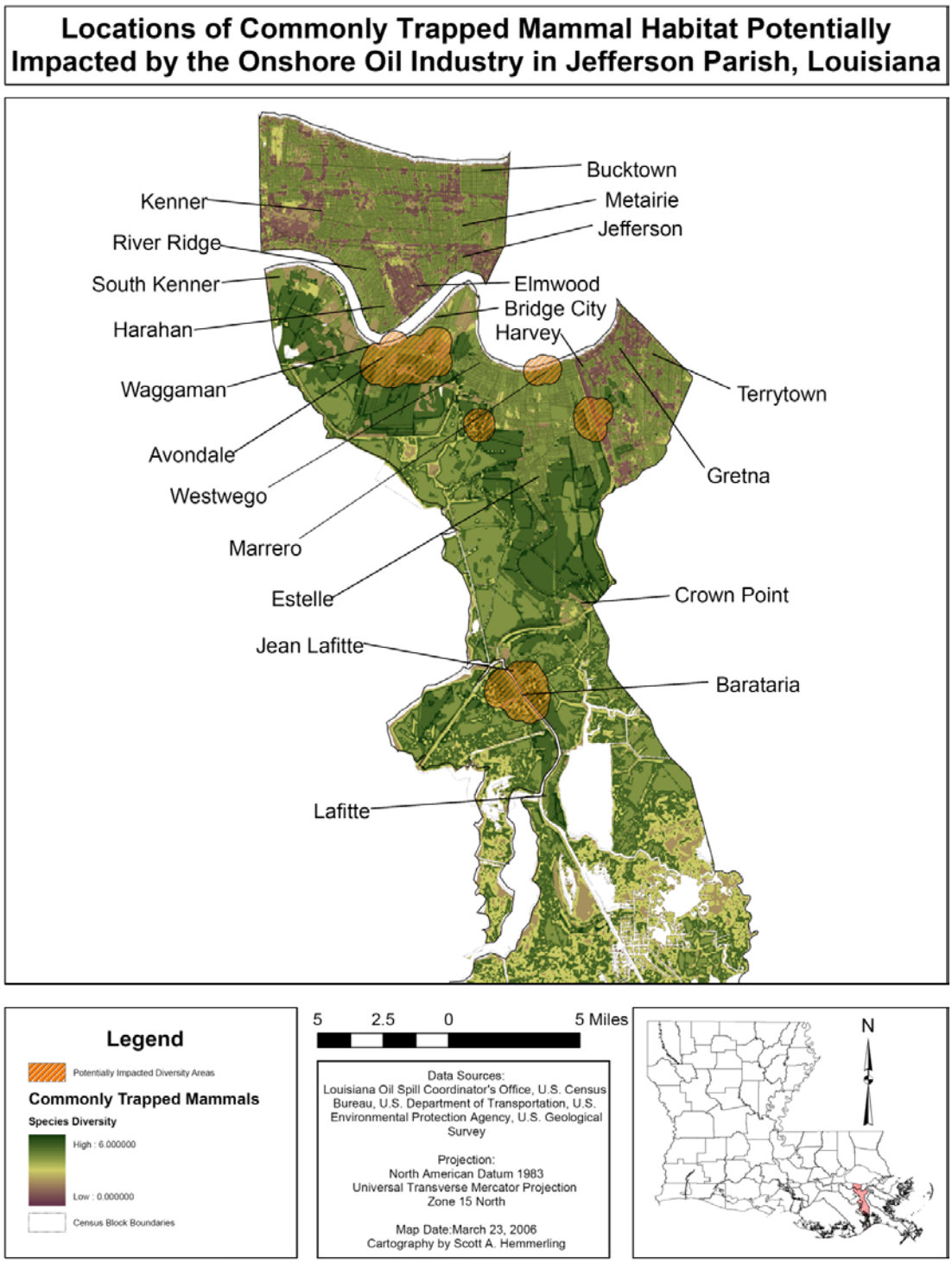


Figure 42. Locations of potentially impacted trapping zones in Jefferson Parish, Louisiana.

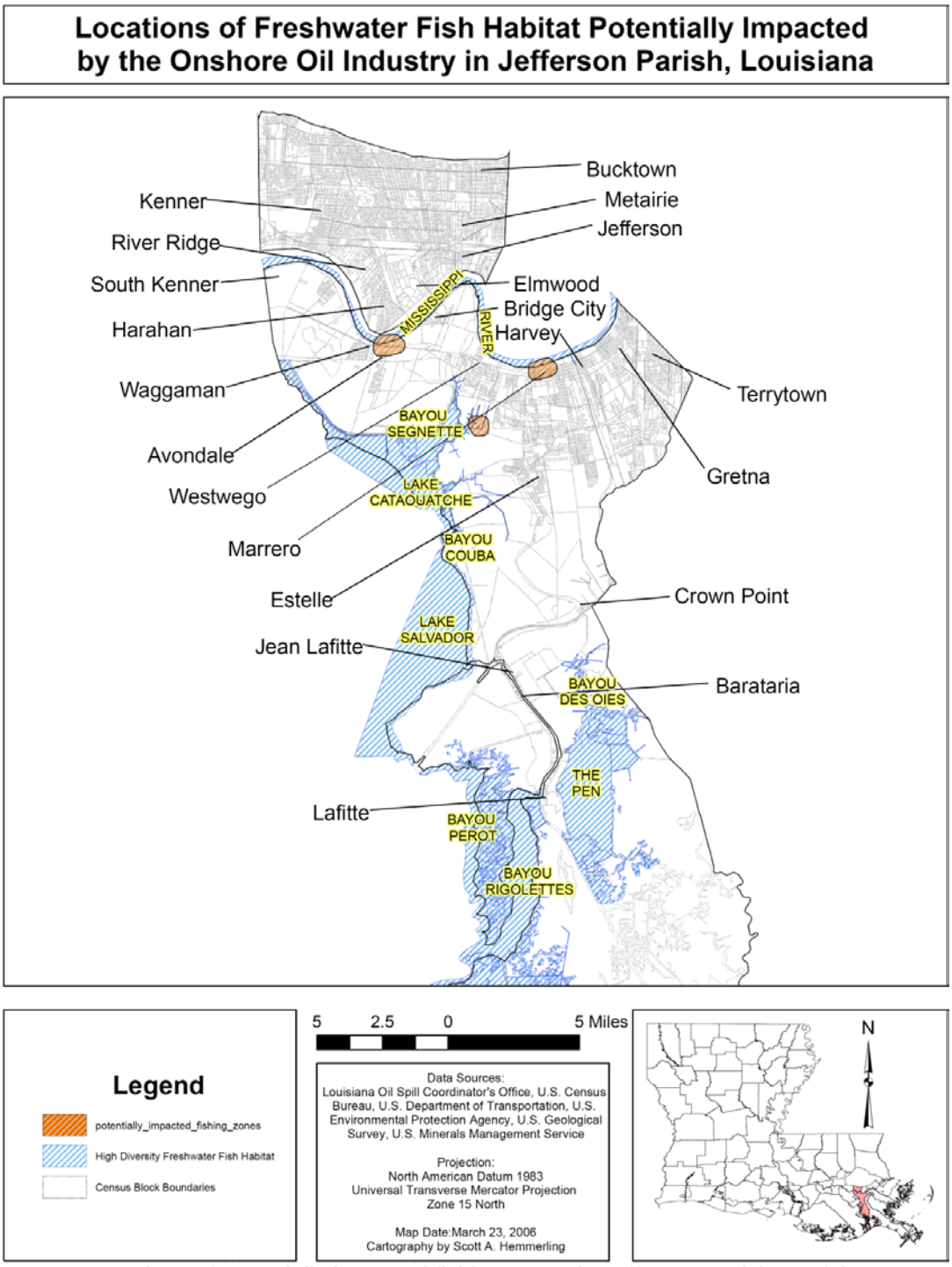


Figure 43. Locations of potentially impacted fishing zones in Jefferson Parish, Louisiana.

Analysis of Human-Wildlife Proximity

We again calculated odds ratios for the proportion of minority population in the blocks within a half-mile of potentially impacted wildlife habitat (Table 25). Our analysis indicates that there is an unequal social distribution of potentially impacted wildlife and fishery habitat in Jefferson Parish. As in Lafourche Parish, the most equitable distribution is seen around the potentially impacted freshwater fisheries of the parish. Minority residents are no more likely to live in proximity to potentially impacted fisheries than anywhere else in the parish. This is likely due to the fact that the primary areas of freshwater fish habitat are found in the Mississippi River, and much of the shoreline of the river on the west bank of Jefferson parish is commercial and industrial property.

The African-American population is more likely to be found living in proximity to both potentially impacted hunting and potentially impacted trapping land. This is largely due to the more dense population clusters found in the more industrialized northern portion of west bank Jefferson Parish. These areas include portions of Avondale and Waggaman, which lie along the urban-rural fringe, and have many clusters of high African-American census blocks, as well as more densely populated areas along the southern portion of the Harvey canal, toward Estelle. The Native American population is only about 50 percent as likely to reside in proximity to potentially impacted wildlife habitat as anywhere else in Jefferson Parish; the Asian and Hispanic populations are in many cases less than 10 percent as likely to reside in proximity. These numbers reflect the concentration of the Asian and Hispanic populations within the highly urbanized centers of Jefferson Parish.

Table 25. Odds Ratio Values of Potentially Impacted Wildlife Habitat in Jefferson Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

Habitat Type	Racial Variables									
	White		African American		Native American		Asian		Hispanic	
	Value	Significance	Value	Significance	Value	Significance	Value	Significance	Value	Significance
Hunting[1]	.975	.000*	1.528	.000*	.507	.000*	.139	.000*	.072	.000*
Trapping[2]	.986	.000*	1.251	.000*	.515	.000*	.148	.000*	.087	.000*
Fishing[3]	1.010	.000*	.578	.000*	.516	.001*	.054	.000*	.033	.537

* Statistically significant at 99% confidence level

[1]Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by onshore oil-related development (n = 221)

[2]Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by onshore oil-related development (n = 341)

[3]Sample consists all census blocks within 0.5 miles of freshwater fish habitat potentially impacted by onshore oil-related development (n = 78)

St. Bernard Parish

St. Bernard Parish is entirely within the Louisiana Coastal Zone. It covers approximately 1,327,300 acres, 80 percent of which is water (Figure 45). Of the remainder, 18 percent is wetland and only 2 percent is developed (Wicker et al. 1982). In all, there are 22 management units within St. Bernard Parish. We have identified four areas within St. Bernard Parish that contain eight clusters of potentially impacted wildlife habitat. Four of these clusters are potential habitat for commonly hunted fauna and cover approximately 6,410 acres of land (Figure 46). The other four are potential habitat for commonly trapped mammals and cover slightly less land, 6,341 acres (Figure 47). The clusters of commonly hunted and trapped faunal habitat are in the same four areas, one located entirely on the urbanized levee in Chalmette, one in the Central Wetlands Environmental Management Unit across the Forty Arpent Canal from Chalmette and Meraux, one around Bayou Terre Aux Boeufs in Toca and Kenilworth, which extends beyond the semi-urban management unit into the Central Wetlands, and the final location around the La Loutre Wetlands Environmental Management Unit just below the Mississippi River Gulf Outlet (MRGO) spoil bank near Yscloskey. These same locations, with the exception of the Toca and Kenilworth area, also contain the parish's most at-risk freshwater fisheries (Figure 48).

Chalmette

The potentially impacted wildlife area in Chalmette is located on the Chalmette National Battlefield, part of the Jean Lafitte National Park, located six miles from the city of New Orleans. Although selected wildlife species may inhabit the National Park and potentially use some of the land as a breeding area, this area is not a potential hunting or trapping area.

Central Wetlands

The Central Wetlands, which extends from the Forty Arpent Canal at the edge of the urban and semi-urban units of St. Bernard Parish up to the spoil banks of the MRGO, is a vast region of greatly modified swamp area. Construction of the MRGO greatly altered the hydrology of the unit in 1963. The salinity of the swamps has increased dramatically, changing from fresh to slightly brackish.

Changes in salinity led to decreases in sawgrass marshes and cypress swamps important for the production of species such as muskrat, mink, raccoon, white-tailed deer, and waterfowl, which brought about notable decreases in the population of these commonly hunted and trapped fauna (Wicker et al. 1982). Despite the increase in water salinities, a number of waterfowl still winter in this unit. Many of the Central Wetlands' shallow, brackish ponds, formed by the breakup of larger wetlands, are important wintering grounds for large numbers of waterfowl species (Wicker et al. 1982).

La Loutre Wetland

The La Loutre Wetlands encompass the area between the Bayou La Loutre natural levees and the MRGO spoil banks. The construction of the MRGO cut direct water exchange between the wetland area and Lake Borgne, therefore the area has become increasingly brackish. Despite the deterioration of the unit, the proximity of the wetlands to the semi-urbanized levee makes this an important wildlife resource area in St. Bernard Parish. Nutria, muskrat, and raccoon remain important faunal species in the unit.

Analysis of Human-Wildlife Proximity

The contingency analysis has revealed that the social distribution of potentially impacted wildlife and fishery habitat in Lafourche Parish does not differentially impact minority residents (Table 26). In fact, only the white population in St. Bernard Parish is statistically more likely to found living in proximity to potentially impacted faunal habitat.

The African-American population is the least likely minority group to be found living in proximity to all potentially impacted wildlife habitat. Given the results of the hazards analysis finding that the African-American population resides in populated centers away from both the refining districts and the gas processing plants, these results are hardly surprising. Violet, where most of the parish's African-American population resides, is located along the urban levee of the parish, where wildlife habitat diversity is the lowest. Similarly, because most of the refining-related industries in St. Bernard Parish are concentrated both to the east and west of Violet, the community has far fewer industries and a less significant risk surface. As we found in Jefferson Parish, the Native American population is only about 50 percent as likely to reside in proximity to potentially impacted wildlife habitat; the Asian and Hispanic populations are less than 10 percent as likely.

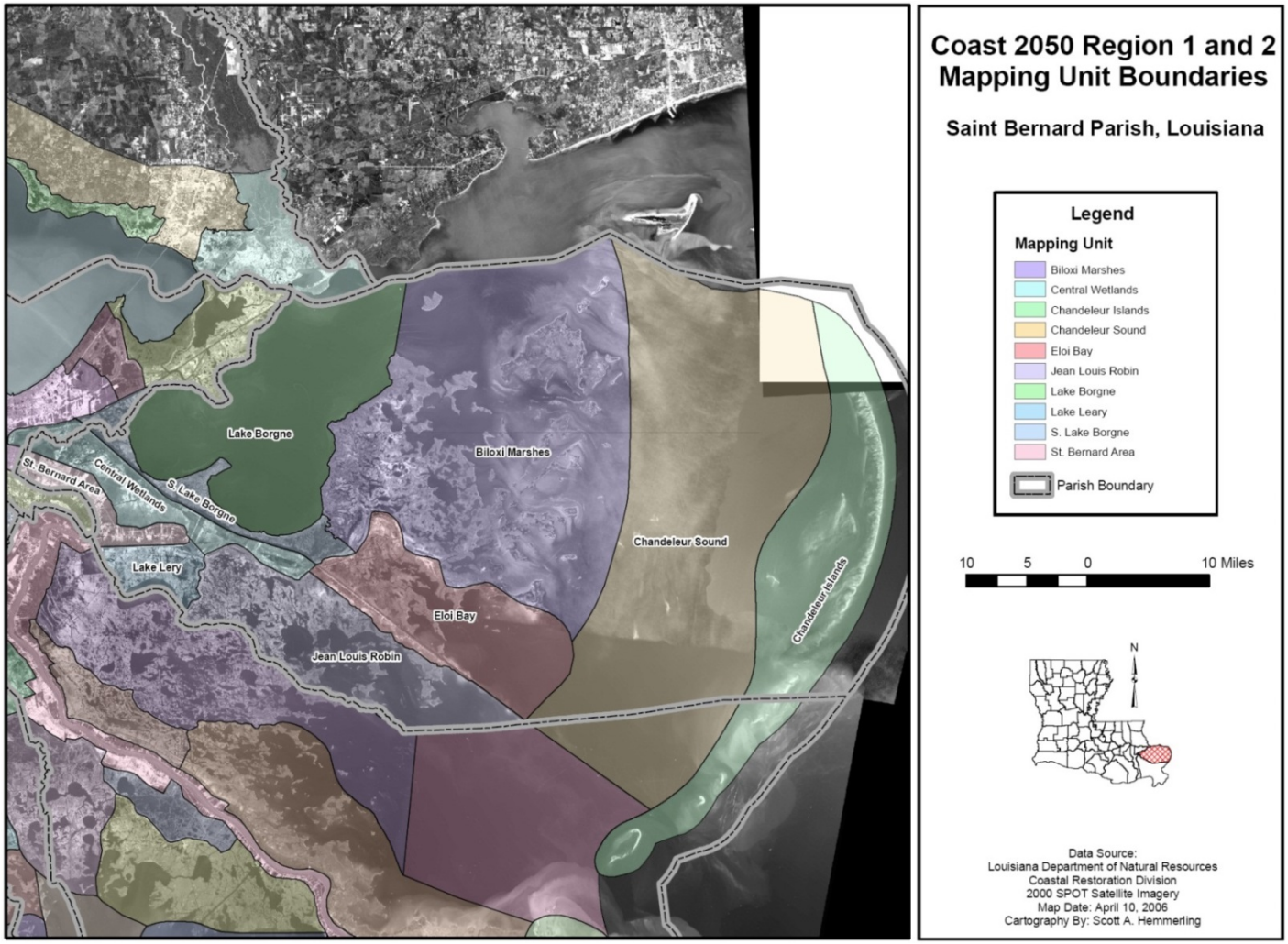


Figure 44. Coast 2050 Region 1 and 2 mapping unit boundaries in St. Bernard Parish, Louisiana.

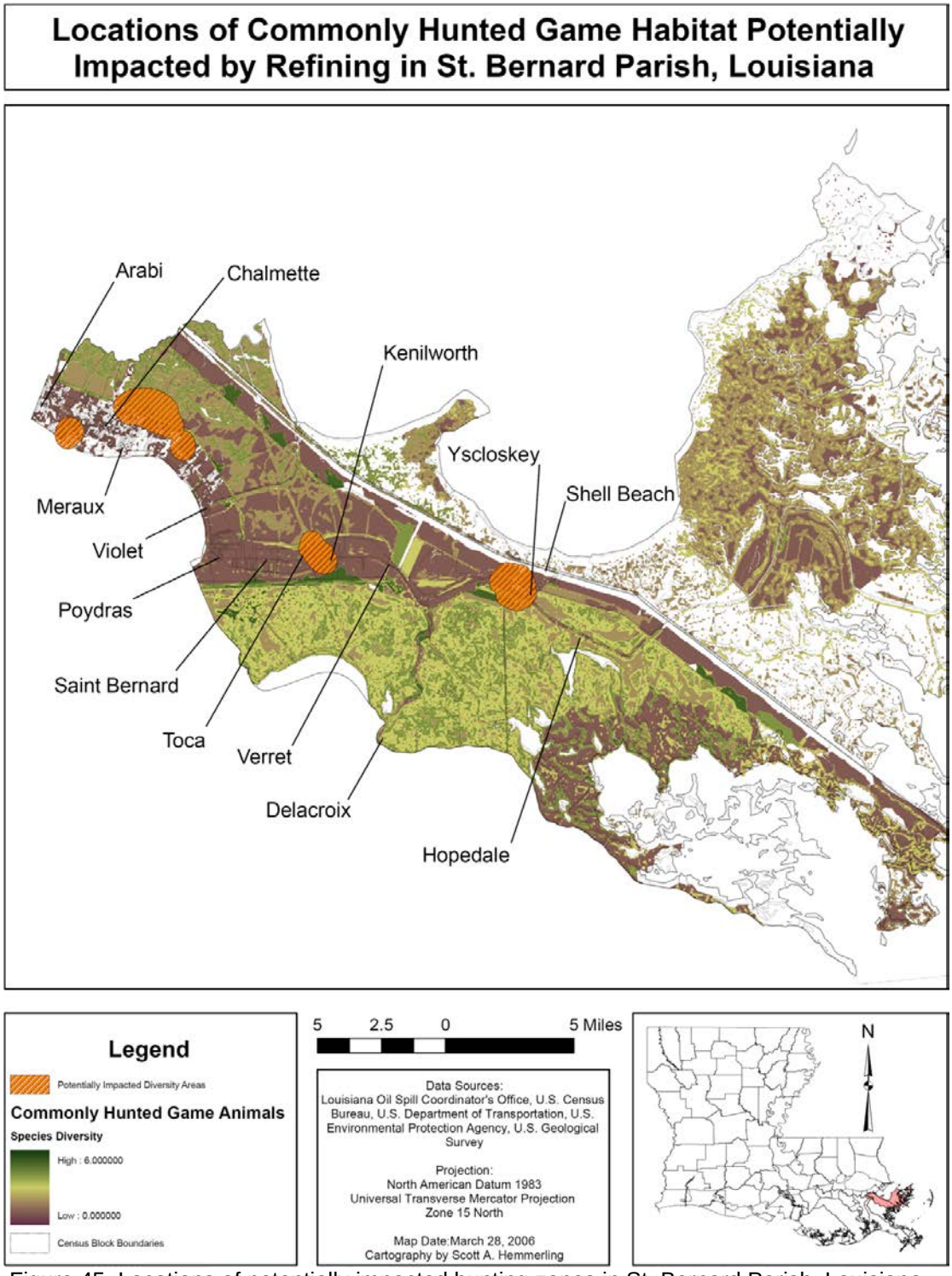


Figure 45. Locations of potentially impacted hunting zones in St. Bernard Parish, Louisiana.

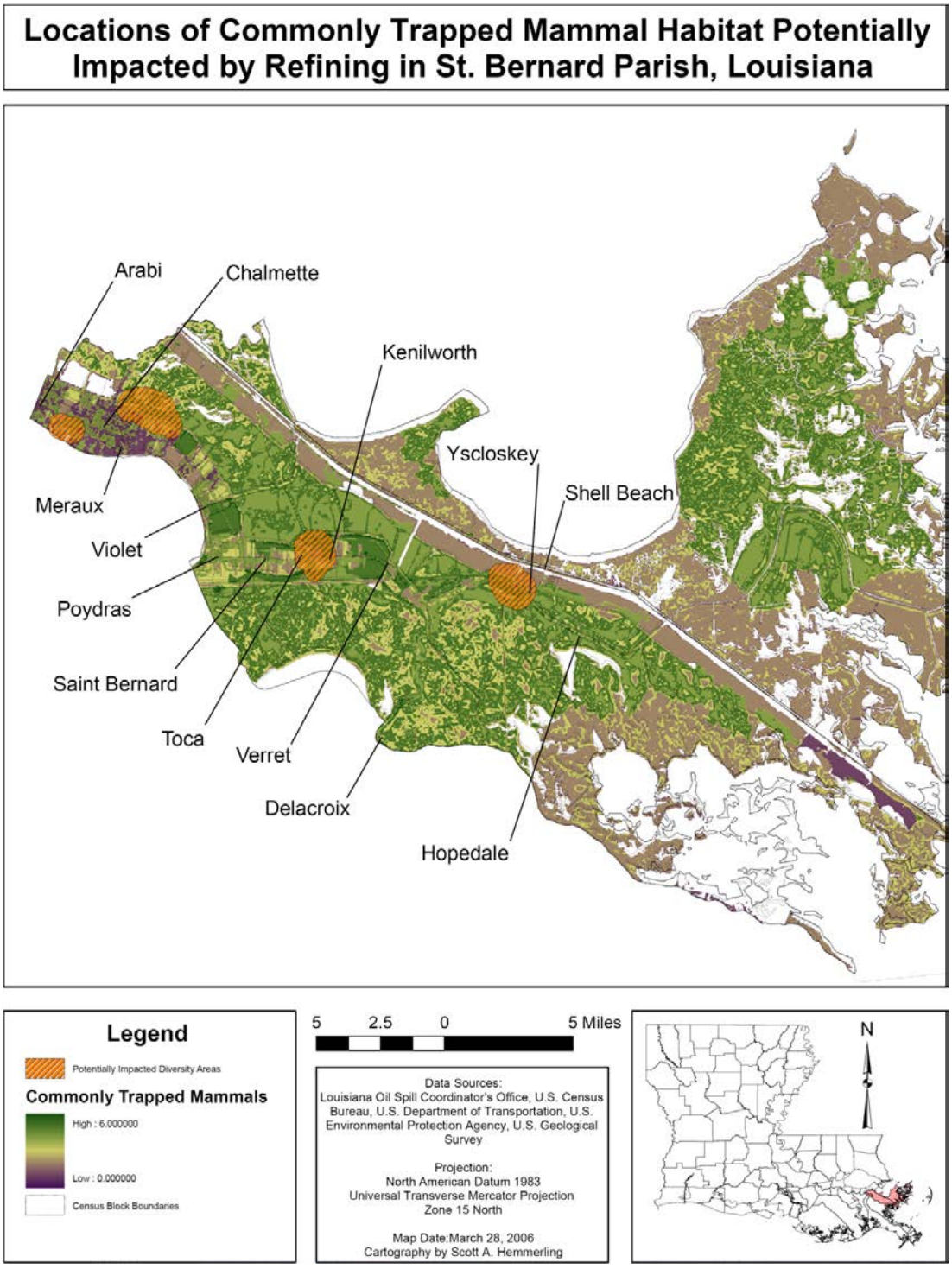


Figure 46. Locations of potentially impacted trapping zones in St. Bernard Parish, Louisiana.

