2016

Ballot-Box Environmentalism across the Golden State: How Geography Influences California Voters' Demand for Environmental Public Goods

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BALLOT-BOX ENVIRONMENTALISM ACROSS THE GOLDEN STATE

HOW GEOGRAPHY INFLUENCES CALIFORNIA VOTERS' DEMAND FOR ENVIRONMENTAL PUBLIC GOODS

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In partial fulfillment of a Bachelor of Arts Degree in Environmental Analysis,
2015-16 academic year, Pomona College, Claremont, California

Readers:
Bowman Cutter
Char Miller

Many thanks to my advisors and readers,
Professors Bowman Cutter and Char Miller,
for all your knowledge, advice, and support
that helped make this project a reality.

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Introduction: Politics, Economics, and Geography

In California, environmentalism is a particularly powerful political force. Schmidt (2007) contended that Californians are simultaneously pulled by the state's natural beauty even as they are pushed by many regions' notorious pollution problems, and by growing threats such as climate change to their long-term well-being. Moreover, California has become a de facto leader in environmental legislation for the United States. This leadership is exemplified by a legacy of recent laws including the Global Warming Solutions Act (AB-32), the 2006 law regulating carbon dioxide emissions (which in fact faced an unsuccessful challenge in a proposition discussed in this paper). As the world's ninth largest economy (if considered distinct from the other 49 United States) (Hertsgaard, 2012), California has bargaining power due to its large market-share; its environmental and economic decisions have the ability to impact the planet physically and economically. Proponents of environmental regulation hope and believe that these decisions will ensure—rather than limit—the state's long-term industrial success as well as the health of its people and environment, but this opinion is not universal. According to some sources, public support for environmental protection has declined since its peak around the twentieth anniversary of Earth Day in 1990 (Daniels, Krosnick, Tichy, & Tompson, 2012). Public opinion matters, and this is especially true in California, where many environmental regulations are decided through direct democracy, with the state's extensive ballot initiative and referendum system. An understanding of the factors that influence public support for environmental protection can shape how policymakers and advocates design environmental initiatives to be successful at the ballot box. The historical results of environmental decision-making through California's direct democracy—examined through the economic lens of demand for public goods—provide a detailed and first-hand source of this data on public opinion.

Direct democracy is a longstanding tradition in California dating back to the Progressive Era of the early 1900s. Before joining Theodore Roosevelt on the Bull Moose ticket in the presidential election of 1912, California governor Hiram Johnson successfully pushed through a State constitutional amendment for initiative, referendum, and recall, stemming from a "deep-rooted belief in popular government, and not only in the right of the people to govern, but in their ability to govern" (Johnson H. , 1911). California continues to lead the nation in its use of popular voting on citizen-initiated and legislatively-referred propositions, for statutes and for state constitutional amendments. Although the Progressives lauded initiatives as a populist check on moneyed corporate interests, a century later, given the resources needed to finance a proposition campaign, many are concerned that—"in a classic case of unintended consequences" (Callahan, 2012)—initiatives have become vehicles for wealthy interest groups to exercise disproportionate political power on state laws. Others are concerned that initiatives enable a "tyranny of the majority" that has marginalized minority populations (Johnson K. R., 2008). A close examination of California voting patterns makes it clear that the Golden State's populous areas tend to call the shots in regards to environmental and other propositions, but a great deal of variation in political preferences exists among these areas and across the state.

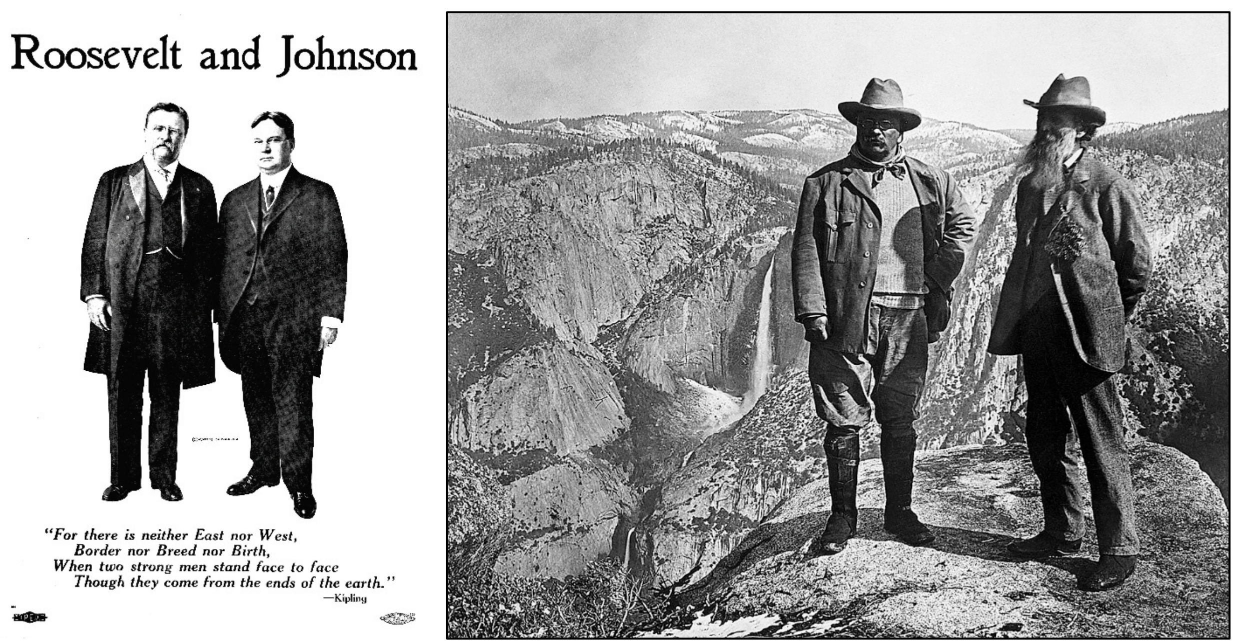

Figure 1. An era of emerging direct democracy as well as environmentalism. Left: President Theodore Roosevelt and California's Governor Hiram Johnson, on a political poster for the 1912 Progressive Party ticket (Allied Printing Trade Council, 1912). Right: President Theodore Roosevelt and John Muir at the incipient Yosemite National Park in California (Underwood & Underwood, 1903).

In California, voters are frequently faced with ballot initiatives and referendums (collectively, "propositions") dealing directly or indirectly with environmental protection. To evaluate environmental benefits in economic terms, economists consider the ecosystem goods and services that the environment provides. As public goods, environmental goods are collectively supplied (Deacon & Shapiro, 1975): the individual does not necessarily pay a unit price to benefit from a quantity of environmental quality like water or air purity. Because laws for environmental protection come at a direct or indirect cost to the taxpayer, individuals' voting records on state propositions can indicate their monetary willingness-to-pay (WTP) for the environmental public goods in question. While individual voters' decisions are confidential, voting records are publicly available at a high geographic resolution, so it is possible to analyze these records in conjunction with geographic space and local socioeconomic patterns to glean information about the demand for environmental public goods.

Many studies (e.g., Deacon & Shapiro, 1975; Kahn, 2002; Wu & Cutter, 2011) have focused on characterizing the relationship between income and demand, but the nature of this income effect is debated. Some studies have characterized environmental protection as a normal public good (demand increasing with income), while others (using what may be more robust methods) have found it to be an inferior public good (demand decreasing with income) or a combination of the two. The WTP of a good is also a function of its price, and in the case of the environment, this price is the cost of the regulation in question. The cost of the regulation is, in part, the sticker cost of the ballot initiative as it is distributed to the taxpayer (for example, the bond purchases that fund many successful environmental propositions in California must be paid back over the subsequent decades, often with total interest equal to its sticker price). Cost can also mean the indirect effects of the regulation on the voter's personal life; for example, a voter personally invested in resource-extractive industries like mining and forestry might be less likely to vote to impose a new profit-limiting environmental regulation.

The study of voters' environmental policy preferences lies at the intersection of economics and political geography, and beyond the income and price effects on environmental public goods there are various demographic, cultural, and geographic factors that also influence preferences. Whether these factors are truly influences in their own right (as Agnew (1996) argued), or merely proxies for income and price effects (as Kahn and Matsusaka (1997) asserted), or some mixture of the two, is up for debate. Environmental justice scholarship (e.g., Allen, 2001) suggests that demographics, particularly race, are predictors of exposure to poor environmental quality. If support for environmental policy is determined by personal perception of environmental conditions (Carman, 1998) then we should expect demographics to influence environmental policy support. Political ideology regarding self-determination and government intervention also transcends predictable socioeconomic preferences, and determines how much an individual—regardless of costs and benefits—would accept government-imposed environmental regulations. Ideology also determines the relative prioritization of unfettered economic growth versus environmental protection by restrictions thereupon (Carman, 1998). At the same time as votes may be influenced by political ideology, political ideology is in turn influenced by the aforementioned cost factors, and it is surely no coincidence that environmentally conservative areas of California have roots in resource-extractive industries. In this thesis I intend to peel apart the relationship between the economic and political facets of environmental policy support.

Some types of environmental regulations are more likely than others to bring in widespread public support. In fact, Konisky and colleagues (2008) found that voters in the United States tend to be more supportive of regulations addressing pollution-related issues (like urban smog, waterway contamination, and acid rain) than they are of those concerned with resource scarcity (like land and forest protection and species extinction). The tangibility of direct human benefits might play a role: pollution has personal health consequences, while resources are a longer-term sustainability issue. Looking at water bonds in California, like Propositions 50 (2002) and 84 (2006), we can see lawmakers bundling conservation programs for wetlands purchase and ecological restoration alongside drinking water and pollution control components, and framing these propositions around "Water Quality" and "Safe Drinking Water." The same study revealed that smaller-scale issues also tended to have greater support: localized pollution mitigation and land preservation tends to have wider support, in practice, than global issues like climate change, ozone depletion, and mass deforestation. Again, the local environmental protection is tangible, while global issues are long-term, abstract, and often eclipsed by short-term economic goals.

Non-spatial social science research sorts people (voters) by membership in socioeconomic groups (bins of census demographics), and assumes that this membership alone accounts for preferences and behavior—without regard to the space within which the people exist and are organized. If dealt with at all, geographic influence is treated as a source of bias, corrected with spatial lag models to produce better global models. But as Agnew (1996) stated, "It is not simply the compositional differences between different regions," but rather, "the nature and understandings of politics in the regions as experienced by different groups of actors that are at play" (p. 132). Economically, spatial differences in labor, markets, and dominant industries impact the social structure and the character of local politics beyond just these compositional differences. Moreover, the historical and geographical context of a locality or wider region produces unique lifestyles and attitudes, and creates distinct cultures within which political preferences are realized (Agnew, 1996).

The distinct regional differences outlined by Woodard (2011)—who traced out the historical and geographical roots of eleven distinct sociopolitical "nations" that continue to influence attitudes and dominant cultures across the United States—suggest that cultural ideologies must inform stances on environmental regulation and other issues, even across economic and demographic lines. Strikingly, though not surprisingly, the vast and heterogeneous state of California is split across three of these nations, roughly divided into Southern California, the coastal North, and the inland North.[1] Interregional conflicts of environmental values emerge

[1] The three regions within California that are outlined in Woodard's *American Nations*: (1) Southern California including the Los Angeles metropolitan area and extending into the American Southwest and Northern Mexico, has a dominant culture stemming from Spanish colonialism. It is a cultural "hybrid between Anglo- and Spanish America" where "Hispanic language, culture, and societal norms dominate." (2) The West coast of Northern California, beginning at Monterey and extending

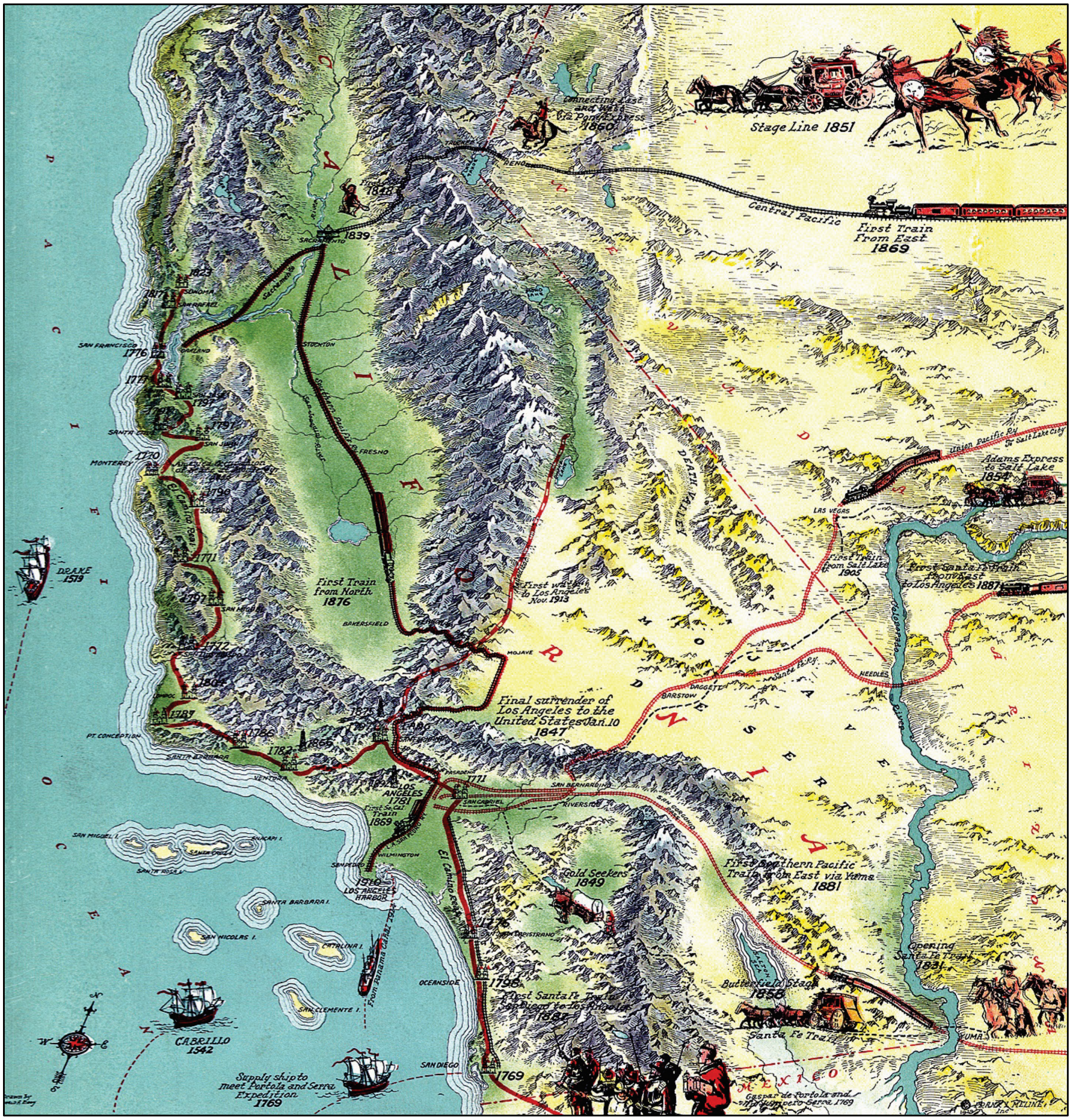

Figure 2. Thematic map published in 1929 depicting historical paths of settlement in California, which ranged from industrialization and the railroad industry for the inland North, to the Spanish mission system for the South and Central Coast. As archived by the Library of Congress (Eddy, 1929).

northward through the Bay Area and into the coastal Pacific Northwest, has historical roots in migrants and missionaries from New England. It combines a "strong strain of New England intellectualism and idealism" with a "culture of individual fulfillment." (3) The interior of Northern California, including Sacramento and the San Joaquin Valley, is an extension of the western interior region encompassing the Great Basin and Rocky Mountains, and has origins in westward industrial expansion. It tends to be more libertarian and anti-government while coexisting with and depending on the corporate resource extraction industry (Woodard, 2011).

between these regions, which grew from disparate immigrant groups for reasons ranging from religious missions to industrial expansion. Consider, for example, the clash between wealthy coastal exurban migrants moving into timber and mining communities in the Eastern interior (Nevada County)—the former pushed environmental regulations to maintain natural scenery, while the latter retaliated to maintain their natural resource-based economy (Walker, 2003). Such regionally-distinct cultural ideologies must inform stances on environmental regulation. Even more so, influenced by cultural values, the roles that socioeconomic factors play in determining environmental voting records are unlikely to be the same across these distinct regions with their distinct historical and geographical contexts. Therefore, I expect to see differences in the *relationships between* socioeconomic factors and environmental voting records across the state of California. Using Geographically Weighted Regression to produce localized estimates for the relationships between demographic variables and voting records, I allow the data to reveal a glimpse into the spatially heterogeneous local political climates of California.

Using voting data from environmental ballot propositions, I investigate how different population factors (income, employment, race, etc.) influence the demand for environmental public goods in California. Moreover, recognizing distinct cultural heterogeneity across the state that may transcend variations in underlying demographics, I use a geographically weighted regression (GWR) model to determine whether the influences of these factors (income, employment, race, etc) vary spatially across the state. For each environmental proposition between 2002 and 2010, I discuss the proposition's background, issues, and debates at the time that might have influenced voters in different regions; present the geographic distribution of support for the proposition; and run the GWR model to spatially analyze this support. My theory of testable equations is largely based on that of Wu and Cutter (2011); that said, this study's novel difference is the use of a GWR model, which has not yet been implemented in studies of environmental voting.

Recognizing that the distribution of support for one type of environmental proposition (e.g., water resources protection) may not mirror that of another type (e.g., climate change mitigation),[2] I examine each of seven propositions separately, and only aggregate results where the trends I find are indeed similar. In Section 2, I introduce the propositions that I will study—a selection of ballot measures representing various environmental issues—and present the issues at play during their respective elections. Section 3 reviews the present literature on environmental voting as it relates to my empirical study design. Section 4 outlines the specific methods, while Section 5 describes the data and summarizes the distribution of the variables I use in my model, and Section 6 the two model equations used. Section 7 presents the results, Section 8 analyzes the results, and Section 9 concludes.

[2] Daniels and colleagues (2012) present substantial evidence against assuming homogeneity of different categories of environmental concern.

2

BACKGROUND: SEVEN PROPOSITIONS

In the following sections, I briefly outline the background of each proposition, focusing on the "pro" and "con" media arguments that would have influenced and reflected voter group attitudes at the time of the vote. I present statewide maps of pro-environment vote percentages by block group, and plot the distributions by the nine economic regions delineated in Figure 3:

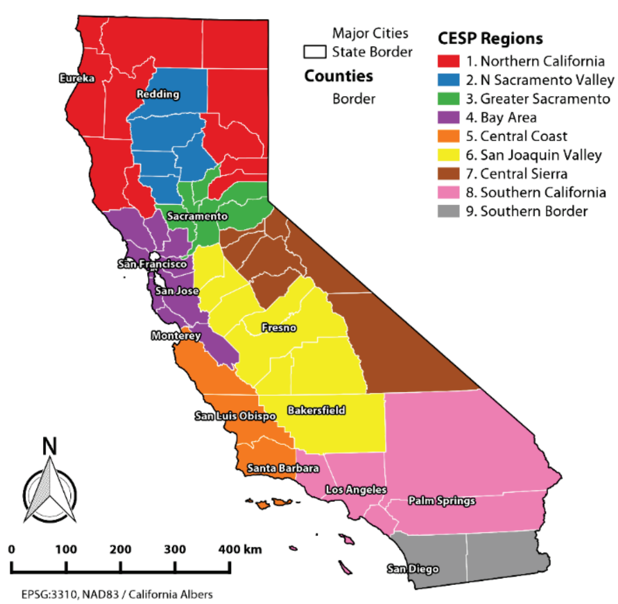

Figure 3. California economic regions deliniated by county (California Economic Strategy Panel, 2006). These regions are referenced by name in the following figures in this section.

Propositions 50 and 84 are bond measures largely related to water resources protection. Proposition 87 proposed new investments in alternative-fuel vehicles. Proposition 1A allocated bond funding towards the new California High-Speed Rail project. Proposition 7 proposed new increases in Renewable Portfolio Standards for utilities. Proposition 21 would have provided stable funding to California's State Parks. Finally, Proposition 23 would have reversed the landmark AB-32 climate change legislation (including SO_2 cap-and-trade among other provisions).

These propositions focused on a variety of environmental issues, ranging from land and resources conservation to pollution and climate change mitigation. Tangibility of benefits ranges from the immediate and local to the far-reached and global (see Konisky, Milyo, & Richardson, 2008). Included also are several different payment mechanisms, ranging from direct costs to voters (vehicle license fees) to longer-term and little-understood costs (borrowing bonds) to indirect costs borne by utilities rather than taxpayers. Interestingly, of the propositions studied, voters only approved those measures funded through bonds.[3]

2.1 Proposition 50 (2002)—Water resources

Proposition 50 authorized $3.4 billion in bonds to fund a variety of water resources-related projects. Proposition 50 was an atypical water bond (according to Fischer, 2002) in that it had a number of local and regional projects stretching across the state. Proposition 50 passed with 55.4% of the popular vote.