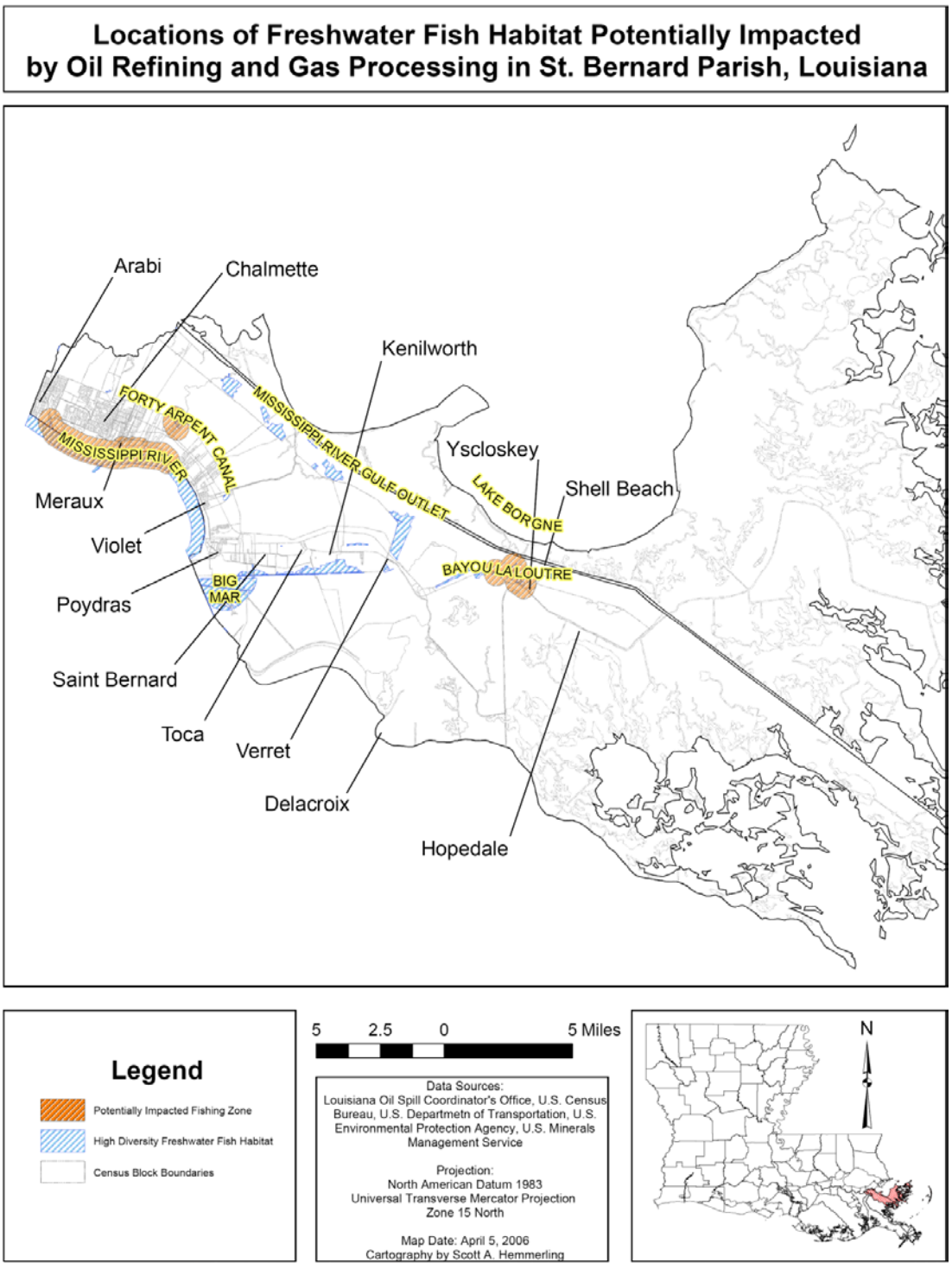


Figure 47. Locations of potentially impacted fishing zones in St. Bernard Parish, Louisiana.

Table 26. Odds Ratio Values of Potentially Impacted Wildlife Habitat in St. Bernard Parish, Louisiana with Census Block Race Variables: White, African American, Native American, Asian, and Hispanic

Habitat Type	Racial Variables									
	White		African American		Native American		Asian		Hispanic	
	Value	Significance	Value	Significance	Value	Significance	Value	Significance	Value	Significance
Hunting[1]	1.160	.000*	.001	.000*	.431	.000*	.049	.000*	.101	.000*
Trapping[2]	1.144	.000*	.012	.000*	.459	.000*	.051	.000*	.097	.000*

* Statistically significant at 99% confidence level

[1]Sample consists all census blocks within 0.5 miles of commonly hunted wildlife habitat potentially impacted by oil refining-related development (n = 239)

[2]Sample consists all census blocks within 0.5 miles of commonly trapped mammal habitat potentially impacted by oil refining-related development (n = 230)

3.5 CONCLUSIONS

Environmental justice guidelines suggest that federal agencies consider the impacts that proposed actions may have on the wildlife and fisheries on which low-income and minority populations depend. In fact, CEQ takes this mandate one step further, stating that anywhere agency actions may impact wildlife and fisheries, there is the potential for environmental justice impacts. This raises several practical issues that are relevant to the wider debates around environmental justice.

First, the regulations do not clearly define a methodology for identifying impacted areas. Building on a methodology used in previous research (Hemmerling and Colten 2004), we have developed a model to identify areas of high wildlife diversity, focusing on those animals commonly hunted and trapped. When this model is examined in conjunction with a similarly developed industrial hazards model, we are able to identify "hot-spots" where wildlife populations are most at risk from industrial development.

Second, environmental justice guidelines suggest that potential impacts to communities should be considered. Yet it is not entirely clear how affected communities are to be identified. In most subsistence literature, there is a clear focus on Native Americans and reservation lands. In these cases, the community is defined by the boundaries of the reservation. Yet many Native Americans do not reside on reservations. Similarly, other racial and ethnic groups often do not reside in homogenous communities.

In the case of Lafourche Parish, for example, the Houma are the dominant Native American group. The United Houma Nation is not federally recognized, nor do they have a reservation. Instead, the Houma are found living in small pockets throughout the parish. Similarly, there are clusters of Asians, Hispanics, and African-Americans scattered across the parish. With the model developed in this research, we are able to identify those pockets of minority populations that live in close proximity to potentially impacted wildlife and fishery areas. We use this methodology to identify areas with a heightened potential for environmental justice impacts, as defined by CEQ.

It is important to note that minority groups are often disproportionately affected in ways not necessarily acknowledged or even understood. This research takes a more inclusive environmental justice approach by incorporating the health and safety of the ecosystem upon which a wide variety of people depend for subsistence, traditional, cultural, and religious purposes. This research, by identifying critical areas where minority groups may be exposed to multiple risks through consumption of potentially contaminated aquatic and terrestrial wildlife, provides but one example of how environmental justice research is able to move beyond the traditional residential exposure model towards a more place-specific model that includes the social and cultural context.

CHAPTER 4. PROCESS-BASED ENVIRONMENTAL JUSTICE AND THE SPATIAL DEVELOPMENT OF THE OIL INDUSTRY IN SOUTHEAST LOUISIANA

4.1 INTRODUCTION

In previous chapters, we found that certain socioeconomically disadvantaged groups face disproportionate risks due to the presence of the oil industry and its associated infrastructure in southeast Louisiana. As we have shown, outcome-based analysis such as this may result in identifying environmental inequity, but the inequity revealed may not necessarily result from discriminatory intent. Most analyses in the literature are similarly cross-sectional, linking the location of polluting sites to population demographics for one period of time. They are thus outcome-based and can evaluate only environmental equity. We consider a process-based analysis to be the natural extension of finding inequity in an outcome-based analysis (Talih and Fricker 2002).

In this chapter, we develop a systematic methodology for the analysis of process-based procedures that may result in the formation of environmental injustice or inequity. Previous research into the socio-historical foundations of environmental justice has explored this in a number of ways. The most common method involves analyzing the demographics of the communities at the time in which facilities were sited and tracing the socioeconomic shifts that occurred over time (see, for example, Mitchell et al. 1999). This method has been critiqued for being "markedly reductionistic" in that it simplifies the question of causal dynamics to a chicken-or-egg dichotomy (Szasz and Meuser 2000). Like all forms of stratification, environmental inequalities are relationships that are constituted through a process of continuous change that involves negotiation and often conflict among multiple stakeholders (Pellow 2000). A view of environmental inequity formation that fails to take into account the complex interplay of social forces and the dynamics of neighborhood change would give researchers and analysts an incomplete understanding of the dynamics and causation of environmental equity.

Just as a finding of present-day environmental inequity is not evidence of discrimination, an historical lack of association between minority population and facility siting does not demonstrate a lack of discrimination (Talih and Fricker 2002). To understand the causative factors of environmental inequity, it is necessary to move beyond process-based analyses that focus on the socioeconomic characteristics of potentially impacted populations and toward a more dynamic model that incorporates various causal factors and mechanisms that may have contributed to the present-day landscapes of inequality. This includes processes such as industrialization, urbanization, migration and demographic shifts, housing developments, as well as institutional forces (Frazier et al. 2003). In doing so, we do not intend to underemphasize the role that race and class play in the siting process. To the contrary, race and class are vital components of neighborhood dynamics.

In the first half of the chapter, we examine the historical and spatial evolution of the oil industry in southeast Louisiana. We identify locations of significant oil-related developments and determine the proximity of minority populations to these developments. In the second half of the chapter, we use a number of spatial analytical tools to examine the forces shaping residential patterns and industrial location in southeast Louisiana. Finally, we discuss theories of environmental inequity formation and analyze each of the three case study parishes.

4.2 Historical and Spatial Evolution of the Oil Industry in Southeast Louisiana

4.2.1 Early Oil and Gas Developments in Louisiana

The 1935 discovery of oil at the Lafitte Field in southern Jefferson Parish marked one of the earliest significant discoveries in southeast Louisiana. The groundwork for this discovery was laid in the early decades of the twentieth century by a series of innovations and discoveries that allowed drillers to move into the marshlands of Louisiana's coastal zone. Although the first major discovery of oil in Louisiana was the Jennings Field in southwest Louisiana, struck in 1901, the majority of early developments were in north Louisiana, where the fields were more easily accessible (Lindstedt et al. 1991). Development in one of these fields, Caddo Lake, marked the first successful technological adaptation to the marine environment, when overwater drilling occurred in 1910. In order to drill and produce without direct connection to the land, platforms were constructed on pilings driven into the lake bottom and drilling equipment was barged to the site (Gramling 1996). Adaptations of this technology would prove vital when oil and gas exploration and drilling moved into the coastal fringe of Louisiana.

Wetland exploration continued sporadically in Louisiana until, in 1926, Sweetlake field, in Cameron Parish, became the first commercially successful oil field drilled in Louisiana's coastal zone, spurring further oil and gas exploration in this region. During the 1930s, two innovations made wetland drilling significantly more time and cost effective. Trappers in the Mermentau Basin used a large-wheeled motorized vehicle they called a "slat-wheel buggy" to traverse the chenier marsh habitats of southwest Louisiana (Austin et al. 2002). In 1936, engineers with the Gulf Oil Company built on this concept by replacing the wooden slats with large (ten feet high and three feet wide) rubber tires, allowing the vehicle to move through wetter areas. Engineers tested this marsh buggy, as it came to be known, along Bayou Lafourche and it proved successful in traversing marshy grasslands and deeper water, as well as areas of dense growth and hummocks. The use of the marsh buggy opened up the wetlands to geophysical crews, followed by drilling and pipelining operations.

A second technological breakthrough that ultimately opened up the marshland of southeast Louisiana to drilling operations was the submersible drilling barge. In the marshland and open waters of coastal Louisiana, the underlying sediment consisted of thick layers of silt and decayed vegetation. The pilings that supported the drilling platforms had no solid foundation, and as a result, up to 250 pilings were needed for a single exploratory platform (Gramling 1996). As these techniques became increasingly cost inefficient, the Texas Company developed the first

commercial submersible drilling barge. The barge could be towed to the drilling site and sunk, providing a stable base for drilling. At the completion of drilling the barge could be raised and moved to a new location. The first successful use of such a drilling barge was in the Lake Pelto No. 10 field in Plaquemines Parish in 1933 (Gramling 1996). Later versions of this drilling barge were larger, allowing extraction operations to move offshore into deeper water, and in 1938, the first unprotected drilling structure offshore was completed in the Gulf of Mexico, one and a half miles offshore in the Creole field. The development and acceptance of the submersible drilling barge had important impacts far beyond the oil fields, as marine supply and construction infrastructure began to develop throughout coastal Louisiana in the 1930s and 1940s (Gramling 1996).

4.2.2 Early Developments in Southeast Louisiana

Pre-1930

Although the first productive onshore oil wells in Southeast Louisiana were not drilled until the 1930s, the early years of the century saw a number of advancements that developed the area into a prime oil-producing region. St. Bernard Parish, for example, had refineries operating within its borders before the onshore oil boom that began in the 1930s. The Sinclair Refining Company had an early refinery in Meraux (then known as Merauxville) refined crude oil shipped via tanker from Venezuela. At the time, Meraux was largely woods and prairies, though populated enough that residents could petition the local police jury in Chalmette to declare the refinery a public nuisance in 1925, due to the release of "nauseous gasses and fumes…which are unhealthful and make living conditions very uncomfortable and unbearable" (Louisiana Historical Records Survey 1941).

The Chalmette oil refinery also came on line in the 1920s. The property was first leased on January 1, 1920 to the Pelican Oil Refining Company for a period of ten years. Before the land was even developed, the lease was transferred to the Chalmette Oil and Refining Company. By the end of the 1920s, both refineries were in operation in St. Bernard Parish, with the refined oil and gasoline from Sinclair transported via pipeline to the Chalmette refinery where the Southern Railway had a terminal (Louisiana Historical Records Survey 1941). Although the Sinclair Refinery would ultimately shut down, the Chalmette refinery has continued through various ownership changes to operate until the present day.

Although no census subdivision data are available for the 1920 census, overall there is a decline in the African-American population for St. Bernard Parish between 1920 and 1930 from 32.1 percent to 20.5 percent. Though many of the jury wards in the parish had slightly above average percentages of African-Americans, only the more rural Sixth Ward, containing the communities of St. Bernard, Toca, and Kenilworth, had significantly higher numbers (Figure 49). The white population, on the other hand were significantly more likely to reside in the Arabi and the New Orleans First Ward. It bordered the Ninth Ward, which, at that time was an ethnically diverse working-class neighborhood (Wells 2004). In addition, there were slightly greater proportions of whites in Chalmette and the Third Ward by 1930; in Meraux and the Fourth Ward, there was a slightly higher African-American population. Though this pattern

persisted throughout the century, later more refined census procedures would reveal that the Fourth Ward communities of Meraux tends to be largely white; the downriver areas of the Fourth Ward, such as Myrtle Grove, tend to be largely African American.

Jefferson Parish was also experiencing some initial oil-related growth before the local discovery of the large oil fields during the 1930s. During the 1920s, the Jefferson Parish Oil Commission granted a number of permits and petitions. Many of these were for petroleum bulk storage tanks and facilities. These facilities were built along both banks of the Mississippi River, where the product could be barged or shipped to the terminals. In 1925, for example, both the Gulf Refining Company and Mexican Petroleum Oil Company requested permits to erect oil storage tanks in Jefferson Parish. The Gulf Refining Company had an existing property in Gretna, on the West Bank, and was granted permission to erect and operate a bulk distributing oil station and gasoline storage tanks on their property in the Seventh Ward. In 1928, Gulf Refining Company requested an additional permit to erect an 80,000-barrel oil tank between Ninth and Tenth Streets in Gretna. This same year, the Oil Commission granted an application for the construction of a small oil refinery and crude oil storage depot, again in the Seventh Ward, "provided that it did not increase the insurance rates on the property in the vicinity, and that the owner of the refinery would use the most modern methods and machinery made, to eliminate as much as possible the odor that emanates from said plant" (Louisiana Historical Records Survey 1939). As the decade closed, there were additional permit applications. In 1929, for example, the International Lubricant Corporation applied for a permit to erect an oil storage tank on the East Bank of Jefferson Parish.

The changes of the industrial landscape throughout the 1920s coincided with a number of demographic shifts in Jefferson Parish. As noted above, the proportion of St. Bernard Parish African-American residents sharply declined in the period between 1920 and 1930, from 5.9 percent to 3.3 percent. By the 1930 census, when the U.S. Census Bureau recorded population by parish subdivisions, the African-American population is slightly more likely to be found residing in the wards along the Mississippi River where many of the bulk storage facilities were constructed (Figure 50). However, the Fifth Ward, with the highest concentrations of African-Americans in Jefferson Parish, was not developed in this early stage of storage facility construction.

With the initial development of the offshore industry more than a decade away, Lafourche Parish, in the years building up to the discovery of large oil fields in southeast Louisiana, relied principally on the processing of food and food products, particularly sugar, molasses, and seafood (Louisiana State University Division of Research 1949b). During this period, the parish was home to a large fishing fleet. However, this did not lead to the development of the shipbuilding industry which came to play an important part in the economy of Lafourche Parish after the offshore oil industry emerged.

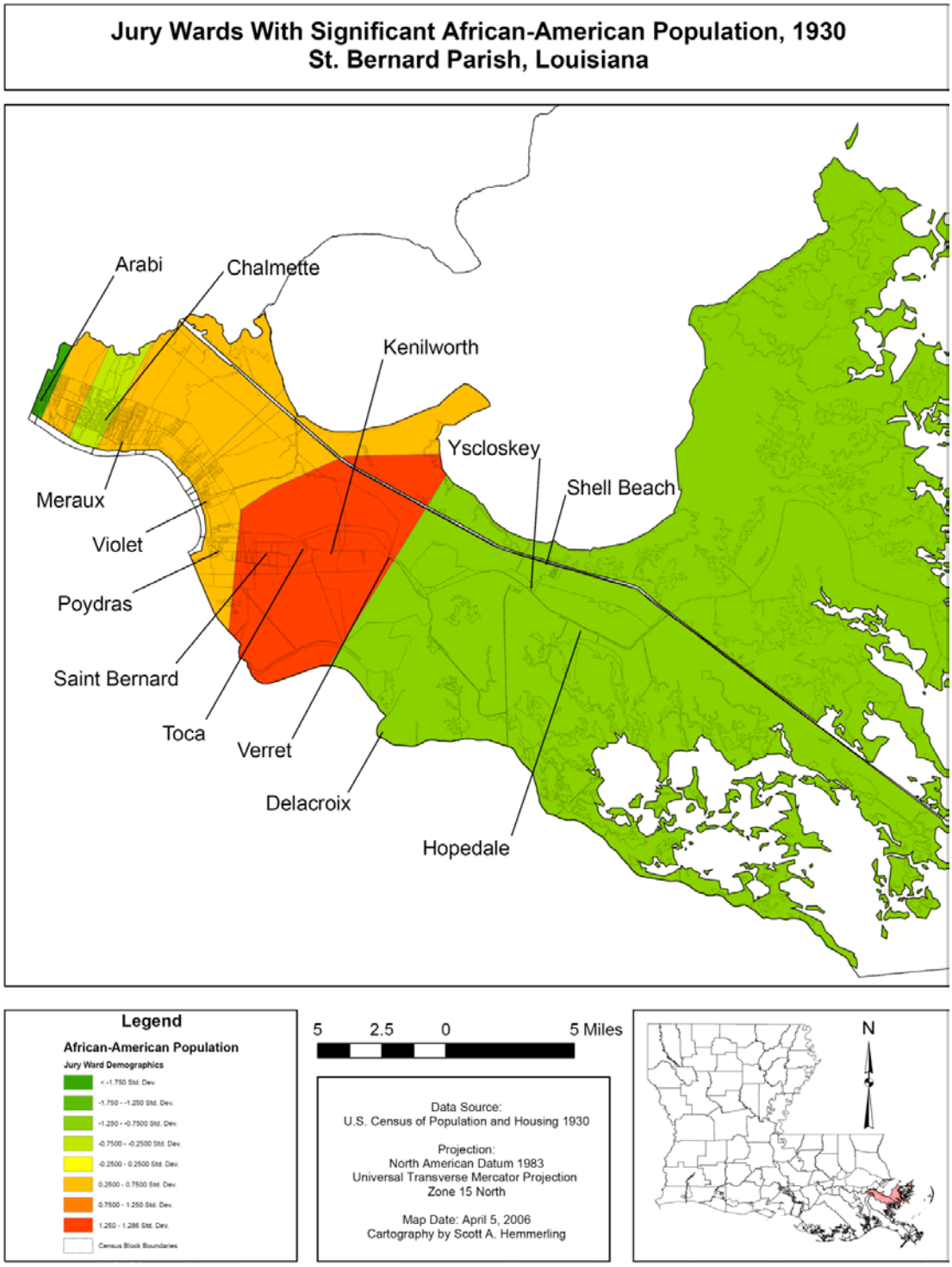


Figure 48. Jury wards with significant African-American population, 1930, St. Bernard Parish, Louisiana.