Among these regional projects was $850 million in funding for CALFED Bay-Delta, a multifaceted program dealing with water supply, water quality, ecosystem restoration, and flood infrastructure. CALFED was born out of the Bay-Delta Accord, an agreement between the State of California and four federal agencies on standards for management of the watershed. According to the organization, the agreement reconciled the historically competing interests in the Delta between environmentalists, agriculture, and urban water users (CALFED Bay-Delta Program, 2007).

[3] A technicality: Proposition 23 (which would have suspended the AB-32 Global Warming Solutions Act) failed, but in this paper I consider "no" votes on 23 to be "yes" votes for the environment—essentially, "yes" votes on AB-32 itself. So the success of the "No on 32" campaign is a non-bonds win for the environment at the ballot-box.

Figure 4. The Yolo Bypass Wildlife Area in the Sacramento–San Joaquin River Delta, a restored seasonal and perennial wetland ecosystem (and beneficiary of the CALFED Bay-Delta program). The managed area simultaneously provides shorebird habitat, flood control services, agricultural rice production, and environmental education (photos by the author).

The second major component of Proposition 50 was $640 million in funding for the goal of integrated water resource management (IWRM) (Kinsey & Murray, 2002). The IWRM paradigm emphasizes ecological watershed management and demand management over engineered waterworks solutions to expand water supply, and encourages "local collaboration on common water solutions such as water recycling, conservation and storage" (Weiser, 2006).[4] Within the IWRM category, Proposition 50 was intended to fund land acquisition such as the purchases of wetlands for conservation and watershed health. Moreover, Proposition 50 was atypical in that it *explicitly* prohibited spending of its bond funds on hard infrastructure such as reservoirs (Fischer, 2002). As with later water bonds that deemphasized supply solutions, this was a point of contention.

[4] This is indicative of a greater trend described by Allan (2005), in which an infrastructure- and supply-focused "hydraulic mission" has, in the Global North, shifted to a demand management paradigm in response to increased risk awareness (see also Pahl-Wostl, Jeffrey, Isendahl, & Brugnach, 2011).

Other components of the Proposition's bond funds were targeted towards community drinking water system upgrades, environmental water accounts (purchasing water as an ecological reserve for minimum flow), pollution prevention, desalination, and ecological restoration of the Colorado River (Kinsey & Murray, 2002). The California legislature would have the authority to decide specific destinations of funds within these categories.

On the 2002 general election ballot, Proposition 50 was concurrent with an expensive schools bond (Proposition 47), which catalyzed debate about the appropriateness of the large proposed expenditures. Consequently, the measure faced neutrality or even opposition from many environmental groups, who argued that the local beneficiaries of each local project should pay, rather than the statewide taxpayers (Fischer, 2002). Northerners argued that the measure would disproportionately benefit Southern California. Agricultural and economic interests contended that the provisions for park and wetlands acquisition could be "turning prime farmland into wildlife habitats" (Rizo, 2002).

Despite these challenges, Proposition 50 passed with 55.4% of the popular vote.

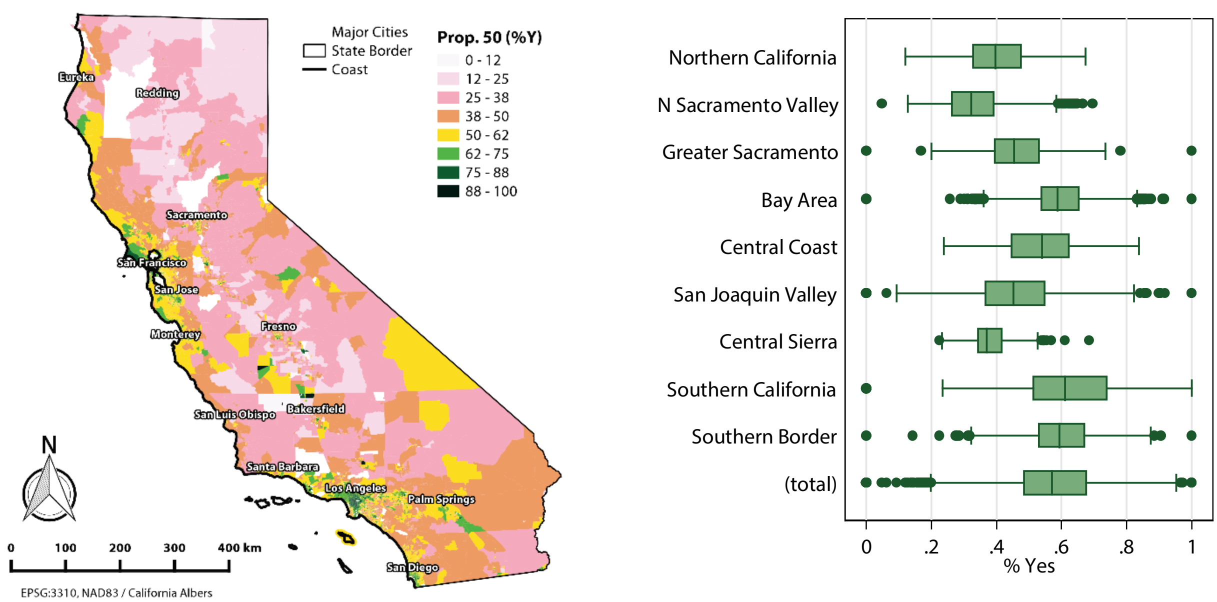

Figure 5. Geographic distribution of voting results for Proposition 50. Regions delineated on the box plots are defined in Figure 3.

2.2 Proposition 84 (2006)—Water resources and parks

Proposition 84 promised another $5.4 billion in bond funds for an assortment of water and parks projects, including maintaining Delta levees, building drinking water treatment plants, implementing flood control measures, conducting ecological restoration, and purchasing parkland (Rogers, 2006).

Similar issues emerged as with Proposition 50. The first challenge was the high pricetag. Proposition 84 was the "largest water and parks bond measure in state history" (Weiser, 2006). With interest, its $5.4 billion price tag would cost the state $10.5 billion to pay back (Attorney General, 2006). The use of bonds funding for environmental purposes was controversial; opponents like Weiser (2006) argued that bonds effectively become taxes because the State's general fund is used to pay debts.

Like its 2002 predecessor, Proposition 84 also emphasized IWRM solutions and allocated no funds towards expanding water storage infrastructure. Newspaper editorials criticized the lack of allocation for water storage, the "No. 1 need California has" according to an opponent interviewed in the *Contra Costa Times*.

Third, some were troubled by the bond measure's potentially-unequal distribution of benefits across the state. Proposition 84 was controversial for its explicit earmarking of funds to special interests, such as the San Joaquin River Conservancy. The *Orange County Register's* editorial board asserted that the measure gave monetary contributions too much influence in environmental regulation. They argued that the measure represented a "pay to play" situation, where local environmental organizations who donated the most to the campaign were given grants through the Proposition (Editorial Board, 2006).

Proposition 84 passed with 53.8% of the popular vote, and a very similar distribution of votes as its predecessor, Proposition 50.

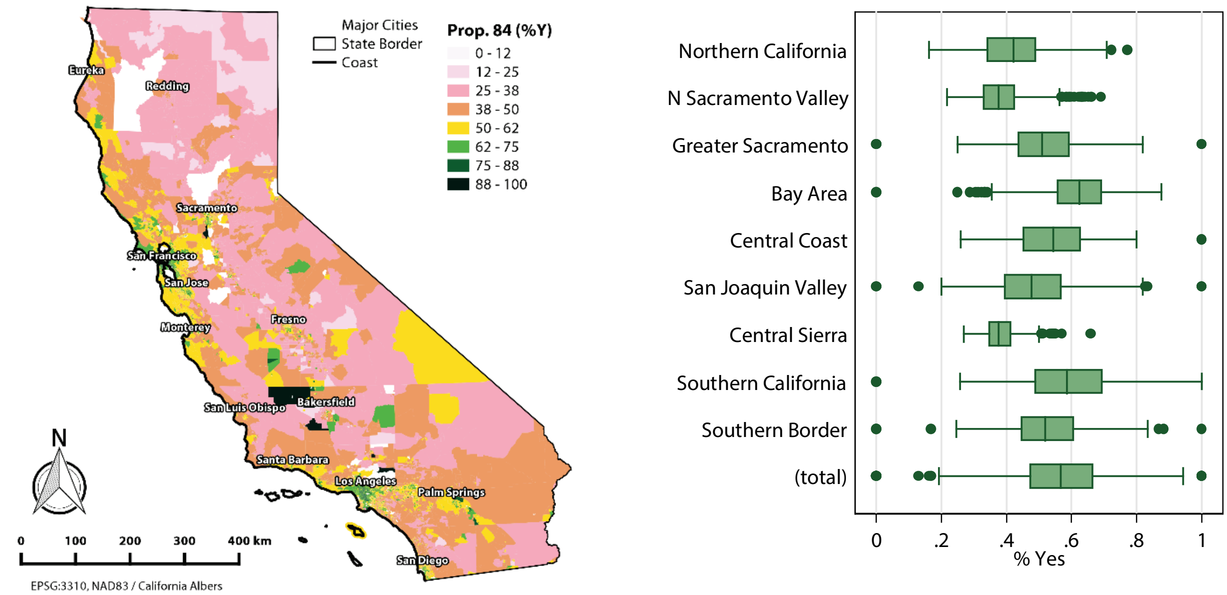

Figure 6. Geographic distribution of voting results for Proposition 84.

2.3 *Proposition 87 (2006)—Investments in alternative fuels*

Proposition 87 presented voters with the option of taxing oil producers to fund alternative fuels. Funds would be invested in the alternative fuels industry to develop wind, hydro, and solar power in addition to alternative vehicle fuels like ethanol and biodiesel. They would also go towards infrastructure including public transit fleet retrofits and fuel pumps.

A major proponent of the measure, Senator Barbara Boxer (D-CA), argued that the proposition would help to reduce dependence on foreign oil (Boxer, 2006), but the measure faced widespread opposition from a variety of different angles.

A common argument was that of economic leakage: the bill would tax oil producers within the State of California only, which would likely incentivize producers to do business elsewhere (Rojas, 2006).

Arguably, gas and utility rates could have increased with the Proposition as well (Rojas, 2006); voters could interpret this possibility as a tax while deciding on the costs of accepting the measure. At the same time, a *San Jose Mercury News* editorial criticized Proposition 87 for *not* being a tax-funded investment in alternative fuels (oil producers were prohibited from passing the cost on to consumers via higher gas prices). The authors argued that citizens should help pay if they would indeed benefit from alternative fuels, rather than having one industry completely subsidize another (Editorial Board, 2006).

The measure was also criticized for its insufficient capability for citizen recourse if the funds were spent poorly, or if no results were obtained from the $4 million investment in alternative energy companies (Editorial Board, 2006).

Proposition 87 failed to pass with 45.3% of the popular vote.

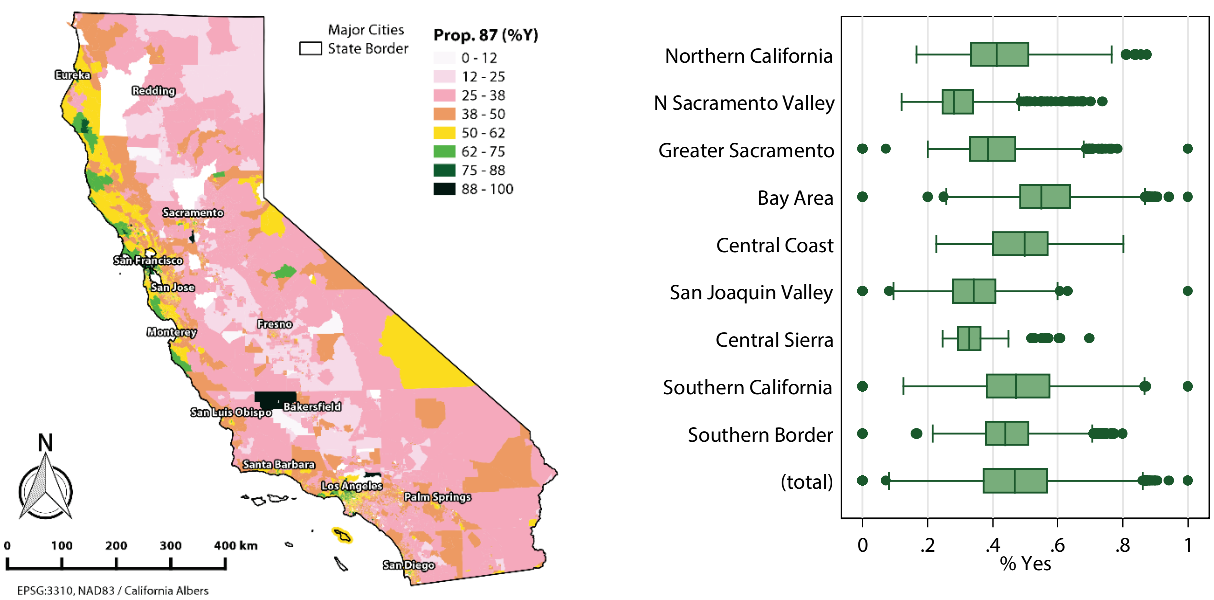

Figure 7. Geographic distribution of voting results for Proposition 87.

2.4 *Proposition 1A (2008)—California High-Speed Rail*

Proposition 1A allocated $9.95 billion in bond funds for the construction of the high-speed rail (HSR) train line to connect San Francisco and Los Angeles. A referendum originating in an assembly bill following years of initial planning and research, Proposition 1A stated that the rail system would be constructed “as quickly as possible” in order to “link all of the state’s major population centers, including Sacramento, the San Francisco Bay Area, the Central Valley, Los

Angeles, the Inland Empire, Orange County, and San Diego." The phrasing of the bill specifically identified the environmental motives for the bill, stating that the "continuing growth in California's population and the resulting increase in traffic congestion, air pollution, greenhouse gas emissions, and the continuation of urban sprawl" make the construction of the rail line "imperative" (Safe, Reliable High-Speed Passenger Train Bond Act for the 21st Century, 2007-2008).

Supporters claimed the project would generate $2 in economic benefits for each $1 spent. The plan's anticipated economic benefits are strong for the Central Valley, particularly the Bakersfield area, due to the key role of these regions in the construction of the project (Shepard, 2008). A report disseminated by the High Speed Rail Authority (Kantor, 2008) enumerated these benefits, which include market accessibility, congestion reduction, pollution reduction, and trip cost reduction.

Kern County (Bakersfield) as a result came out in strong support, following the project's promises of job creation through the construction and operation of the high-speed rail system. Arguably, the system would be particularly beneficial not as a replacement for Bay Area and Los Angeles residents' air travel between the major cities, but as a transit connection for San Joaquin Valley residents to reach these urban centers (Shepard, 2008). Holian and Kahn (2014) argued that historically-conservative San Joaquin Valley cities like Bakersfield and Fresno would "effectively become suburbs of Los Angeles and San Francisco once HSR is built," explaining why the majority of voters in these two cities supported the bill.

As Shepard (2008) stated, for the transportation use benefits—and the associated reductions in air pollution from transit mode shift away from private vehicles—the value of the project for the Central Valley (San Joaquin Valley) would depend on the number of stops that the train would make in the Central Valley. San Joaquin Valley pollution authorities have expressed concerns as to whether Valley stops would get cut if construction costs go above budget.

The initiative contained taxpayer protections that would prevent costs from escalating at direct taxpayer expense, or from funds being wasted. While the initiative's bonds only covered a portion of the funds required for the HSR project, the HSR Authority was prohibited from spending greater than 10 percent of the funds "until matching funds are secured" (Shepard, 2008).

The bill was described as betting on the economy of the state 10 years down the line to pay off the costs of the project (Shepard, 2008); this was a necessary way to look at it, because the vote came in 2008, the year of the financial collapse. Authors of many editorials were still concerned as to whether, taxpayer funds aside, the remaining balance of project funding from private investors could be secured in a time of recession. Many pointed to the California public education system, flood control infrastructure, and road infrastructure as more pragmatic and constructive destinations for such substantial expenditure (Eastin, 2008).

The proposition passed with 52.6% of the popular vote, with majority counties concentrated in the coastal North or in the Los Angeles region, in addition to notable support in the Bakersfield/Kern County area. Block-groups located close to proposed HSR stations also tended to be more supportive in general,[5] as is visible on a map showing proposed routes at the time.[6]

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[5] $\rho = -0.3418$ correlation between log-odds of supporting vote, and log-distance between block-group inside point and nearest HSR station.

[6] Route and station map KML data retrieved via archive.org from the 26 August 2010 version of the California High-Speed Rail Authority website, http://www.cahighspeedrail.ca.gov/google-map as it would have appeared to voters preparing for the November 2010 election. Data was hosted by Newlands & Company, Inc.

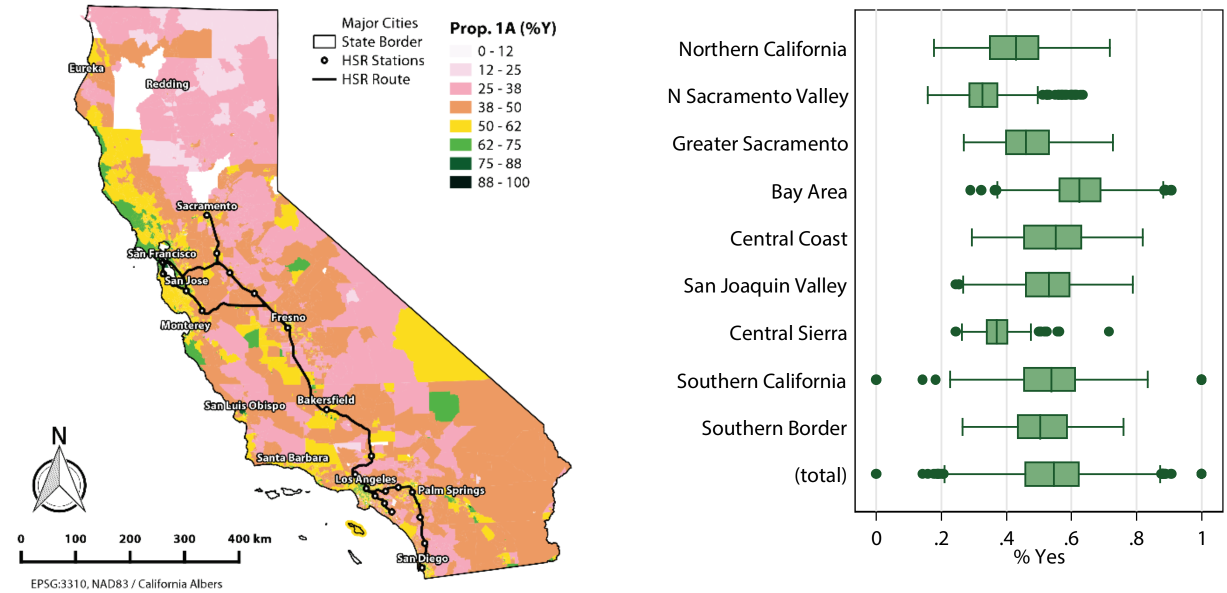

Figure 8. Geographic distribution of voting results for Proposition 1A.

2.5 *Proposition 7 (2008)—Increased Renewable Portfolio Standards*

Proposition 7 would have increased the Renewable Portfolio Standards for California utilities from the present level (20% by 2020) to a new goal of 40% by 2020 and 50% by 2025. The law would also have accelerated the approval process for smaller, low-impact renewable energy projects, and would have removed limits on fines for utilities that fail to meet standards.

The law was heavily criticized, even by many environmental groups. The Sierra Club argued that the existing system of state renewable energy support, which is regulated by the Air Resources Board, Energy Commission, and Public Utilities Commission, is working properly and does not need Proposition 7's overhaul. Renewable energy groups themselves (such as the California Solar Energy Industries Association) were concerned for Proposition 7's effects: the law would ostensibly count only large-scale solar energy projects (those 30W or greater) toward California's goal of 50% of renewable resources by 2025. Favoring these large projects would disincentivize small but valuable projects like rooftop installations on schools and businesses. This argument was widely spread in TV ads. Others argued that Proposition 7 would be an effective tax for consumers by increasing utility rates (Nauman, 2008).

At the same time, an outspoken supporter of the Proposition, David Freeman (2008), argued that the law was being misinterpreted: that in fact facilities of any size would continue to count toward the RPS, and that the 30W distinction was merely a lower limit on the size of plant that would require Energy Commission *approval* to operate.