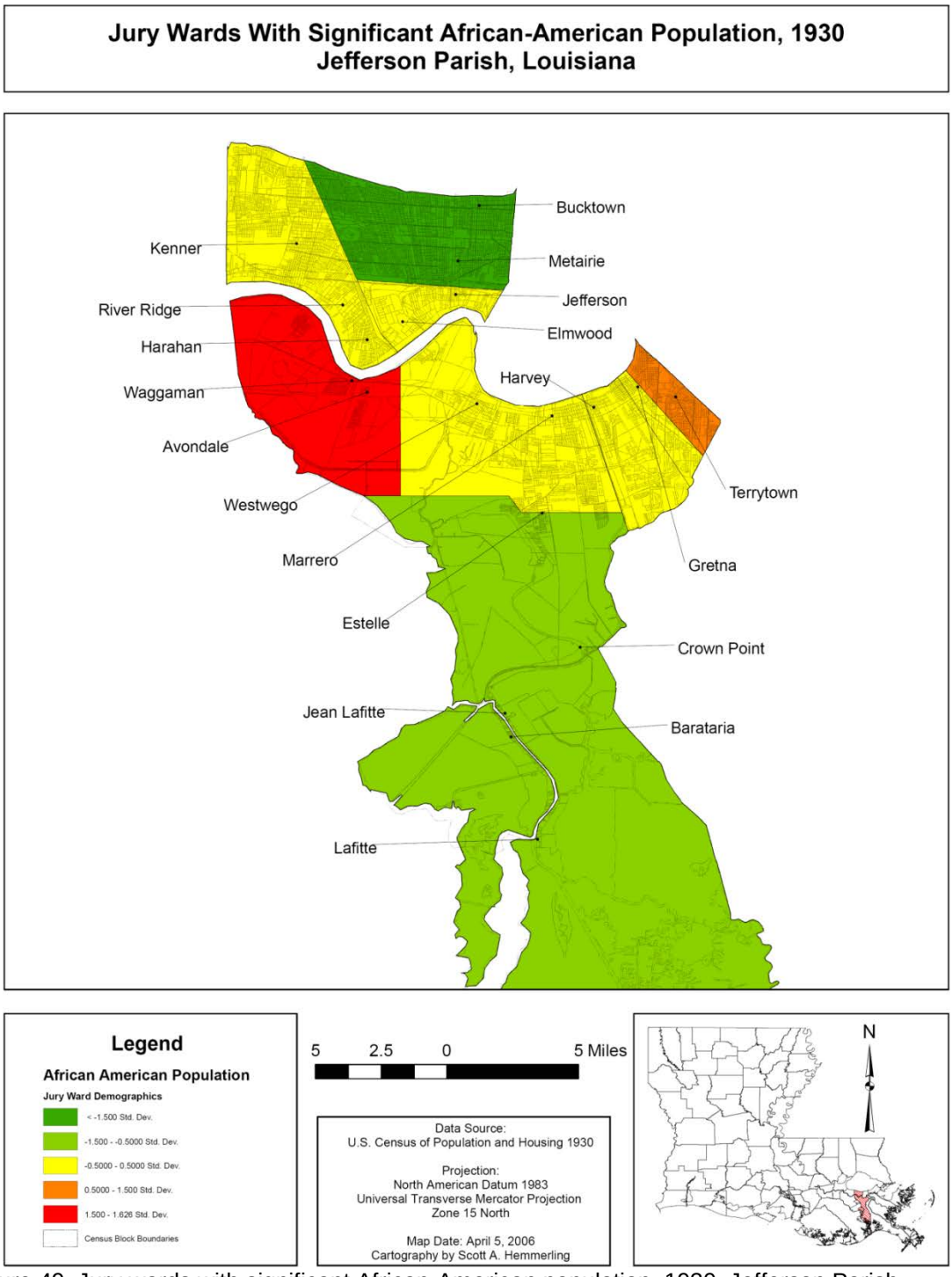


Figure 49. Jury wards with significant African-American population, 1930, Jefferson Parish, Louisiana.

1930–1940

Although technological innovation made oil field development in the marshes of south Louisiana possible, it took government action to make it economical. In 1933, as a conservation method, the U.S. government began the prorationing program. The idea behind prorationing was to have all producers would cut their production and ration out their output, with each producer maintaining their proportion of the total output (Gramling 1996). When Secretary of the Interior Harold Ickes set southern Louisiana's proration allotment at 44,528 barrels daily, nearly double that of northern Louisiana, thousands of oil field workers poured into the region, setting off an oil boom that continued for decades (Franks and Lambert 1982).

This same year, the Texas Company, using geophysical instruments developed during World War I to detect the presence of hostile submarines, determined that land it held approximately 20 miles south of Gretna in the marshy Barataria region of Jefferson Parish contained a large salt dome, which was likely to be a geologic trap for large quantities of oil (Dabney 1934). The company brought a submersible drilling barge through newly dug canals and began to develop the site that ultimately became the Lafitte field. In 1935, the company struck oil as well as large quantities of natural gas. In order to process the natural gas, a 15,000-gallon natural gas absorption plant was constructed in the Lafitte Field, the first such plant in Southeast Louisiana. A 10-inch gas pipeline moved the processed gas from the plant to the Freeport Sulphur Company in Plaquemines Parish. At the time, this was the only commercial use of natural gas from a Southeast Louisiana field (Baton Rouge Oil Scouts Association; BROSA 1938).

The Lafitte oil and gas field, as well as the natural gas processing plant, were located near a fishing village of the same name, in the largely rural Sixth Ward of Jefferson Parish. Over 60 percent of the non-African-American minority resident in Jefferson Parish resided in this ward (Figure 51). According to the 1930 census, the majority of the non-African-American minority population in Jefferson Parish was Native American. In fact, Jefferson Parish was second only to Terrebonne Parish in the number of Native Americans residents. The Barataria region of central Jefferson Parish was traditionally home to large Houma and Chitimacha populations, many of whom still resided in the area (Jefferson Parish Police Jury 1950). The number of Native Americans found in Jefferson Parish dropped dramatically between 1930 and 1940. It is difficult to ascertain whether this drop was due to changes in the enumeration methods used by the U.S. Census Bureau or whether there was a significant outmigration by Houma residents. The latter is suggested by a concurrent drastic rise in Native American population in neighboring Lafourche Parish. This region also contained a number of small fishing and shrimping villages settled by Asian immigrants. Two such shrimping communities include Manila Village settled by the Philippine and Bassa Bassa settled by the Chinese (Louisiana State University Division of Research 1949a).

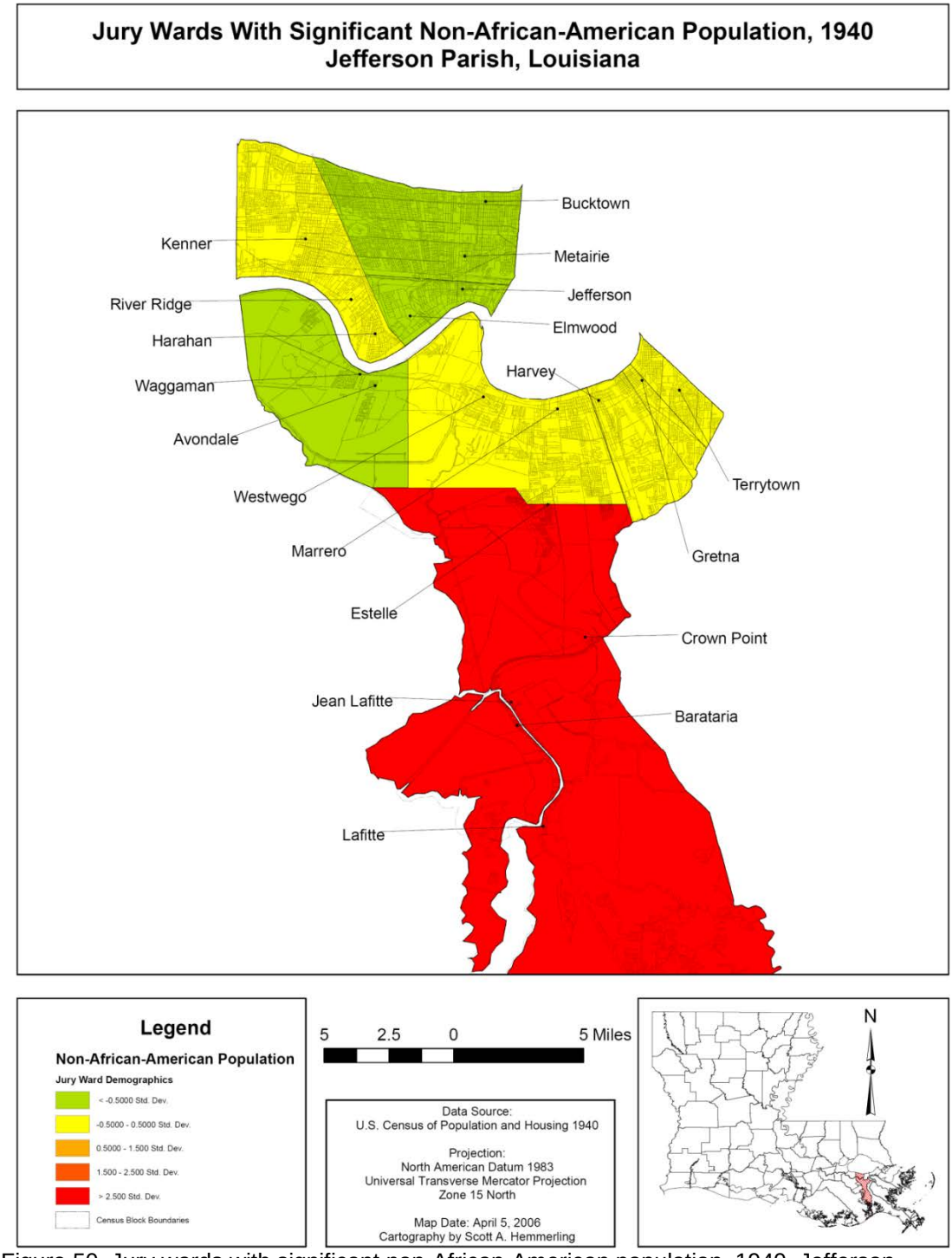


Figure 50. Jury wards with significant non-African-American population, 1940, Jefferson Parish, Louisiana.

During the late 1930s, a number of conflicts developed between residents and oil companies. First, local fishermen charged the oil companies with killing off fish and oysters with the dynamite they used in seismographic work (Conner 1977). Residents of the parish also charged that the oil companies did not use local labor or businesses in the oil fields. In 1936, residents of Jefferson Parish filed a complaint with the Jefferson Parish Police Jury stating that the Texas Oil Company employed a negligible number of local residents compared to the number of people in that area who were unemployed. The Police Jury, in response, issued a resolution requesting that the Texas Oil Company show some cooperation and consideration for these issues, just as the Police Jury "has not hesitated in the past, in granting the Texas Oil Company rights and privileges to facilitate their operations." The oil companies did begin to use many of the local machine shops, resulting in increased industrialization in many of the communities on the northern portion of the Parish's west bank.

The developments at Lafitte, Barataria, and Crown Point fields in the late 1930s would significantly alter the industrial landscape of Jefferson Parish, not only in the Sixth Ward where the fields were located, but all across the parish (Figure 52). In particular, the industrial areas along the Mississippi River greatly expanded following the discovery of oil in the region. From Gretna to Avondale, through the towns of Harvey, Marrero, and Westwego, the west bank of the Mississippi River**,** then, as today, was an "uninterrupted line of warehouses, manufacturing plants, packing houses, and distilleries" (Louisiana State University Division of Research 1949a).

The addition of a number of specialized oil-related businesses dealing in products, such as drilling muds and oil field machinery, sprung up in the area, especially along the Harvey Canal. The Harvey Canal, perhaps more than any other landscape feature, served as a focal point for Jefferson Parish's industrial development. The canal, long used by fishermen and hunters to drive their boats to the New Orleans riverfront, was connected to the Mississippi River when a brick and wooden lock was constructed in 1907 (Dabney 1960). Before oil was discovered in Jefferson Parish, three businesses had operations on the canal, employing 50 people. By 1940, twenty businesses were active on the canal, employing some 600 people (Dabney 1960).

These oil field supply industries represent just part of the upstream portion of the oil industry. The downstream segment of the industry included the transportation of the product from the oil field to the production outlets. Shortly after the discovery of oil and gas at Lafitte Field, the Texas Company constructed two pipelines in Jefferson Parish, each approximately 25 miles in length. The first, a six-inch line constructed in 1935, moved crude oil from the field to the company's Amesville Terminal on the Mississippi River in Marrero (BROSA 1936). The Amesville terminal also received product from other oil fields in the region, such as the Paradis Field in nearby Saint Charles Parish. The product received at Amesville was sold at terminal and shipped by tanker to various ports in the region (BROSA 1936).

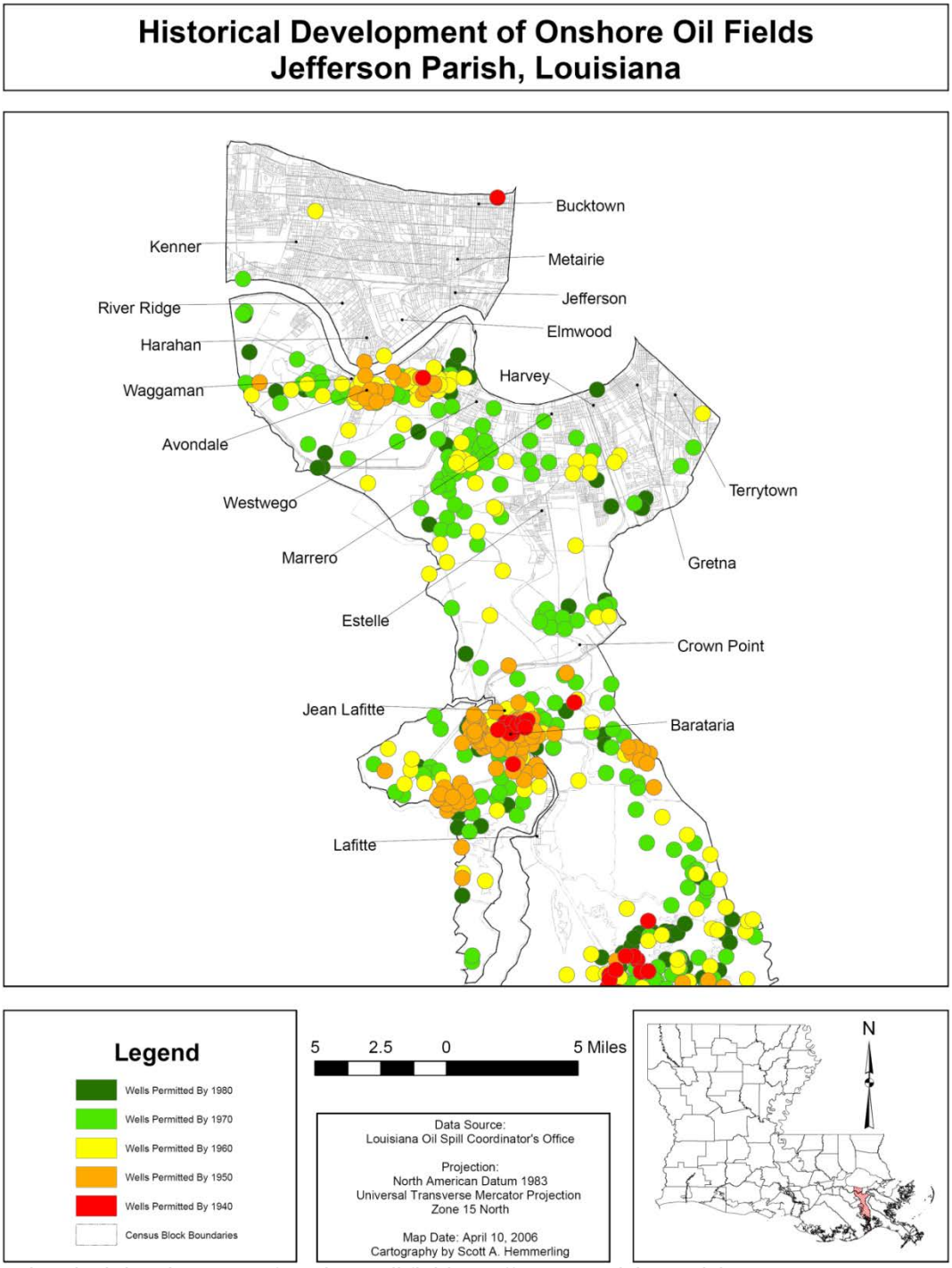


Figure 51. Historical development of onshore oil fields, Jefferson Parish, Louisiana.

Though some oil companies proposed large pipeline projects during the early years of the oil industry in Southeast Louisiana, the shipping of oil by barges and tankers proved too cheap and convenient to warrant the costs at the time. Most producing fields in Southeast Louisiana are in proximity to a veritable maze of navigable inter-connecting waterways which afford an easy inexpensive method of transporting crude from producing areas to storage, refineries, tanker terminals and loading racks. Most of the pipeline laid in the early years of the oil industry moved oil from the wells to loading docks in the immediate vicinity of the fields, where it could be transported by barge. When the California Company discovered the Barataria Field in 1939, it barged product to Westwego for storage in Sun Oil Company tanks (BROSA 1940).

The early terminals for the Lafitte and Barataria fields, for example, were located in the Jefferson Parish's Fourth Ward, an area that includes Westwego and Marrero. By 1940, Jefferson Parish's west bank had some 49 petroleum bulk storage tanks with a capacity of approximately 2,367,000 barrels. Standard Oil Company's facility at the Avondale Terminal, located in the Fifth Ward, contained the majority of this storage capacity (BROSA 1940).

Before the discovery of oil at Lafitte field, three of the six wards on Jefferson Parish's west bank had African-American population concentrations above the parish averages. The most significant concentration of African Americans resided in the Fifth Ward, which contained the communities of Waggaman and Avondale. Smaller concentrations were located in the First and Second Wards, which included the community of Gretna. Interestingly, the Third and Fourth Wards, the locations of the Harvey Canal and the tanker terminals in Marrero and Westwego, had significantly lower concentrations of African-American population. By the time of the 1940 census, very little had changed in terms of minority population concentrations, although the Third Ward, including the area around the Harvey Canal, was slightly above the parish average in terms of African-American population.

1940–1960

A number of external factors would change the complexion of the oil industry in Louisiana during the 1940s. Chief among these was the U.S.'s entry into World War II. Before the war, barging proved to be the most inexpensive and efficient means of oil transportation, since most of the producing fields in South Louisiana are in proximity to a navigable canal or waterway. Oil to be sold to eastern and northern markets could be barged from producing fields to tanker terminals along the Mississippi River. It was common practice during the early years of the oil industry to transport oil produced in South Louisiana by tanker to the Port Arthur and Houston areas for refining and then transport the product back to the New Orleans area for shipment to eastern and northern markets (BROSA 1943).

The heavy demand on barging and vessel facilities, together with the submarine threat in the Gulf of Mexico, led the government to step in and regulate barge transportation. By June 1942 the barging facility situation in South Louisiana had become so acute that a government subcommittee on barge movements recommended that all westerly movements be discontinued. The committee marked off mile posts in 100 mile segments along the Gulf Intracoastal Waterway. Beginning at New Orleans with Mile Post 100 located at Morgan City, Mile Post 200 on the Vermillion and Cameron Parish line, and Mile Post 300 at Port Arthur, Texas. The

committee ruled that oil produced east of Mile Post 200 could not be barged west of that mile post and that oil produced between Mile Post 200 and Mile Post 300 could not be moved west of Mile Post 300 (BROSA 1943).

This rule had several important impacts on Louisiana's oil industry. First, it forced many refinery operators to open new crude sources close to their plants. Two refineries came online in the study area during the 1940s. The first was located in St. Bernard Parish, in Meraux, the site of the Sinclair Refinery in the 1920s. Throughout the 1940s, several attempts were made to operate a refinery in Meraux. In 1940, General Oil ran the refinery, though it ceased production in September of 1941. The property was sold to the Farm Bureau Co-Op Association in 1943, which operated the refinery until 1945, when production again shut down. Beginning in September 1948, Gilcrease Oil took over the refinery, which once again ceased operation in March 1949. Finally, in 1953, Ingram Products took over operations of the refinery, which went online in March of 1954. From this point forward, the refinery continuously operated in Meraux, though the Murphy Oil Company acquired Ingram Oil and the Meraux refinery in 1963. The second regional refinery to come online was in Marrero in Jefferson Parish, which began operation in 1941. The Orleans Refinery, later named Clarks Super Gas, Clarks Oil and Refining, and Petco, operated continuously in Marrero until 1958, when the last refinery runs were recorded. The refinery was shut down in 1963.

In addition to stimulating the development of new crude sources and refinery growth, the ban on east-west barge trafficking also triggered pipeline construction, as oil companies sought ways to supply their own refineries with petroleum extracted in South Louisiana. To move massive quantities of oil from the wells to the refineries, often across miles of marshland and open water, pipeline companies needed to adapt their pipelines to the marine environment. Lay-barges were developed, allowing pipeline companies to position and assemble a continuous pipeline network in open water, a development that eventually led to the proliferation of the massive pipeline network in the northern Gulf of Mexico (Gramling 1996).

Throughout the 1940s, oil production in the inland and coastal zones of Louisiana increased rapidly, doubling with each succeeding decade until the end of the 1960s (Lindstedt et al. 1991). During this time, Westwego, Marrero and Avondale in Jefferson Parish were the primary production outlets for many of the oil fields of Southeast Louisiana. Despite these increases in oil production, the Baton Rouge Oil Scouts Association reported that the levels of both exploration and discovery were markedly reduced during this period (BROSA 1941). By 1945, perhaps in response to the decline in new discoveries, geophysical prospecting began expanding steadily outward into the Gulf of Mexico. In May of 1946, the Magnolia Petroleum Company began work on a platform in the Gulf of Mexico approximately ten miles southeast of Terrebonne Parish (BROSA 1946). This earliest attempt, in what are now federal waters, used local expertise and vessels (primarily shrimp boats) for transportation of personnel and supplies to the drill site (Gramling 1996). Though the Magnolia well proved to be dry, Kerr-McGee used the same drilling technology to prospect in two leases located in the Ship Shoal area, located fifty-four miles off the coast of Terrebonne Parish, well out of sight of land (Franks and Lambert 1982). The discovery of oil on Ship Shoal block 32 in November of 1947 would dramatically alter the face of the Louisiana oil industry.

The offshore oil industry requires a network of onshore support facilities. Because of the cost of building production platforms offshore, the entire platform was fabricated on land and transported offshore (Gramling 1996). In the years following the discovery of offshore oil, a number of fabrication yards dedicated to the construction of offshore oil platforms opened in Louisiana. In addition, the Ship Shoal discovery set off a boom for Louisiana shipyards. In the late nineteenth century and through the first four decades of the twentieth, Louisiana shipbuilders relied primarily on the seafood industry. Shrimp boat construction was often a backyard industry, with vessels frequently built following designs passed down from one generation to the next. The offshore oil industry required much larger vehicles to transport crews and supplies to the drilling platforms. As a result, ships were increasingly built in shipyards rather than backyards.

Because of its proximity to the offshore oil fields, Lafourche Parish quickly became an important site for onshore support infrastructure, particularly boat and ship building and repairing. During the 1940s and 1950s, five shipyards began operations along Bayou Lafourche and the Intracoastal Waterway in the southern portion of Lafourche Parish. During this period, south Louisiana's population grew steadily and shifted from remote rural areas in the marshes to more densely settled communities where employment with the petroleum-related industries was available (Davis and Place 1983). Land for residential, commercial, and community use is at a premium in the coastal zone, where dry land suitable for construction is limited. Petroleum related industries, such as supply bases, shipyards, ports, platform fabrication yards, gas processing plants, and refineries generally require from 1 to over 1,000 acres of land for construction and operation (Lindstedt et al. 1991).

The 1940 census shows a residential minority pattern similar to that which exists in Lafourche Parish today. The African-American population resides in the jury wards north of the Intracoastal Waterway, with especially high concentrations around Thibodaux and Raceland (Figure 53); the Native American population is highly concentrated in tenth ward, the southernmost jury ward in the parish (Figure 54). By 1960, the Native American population had migrated northward, settling in greater numbers in the wetland to the west of Bayou Lafourche, in the vicinity of Grand Bois (Figure 55).