However, Proposition 7 failed with 35.6% of the popular vote. Regional differences in median support for the proposition were far lower here than for other measures in this study—specifically, the Bay Area and other typically pro-environment regions did no stand out in their support in this case.

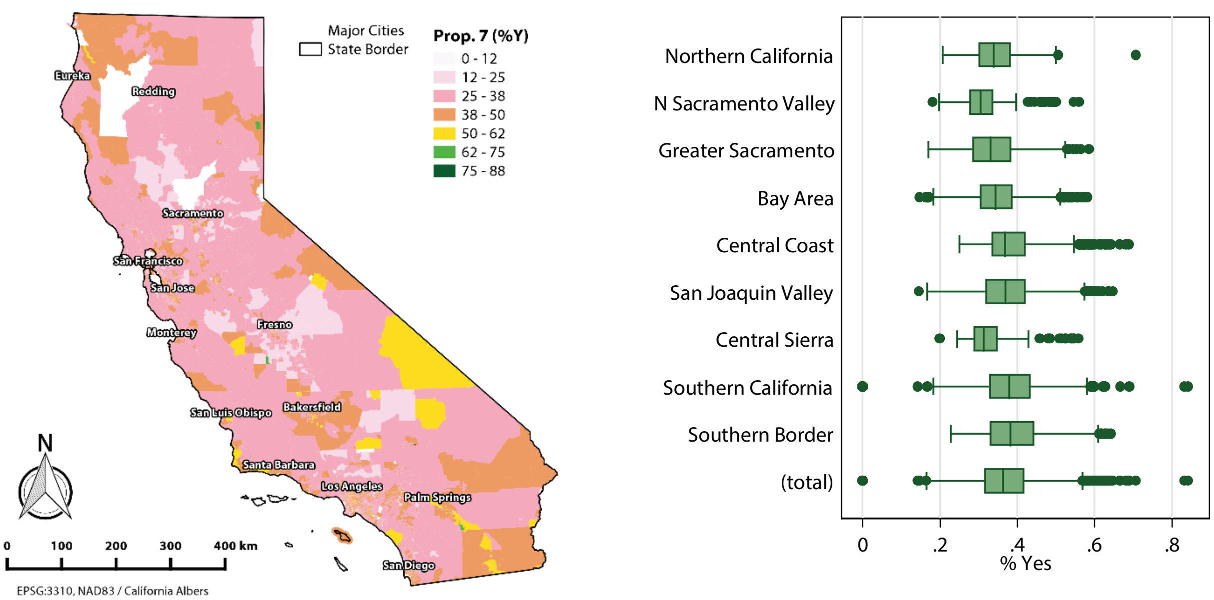

Figure 9. Geographic distribution of voting results for Proposition 7.

2.6 *Proposition 21 (2010)—Vehicle license fee for State Parks funding*

Proposition 21 called for an $18 increase in annual vehicle license fees, in order to provide funding for California State Parks outside of the state's annual budgeting. In return, vehicles having paid the fee would have received free day admission to the State Parks. A number of states have already instituted such a plan: Montana has a $6 per vehicle fee in return for an annual pass, but allows drivers to opt out of the program at registration; Michigan and Washington offer similar passes on an opt-in basis, though the opt-out programs have been more successful (Walls, 2013).

Advocates for Proposition 21 adamantly supported the proposition as a way to "shield parks from Sacramento's financial and political volatility" (Alexander & Rogers, 2010) by securing a stable source of annual funding through the DMV—the proposition's passage indeed would have remedied the California State Parks system's chronic funding problems, which were particularly problematic in the years leading up to Proposition 21's proposal. It was argued that negative externalities from park closures may outweigh the financial benefits of park closures; these externalities include declines in complementary food, supply, and lodging purchases, increased strains on local and municipal parks, and particular disadvantages for low-income park users who must travel farther to the remaining parks (Baker, Demartini, & Higgins, 2012).

The proposed state budget prior to Proposition 21, which was later changed after the public uproar, would have closed over 200 of the state's 278 parks. Even though this plan did not go through, the parks system continued to face reduced staffing, maintenance, and operating hours. While the number of employees remained stable, the number of visitors and the size of parkland had increased dramatically in the preceding two decades. Ballot initiative bonds added hundreds of thousands of acres of new parkland but had not provided the necessary funds for staffing and maintenance, and the Parks faced a $1.2 billion maintenance backlog in 2008 (Alexander & Rogers, 2010) . In addition to addressing these issues, many also saw the initiative as a sound personal investment in free access to well-maintained state parks because of the day-use fee waiver (Editorial Board, 2010).

Much of the opposition to the measure came from conservative anti-tax groups, and from the automobile industry concerned with driving disincentives associated with vehicle license fees. Opponents argued against the measure on grounds of fairness in making all drivers pay for parks whether or not they planned on visiting them to make use of the waived day use fee. They also criticized the "ballotbox budgeting" circumventing legislative budget decisions (Alexander & Rogers, 2010).

While $7 million was spent in support of the measure compared to less than $100,000 in opposition (Alexander, 2010), the measure failed with 42.7% of the popular vote.

After the measure's failure, supporters urged those who voted yes (who were largely concentrated along coastal Northern California and the I-80 corridor from Sacramento to Tahoe) to voluntarily donate $18 annually to the State Parks Foundation. Many credited the tough economic times as the reason for the measure's failure (Editorial Board, 2010). In an interview after the proposition's failure, the president of the State Parks Foundation agreed that the referendum effectively measured not public support for parks and conservation, but rather ideological rejection of raising fees and taxes. The libertarian-leaning inland tended to reject the proposal, while many regions of the coastal north were more supportive (Alexander, 2010). This pattern mirrored the typical regional distributions of support for these propositions.

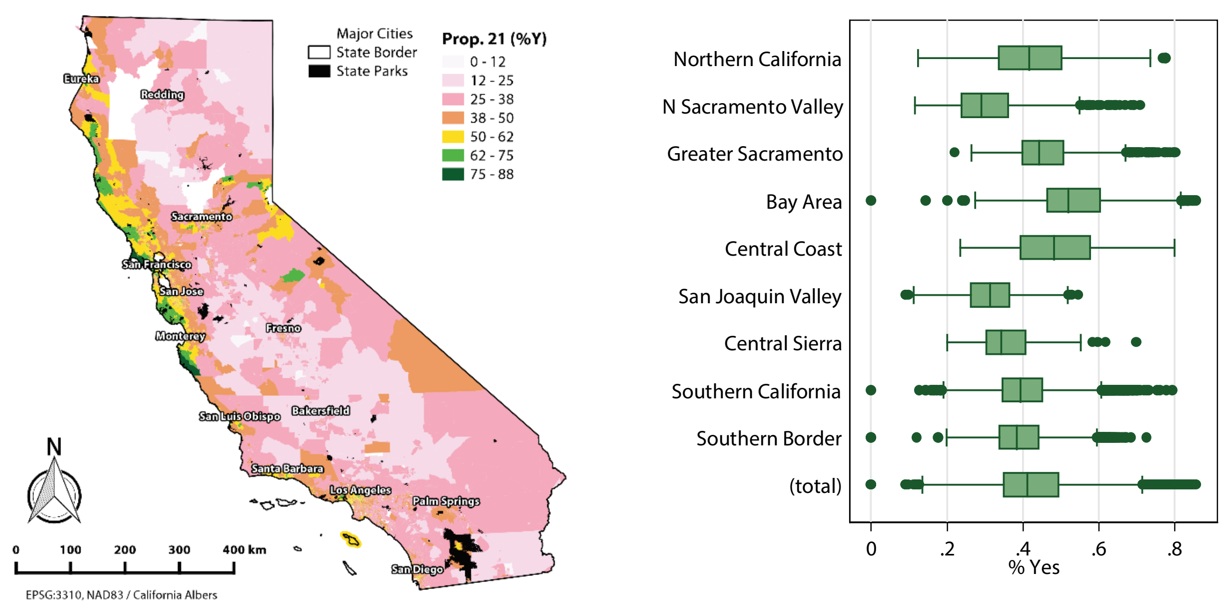

Figure 10. Geographic distribution of voting results for Proposition 21.

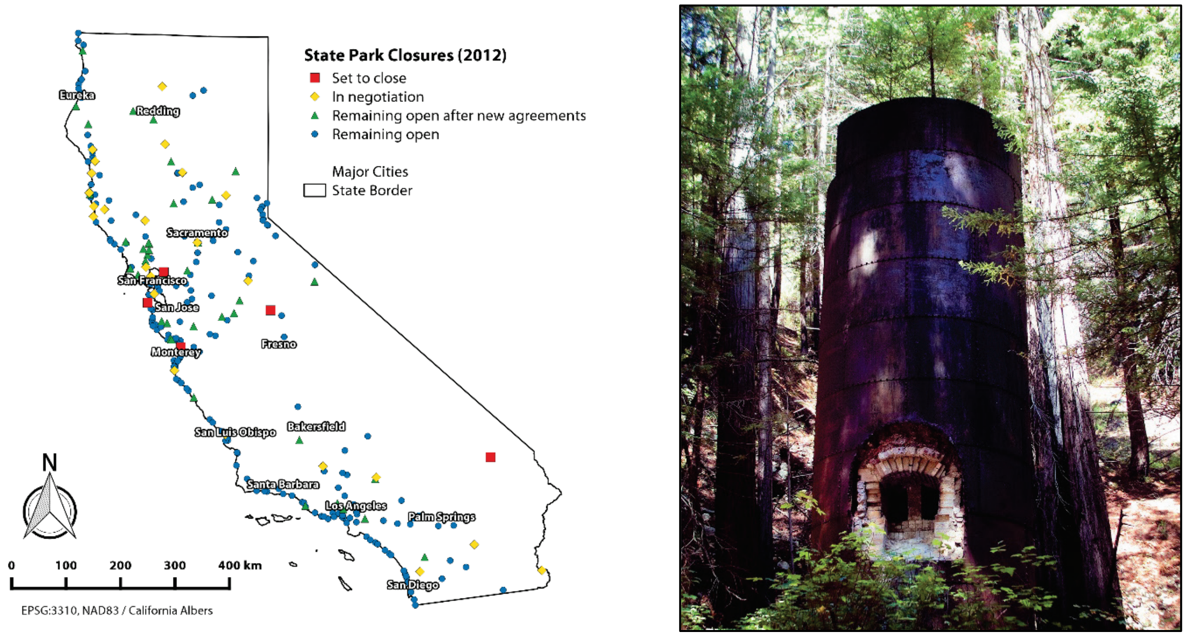

Figure 11. Two years later, a big park closure scare: Seventy parks were scheduled for closure, though most were saved by negotiating deals involving service reductions, joint management agreements, and privatization (map data: The California Report, 2012). For example, Limekiln State Park (pictured) on the Big Sur Coast was slated for closure, but eventually saved via a concession agreement between the California Department of Parks and Recreation and the private California-based Parks Management Company (photo by the author).

2.7 Proposition 23 (2010)—Suspension of Global Warming Solutions Act (AB-32)

Proposition 23 called for the suspension of its reverse-namesake, the Global Warming Solutions Act of 2006 (AB-32), until employment drops to 5.5% for one year. In the debate over the proposition, both sides framed the issue around jobs and economic prosperity, with supporters of Proposition 23 claiming that overturning AB-32 would create jobs, and opponents claiming the opposite.

AB-32 was passed in 2006 but the cap-and-trade system was set to go into effect in 2012—two years after the bid for Proposition 23—and would require immediate capital investments to prepare for the regulations. Critics of the original law argued that its “timing couldn’t be worse” considering the continuing economic troubles following the 2008 crisis (Kimitch, 2010).

Supporters of 23 framed the AB-32 suspension as a jobs creation initiative that would improve job outlook in the traditional manufacturing and energy sectors. They argued that energy-intensive industries (including aluminum refining, forestry, mineral extraction, oil extraction and refining) were being disadvantaged by the AB-32 law (van der Meer, 2010). They also claimed that Proposition 23 would, in fact, not threaten the growth of green jobs, because all of the state's other environmental regulations (such as vehicle emission standards, investments in solar roofs, energy efficiency regulations, and renewable portfolio standards) would remain intact. Many saw AB-32 in the first place as a scheme to further enrich Silicon Valley corporations seeking to capitalize on demand for clean energy (Duran, 2010).

AB-32 had, however, received strong support as well from environmental justice (EJ) advocates. While AB-32 dealt directly with carbon dioxide (CO_2) emissions, CO_2 emissions reductions would carry co-benefits of reduced particulate matter and ozone pollution. By pushing for the AB-32 law to emphasize public health benefits rather than abstract environmental protection, EJ groups were able to attract the support of Latino Democrats who are "not necessarily seen as reliably pro-environmental." California's well-organized environmental justice movement also successfully negotiated the omission of a mandate for cap-and-trade as the market mechanism for CO_2 reduction, following from opposition to Los Angeles' cap-and-trade program RECLAIM (Sze, et al., 2009).

Suspending AB-32, argued Alvarado and Archambeau (2010), would disproportionately impact low-income and minority families, who would suffer from the resulting higher energy prices and polluted air. Opponents to Proposition 23 argued that AB-32 itself was generating the strongest job growth through clean-energy jobs, and had numerous positive externalities as well. Opponents also condemned the strict 5.5%-unemployment criteria in Proposition 23 under which AB-32 could resume, arguing that unemployment rarely holds at such a low level for a full year.

Proposition 23 failed having obtained only 38.5% of the popular vote, so AB-32 remained in effect. Voting trends on such a measure are especially likely to reflect personal stake in resource-extractive industries; Holian and Kahn (2014) also noted that "political liberals and more educated voters favor [regulations such as AB-32] while suburbanites tend to oppose such initiatives." This proposition is an interesting case because it called for the overturning, rather than passage, of an environmental law or program. While there is evidence that voters are more likely to extend an existing policy than approve a new one (Kotchen & Powers, 2006, p. 382), in analysis I treat a "no" vote on Proposition 23 as a "yes" vote for AB-32.

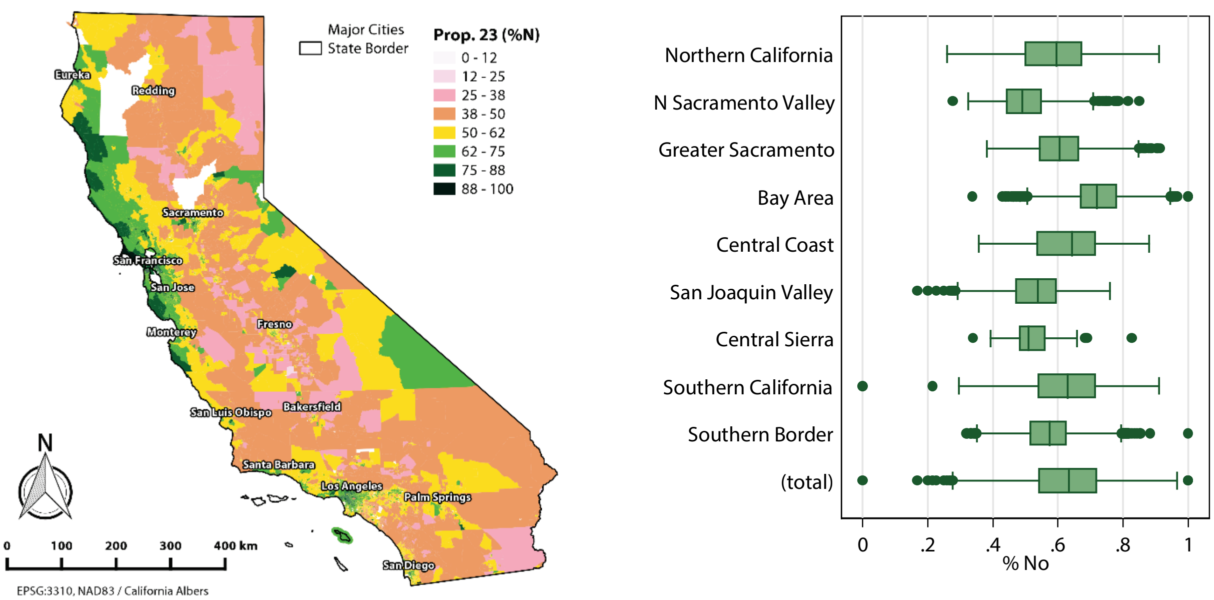

Figure 12. Geographic distribution of voting results for Proposition 23. (Note: For this proposition I show/analyze the proportion "No" votes rather than "Yes" votes, as voting against the proposition was the move for environmental support.)

3
LITERATURE REVIEW

3.1 Characterizing demand for environmental public goods

A number of methods exist for gauging willingness-to-pay (WTP) for public environmental goods and services. Contingent valuation (CV) is a stated preference method that elicits conscious monetary WTP via a survey questionnaire, which frequently poses a question in terms of a hypothetical service rate increase, tax increase, or other payment mechanism. Revealed preference methods include the hedonic price model, which extracts from property values the WTP for the property's natural environment, voting records of elected representatives on environmental legislation, and voting records of the public on environmental propositions. The latter approach, which I employ in this paper, provides distinct advantages over the others. CV frequently yields demand functions "inconsistent with economic theory" (Kahn & Matsusaka, 1997) and is subject to bias from the hypothetical nature (Diamond & Hausman, 1994). Hedonic models are limited to localized environmental goods, and provide only marginal values (Kahn & Matsusaka, 1997). Studying the voting records of elected representatives on environmental legislation to infer the WTP of their constituents for environmental goods requires an assumption of "political equilibrium" (Deacon & Shapiro, 1975), that legislators act as pure representatives of constituents' wishes and not as delegates drawing from their own political ideology. Considering ballot initiatives and referenda (collectively, "propositions") bypasses the whims of representatives and directly measures public opinion.

Deacon and Shapiro (1975) developed the underlying economic model for the problem: the utility-maximizing consumer compares their expected utility if the proposition passes to that if it does not, and makes the voting choice accordingly. The likelihood of a "yes" vote from a particular voter is a proxy for the voter's willingness-to-pay for the environmental good. With any good, public or private, a consumer's WTP is a function of the price of the good, their income or wealth, and their personal preferences (though economic models proxy for the latter using demographics rather than measuring them directly). Properly estimating the income effect on demand has been the focus of most of the literature, attempting to characterize environmental goods as normal goods, inferior goods, or a hybrid of the two.

The "income effect" is defined as the change in WTP associated with a marginal change in income (Schläpfer, 2006) and for public goods can be measured directly through the voter's income. Estimates of income effects have varied amongst studies of voting on state environmental propositions. Those aggregating voters at the county or municipal level (e.g., Deacon & Shapiro, 1975; Salka, 2001) have tended to find a positive income effect. Kahn and Matsusaka (1997), also using county-level data, implemented a quadratic model and found a concave relationship, with a positive income effect across most of the income distribution, turning around and becoming negative only for the highest of incomes. Kline's (2006) result from a different but related question—the effect of income on the prevalence of open space conservation referenda on county ballots—also found such a shape to the income effect. The positive income effect is in many ways the expected result, and suggests that environmental goods are normal goods, with increasing income resulting in an increased demand. Expressed another way, we would expect higher-income voters to be more supportive because they are better able to afford the costs of environmental protection. In regards to propositions on open space preservation (in particular, Kline J. D., 2006), such a negative income effect may be related to the availability of private substitutes for public open space through club memberships (Wu & Cutter, 2011) and ecotourism (Kahn, 2002).

However, the aforementioned studies used highly aggregated data, at the county level, and may commit ecological fallacy in attempting to attribute the positive correlation between county median incomes and county environmental support to the preferences of individual voters. In fact, studies conducted with less-aggregated data have found the opposite effects. Kahn (2002), for example, used data at the census tract level, and found negative income effects in all environmental propositions studies (aside from a tangentially-environmental proposition on smoking bans). Wu and Cutter (2011) used an even tighter geographic level, the block-group, with a quadratic model and found a *negative* income effect that turns around and becomes *positive* for high incomes. In an explicit test for aggregation bias, they also found that estimates were substantially different at block-group level than from even census tracts; assumedly, tighter levels of aggregation should better approximate individual preferences, as is the goal of this study.

It has also been shown that the effects of income inequality also play a role in income effect; that is, that decisions are made based on a voter or consumer's relative income in relation to the local income distribution (Magnani, 2000), and accordingly more income inequality is associated with less funding for environmental improvement (Marsiliani & Renstrom, 2003). These findings are grounds for analyzing income effects in terms of proportions of households by income category (Wu & Cutter, 2011), rather than by mean or median income.

Determining the analogous "price effect" for environmental public goods, however, is more difficult because voters do not face a price in the conventional sense, but rather a cost determined by the impacts of the legislation on one's personal wealth and health. Empirically, the price effect can be approximated by a number of proxies specific to the environmental proposition in question; Kahn and Matsusaka (1997) provide a basis for selecting specific price effect variables, based on the potential impacts of a proposition on a voter's employment and by extension future wealth. In practice, these proxies deal not only with costs, but also with differential benefits received from the proposition.