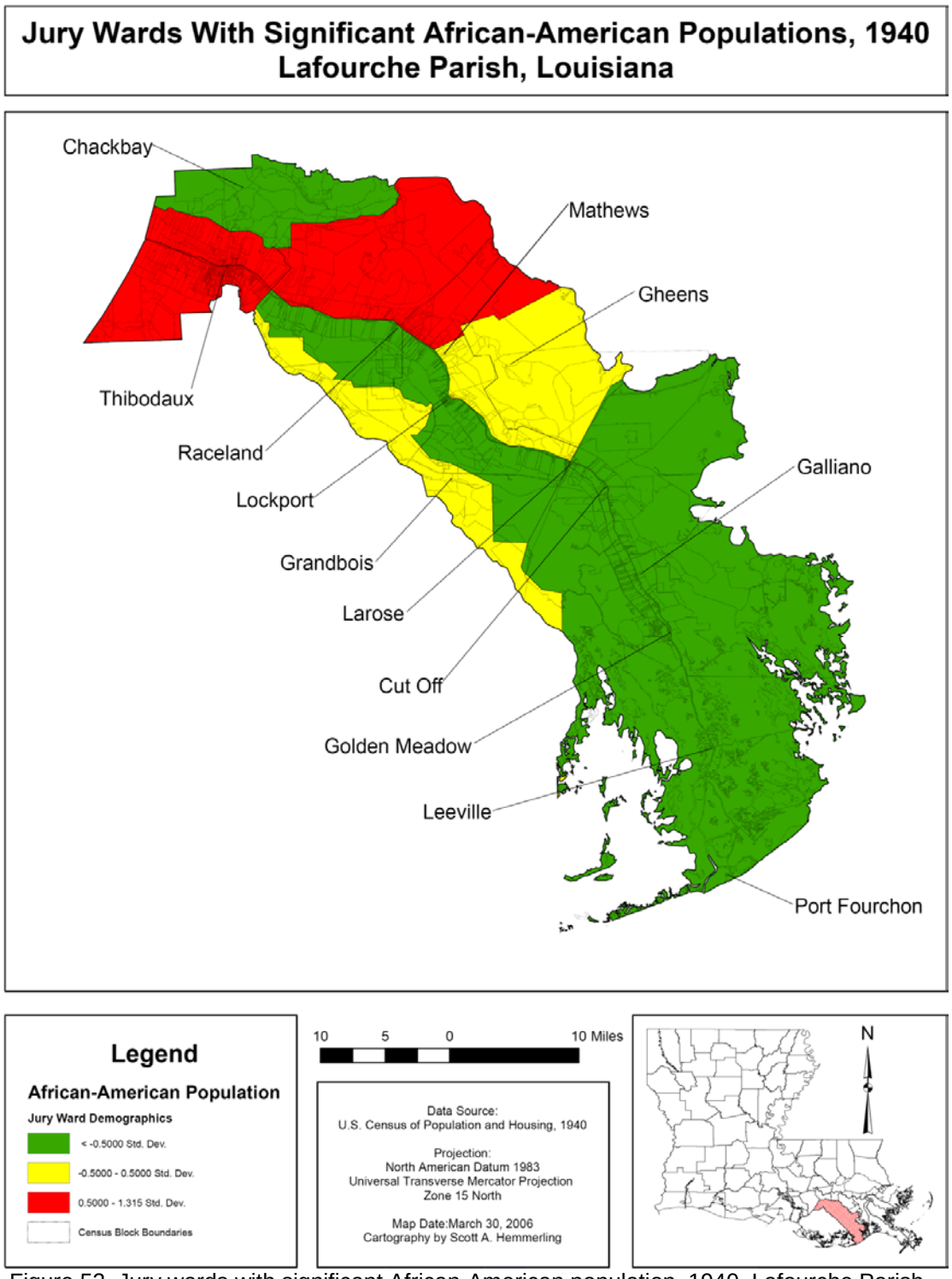


Figure 52. Jury wards with significant African-American population, 1940, Lafourche Parish, Louisiana.

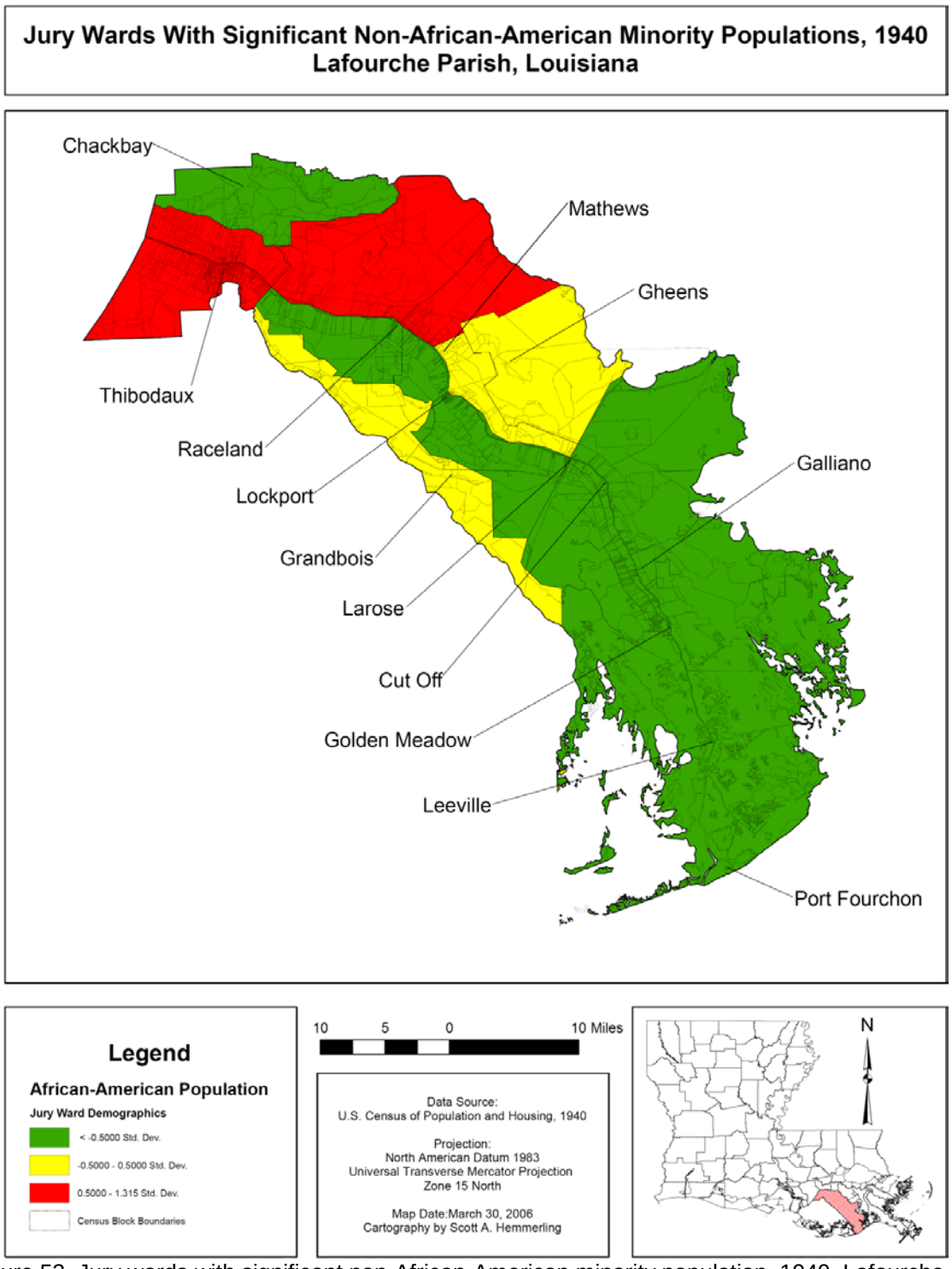


Figure 53. Jury wards with significant non-African-American minority population, 1940, Lafourche Parish, Louisiana.

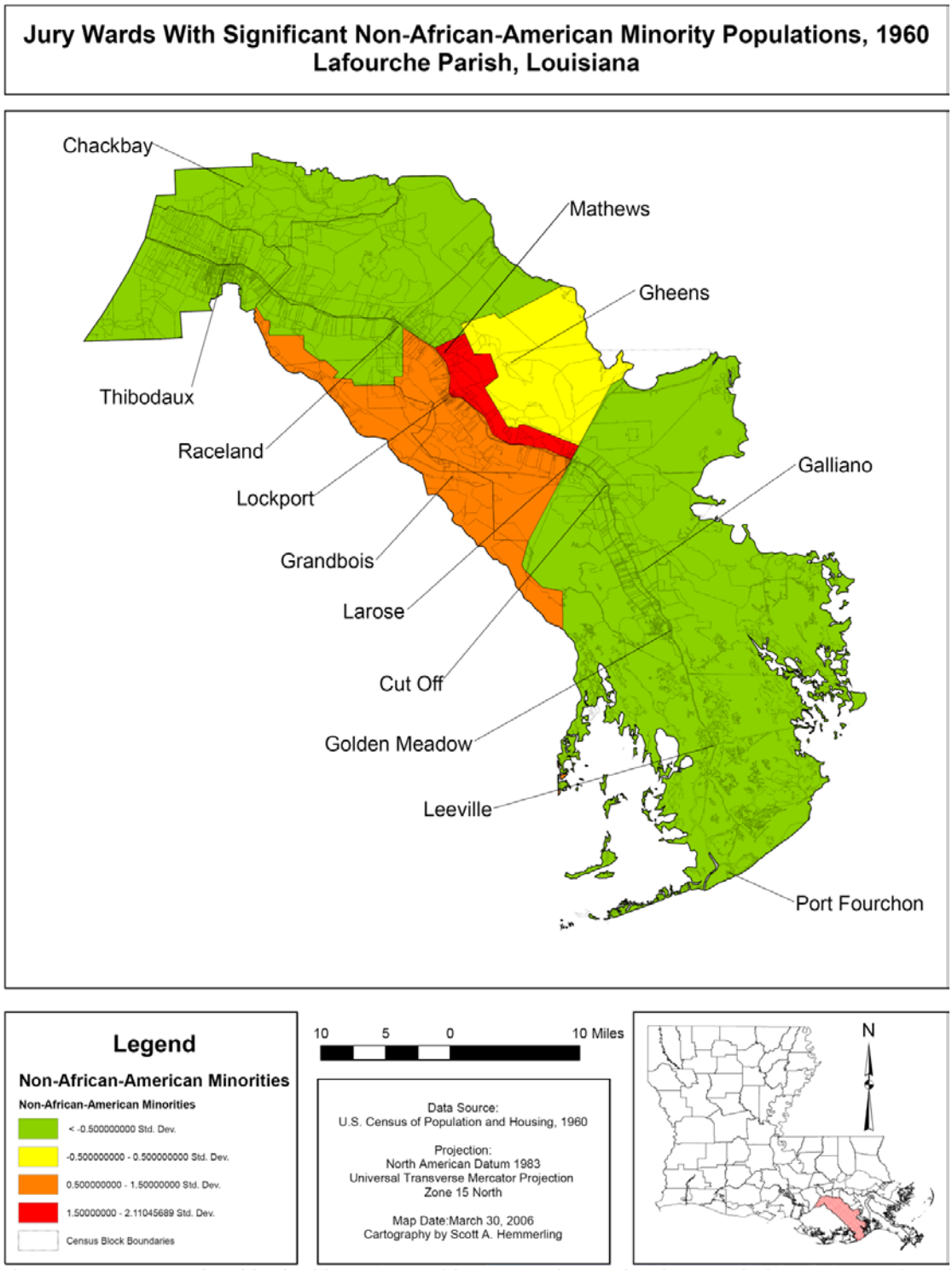


Figure 54. Jury wards with significant non-African-American Minority population, 1960, Lafourche Parish, Louisiana.

1960–1990

The offshore oil industry rapidly expanded during the 1960s and early 1970s, resulting in high levels of immigration and population growth in traditional settlements that had become staging areas for offshore activities, such as Larose and Golden Meadow in Lafourche Parish. This growth sometimes strained existing transportation networks, community infrastructures, and the delivery of social services (Gramling 1996). In the mid-1970s, some coastal Louisiana communities exhibited many of the characteristic stresses and strains associated with the classic boom town (Gramling 1996).

After several decades of growth oil production in coastal Louisiana began to peak in 1968, when more than 1 billion barrels were produced in the inland, coastal, and OCS regions combined. Production continued at levels above 1 billion barrels for four more years, peaking in 1971 at 1.2 billion barrels (Lindstedt et al. 1991). The production of natural gas peaked in 1970, with all three regions combined producing 10 trillion cubic feet of gas. By 1973, the OCS surpassed the Louisiana coastal zone as the dominant oil-producing region in the state. Likewise, though onshore natural gas production reached its peak in 1970, production in the OCS continued to rise until peak natural gas production was reached in 1980 (Lindstedt et al. 1991).

U.S. demand for petroleum products began to fall in the late 1970s, resulting in a crash in oil prices in the mid-1980s. As a result of this bust, unemployment rates in coastal Louisiana skyrocketed, and many residents left the area to seek employment elsewhere. This marked a period of time in which much of the onshore support network began to shut down.

1990–Present

The last decade of the twentieth century and the first years of the twenty-first was a period of recovery for the Louisiana oil and gas industries. The increasing production since 1990 is primarily the result of expanding activities in the deepwater Gulf of Mexico, defined here as production in more than 1,000 feet of water (Hughes et al. 2001). Development of new exploration, drilling, and platform technology made the move into the deepwater Gulf possible. By 2002, there were approximately 7,400 active leases in the Gulf of Mexico, 54 percent of which are in deepwater (Baud et al. 2002).

Deepwater production began in 1979 with Shell Oil Company's Cognac Field. Despite the success of the Cognac Field, it was another five years before the next deepwater field went online. Nearly a decade later, in 1992, only five deepwater fields were in production. Since this time, however, deepwater production has grown at an ever-increasing rate so that, by the end of 2001, there were fifty-one fields in production in the deepwater Gulf. Over the ten-year period from 1992 to 2001, deepwater oil production rose over 800 percent and deepwater gas production increased nearly 1,500 percent (Baud et al. 2002).

A number of factors have contributed to this rejuvenation of oil and gas activities in the Gulf of Mexico. First, new exploration technologies have increased discoveries on the deepwater shelf of the Gulf of Mexico in recent years. Second, new and improved technologies have been

developed in recent years that have allowed for the extension of conventional oil fields into deepwater (Hughes et al. 2001). Finally, the passage of the OCS Deep Water Royalty Relief Act (DWRRA) in 1995 has had a significant impact on deepwater Gulf of Mexico activities. This legislation provides a number of economic incentives for operators to develop fields in water depths greater than 656 feet, including the automatic suspension of Federal royalty payments for the initial volumes of oil or gas produced. This initial volume is graded, with deeper oil fields receiving higher royalty relief volumes (Baud et al. 2002). The DWRRA encouraged extensive leasing in the deepwater Gulf of Mexico and allowed oil companies to spend more money on exploration and discovery in the deepwater Gulf. In 1999, deepwater oil production surpassed shallow-water production and now approaches the high shallow-water mark established in 1971.

As deepwater production continues to expand, the onshore support infrastructure will continue to see increased activity as well. Some 600 offshore oil platforms are located within a forty-mile radius of Port Fourchon, a land-based support terminal for the offshore oil and gas industry in the Central Gulf of Mexico. Further development of OCS activity and Port Fourchon is expected to markedly affect Lafourche Parish. Rapid increases in parish employment, which began in 1995, have been concentrated in water transportation and shipbuilding (Hughes et al. 2001). In 1998, the Larose Gas Processing plant went online.

4.3 PROCESS-BASED ENVIRONMENTAL EQUITY ANALYSIS

4.3.1 Economic Theories of Environmental Inequity

There are many inherent difficulties in showing that environmental injustice is the result of intentional discrimination. Most facility owners readily agree that siting decisions are driven by economics. The Louisiana Chemical Association, for example, in a report to the Louisiana Advisory Committee of the U.S. Commission on Civil Rights made clear that their siting decisions are based on a number of factors, among them abundant land to site large-capacity operations, the proximity to deep water ports and rail transportation, access to natural resources and gas pipelines, and the presence of a neighboring plant to supply chemical feedstocks (Louisiana Chemical Association 1992). They clearly state that minority communities have in no case been targeted for facility siting and that this concern “does not square with the economic and logistic realities that must be faced in the site selection process” (Louisiana Chemical Association 1992). Yet, by ignoring the socioeconomic status of the host neighborhood, industry may have intensified existing disparities in the distribution of polluting industries.

To test these arguments, we first must explore the economics of environmental injustice formation. The most controversial claim made by some environmental justice advocates is that minority and low-income communities are specifically targeted by industry because of their socioeconomic status. Economic theory offers three distinct explanations for the genesis of such environmental racism (Hamilton 1995). The first explanation is that some form of pure discrimination has occurred, whereby facility owners trade off profits for prejudice. Though few advocates of this point of view argue that such overt racial hostility is the cause of existing environmental inequities, many believe that minority and low-income communities are targeted

because they lack the political power and technical knowledge to resist the siting of facilities in their neighborhood (Daniels and Friedman 1999).

Another explanation is that a facility will locate where it does the least amount of damage because this will limit potential compensation claims. The siting industry would do this by taking into account factors such as the number of people potentially impacted by the industry, their incomes, and the property values of the surrounding neighborhood when determining the costs of it externalities. According to this theory, industry operates under the assumption that low incomes and education are related to low willingness to pay for the environment and low expected damages in liability cases. When these variables are in turn associated with race, polluting industries might choose to locate in minority areas because compensation demands and expected liabilities from operation are lower there (Hamilton 1995).

Finally, the theory of collective action states that communities with high political participation are more likely to mount collective action efforts to either stop the siting of certain facilities or to force the industry to internalize its externalities. Such efforts require a mobilized population with a vested interest in the community. Previous research has shown that political mobilization is closely associated with home ownership. The higher the value of owner-occupied housing, the greater the stake in the community, and the more likely a high level of mobilization will occur (Lester et al. 2001). Therefore, in theory, if minority and low-income communities inhabit run-down neighborhoods, they would be less likely to mount effective collective action efforts. Industry may choose to locate in these neighborhoods because that is where the expressed opposition is the least (Hamilton 1995).

4.3.2 Theories of Neighborhood Change and Environmental Justice

Clearly, there is a spatial dimension to all forms of neighborhood change. Spatial processes have been major driving forces shaping the landscape of demographic, social, and economic differentiation (Liu 1997). Contemporary patterns of residential segregation by race and class, for example, have developed within the context of residential neighborhoods formed in earlier growth phases (Knox 1994). Some of the spatial processes influencing residential segregation patterns may be influenced by the presence or absence of potentially hazardous facilities, though others may not. Both the classical invasion-succession and the neighborhood life-cycle models, for example, are not driven by the presence of potentially hazardous facilities, whereas the push-pull model and the institutional theory of neighborhood change rely intrinsically on the siting of potentially hazardous facilities.

The classical invasion-succession model, perhaps best characterized as the process of white flight, is based on the notion that the proportion of minority residents in a neighborhood would gradually increase until a “tipping point” is reached. After this point, the non-minority residents of the neighborhood begin to move out, presumably in response to the influx of minority residents. Normally, this model assumes that minority residents can move into areas with or without potentially hazardous sites. The model suggests that the post-siting decline in neighborhoods that host potentially hazardous facilities might be the result of minority expansion, which had started before siting (Liu 1997).

The neighborhood life cycle model suggests that communities go through natural cycles of development, transition, aging, decay, and renewal (Talih and Fricker 2002). Through this life cycle, we would expect the housing characteristics to decline and socioeconomic status becomes successively lower. Under this model, population density and the age of the housing stock are usually seen as the two most important community characteristics that determine neighborhood change. Again, as in the invasion-succession model, the presence or absence of potentially hazardous facilities is not a necessary condition for this decline process, although it has been suggested that the presence of such facilities may accelerate the decline process (Liu 1997).

Unlike these two models of neighborhood change, the push-pull model assumes that some externality, such as the siting of potentially hazardous facilities, pushes out more affluent residents and pulls in less affluent ones. Though many other factors, such as property values, play into mobility decisions, in some cases the increased concern with environmental risks may be influential in shaping internal migration patterns. Population would be expected to flow away from areas that pose high levels of environmental risk and toward those characterized by low risk levels, even when controlling for other contextual factors associated with migration streams (Hunter 1998). However, migration is rarely even, and strong associations between race and pollution may arise through the Tiebout process, whereby residents who place a high value on the environment and have access to the resources may leave the community while minority or low-income residents who lack the resources to purchase a higher level of environmental amenities remain or move in (Hamilton 1995). Thus, the siting of a potentially hazardous facility may serve as a catalyst for the segregation of the surrounding neighborhood, despite the fact that the neighborhood may have been neither low-income or minority at the time of the siting.

The pull in the push-pull model operates largely through changes in neighborhood economics, especially property values (Talih and Fricker 2002). A facility locating in a given area may make the neighborhood less desirable, thereby decreasing the neighborhood's property value. This makes housing more available to lower income households and less attractive to higher income households, ultimately making the neighborhood poorer than it was before the facility siting (Been 1994).

Finally, the institutional model of neighborhood change suggests that institutions, such as banks, insurance companies, and universities, have a very important role in neighborhood change. This model implies that the presence of potentially hazardous facilities does not necessarily lead to neighborhood decline. In fact, such institutions may dramatically impact the local economic structure for better or for worse, often affecting the direction in which the surrounding neighborhoods will develop (Liu 1997). In some cases, facilities may be attracted to neighborhoods that are in the aging or declining stage of the neighborhood life cycle, altering the socioeconomic status of the neighborhoods. Socioeconomic status might increase following the siting of the facility, or the neighborhood may continue to decline. Thus, according to this view, the siting of potentially hazardous facilities many not necessarily be the cause of neighborhood decline, but could in fact be the result of neighborhood decline (Talih and Fricker 2002).

4.3.3 Analysis of Environmental Justice and the Siting of Oil-Related Infrastructure in Southeast Louisiana

St. Bernard Parish

In St. Bernard Parish, the first of the study area parishes to exhibit significant oil-related development, the African-American population hovered just below the state average for the first decades of the twentieth century, dropping from 43.67 percent in 1900 to 32.15 percent in 1920. The development of the oil refineries in Chalmette and Meraux in the 1920s dramatically altered the population demographics in St. Bernard Parish, with the white population rising significantly in the years following facility siting and African-American population either holding steady or dropping. Though there are no census data for either Chalmette or Meraux, the jury ward data suggests that the same overall parish pattern holds for each of these communities. In 1930, the third ward, containing Chalmette, had only 18.99 percent African-American, significantly below both the parish and state averages. Numbers continued to drop in the coming decades until, by the 1960s, the African-American population in the third ward numbered well under 1 percent of the total population. Chalmette itself only appeared in one census prior to 1980. In 1950, there were only five African-Americans enumerated out of a total of 1,695 residents in Chalmette, again well less than 1 percent of the total population.

This pattern holds for the Fourth Ward as well, though not as dramatically, at least on the surface. At the start of the 1930s, the fourth ward was over 60 percent rural compared to just over 14 percent for the third ward. The proportion African-American at the time was 28.01 percent. This value was above the parish average and below the state average. Over the course of the 1930s, the percentage African-American in the fourth ward rose to 31.31 percent, even as the parish average dropped to under 20 percent. Later censuses show that Meraux, bordering Chalmette on the east, contained most of the jury ward's white population, and the ward's African-American population largely resides to the east, on the border of the fifth ward, which contains the communities of Violet and Poydras. Though this pattern may have been in place in the first half of the twentieth century as well, this question cannot be answered with the available census data.

By the mid-1930s, the refinery that had been sited in Meraux in earlier decades had shut down, which may partly explain the lack of urbanization in the fourth ward compared to the neighboring third ward. However, the attempts to reestablish the refinery site throughout the 1940s and the successful development of the site in the early 1950s had the same effect on the population of the fourth ward as had the siting of the Chalmette Refinery on the third ward. The proportion African-American dropped dramatically from a high of 31.31 percent in 1940, when the General Oil Company brought the refinery online to 11.59 percent by the end of the 1960s, the decade when the Murphy Oil Company took over the refinery.

Jefferson Parish

In Jefferson Parish, the potential environmental justice impacts of the onshore oil industry may be gauged in one of two areas. The first is the location of the oil fields and the second is the siting of the support infrastructure, particularly the petroleum bulk storage facilities. In Jefferson Parish, the majority of the oil fields are located in the rural areas of the parish and the bulk

storage facilities are sited on the Mississippi River in the more developed portions of the west bank.

The Sixth Ward includes the Barataria region of Jefferson Parish, including the Lafitte and Barataria fields, which both came online in the late 1930s. In 1940, 71 of the parish's 118 non-African-American minority residents (over 60 percent) resided in the sixth ward. The lack of census data for communities in the sixth ward makes it difficult to draw conclusions as to the proximity of these residents to the oil fields. Most people lived in developed areas, with only 2 percent of the population residing in rural areas. As the oil field development in the Barataria region took place in rural areas, few residents of the parish are likely to have resided in close proximity to the fields.