After isolating income and price effects, the remaining variation in voting patterns on environmental propositions can be explained by differential benefits and by personal preferences. The appropriateness of including these variables, particularly the latter, in an econometric model is debated.

Studies such as Kahn and Matsusaka's (1997) have attempted to understand the environment strictly as an economic good; that is, by including only income and price variables, or proxies therefor. Kahn and Matsusaka (1997) found only a small increase in explanatory power from adding preference variables (related to party registration and party voting) while most variation not already explained by income as price remained unexplained; the authors argued that regardless of voters' actual underlying motivations, "little is lost by studying environmental demand as if it were any other economic good, that is, by focusing on price and income effects." Konisky and colleagues (2008), however, found party affiliation and stated political ideology to be consistent predictors of environmental policy support, and Deacon and Shapiro (1975) accounted for political preferences through voting records for environmental candidates. Furthermore, studies following since 1997 (e.g., Kahn, 2002; Wu & Cutter, 2011) have included other variables such as age, race, and ethnicity, which may capture a combination of price effects (including costs and benefits) and preferences. Kahn (2002) even argued that "the role of population demographics in explaining regulatory passage and enforcement has been under-researched."

The effects of geography on WTP for public environmental goods have received little attention. Where geography has been considered, it has been largely in the context of price effects. For example, Deacon and Shapiro (1975) included rough coastal and non-coastal zones to account for the differences in direct use value and aesthetic value that citizens across the state would obtain from a coastal protection proposition, and likewise with transit district for a transportation proposition. For other propositions, it may be more difficult to delineate clear boundaries of impact, however. Geography may also be considered as a proxy for preferences, through population self-sorting at various scales into regions with like-minded views and needs. Many studies (incl. Kahn & Matsusaka, 1997; Wu & Cutter, 2011) have included urban versus rural designation in models, capturing the differential costs and benefits of propositions on urban and rural populations, and California's distinct urban-versus-rural trends in political preferences. Conceivable but scarcely dealt with are the influences of geography on income effects, and the potential for different regions to face distinct and localized costs and benefits that may impact local voters' demand. The only study on environmental propositions to have used a spatial model is Wu and Cutter's (2011), which found evidence of bias from spatial dependence (i.e. a model with spatial lag and spatial error terms produced estimates of a lower magnitude than one without). No study, however, has used geographically weighted regression (GWR) techniques to produce varied estimates over space.

Preservation of open space is often the jurisdiction of counties and municipalities, and various studies have asked similar questions of local open space preservation measures across the United States. While local measures have much smaller and less varied voting populations, they are advantageous for study in their variation in payment mechanisms, and their conclusions are relevant for statewide propositions as well. Comparisons across municipalities that proposed similar referenda have concluded that wealthier and more educated voters are more likely to pass open space preservation measures (Nelson, Uwasu, & Polasky, 2007), while voters in general tend to interpret higher "pricetags" as more beneficial because of the extra cost (Kotchen & Powers, 2006). Kline and Wichelns (1994) also investigated propositions for purchase of development rights (PDR) programs that require farmland to remain in agricultural use; while different from open space preservation, the authors described farmland preservation motives in terms of environmental resource conservation, food systems security, and management of municipal growth. Multiple studies (Kline & Wichelns, 1994; Kotchen & Powers, 2006) have shown that PDR programs conserving open farmland tend to receive more public support than wildland open space preservation, suggesting rural communities' prioritization at the ballot box of agriculture over environmental preservation. Kotchen and Powers (2006) also showed that existing levels of open space, and the rate of loss thereof, influenced voters' conservation tendencies, often in the positive direction.

In the context of local open space referenda, Kotchen and Powers (2006) found that bond funding mechanisms are significantly more likely to be passed than sales taxes, property taxes, and other funding mechanisms. In fact, the model predicted that the difference in funding mechanism could have such an impact as to make it pivotal for the referendum's passage or failure. The authors' possible explanations for the preference for bonds included (a) that cost onset is delayed for bonds but immediate for taxes; (b) that benefit is often an immediate and tangible project for bonds, while more general funding for taxes; and (c) that the public is often ignorant of the functionality of bonds and how costs might manifest on a personal level. Theoretically, when costs are directly felt, income effects should be stronger, so income effects are expected to be lower in bond-funded propositions (Schläpfer, 2006), although evidence for the causality of payment vehicles on the income elasticity of WTP for public environmental goods is uncertain, as Schläpfer's (2006) meta-analysis of CV studies found no consistent effects. Findings regarding voter preference for bond funding, from local open space measures and from CV studies, may help to explain patterns in statewide environmental propositions.

3.2 *The case for geographic heterogeneity*

In addition to addressing aggregation of the population, this study also addresses aggregation of the parameter estimates themselves using GWR. Prior studies have not addressed whether, and to what extent, the income effect and other relationships vary in magnitude across the study area, but theory suggests that there are limitations to such a one-size-fits-all approach. GWR techniques have found geographic heterogeneity across the social sciences, from land cover change (Ogneva-Himmelberger, Pearsall, & Rakshit, 2009) to urban growth patterns (Partridge, Rickman, Ali, & Olfert, 2008) to real estate (Sunding & Swoboda, 2010). And while not investigated directly through GWR, there is evidence of the spatial dependence of voting behavior specifically. Wu and Cutter (2011) found spatial heterogeneity in the form of statistically-significant spatial lag terms; it is difficult, however, to determine whether this significance implies an independent spatial effect on voting preferences, or (as I hypothesize) a deeper heterogeneity, one that impacts the ways people respond to their sociopolitical circumstances to determine their vote.

So-called contextual effects or neighborhood effects may be at play, causing heterogeneity along regional lines. New arrivals to a community or region, through immigration or birth, are politically socialized to the values and priorities in the community's dominant culture (Rodden, 2010); these values then inform political preferences at the ballot-box, and may influence the way personal socioeconomics like income are factored in to a person's decision. Additionally, regional differentials in news, information, and resources can determine the decisions made by individual voters. According to Cho and colleagues' (2006) theory,

> "…neighborhood context influences political participation because it structures information flow and affects the exogenous forces that come to bear on potential voters. While people [and their political preferences] are not completely determined by their local environments, they are affected by the knowledge and resources most readily available to them" (p. 158).

Particularly salient to environmental resource-related politics, people's preferences may also be related, bidirectionally, to the location of resources in question. According to Hannon's (1994) work on geographic self-selection and discounting, people choose to live in certain locations based on their preferences for local environmental characteristics. Through this lens, the state's population distribution is not a random selection in relation to environment, but rather a reflection of people valuing certain amenities and choosing to live closer to said amenities, socioeconomics permitting. At the same time, contingent valuation studies (e.g., Pate & Loomis, 1997; Sutherland & Walsh, 1985) have shown that people's proximity to an amenity determines their willingness-to-pay (WTP) for the preservation of said amenity. The quick fall-off of WTP with distance holds particularly true for questions of environmental benefits that provide direct use-value to proximate communities. For issues not driven by use-value, that is, environmental conservation purely for the altruistic sake of environmental conservation, distance has less of an effect (Sutherland & Walsh, 1985).

A geographically-weighted regression (GWR) analysis will provide disparate parameter estimates, such as that of income effect on demand for environmental public goods, along geographic space. Subsequent analysis of the distribution of these effect estimates, in terms of geographic regions and in terms of local characteristics, will reveal the forces driving them.

4
METHODS

I estimate two versions of a regression model of the likelihood of environmentally-supportive votes on income and other demographic and geographic characteristics, using data at the census block-group level. For each model version (referred to as Model I and Model II), I run a traditional ordinary least-squares regression model, followed by a spatially-disaggregated geographically weighted regression (GWR) model.

GWR model estimation uses Fotheringham and colleagues' (2002) Windows-based spatial modeling package GWR4. Pre-and post-estimation data analysis is conducted using Stata/SE 12.0. Geoprocessing tools from ArcInfo 10.0 were used for preparing geographical data for analysis, while QGIS 2.10 was used to generate maps of variables and estimates.

4.1 The mechanics of geographically weighted regression

GWR is a technique significantly developed and refined by Fotheringham and colleagues (2002), which is "based on the premise that relationships between variables measured at different locations might not be constant over space." In other words, rather than producing a single global estimate $\hat{\beta}_j$ for the coefficient of each variable $\vec{x}_j \in \{\vec{x}_1 \dots \vec{x}_k\}$, GWR produces for each variable a *series* of slope coefficients $\{\hat{\beta}_{1j}, \dots, \hat{\beta}_{nj}\}$, for each of the n observations:

$$\hat{y}_i = \sum_{j=1}^{k} \hat{\beta}_{ij} x_{ij} + \epsilon_i \quad \text{for } i \in \{1, \dots n\}$$

The value of the local slope parameters $\{\hat{\beta}_{i1}, \dots, \hat{\beta}_{ik}\}$ at each point i is obtained using a weighted least squares (WLS) regression in which the point itself receives the most weight, and points farther away receive less weight. The local WLS $\tilde{\beta}$ estimate at the point itself becomes the $\hat{\beta}$ for this point in the GWR model.

$$\tilde{y}_i = \sum_{j=1}^{k} \tilde{\beta}_{ij} x_{ij} w_i + \varepsilon_i \quad \text{for } i \in \{1, \dots n\}$$

This in turn requires the choice of a spatial weighting function to determine the decay in weights w_i with distance, and the choice of a bandwidth to calibrate this function and determine the size of the radius of neighboring points, or the number of neighboring points, to consider before weights drop off to zero. The bi-square function is recommended as a spatial weighting function by Fotheringham and colleagues (2002, p. 57). Bi-square provides a Gaussian-like decay that, unlike a Gaussian function, drops off to zero at a finite distance, making it less computationally intensive. The function is defined as

$$w_i = \begin{cases} \left[1 - \left(\frac{d_i}{b}\right)^2\right]^2 & \text{if } d_i < b \\ 0 & \text{if } d_i \geq b \end{cases}$$

where b is a selected bandwidth distance. Rather than selecting a fixed bandwidth, Fotheringham and others advise to instead select an adaptive bandwidth which is narrower in regions where the density of data points is higher, allowing for examination of finer-resolution changes where possible, and addressing high bias in high-density areas and high variance in low-density areas. For the adaptive kernel, a specified number of nearest neighbors a is chosen, and b_i is calculated as the distance to the ath nearest neighbor.