The jury wards that contained the largest number of petroleum bulk storage facilities, the fourth and fifth, showed vast differences in minority proportions in the years prior to the arrival of the oil industry. The fourth ward, containing the towns of Marrero and Westwego, had only 18.75 percent African-American in 1930, below both the state and parish averages. The fifth ward, containing the community of Avondale, contained 40.04 percent African-American in 1930, slightly higher than the state average and well above the parish average. Note that it is difficult to make any definitive conclusions based on this early data, given the relatively large jury wards. The relatively large unit of analysis available in the 1930 census may mask significant pockets of minority residents.

There are distinct differences in the character of each of these jury wards. In 1930, the fourth ward was almost entirely urbanized, with the U.S. Census Bureau classifying only 7.34 percent of the 11,345 residents as rural. This stands in sharp contrast to the demographics of the fifth ward, which contained less than a thousand residents, 35.72 percent of which were rural. However, by 1940, the population in each of these jury wards was becoming increasingly urban. The rural percentage dropped nearly 10 percent in the fifth ward down to 25.61 percent in the years between 1930 and 1940, and the rural proportion in the fourth ward dropped down to 5.27 percent.

In 1940, the Orleans Refinery (later Clarks Refinery) opened in Marrero in the fourth ward. At the time, the proportion of African-Americans in the fourth ward was below both the parish and state averages. By the time the refinery recorded its last run of petroleum in 1958, the fourth ward had 21.28 percent African-Americans, compared to the parish average of 15.15 percent. Though we do not have census data for Marrero itself for the period in which the refinery was in operation, we do know that a decade later, in 1980, the proportion African-Americans in Marrero was 31.54 percent compared to the parish average of 13.86 percent. It would appear that the presence of this refinery may have created a push-pull effect in the fourth ward, though without earlier community-level data, that cannot be stated conclusively.

Lafourche Parish

The Kerr-McGee oil strike in the Gulf of Mexico in 1947 began a boom in activity in Louisiana shipyards as companies sought to supply vessels necessary to transport both crew and supplies to the offshore drilling platforms. In Lafourche Parish, four new shipyards began operation in the latter half of the 1940s. Two of these were located in Lafourche Parish's

southernmost jury ward, with a third sited on the border. The tenth ward includes Port Fourchon as well as the communities of Leeville, Golden Meadow, Galliano, Cut Off, and part of Larose. In 1940, the tenth ward was home to all but one of the parish's non-African-American minority population of 321. Of this total, the U.S. Census Bureau has identified 319 as Native American.

This data would seem to suggest that the siting of shipyards in the 1940s disproportionately impacted the Native American population of Lafourche Parish. However, caution should be exercised in drawing such a conclusion. The tenth ward is by far the largest jury ward in Lafourche Parish, and 38.36 percent of its 38,615 persons live in rural areas away from the towns where the shipyards were constructed. The 1950 census, which included data for both Larose and Golden Meadow seems to verify that the Native American population was still largely rural during this decade. In 1950, the number of Native Americans in Lafourche Parish had grown to 435. Of this total, only six lived in Larose and none in Golden Meadow. No significant Native American influx into these communities appears until the 1980 census. By this point, all three of the shipyards sited in Larose were already in operation, as well as two of the three in Golden Meadow. The third shipyard to locate in Golden Meadow was sited in 1983, when the community was already disproportionately Native American.

4.3.4 Analysis of Environmental Justice Dynamics

By examining the demographic characteristics of the host jury ward at the time of facility siting, we are able to determine whether potentially hazardous facilities were initially disproportionately sited in the proximity of low-income and minority populations. This allows us to establish a benchmark on which to compare the neighborhood composition at the time of siting with the neighborhood composition now. This approach, however, does not support the evaluation of possible causal links between the presence of oil-related infrastructure and the change in neighborhood characteristics. The presence or absence of potentially hazardous facilities is neither a necessary nor sufficient condition for neighborhood changes (Liu 1997).

As discussed above, areas undergoing industrial development generally exhibit patterns of fairly rapid population expansions. In many cases, over time, the minority proportion in these areas increased. The several theories of environmental equity formation offer varying explanations about how and why areas might become increasingly poor and minority. In this section we attempt to determine which of these theories best explains the presence of environmental injustice in certain areas of southeast Louisiana. Using multiple regression analysis, we test which factors most influence population migration into census tracts within the study area.

The migration data used to calculate the dependent variables analysis are based upon the 2000 census question regarding place of residence in 1995 (Hunter 1998). The independent variables were drawn from a number of sources, particularly U.S. Census Bureau 1990 data, U.S. Geological Survey 1990 land use and land cover data, and USEPA 1996 air release data. Ultimately, the population migration data allows us to show environmental injustice formation as a more dynamic process. We would be able to say that these were the conditions, people responded by moving in or out of areas, leaving us with a new set of conditions. It should be

noted that we are specifically examining inmigration patterns. In other words, we are examining the factors that draw persons into an area and not those that move people out of a region. We do not assume that populations are drawn to particular regions because they are hazardous, but we do assume that populations are drawn to potentially hazardous areas because of employment opportunities and real estate values.

To determine what is driving migration patterns in the three study area parishes, we first ran the regression for the total population, then by individual minority groups. This allows us to consider differential motives for moving into particular areas. Surrogate categories are used here. For example, it would be a mischaracterization to say that a particular population group moves into an area because the house values are high. It would likely be more accurate to say that people tend to want to live in nicer neighborhoods where the housing stock tends to be more valuable. Conversely, we cannot assume that a migration shift into an area with lower house values represents downward mobility (i.e. a desire to live in a run-down area). Rather, we can likely say that these people move into the area because houses and rents are affordable. A significant finding that an individual moves into areas with his/her own race or ethnicity could contradict this.

We selected a number of variables based on their ability to best model the different theories of environmental equity formation. For example, invasion-succession would be characterized by white migration into more segregated white neighborhoods, whereas minorities may be moving into more integrated areas. If the white population is decreasing in terms of raw numbers, then we have a situation of possible white flight. If the African-American population is increasing along with the white population, but blacks to a greater extent, then we can assume that market dynamics are important in this area. Because we are using regression analysis, economic factors such as house value, median rent, and income are controlled. In the case of pure invasion-succession, we would expect to see the racial characteristics change first, and not economic status.

A general movement to or from older, densely populated neighborhoods typifies the neighborhood life cycle model. As the age of the housing stock increases, we would expect to see resultant changes in the demographic makeup of the community. In other words, as the neighborhoods get older, the quality of the housing stock decreases, values and rents decrease, and low income and minority residents move in. Of course, this regression analysis takes into account house values which is important in particular areas of southeast Louisiana, such as historic neighborhoods where house values are high. We would expect total migration to be away from these older, densely populated areas. However, minorities would be more likely drawn to such neighborhoods, whereas the white population would tend to move into newer houses.

A movement to or from more or less desirable neighborhoods characterizes the push-pull model. Areas with a high percentage of industrialization would serve as a push force, resulting in affluent migration into non-industrial areas. It is expected that total migration would be towards areas with low industrialization. Assuming that property values in industrial areas are lower, we would expect to see less affluent residents living in these areas. Under the push-pull model, we would hypothesize that minority residents are more likely to move into areas with low

property values, whereas whites are more likely to move into areas with high property values. However, these hypotheses do not consider the percentage of residents employed in manufacturing. Blue-collar working class residents of any race might move into more industrial areas because of the nearness to manufacturing employment. In fact, previous research has suggested that the migrations of working-age people into a region comprising one or several parishes may be interpreted as a sign of regional growth and employment growth of the industries within the region (Shanafelt 1977). Finally, we looked at environmental conditions within each parish during the mid-1990s. For this, we used data on the release of common air pollutants. Air emissions, including smoke and other forms of particulate matter, are the most visible form of pollution, and would likely have the most immediate effect on decisions to move into an area. Previous research has demonstrated that the level of air pollutants demonstrates the strongest relationship with county level migration patterns (Hunter 1998).

To test for institutional effects, we would have to establish that some other factor was already in play (for example, the neighborhood was in decline, house values dropping, etc.) when the facility sites there. The institutional change (positive or negative) would occur in the interim. We would expect to see some type of shift in the neighborhood dynamics for better or worse following the siting, whether that be, for example, in property values or racial makeup.

Regional Migration Patterns

The initial portion of the analysis looked at the migration rates within all three of the case study parishes, Lafourche, Jefferson, and St. Bernard. By using the stepwise multivariate analysis, we formulated the following estimated regression model using the standardized coefficients:

Census Tract Total Inmigration = 46.009 + 0.473 Percent Industrial Land – 0.436 Population Density – 0.320 Median Rent – 0.332 Age of Housing Stock – 0.227 Black/White Segregation

The migration of population into census tract in the three-parish study area is positively correlated with population density and the percentage of the land in industrial usage. It is also positively correlated with lower rents. In other words, people appear to be moving into densely populated, largely industrial areas where the costs of rent are lower. People also tend to be moving into newer housing. Finally, it would appear that people are moving into areas where the white population and the African-American population are more integrated. Notice that this is not related to any of the employment factors. In other words, people do not appear to moving in order to live closer to their jobs, at least not at the regional level. Finally, overall there is a slight non-significant positive correlation between the level of air emissions within the census tract and the movement of the population into that tract, suggesting that environmental factors are not important in terms of the overall migration of population within the region.

When these population patterns are broken down by race, we see quite different patterns emerge. The white population, especially, occupies segregated areas away from industrial land:

Census Tract White Inmigration = 69.171 + 0.760 Black/White Segregation + 0.255 Hispanic/White Segregation + 0.124 Asian/White Segregation + 0.118 Native American/White Segregation – 0.104 Percent Industrial Land

These values stand in stark contrast to those of the African-American population:

Census Tract African-American Inmigration = 27.765 + 0.825 Black/White Segregation – 0.112 Median House Value + 0.088 Percent Industrial Land

The African-American population, when examined over the entire region, tends move into areas that are more industrial and that already have a fairly segregated African-American population. These areas also tend to have lower house values.

Similar patterns exist for the Asian population:

Census Tract Asian Inmigration = 1.280 + 0.337 Asian/White Segregation + 0.263 Population Density – 0.024 Age of Housing + 0.179 Percent Industrial Land + 0.147 Median House Value

Like the African-American population, the Asian population appears to be more likely to move into segregated Asian neighborhoods as well as census tracts with higher levels of industrial land uses. Unlike the African-American population, however, the Asian population tends to move into tracts that, although more industrial, have higher value, newer housing.

Like the white and the Asian and African-American populations, the Hispanic population lives in areas that are highly segregated:

Census Tract Hispanic Inmigration = 1.573 + 0.521 Hispanic/White Segregation + 0.270 Absolute Levels of Hispanic/White Segregation + 0.215 Median Contract Rent

The inclusion of the absolute levels of Hispanic/White segregation suggests that, in addition to moving into areas with large numbers of Hispanic residents, some Hispanics may be moving into areas with highly segregated white populations. In addition, many Hispanics tend to be moving into areas with higher rents.

Interestingly, none of the racial or ethnic groups examined thus far appear to migrate into census tracts where higher proportions of residents live close to their jobs. Similarly, although both the African-American and Asian populations tend to move into areas with higher percentages of industrial land use, none of the groups examined thus far are moving into tracts where larger numbers of residents work in either manufacturing or in the oil industry. This would seem to support the contention that market dynamics are the driving force behind many of the migration patterns found in the three-parish study area (Been 1994).

Of all the minority groups, only the Native American population migrates into census tracts where a large portion of the population works in the oil industry:

Census Tract Native American Inmigration = -0.889 + 0.376 Native American/White Segregation + 0.336 Percent of the Population Employed in the Oil Industry + 0.147 Travel Time to Work

Native American population also appears to be migrating into areas that tend to be farther from their place of employment, at least in terms of travel time to work. What all of this suggests is that the Native American population has tended to migrate into Native American communities where people tend to be employed by the oil industry. These communities also tend to be farther from the actual employment sites.

In general, migration of a population within a parish represents upward economic mobility into better housing or into more desirable areas of the parish. Migrations from one parish to another can either reflect the lack of opportunity in some parishes or more economic opportunities in other parishes or a combination of the two, which is usually the case (Shanefelt 1977). This would provide some evidence of the push-pull model of population mobility.

When examined in total, within-parish migration follows the expected trend. People who migrate to other areas in the parish tend to move away from the locations in which they work. The areas they move into are generally less industrial and have lower overall amounts of air pollution. Finally, the areas into which people have migrated have lower population densities and lower house values.

Migrations from outside of these three parishes show an opposite trend. People from outside these parishes have tended to move into newer housing built in more industrial areas. Interestingly, the data suggests that the areas into which out of parish migrants are moving have lower percentages of residents who work in the manufacturing industry, suggesting that these migrants are not seeking neighborhoods that one would traditionally consider as "blue-collar." Overall, the data suggest a general movement towards newer neighborhoods in industrialized areas. We see very little movement, for example, into areas dominated by wetlands and marshland, where the Native American populations have traditionally settled.

Lafourche Parish Migration Patterns

The next portion of the analysis involved looking at the migration rates of each individual parish. To begin, we looked at Lafourche Parish, which recently has become a center of the offshore oil support industry in southeast Louisiana. Again we used stepwise multivariate analysis and obtained the following estimated regression model using the standardized coefficients:

Census Tract Total Inmigration = 25.234 + 0.760 Employed in the Same Town

In Lafourche Parish, overall migration is positively correlated with the ability to work in the same place that one lives. In addition, there is a slight positive correlation between the age of the housing stock, though not significant to the 95 percent confidence level. These results would seem to suggest that people are moving into older housing close to their jobs. When we include

the percentage of the population employed in manufacturing as a factor, the model does not change. This would further suggest that in Lafourche Parish we do not necessarily see people engaged in manufacturing jobs, such as shipbuilding, moving into more blue-collar type neighborhoods.

When broken down racially, different patterns begin to emerge. The white population has tended to avoid the urban areas in Thibodaux, instead moving into the more rural area east of Thibodaux and the area between Larose and Lockport (Figure 56). Over 60 percent of the variability in this migration can be described by the degree to which the African-American and white populations are segregated:

Census Tract White In-migration = 73.869 + 0.790 Black/White Segregation

Similar results were found for both the African-American and Asian populations in Lafourche Parish:

Census Tract African-American Inmigration = 19.757 + 0.845 Black/White Segregation

Census Tract Asian Inmigration = 1.156 + 0.483 Asian/White Segregation

Significantly, the Asian and African-American populations each settled in tracts in Thibodaux as well as the area between Thibodaux and Raceland, areas that the white population tended to not move into (Figures 57 and 58). These results would all suggest that in Lafourche Parish, the white, African-American, and Asian populations all sought out census tracts where there were higher levels of segregation. In other words, when all other factors, including house values, proximity to jobs, and the quality of air, were controlled for, each of these populations moved into areas where they were segregated from the other two populations. In the case of the African-American population, this one factor accounted for over 71 percent of the total variability in African-American migration.

When we look at the Native American and Hispanic populations we see very different patterns begin to emerge:

Census Tract Native American Inmigration = -1.462 + 0.641 Percent of the Population Employed in the Oil Industry

Census Tract Hispanic Inmigration = -1.550 + 0.667 Percent of the Population Employed in the Oil Industry

Both the Native American and Hispanic populations significantly sought out areas south of the Gulf Intracoastal Waterway, which runs through Larose (Figures 59 and 60). The Hispanic population especially tended to migrate into Larose, and the Native American population tended to migrate into the areas further south, including Cutoff and locations on the eastern bank of Bayou Lafourche. These are largely census tracts were larger proportions of residents are engaged in the oil industry.

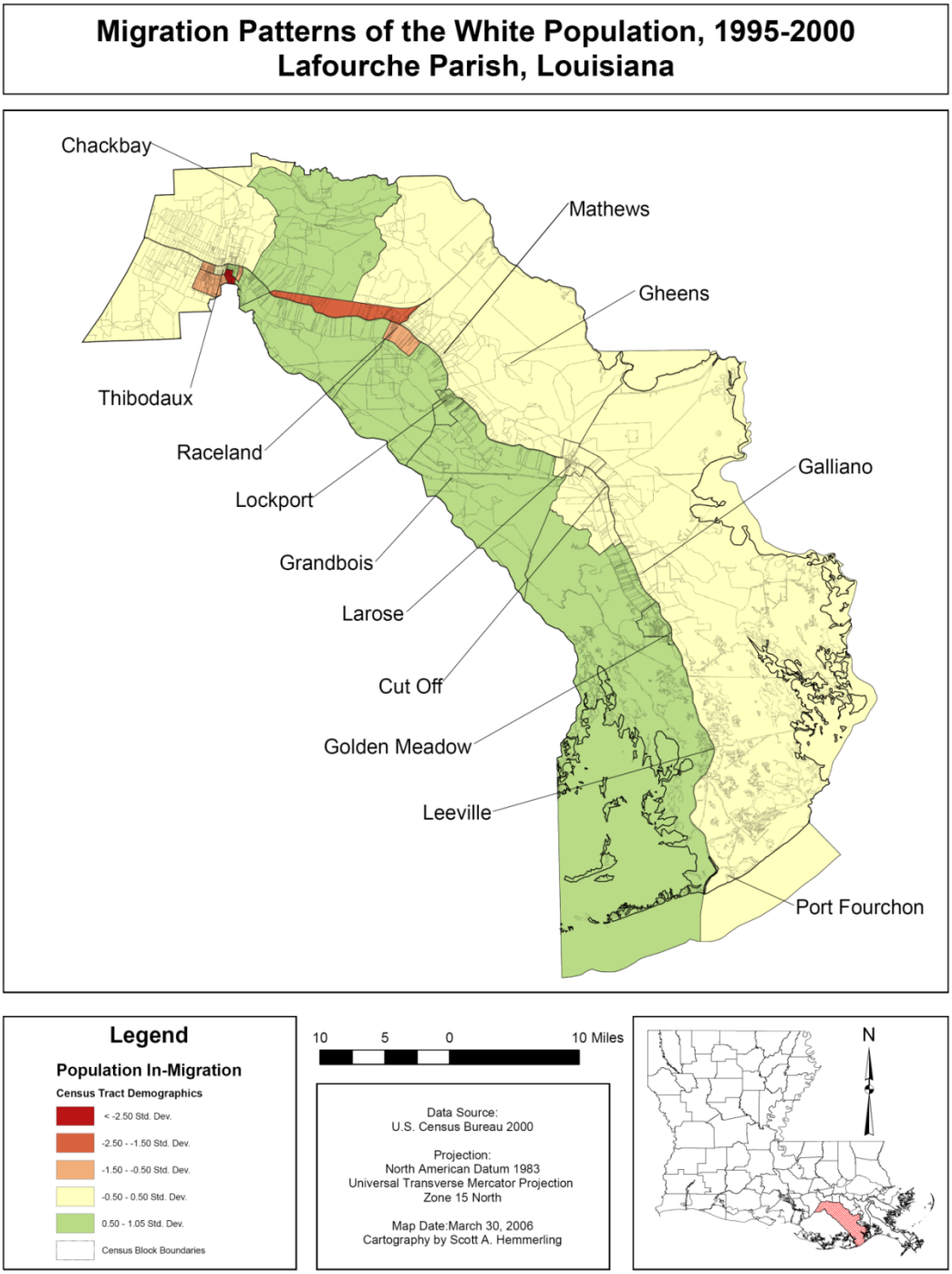


Figure 55. Migration patterns of the white population, 1995-2000, Lafourche Parish, Louisiana.

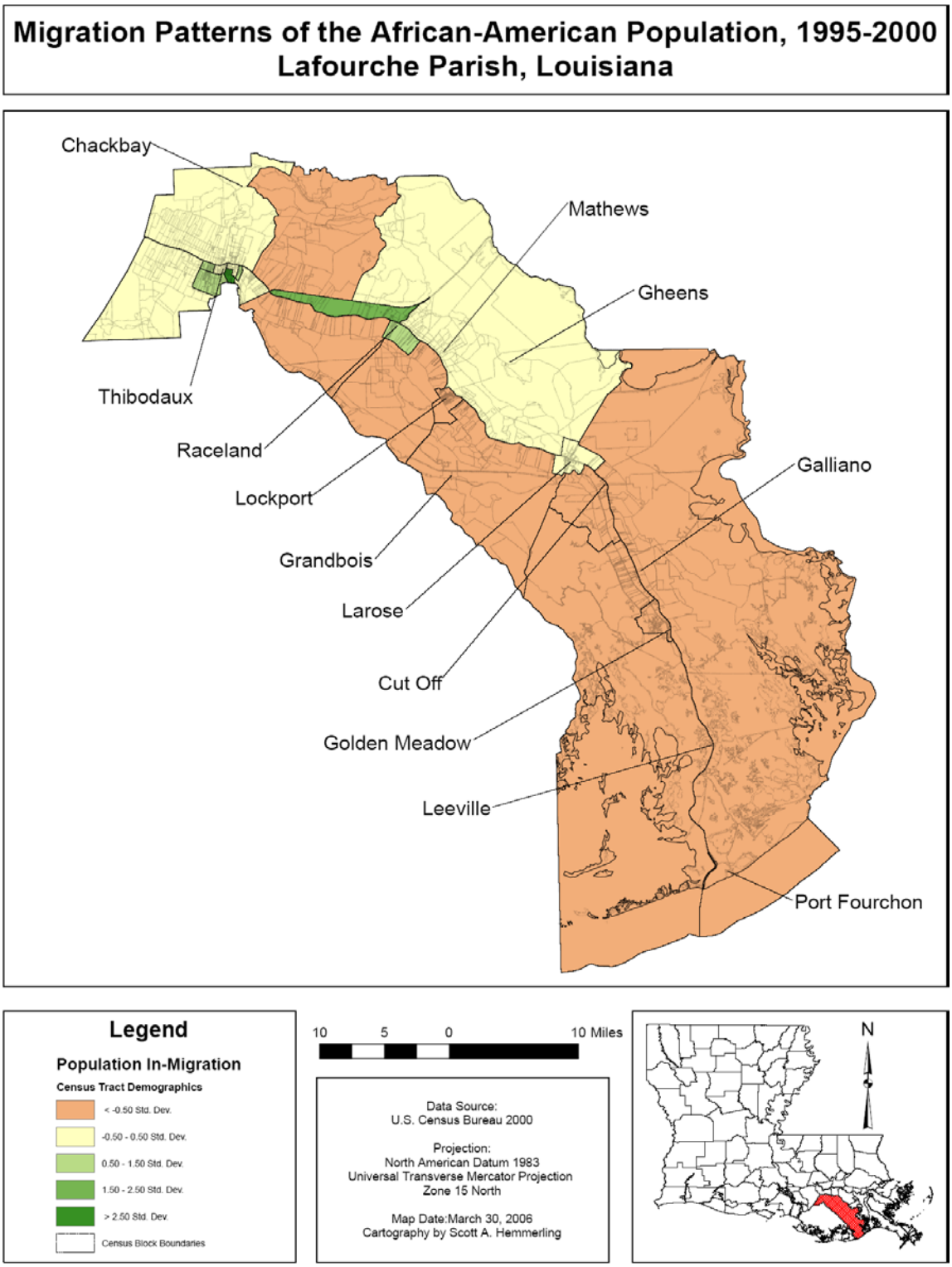


Figure 56. Migration patterns of the African-American population, 1995–2000, Lafourche Parish, Louisiana.

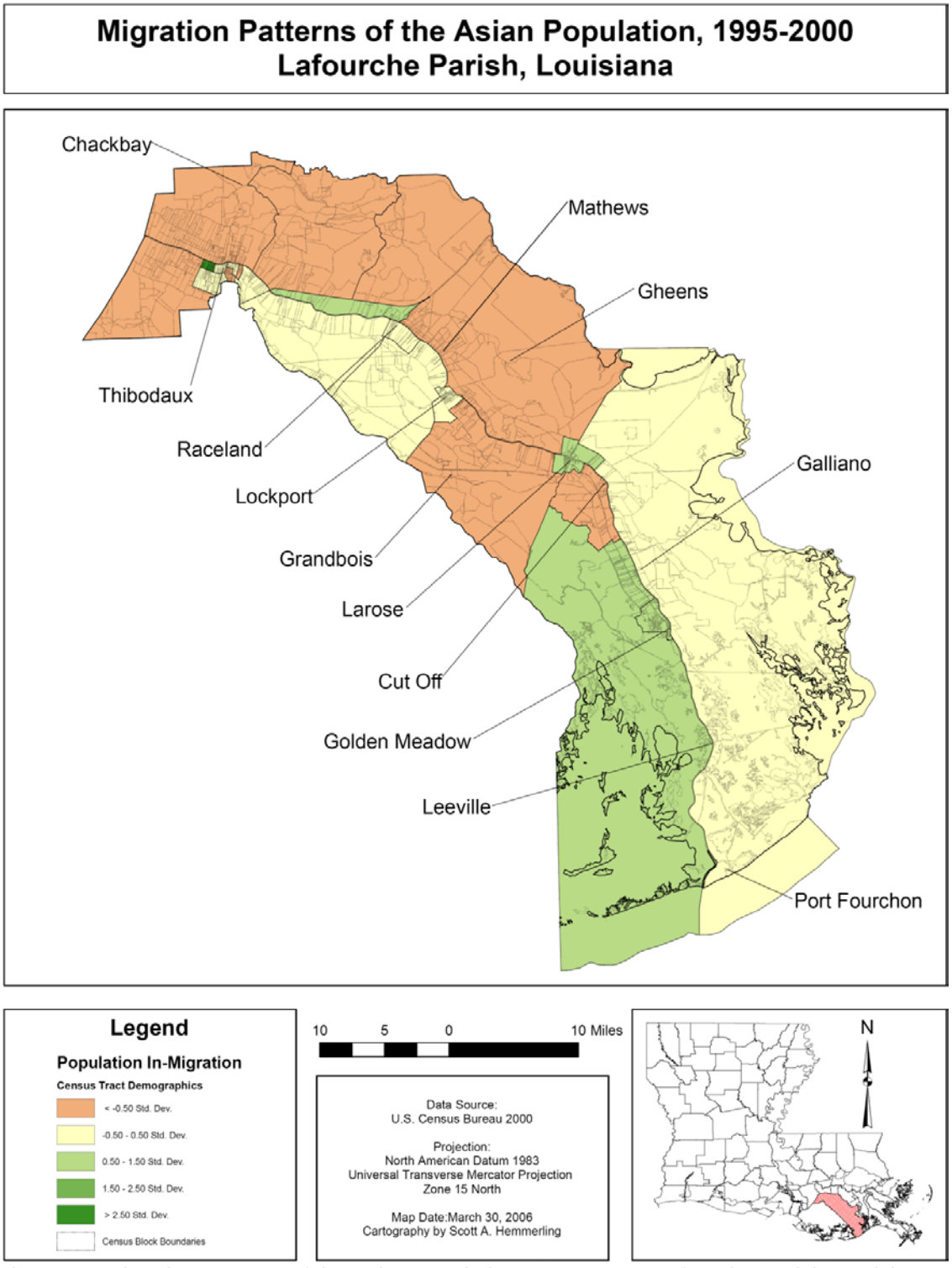


Figure 57. Migration patterns of the Asian population, 1995–2000, Lafourche Parish, Louisiana.

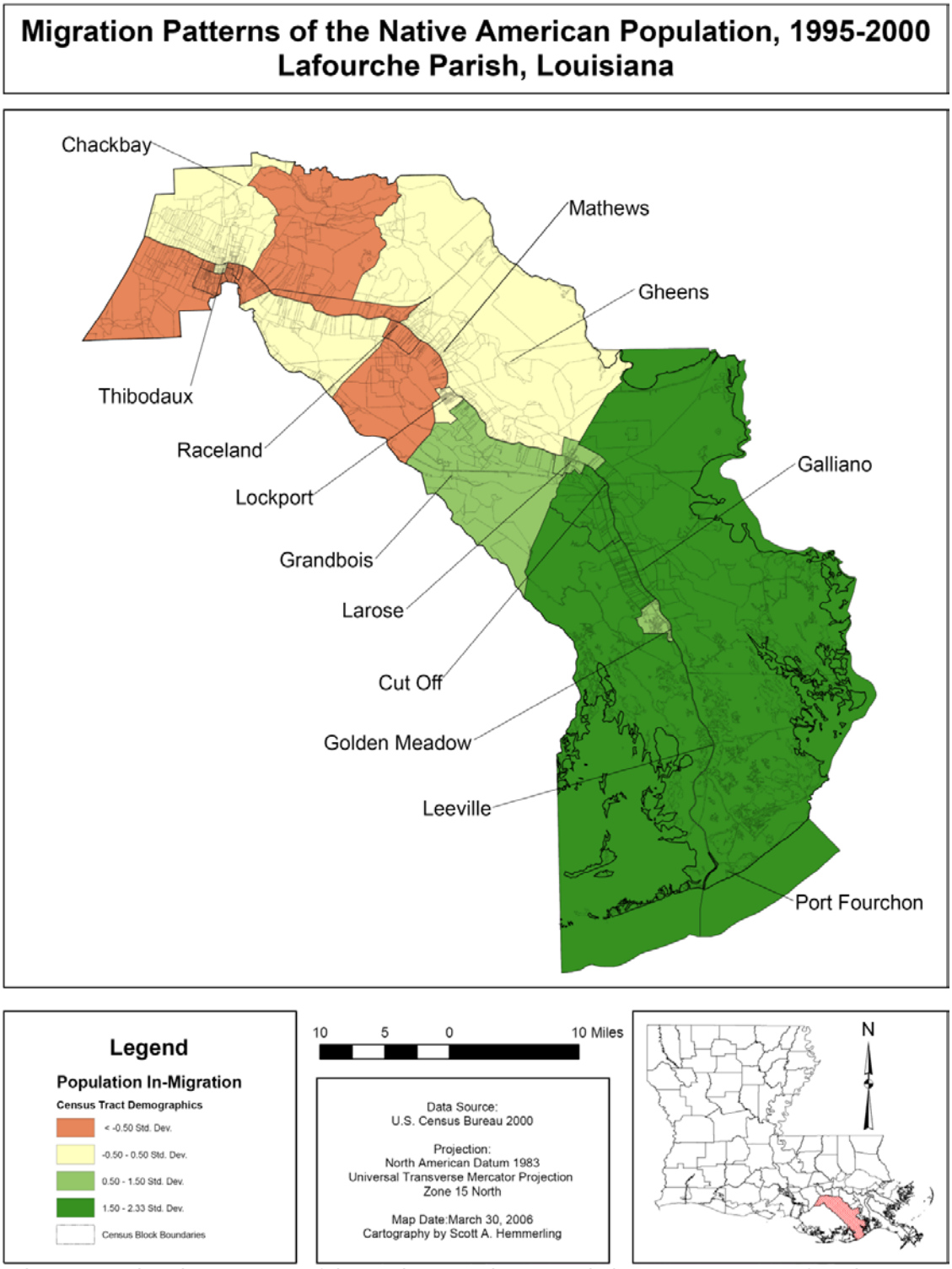


Figure 58. Migration patterns of the Native American population, 1995–2000, Lafourche Parish, Louisiana.

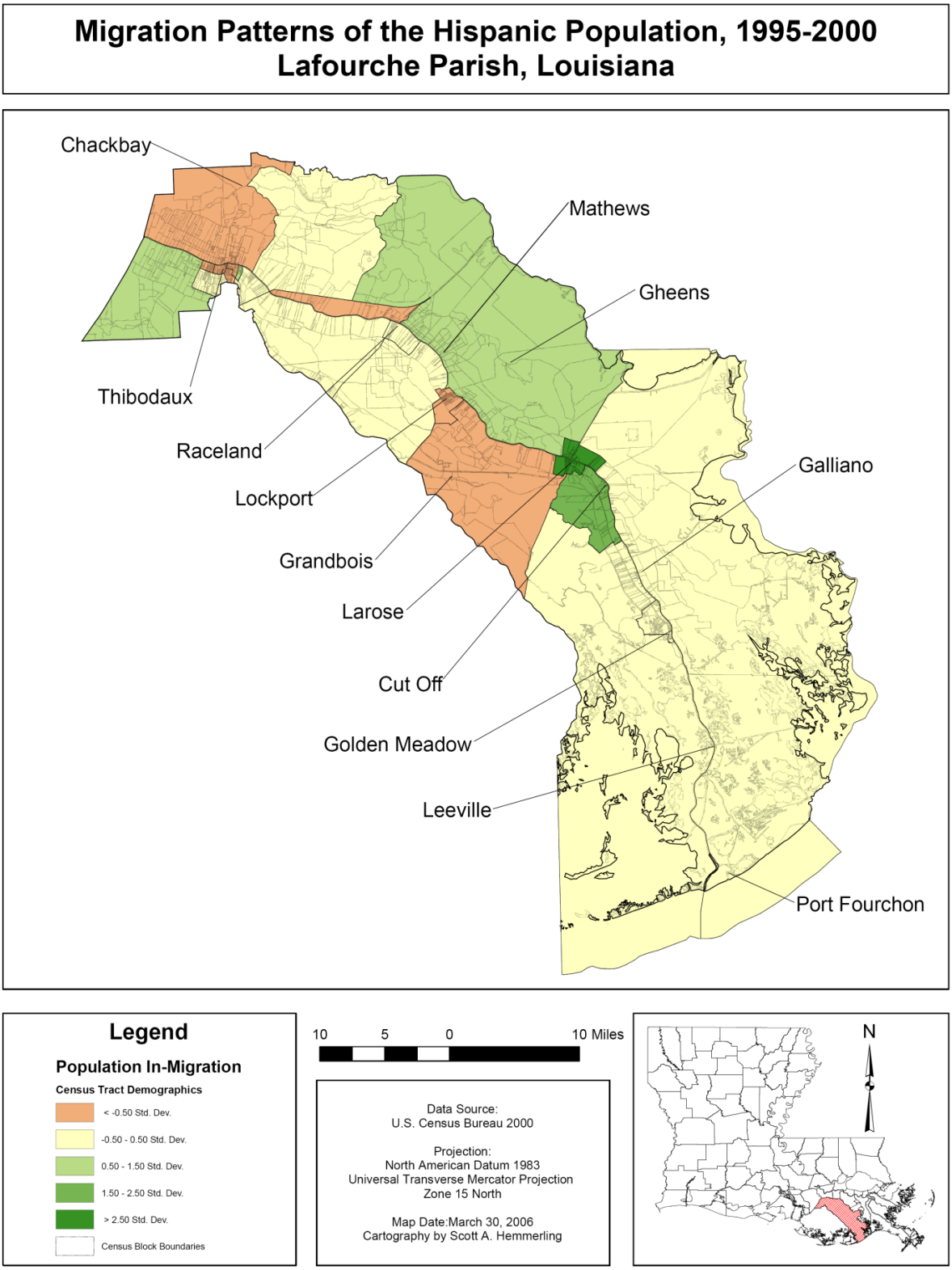


Figure 59. Migration patterns of the Hispanic population, 1995–2000, Lafourche Parish, Louisiana.

Jefferson Parish Migration Patterns

Jefferson Parish, historically, was the center of early oil development in southeast Louisiana. Oil-related development in the area was concentrated around two principal areas, both on the west bank of the Mississippi River. The first was the oil fields. Early on, the vast majority of oil field development centered in the Barataria Region of the parish, especially in the vicinity of Lafitte and Barataria in oil fields of the same names. During this time, the more industrialized communities along the west bank of the Mississippi River were the locations of many of the support industries, particularly petroleum bulk storage facilities. Only later were oil fields such as the Westwego, Avondale, and Bayou Segnette fields developed in the more northerly portion of the West Bank. At the same time that oil-related industries were expanding on the West Bank, the East Bank communities, such as Kenner and Metairie, were developing into suburban residential communities, largely populated by residents of New Orleans.

In this portion of the analysis, we first examine the migration patterns for Jefferson Parish as a whole, then we divide the parish into census tracts on the East Bank and those on the west bank of the Mississippi River. We would expect to find very different reasons for settling in each of these areas that would be quite different from the parish as a whole. Once again stepwise multivariate analysis enables us to model inmigration into the census tracts. For the parish population as a whole, the following regression model was developed:

Census Tract Total Inmigration = 46.009 + 0.537 Percent Industrial Land + 0.385 Population Density – 0.239 Absolute Levels of Black/White Segregation – 0.273 Median Rent – 0.242 Age of Housing Stock

Results are almost identical those found in the model developed for the three-parish study area, likely due to the large total population of Jefferson Parish. The primary difference is that in Jefferson Parish, contrary to the entire region, people are moving into more densely populated areas. Another difference is that in Jefferson Parish, we see that populations are migrating into census tracts with low levels of absolute segregation between the African-American and the white population, suggesting that in Jefferson Parish as a whole there has been a tendency to migrate into more integrated census tracts.

The white population, however, still appears to be moving into census tracts where they are largely segregated from the African-American and Hispanic populations, though they tend to be moving into areas with higher levels of Native Americans:

Census Tract White Inmigration = 90.918 + 0.998 Black/White Segregation + 0.241 Hispanic/White Segregation + 0.246 Absolute Levels of Black/White Segregation – 0.115 Travel Time to Work – 0.114 Percent Industrial Land – 0.112 Native American/White Segregation

It would thus appear that the white population has tended to move away from the more industrialized areas of the parish into areas where the Native American population had resided, suggestive of a move into the more rural areas of the parish (Figure 61). The map of white migration shows this, to some extent. Although the primary areas into which the white population has moved are in the census tracts along the lakefront in northern Jefferson Parish and

the Harahan/Elmwood district, across the Mississippi River from the communities of Waggaman and Avondale, there is also a significant level of inmigration into the census tract containing the rural communities of Lafitte, Jean Lafitte, and Barataria. The regression analysis indicates that the census tracts into which the white population is moving also have shorter travel times between the home and workplace, indicating that these census tracts are either in proximity to the places of employment or closer to convenient transportation routes.

The African-American population, on the other hand, shows a propensity to move into more industrialized areas where the house values are lower:

Census Tract African-American Inmigration = 30.598 + 0.803 Black/White Segregation – 0.137 Median House Value + 0.086 Percent Industrial Land

These communities largely are located on in the industrial districts of the West Bank as well as along the Airline Highway on the East Bank (Figure 62). The African Americans living in these areas are also largely segregated from the white population. Similarly, the Asian and Hispanic communities also tend to move to census tracts in which they are segregated from the white population:

Census Tract Asian Inmigration = 2.048 + 0.325 Asian/White Segregation + 0.317 Population Density – 0.216 Age of Housing Stock + 0.196 Percent Industrial Land

Census Tract Hispanic Inmigration = 1.989 + 0.480 Hispanic/White Segregation + 0.188 Median Rent + 0.296 Absolute Levels of Absolute Hispanic/White Segregation

However, the Asian population appears to be moving into more densely-populated industrial areas where there is a greater proportion of more recently constructed housing, as opposed to the lower value housing that the African-American population in Jefferson Parish has tended to move into. For example, although we see some areas along Lake Pontchartrain where the Asian population is moving, we also see significant Asian migration into areas of Avondale as well as the census tracts along the West Bank Expressway between Marrero and Westwego (Figure 63). Similarly, the Hispanic community, although they also tend to move into more segregated Hispanic census tracts, generally move into areas where the median contract rents are higher, including areas of the lakefront on the border of Kenner and Metairie, and on the Orleans Parish border on the Westbank near Terrytown (Figure 64). The Hispanic population, like the white population, tends to avoid some census tracts, especially those located in Waggaman and along the southern portion of the Harvey Canal, areas into which significant numbers of African-Americans tend to be moving.

In the case of each of these minority groups, it appears that, to some extent, housing variables are driving the population migrations, whether it is low property values in the case of African-Americans, newer housing in the case of Asians, or higher quality rental properties in the case of the Hispanic population. Interestingly, these populations also occupy census tracts where they are more segregated from the white population. Contrast this with the results of the following estimated regression model for the Native American population in Jefferson Parish:

Census Tract Native American Inmigration = 0.800 – 0.256 Employed in the Same Town

The regression model suggests that the Native American population is moving into census tracts where very few residents work in the same town in which they live, including Waggaman and the census tracts south of Marrero, on the boundary of the parish's industrialized areas (Figure 65). However, there is not a significant relationship between Native American migration patterns and travel time from the residence to the place of employment, meaning that the Native American population may not be moving into census tracts where their jobs are located, but they also may not be significantly altering their travel time to work.

To more effectively examine the migration patterns within Jefferson Parish, it is necessary to separate the more industrial West Bank from the more residential East Bank. We suggest that there is a bifurcation of migration patterns between the two banks of the Mississippi River that is masked when we examine the migration patterns of the parish as a whole.

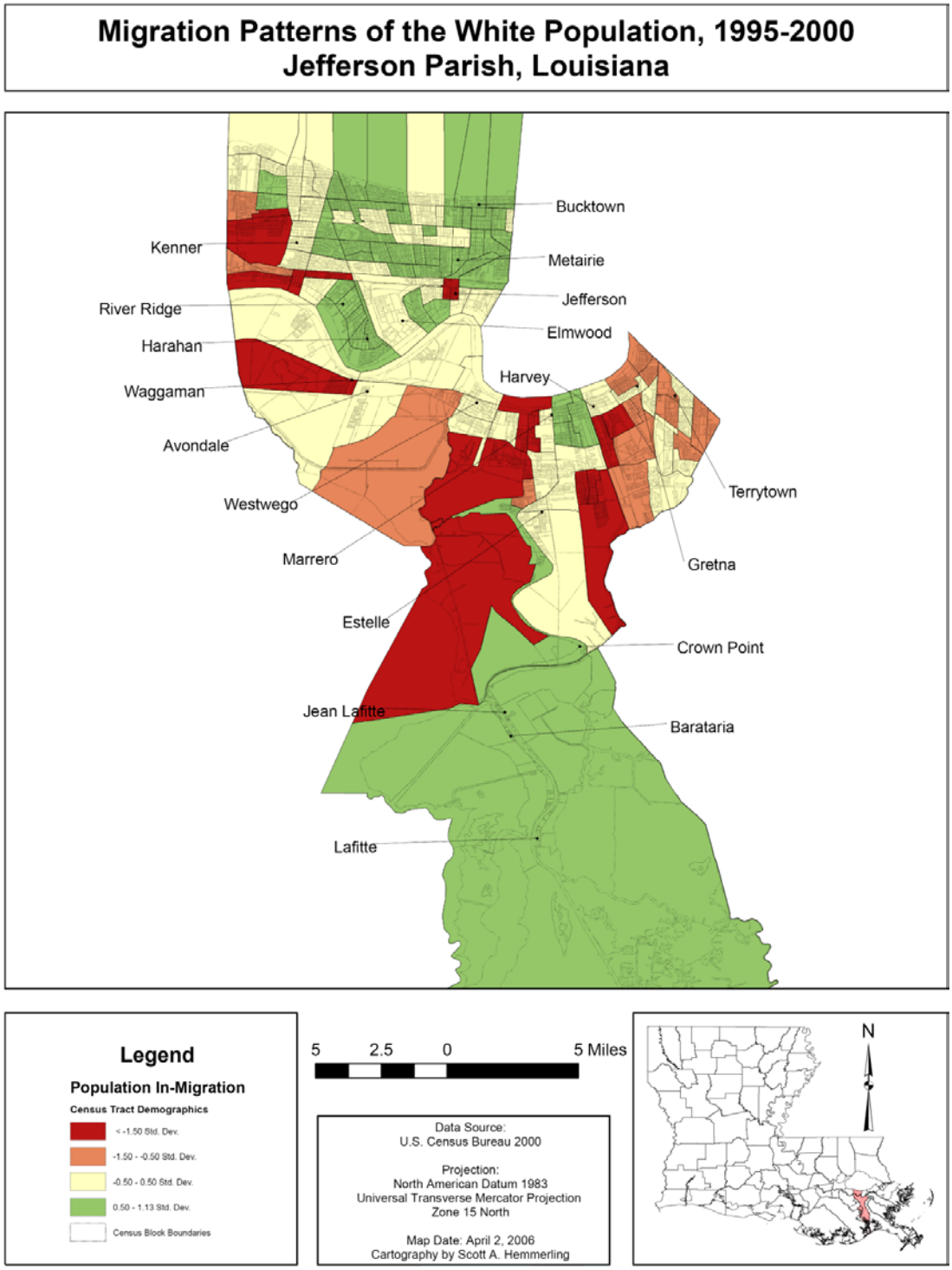


Figure 60. Migration patterns of the white population, 1995–2000, Jefferson Parish, Louisiana.

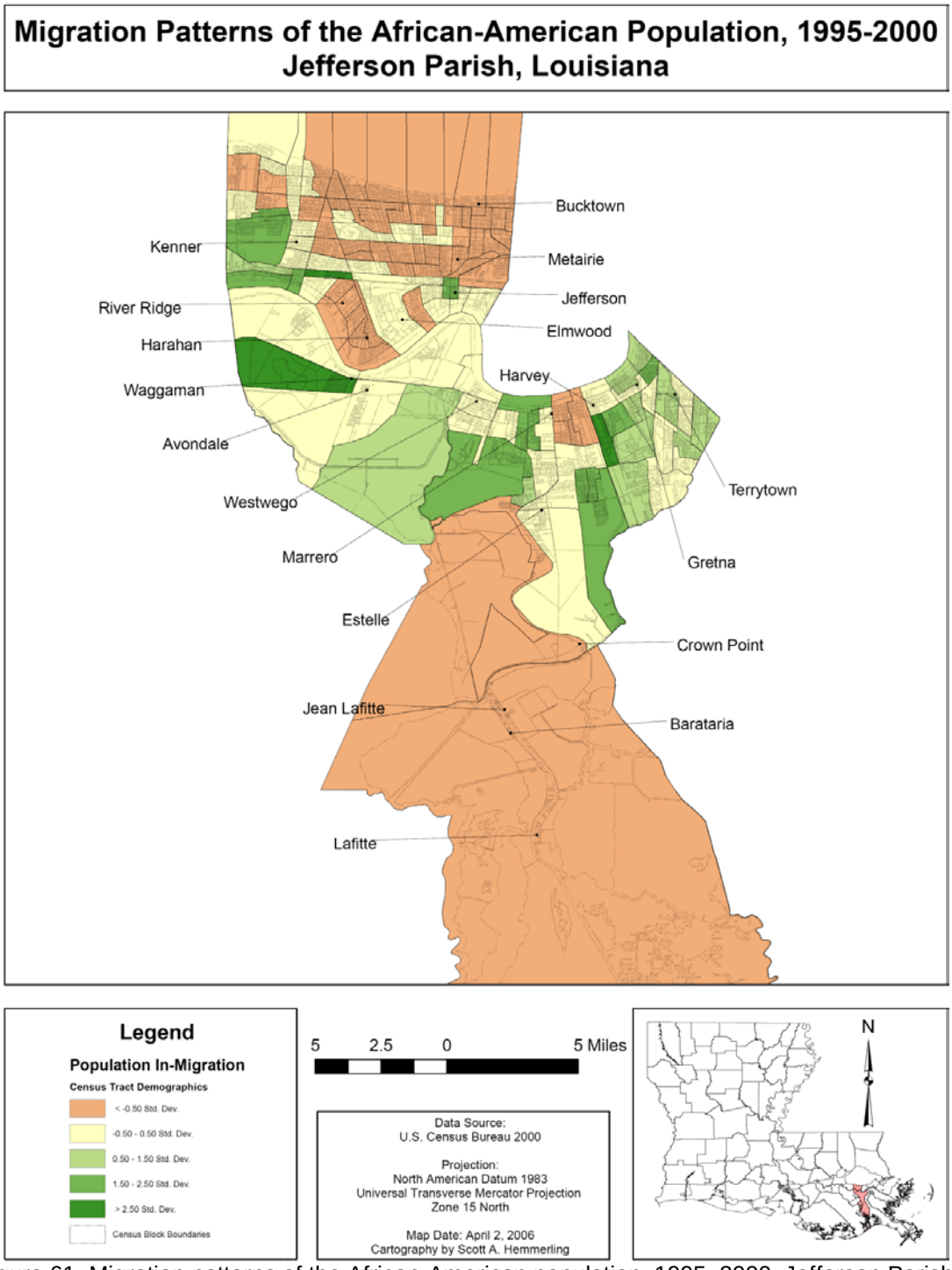


Figure 61. Migration patterns of the African-American population, 1995–2000, Jefferson Parish, Louisiana.

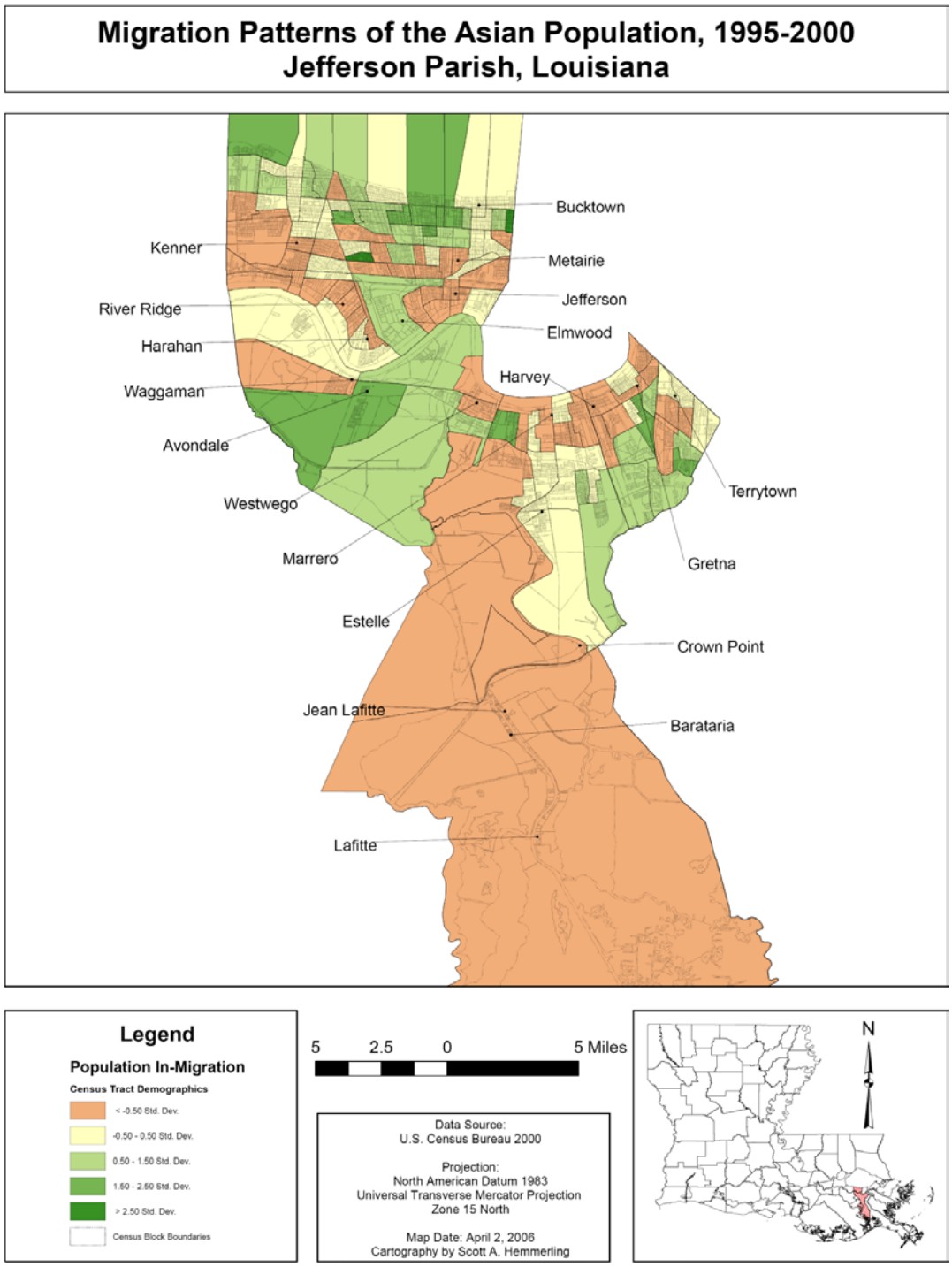


Figure 62. Migration patterns of the Asian population, 1995–2000, Jefferson Parish, Louisiana.

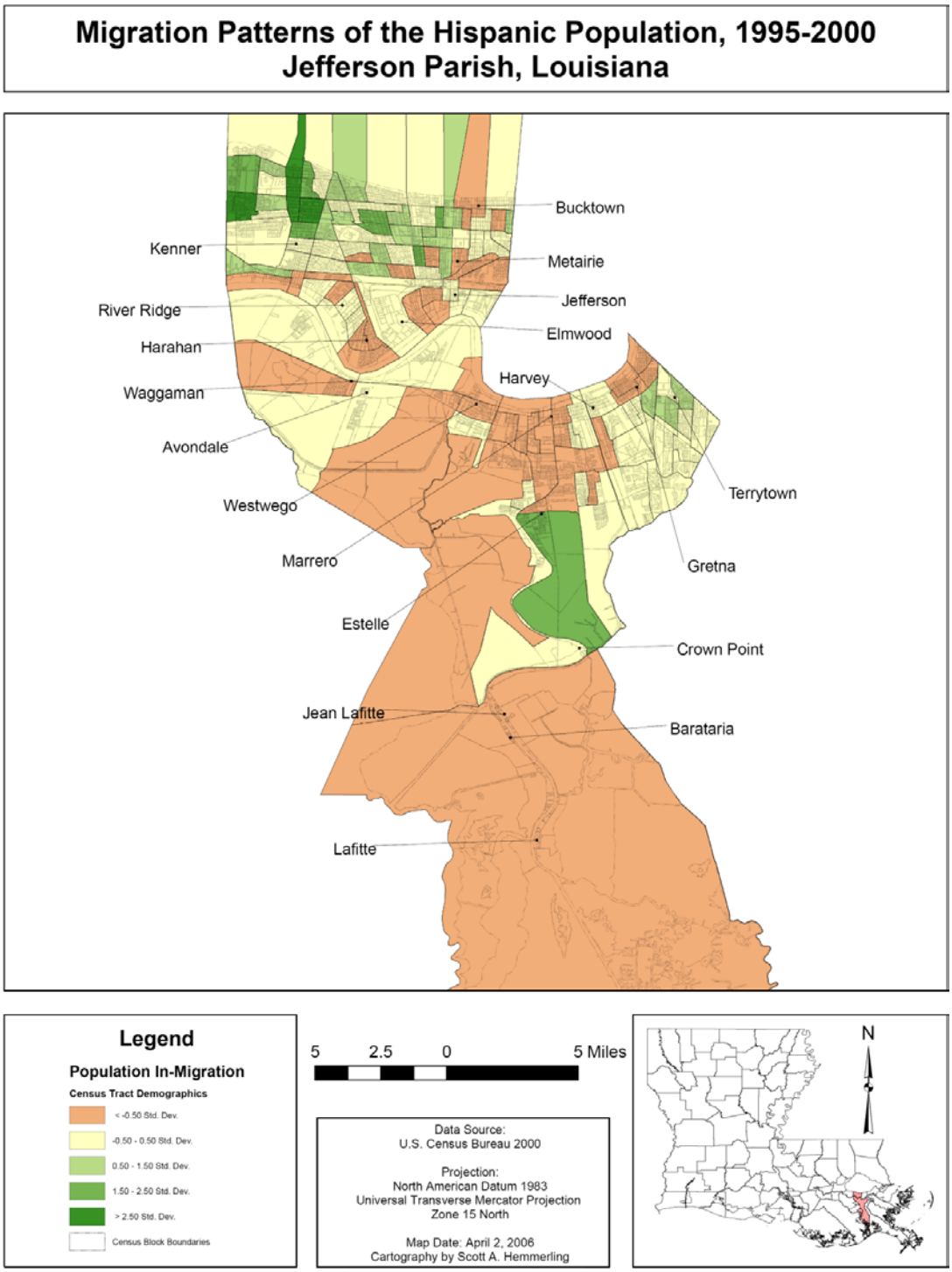


Figure 63. Migration patterns of the Hispanic population, 1995–2000, Jefferson Parish, Louisiana.

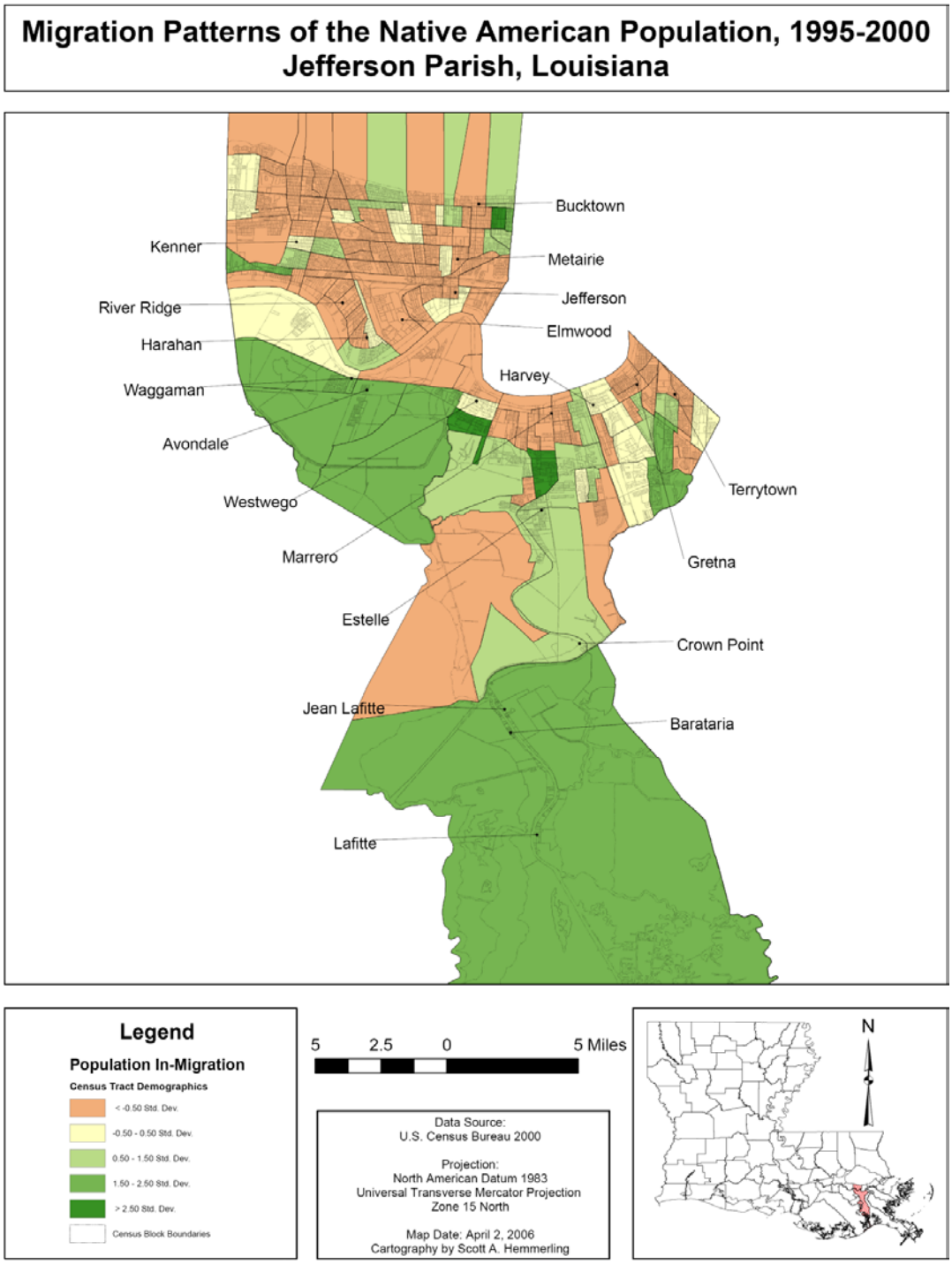


Figure 64. Migration patterns of the Native American population, 1995–2000, Jefferson Parish, Louisiana.

Jefferson Parish East Bank Migration Patterns

There are slight differences when migration of the total population of the East Bank is examined. In particular, racial variables do not appear to be significant:

Census Tract Total Inmigration = 13.679 + 0.775 Percent Industrial Land + 0.462 Population Density

These results suggest that the primary factor in population migration is population density along with the presence of nearby industry. When we examine the white population alone, a more complex pattern emerges:

Census Tract White Inmigration = 91.335 + 0.556 Black/White Segregation + 0.326 Hispanic/White Segregation – 0.114 Percentage Employed in the Oil Industry – 0.092 Percent Industrial Land – 0.223 Absolute Levels of Black/White Segregation – 0.201 Percentage Employed in Manufacturing + 0.217 Asian/White Segregation + 0.181 Absolute Levels of Asian/White Segregation

In the more residential East Bank of Jefferson Parish, the white population tends to avoid census tracts that have high levels of African-Americans, Asians, and Hispanics. However, there also appears to be some movement of the white population into more integrated census tracts, signified by lower levels of absolute segregation between the African-American and white populations. In some cases, these results signify that some degree of gentrification might be occurring on the East Bank of Jefferson Parish.

In addition to avoiding areas with large concentrations of minority residents, the white population also appears to generally avoid moving in to "blue-color" neighborhoods where a number of residents are engaged in industries such as oil and gas extraction and manufacturing. The white population on the East Bank also tends to avoid census tracts where there is considerable industrial land use. Conversely, the African-American population has migrated into more segregated, blue-collar census tracts:

Census Tract African-American Inmigration = 0.585 + 0.719 Black/White Segregation + 0.240 Absolute Levels of Black/White Segregation + 0.188 Percentage Employed in Manufacturing + 0.153 Tons of Air Pollutants + 0.091 Percent Employed in the Oil Industry – 0.105 Median Contract Rent – 0.085 Age of Housing Stock

Notice that, whereas the white population has migrated into more segregated census tracts, the African-American population has significantly moved into areas with significant segregation levels. This supports the contention that there is some degree of gentrification occurring on the East Bank. The African-American population is also moving into areas where the median contract rent is significantly lower, and these areas appear to be those with lower air quality levels. This definitely suggests that market dynamics and low housing costs do, in fact, make areas with lower environmental quality more attractive to certain minority groups (Been 1994). The fact that much of this housing stock may be newer than houses found elsewhere in the parish

may be indicative of the historical quality of many of the homes in the older areas of the parish, such as Old Metairie.

The Hispanic population tends to migrate into communities where they are segregated from the white population and to generally avoid integrated areas as well:

Census Tract Hispanic Population = 11.499 + 0.382 Hispanic/White Segregation –0.201 Age of Housing Stock + 0.340 Absolute Levels of Hispanic/White Segregation

Unlike the African-American population, the Asian community on the East Bank of Jefferson Parish has generally not migrated into manufacturing blue-collar census tracts on the East Bank, though the proportion of the census tract population employed in the oil industry is not significant:

Census Tract Asian Population = 6.356 + 0.519 Asian/White Segregation – 0.229 Percentage Employed in Manufacturing

With the exception of the Native American population, which has not migrated into areas of the East Bank in any significant numbers, the degree to which each of the minority groups are segregated from the white population becomes significant. It appears that the forces driving migration patterns on the East Bank of Jefferson Parish tend to center on push-pull forces, particularly in terms of choices to reside in proximity to those of the same race or ethnicity. In terms of the white population, there are other factors working, as well, particularly a classical invasion-succession pattern that results from the white population moving into census tracts that are becoming integrated, while the African-American population is moving into more segregated portions of the parish that have both increased levels of air pollution and lower house values.

Jefferson Parish West Bank Migration Patterns

The patterns on the west bank are similar in many ways to those on the East Bank in that racial segregation appears to be driving many of the minority migration patterns. Overall, however, the migration patterns appear to be driven by proximity to the workplace:

Census Tract Total Inmigration = 59.907 – 0.338 Travel Time to Work + 0.307 Hispanic/White Segregation

This would suggest that the total population may not be moving into the same towns in which they are employed, but they are moving into census tracts that are closer to their jobs. When broken down into the white population and the various minority groups, this factor is not significant, however. Only the Hispanic population migration appears to be significantly driven by job-related factors:

Census Tract Hispanic Inmigration = 8.311 – 0.399 Employed in the Same Town

Significantly, the Hispanic population appears to move into census tracts where many residents are employed in that same tract. Interestingly, the overall results suggest that most of

the population migration on the west bank avoids areas where the Hispanic population tends to be segregated. This seems to suggest that the Hispanic population will choose housing closer to their places of employment than will any of the other groups, which generally reside in the surrounding census tracts.

The white, African-American, and Asian populations appear to move into specific census tracts due largely to the degree of segregation present in these tracts. The white population, for example, tends not to move into census tracts where there are higher levels of African-American and Hispanic segregation:

Census Tract White Inmigration = 55.222 + 1.485 Black/White Segregation + 0.737 Absolute Levels of Black/White Segregation + 0.182 Hispanic White Segregation

Thus, the white population on the west bank of Jefferson Parish, as on the East Bank, tends to avoid areas with high levels of African-American concentration. Unlike on the East Bank, however, we see that the white population also avoids areas where the African-American and white populations are more segregated, signified by the higher level of absolute segregation between these populations.

This stands in sharp contrast to the population dynamics of the African-American population:

Census Tract African-American Inmigration = 32.156 + 0.158 Black/White Segregation – 0.736 Absolute Levels of Black/White Segregation

The negative value for the absolute levels of segregation between the African-American and white populations suggests that different processes are occurring on the west bank than those found on the east. On the west bank, we find that the white population tends to migrate into areas where they are completely segregated from the African-American population. The African-American population, conversely, appears to be moving into census tracts that are more integrated. This would, as on the East Bank, seem to suggest a classic invasion-succession scenario. On the East Bank, this pattern appeared to be one of gentrification. On the west bank, however, this process appears to be one of white flight, with the African-American population moving into more integrated census tracts and the white population avoiding these tracts by moving into areas where the white population is more highly segregated.

The migration of the Asian population on the west bank also appears to be largely driven by segregation, in this case by the absolute levels of segregation:

Census Tract Asian Inmigration = 2.037 + 0.471 Absolute Levels of Asian/White Segregation

The fact that Asian population migrations were driven only by the absolute levels of segregation would seem to imply that Asian population migration has a bimodal distribution, with the population moving into census tracts that contain either segregated white or segregated Asian populations.

St. Bernard Parish Migration Patterns

Historically, St. Bernard Parish has had an extremely segregated population, especially in terms of the African-American and white populations. One study indicates that much of the inmigration into St. Bernard Parish in the years following World War II, when schools were legally required to integrate African-American and white students, was largely the result of white flight from the Ninth Ward of neighboring New Orleans. This study also points out that much of this migration of the white population into St. Bernard Parish was in part due to new jobs in the Kaiser Aluminum Plant and the oil refineries in Chalmette and Meraux, access to inexpensive land, and housing funds for war veterans (Wells 2004). A statistical examination of modern migrations into St. Bernard Parish reveals that many of these factors continue to drive population movements, as indicated by the following regression model:

Census Tract Total Inmigration = 39.721 + 1.426 Asian/White Segregation + 0.904 Absolute Levels of Asian/White Segregation + 0.513 Percentage Employed in the Oil Industry – 0.410 Median Contract Rent + 0.233 Work in the Same Town

It would appear that the driving factor in terms of all population groups is the ability to live in the same town in which one works, which tends to correlate with employment in the oil industry. It would also appear that these locations tend to have lower contract rents. Interestingly, the only racial variable that appears to be significant in the overall migration into St. Bernard Parish census tracts is the percentage Asian. This is possibly explained, to some extent, by the census tracts into which the Asian population has migrated. The Asian population is the only population that has moved in significant numbers into the census tracts containing Meraux with its large oil refinery, a fact highlighted by the results of the regression model for the Asian population:

Census Tract Asian Population = 0.976 + .569 Tons of Air Releases

Notice that the Asian population cannot be shown to be moving into areas based on the presence or absence of other Asian residents. Housing factors do not appear to be significant, either in terms of house values or rent levels. The above model accounts for just under one third of the total variability in the migration of the Asian population, however, suggesting that there are other significant variables not accounted for in the regression model that would explain why the Asian population is moving into the Meraux and the census tract downriver (Figure 66). Other possible explanatory variables include: segregation from the other minority groups, employment in business sectors other than oil or manufacturing, or other intangible neighborhood quality factors. In any case, the levels of segregation between the Asian population and the white population do not prove to be significant in the regression model for the white population:

Census Tract White Inmigration = 23.692 + 0.681 Black/White Segregation + 0.523 Age of Housing Stock + 0.315 Median Rent + 0.180 Absolute Levels of Native American/White Segregation

As this model shows, the white population migrates in significant numbers into census tracts in which they are segregated from the African-American population. As the map (Figure 67) of

white migration in St. Bernard Parish shows, this includes most of the census tracts in and around Arabi, Chalmette, and Meraux, though the census tract bordering the Ninth Ward of New Orleans is avoided, as is the area directly on the main transportation route in Meraux, which includes the large oil refinery. The white population has tended to move into areas with high absolute segregation levels between the Native American and white populations. This would suggest a bifurcation in migration patterns, with part of the white population seeking out census tracts where the Native American population generally has not settled together, specifically in the more urban tracts in Chalmette and Meraux, and another segment of the white population moving into areas of the parish where the Native American community has tended to be more segregated from other population groups, specifically the rural areas beyond Toca and Kenilworth. This is not to suggest that the white populations necessarily avoid the Native American population. Rather, the data suggests that the white population is becoming more rural, moving into areas traditionally home to large numbers of Native Americans.

The African-American population in St. Bernard Parish has likewise migrated into census tracts where they are highly segregated from the white population:

Census Tract African-American Inmigration = 41.802 + 1.307 Black/White Segregation + 0.696 Absolute Levels of Black/White Segregation – 0.377 Age of Housing Stock – 0.216 Median House Value

The significance of both the general and absolute levels of segregation indicates that the African-American population is moving into census tracts with high levels of African-American segregation, avoiding even areas where there is some amount of integration between themselves and the white population (Figure 68). Significantly, these census tracts also have older, low-value housing.

The Native American population, as we saw in many of the other case studies, has tended to migrate into census tracts for economic reasons:

Census Tract Native American Inmigration = 1.950 + 0.616 Percentage Employed in Manufacturing + 0.552 Native American/White Segregation

An examination of the census tracts into which the Native American population has migrated indicates that, with the exception of a single census tract in Chalmette, they have moved into the more rural census tracts, with the most significant numbers moving into the census tract containing Toca and Kenilworth (Figure 69). These census tracts continue to have significant numbers of Native Americans living relatively segregated from the white population, though the inmigration of white population into these tracts could change this. The Native American population is the only population group that has moved into census tracts in proximity to the refinery in Chalmette and the gas processing plants in Toca and Yscloskey, explaining, in part, the results of the regression model.

Finally, when we examine the spatial pattern of Hispanic population migration, we see what appears to be a bimodal distribution, with the most significant number of Hispanics moving into the rural census tracts of the parish and less significant clusters upriver of the refineries along the

border of St. Bernard Parish with New Orleans' Ninth Ward (Figure 70). The only explanatory variable is a strong negative correlation with the tons of air releases:

Census Tract Hispanic Inmigration = 9.763 – 0.718 Tons of Air Releases

This regression model, along with an examination of the map of Hispanic migration reveals that the Hispanic population has significantly not moved into the census tracts in Chalmette and Meraux, downriver to Violet and Poydras. A likely explanation for the bimodal distribution is that the rural population considered Hispanic by the U.S. Census Bureau are Isleños, descendants of Canary Islanders brought to Louisiana during the time of Spanish Rule in the eighteenth century. The more urbanized population is likely a combination of Isleños and other Hispanics moving into St. Bernard Parish from New Orleans.

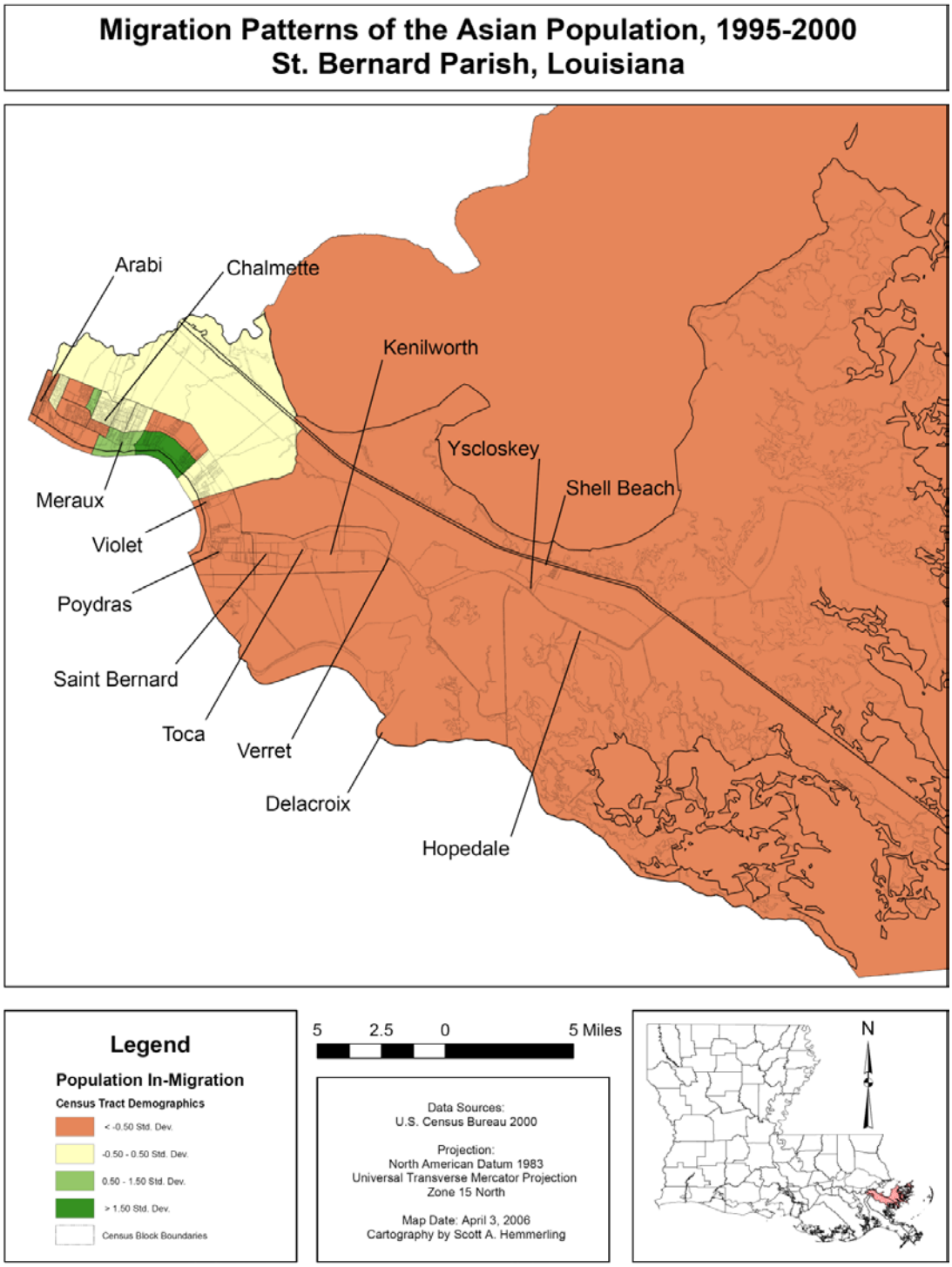


Figure 65. Migration patterns of the Asian population, 1995–2000, St. Bernard Parish, Louisiana.

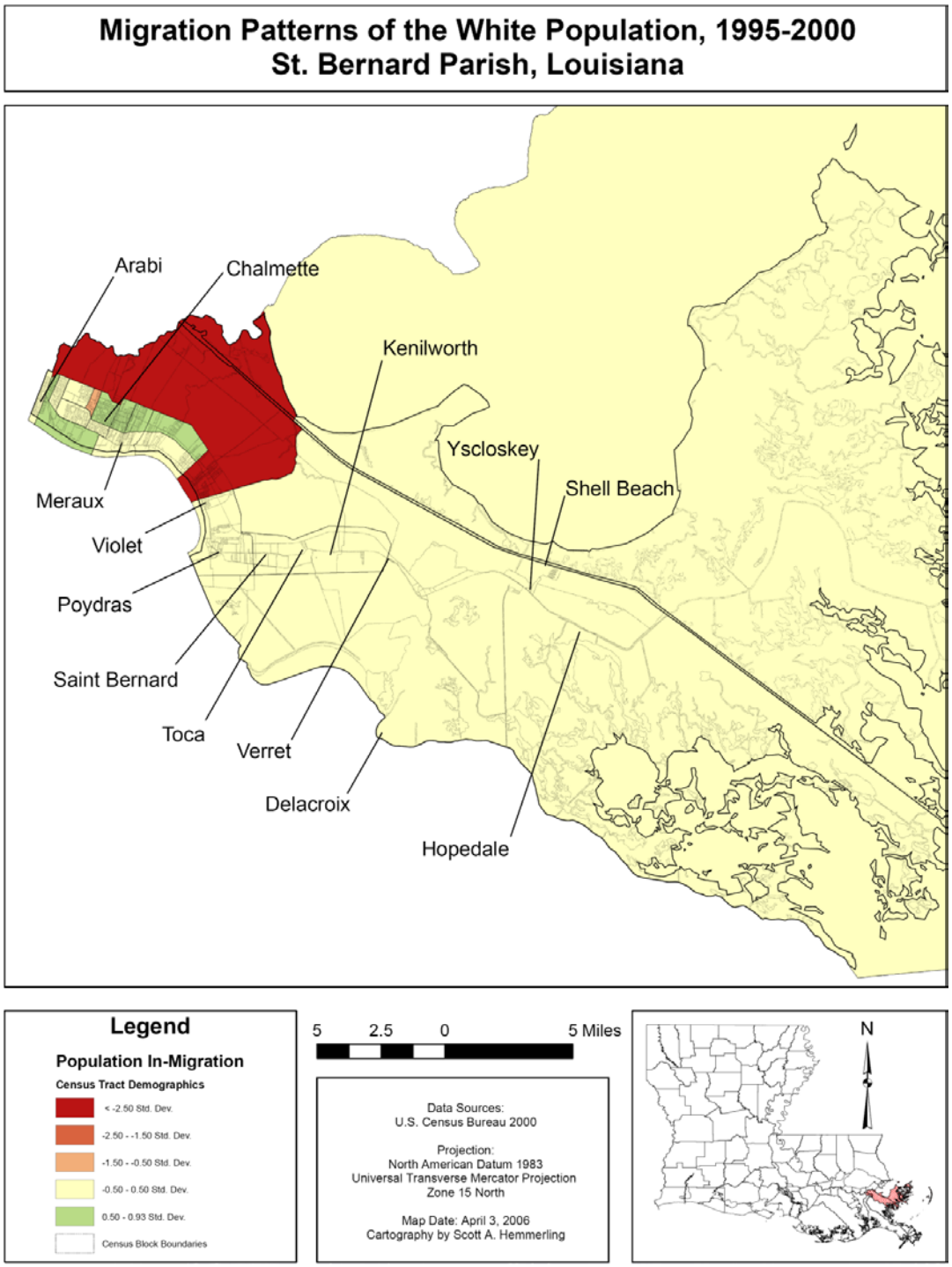


Figure 66. Migration patterns of the white population, 1995–2000, St. Bernard Parish, Louisiana.

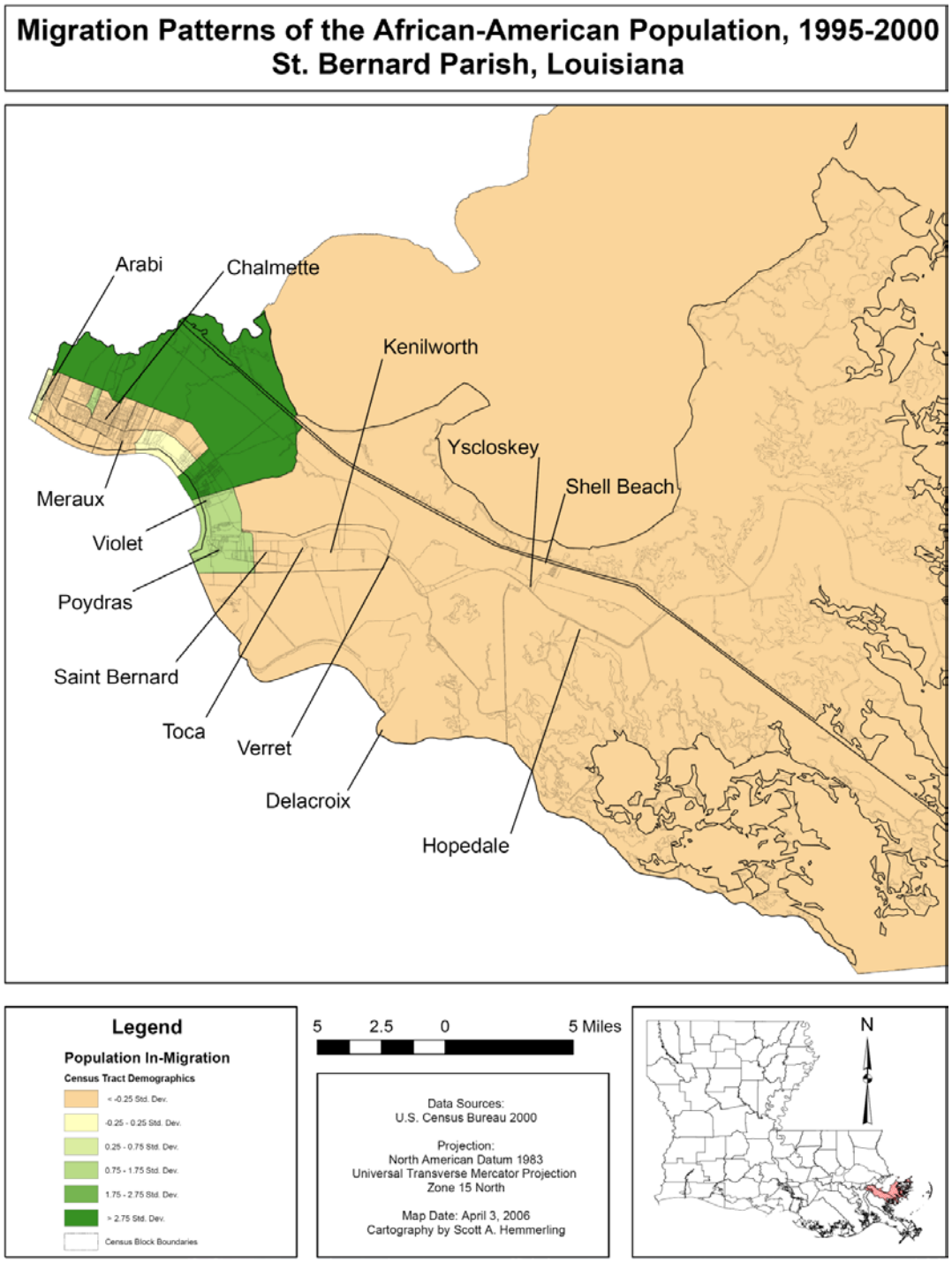


Figure 67. Migration patterns of the African-American population, 1995–2000, St. Bernard Parish, Louisiana.

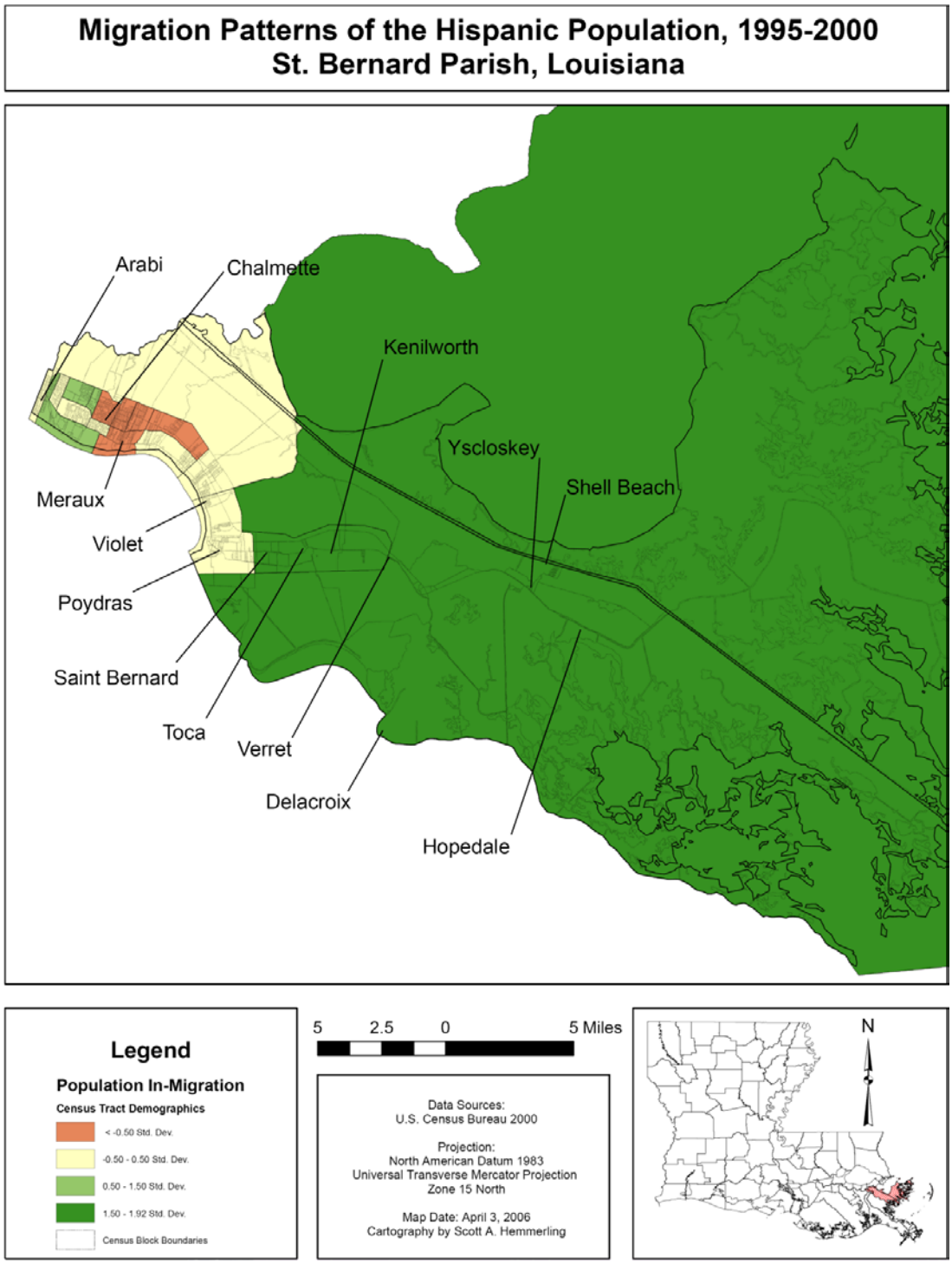


Figure 68. Migration patterns of the Hispanic population, 1995–2000, St. Bernard Parish, Louisiana.

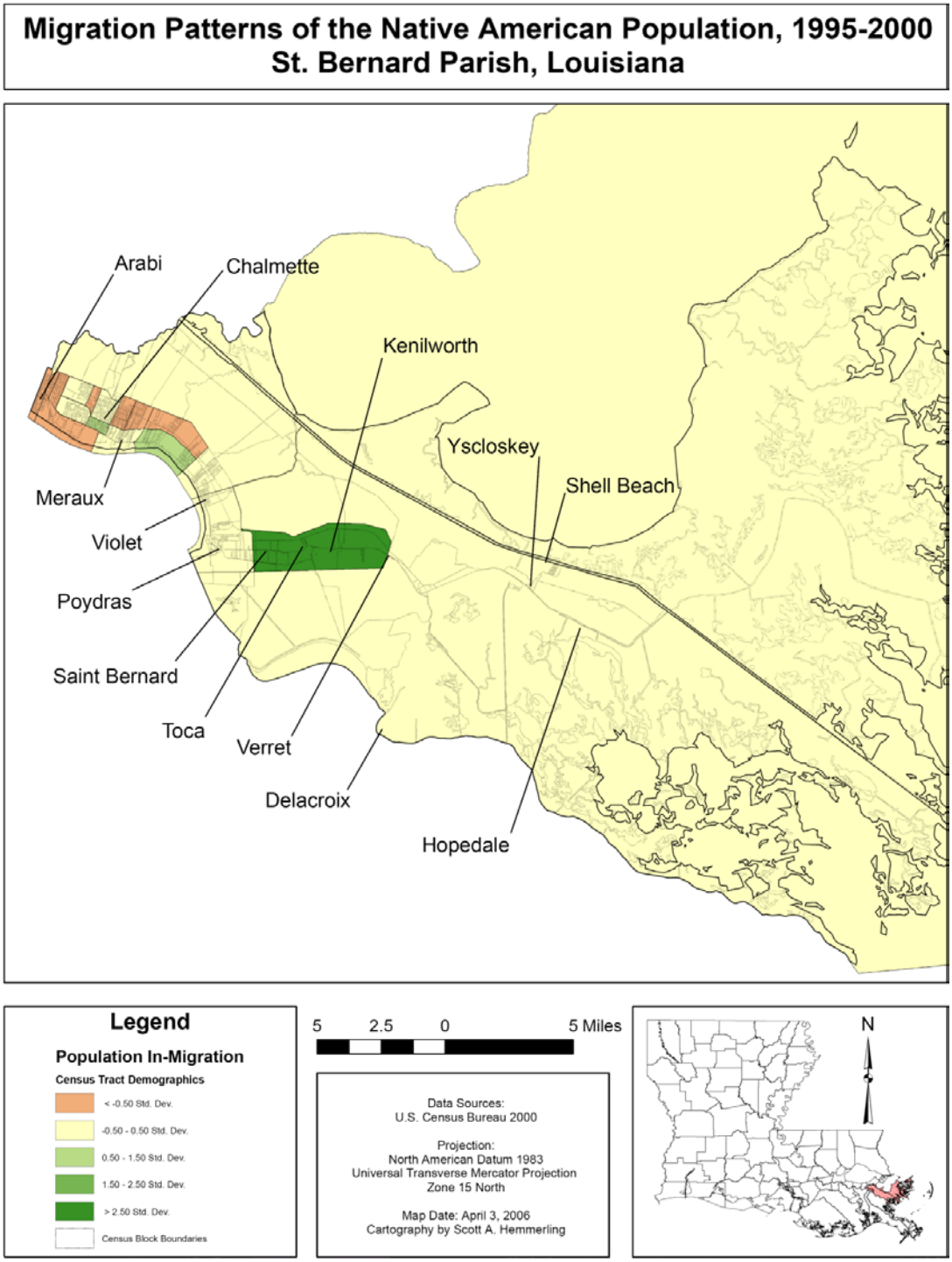


Figure 69. Migration patterns of the Native American population, 1995–2000, St. Bernard Parish, Louisiana.

CHAPTER 5. CONCLUSIONS

Many differing patterns of present-day environmental justice emerge in our case study parishes, from the impact of shipyards and gas plants on Lafourche Parish's Houma population to the siting of petroleum bulk storage in the heavily urban areas of Jefferson Parish's west bank. In this research, we have created a number of localized hazard models, geared specifically to each sector of the oil industry. Of the three sectors of the oil industry explored in this study, we found that offshore oil-related hazards are the most dispersed, and thus the least overtly hazardous. This is due in large part to the fact that the actual extraction sites are located far offshore, away from any human habitation. As a result, industries have fewer constraints on where to locate their facilities. Though Port Fourchon, for example, is clearly a convenient place for offshore support industries to locate, relative to proximity to the offshore wells, it is economically feasible to use other sites. Thus, we see shipyards located all along Bayou Lafourche, from Fourchon to Golden Meadow, up through Larose and Lockport. Petroleum bulk storage facilities occupy locations in many communities across south Lafourche, with a larger facility in north Lafourche. All types of offshore-related facilities are located in adjacent parishes and other states, as well, reducing the overall hazardousness of the region, despite dense population concentrations along the bayou.

The other two sectors are much more constrained in their siting choices, economically, geographically, and politically. In Jefferson Parish, the onshore-related infrastructure must necessarily be placed in the immediate vicinity of the oil fields. Thus there is a much greater clustering of facilities and, consequently, hazardousness. Petroleum refining requires large-scale facilities, a trained labor force, and access to a transportation infrastructure and large amounts of water for reactive and cooling purposes. In south Louisiana, these requirements significantly limited potential siting locations for large refineries. In addition, there are strong political incentives and disincentives that also limit the siting of such a potentially hazardous facility.

As would be expected, the refining district in St. Bernard Parish dominates the overall hazardscape. Nonetheless, when we explore the risk surface statistically, localized high points around Marrero, the Barataria and Avondale fields, and the gas plants in rural St. Bernard Parish also stand out, despite much lower relative values. Though the localized high hazard areas in Lafourche are still significant, they are statistically much less so than in the other two regions.

The flexibility in locating new facilities results in offshore oil-related infrastructure falling lower on the potential hazardousness scale than the onshore extraction and petroleum refining industries. The more dispersed the industries, the less the cumulative potential risk to the region. However, the dispersal of the industries also means that more people are exposed to their potential hazards, albeit at lower levels. In theory, however, increased dispersion should facilitate a more equitable distribution of environmental hazards. In concentrated industries, such as oil refining, we find that the potential impact is limited to a small number of nearby communities, creating an opportunity for extreme cases of environmental injustice.

Further analysis, however, reveals that social and economic factors often cause the levels of environmental equity to subtly shift. Our historical analysis reveals that there is very little evidence of systematic environmental injustice in the siting procedures of various oil-related industries, though certain individual facilities have been sited in minority communities. In most cases, the demographic makeup of the community changed after the facilities arrived. In the case of St. Bernard Parish, a blue-collar suburb of New Orleans, the proportion of African Americans dropped precipitously after the siting of two oil refineries in Chalmette and Meraux. Today, residents are moving into neighborhoods with concentrations of their own race or ethnicity, and they are moving to places closer to their jobs. New residents are moving into Lafourche Parish to live in the town where they work. When examined in more detail, we find that Native American and Hispanic residents are moving into communities in south Lafourche where the oil industry is a major employer.

The fact that minority residents may be moving into communities where potential hazards are already present does not lessen the responsibility of governmental agencies, under federal environmental justice guidelines, to assure that minority residents have access to accurate and up-to-date data about neighborhood health risks so that individuals can make informed decisions about their residence. Similar protections should be afforded to residents who choose to hunt or fish in areas proximate to potentially hazardous facilities. A more inclusive environmental justice agenda needs to acknowledge and protect the health and safety of the ecosystem on which a wide variety of people depend for subsistence, traditional, cultural, and religious purposes.

By addressing issues of industrial risk, aquatic and terrestrial wildlife, and consumption, this study provides but one example of how environmental justice research can move beyond the traditional residential exposure model towards a more place-specific model that includes the social and cultural context.

Finally, it is important that agencies with oversight responsibility remain vigilant, especially when an area is home to disproportionately large minority or low-income populations. Even when minority or low-income residents have moved into potentially hazardous neighborhoods, that community is still entitled to consideration under the federal environmental justice implementation guidelines.

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The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the sound use of our land and water resources, protecting our fish, wildlife and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island communities.

The Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) works to manage the exploration and development of the nation's offshore resources in a way that appropriately balances economic development, energy independence, and environmental protection through oil and gas leases, renewable energy development and environmental reviews and studies.