The optimal bandwidth b or optimal number of nearest neighbors a is selected by minimizing a criterion such as the cross-validation score (CV) or Akaike information criterion (AIC). For its advantage with high sample size computational requirements, we use the CV score

$$CV = \sum_{i=1}^{n} (y_i - \widehat{y_{\neq i}})^2$$

as the criterion for model choice, where $\widehat{y_{\neq 1}}$ is the fitted value of y computed with point i removed. CV score is optimized using a golden section search technique (Fotheringham, Brunsdon, & Charlton, 2002).

4.2 Two models and their goals

I run two models, each with its own goal. Let $p = \left(\frac{Yes}{Yes + No}\right)$ indicate the fraction of votes in a block-group in favor of the proposition in question, where $0 \leq p \leq 1$. Then the dependent variable for both models is the logit, or log-of-the-odds, transformation thereof:

$$\text{logit}(p) = \log(p) - \log(1 - p) = \log\left(\frac{p}{1 - p}\right).$$

These two models are described in detail following the summary of data sources, in Section 6.

4.3 Classical hypothesis testing

Classical hypothesis testing for GWR is challenging because each local parameter estimate, derived from its local WLS regression, is associated with its own t value. Because I am interested in spatial patterns in parameter estimates, the statistical significance of a single point estimate is arguably less interesting than the significance — however measured — of the regional patterns. Additionally, the interpretation of these t values comes with particular challenges.

First, there is a multiple inference problem in that, for n observations and k model parameters, a total of $n \times k$ hypotheses are tested, increasing the probability of Type I errors at the local level. At the same time, these multiple hypothesis tests are not independent: nearby local WLS regressions draw from nearly the sample of a observations, with only a slight variation in the weighting matrix. Byrne, Charlton, and Fotheringham (2009) proposed a variation on the traditional Bonferroni correction for multiple hypothesis testing[7] that "takes

[7] Fotheringham and colleagues (2002, p. 134) initially recommended applying Bonferroni's correction when determining critical t-values for local GWR estimates, to account for the multiple inference problem. This correction involves dividing the desired alpha (e.g., $\alpha = 0.05$) by the effective degrees of freedom of the GWR model: $\alpha^* = \frac{\alpha}{n - v_1}$. However, as Byrne, Charlton, and Fotheringham (2009) later asserted, this method results in "a reduction in statistical power for individual tests, which may result in genuine effects going undetected" (p. 1). The Bonferroni correction also makes the assumption that the

advantage of the intrinsic dependency between local GWR models to contain the overall risk" of "mistaking chance variation for genuine effect" while avoiding traditional Bonferroni's correction "large sacrifice in power." I use Byrne's corrected alpha[8] to determine statistical significance for GWR estimates.

Second, for my spline model (Model II), the income effect estimates for the second and third income terciles are made up of multiple parameters ($IE_{II} = \hat{\beta}_1 + \hat{\beta}_2; IE_{III} = \hat{\beta}_1 + \hat{\beta}_3$), so there is no single significance value to consider. As I am primarily focused on GWR as an exploratory method to see if spatial patterns may exist, I will present the percentage of GWR estimates that are statistically significant, but will map all income effect estimates regardless of the statistical significances of their underlying parameter estimates.

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multiple hypotheses being tested are independent, which is untrue for GWR due to the substantial overlap between local regression kernels.

[8] The effective number of parameters $\tilde{k}$ (as opposed to the k for OLS defined as the number of variables in the model, here $k_\alpha + k_\beta$) can be used to evaluate model complexity. As the bandwidth increases, $\tilde{k}$ decreases as there is more overlap between local regressions, such that $\tilde{k} \to k$. Conversely, as the bandwidth decreases, $\tilde{k}$ increases such that $\tilde{k} \to n$. The effective number of parameters is defined as $\tilde{k} = (2v_1 - v_2)$, where $v_1 = \text{tr}(\boldsymbol{S})$, the trace of the hat matrix $\boldsymbol{S}$, and $v_2 = \text{tr}(\boldsymbol{S}^T\boldsymbol{S})$. The hat matrix $\boldsymbol{S}$ maps y values to predicted $\hat{y}$s via $\hat{\boldsymbol{y}} = \boldsymbol{Sy}$. The degrees of freedom of the GWR model is $(n - v_1)$ while the effective degrees of freedom of the residual is $(n - \tilde{k}) = (n - 2v_1 - v_2)$. (Fotheringham, Brunsdon, & Charlton, 2002, p. 55). For the effective number of parameters $\tilde{k}$, Byrne's (Byrne, Charlton, & Fotheringham, 2009) corrected alpha level is defined as $\alpha^{**} = \frac{\alpha}{1+\tilde{k}+\frac{\tilde{k}}{(n\times k)}}$.

5
DATA

Wu and Cutter (2011) demonstrated using larger units of aggregation, such as counties or census tracts, as the basis of analysis rather than block groups (the smallest geographic unit for census data) can create biased estimates. In particular, they found that income effects in many cases were biased towards zero in the aggregated models, even ending up insignificant or with the opposite sign. Other covariates showed different marginal effects in the aggregated model. To avoid such aggregation bias, which arises from heterogeneity among block groups within a census tract, I use block group level data throughout. Census block-groups are designed to contain relatively consistent population (between 600 and 3000 people according to the US Census Bureau). I still, however, adjust for differences in block-group population using analytical weights, multiplying each independent and dependent variable by the square root of the population under the assumption that variance is inversely proportional to aggregated population.

Voting data were obtained from the Statewide Database, a redistricting database for the State of California that the University of California, Berkeley (Institute of Governmental Studies, 2015) maintains. The database provides voting results and party registration counts at the census block level (converted from state voting precincts). Unless otherwise mentioned, remaining data for covariates are obtained from the US Census Bureau. Year 2000 data come from the 2000 Decennial Census longform, transformed into 2010 census block boundaries by Geolytics, Inc. (2015). Year 2010 data come from the 2010 Decennial Census (US Census Bureau, 2010) and the 2013 American Community Survey (ACS) five-year averages (US Census Bureau, 2014), due to the change in Census Bureau surveying procedures partway through the decade. A linear trend is constructed between 2000 and 2010 data and used to interpolate approximate data for the year of each proposition's vote.

Education is empirically correlated with support for environmental protection (Kahn, 2002; Press, 2003; Wu & Cutter, 2011). I include education level, defined as the percentage of the block group population with a bachelor's degree or higher, in the vector of price effect variables because "environmental legislation is unlikely to threaten the employment of highly educated workers" (Kahn & Matsusaka, 1997). However, I also run an alternate model in which education is excluded. Common sense dictates that income is highly correlated to education; this point calls into question whether it is wise to estimate an income effect while controlling for education level. Comparison of the two models will reveal how controlling for education changes the results of income.

Employment-by-industry in a region is an important factor in the price effect of the demand for environmental goods. Dealing with proposition on transportation funding, Deacon and Shapiro (1975) included access to the BART transit system, and the proportion of citizens employed as transit (public transit or freeway) workers, as additional variables. Later, Kahn and Matsusaka (1997) included variables for personal income from work from a number of industries (construction, agriculture, forestry, and manufacturing) and included each industry if the proposition in question was supported or opposed by the industry, or otherwise was expected to substantially impact employment or revenue in this industry. Studies since then (Kahn, 2002; Wu & Cutter, 2011) have used employment numbers instead of income, and have not chosen a subset for each proposition prior to running the model. Kahn (2002) included the finance, insurance, and real estate (FIRE) industry, but found no significant effect. Following Wu and Cutter (2011), I include in my model the percentage of the population employed in agriculture and forestry, and in mining and petroleum. To avoid the chance of local collinearity in GWR from regions lacking one or the other industry entirely, I sum the two into one covariate.

Kahn (2002) found a positive relationship between age and environmental support, likely because senior citizens lack taxable income so are unlikely to be directly impacted by regulations, while trends in beliefs and political preferences may suggest a negative relationship. Accordingly, Wu and Cutter (2011) split the population into three age groups and found that middle-aged voters, making the largest taxable incomes of the three groups, tended to vote the least in favor of environmental regulation. Thus I include the proportions of potential voters (age 18 and above) in three age groups: 18–34 (the base group, omitted), 35–64, and 65 and above.

Race and ethnicity are likely to play a role in environmental voting patterns, as minority groups (Black and Hispanic/Latino in particular) have been shown to be more likely to support environmental propositions (Kahn, 2002; Wu & Cutter, 2011). This may be due to higher perceived benefits of environmental protection, as racial minority populations along with low-income populations are more likely to be located near polluting sites (Wu & Cutter, 2011). As with income, race and ethnicity are often relatively homogeneous within block groups due to *de facto* segregation. Accordingly, I include the proportions of the population identifying to the Census Bureau as Black and as Hispanic/Latino.

Density has also been shown to be positively correlated to environmentalism (Deacon & Shapiro, 1975; Kahn, 2002; Halbheer, Niggli, & Schmutzler, 2006; Wu & Cutter, 2011). People living in low-density suburban, areas being more car-dependent, may face higher costs from environmental legislation, particularly that which directly impacts the cost of driving (Holian & Kahn, 2014). At the same time, suburban and rural areas may be more accessible to many environmental goods such as open space, implying greater use value and perhaps more environmental support. As Holian and Kahn (2014) and others have done, I use the natural log of the density because of nonlinear effects. On a similar note, impacts from environmental legislation may differentiate along lines of homeownership, and therefore homeownership may affect support for environmental legislation.[9] This variable is included in Model I only, for reasons previously explained.

Kotchen and Powers' (2006) study revealed the potential impacts of existing levels of open space on conservation measure voting patterns: existing open space in an area may motivate

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[9] Holian and Kahn (2014) also argued that home values could decline in the suburbs as increased costs of transportation make suburban living costlier and less desirable. Homeowners' desire to preserve the value of their assets may incentivize them to oppose carbon-related environmental legislation. Because this effect is predicted to be strongest in the suburbs, I originally included an interaction between homeownership (the percent of households occupied by the owners) and density. However, I later omitted homeownership due to its exceedingly high VIF (variance inflation factor) in initial global regressions.

further conservation through the preferences of residents living near open space, while lack of existing open space may also motivate conservation because of scarcity. In light of these findings, for relevant propositions I include in Model I the proximity to amenities affected by the proposition. As Propositions 50 and 84 both include coastal protection measures, I include the distance to the coast in their models, under the assumption that coastal communities are more likely to support coastal protection. For Proposition 1A, much of the measure's support came from regions directly benefitted by a proposed high-speed rail station—even in places like Fresno and Bakersfield that are typically less supportive of environmental propositions. Therefore I include the distance to the nearest high-speed rail station in the model. For Proposition 21, hypothesizing that the presence of state parks will motivate support for State Parks program funding, I include the distance to the nearest State Park. I also include the distance to the nearest non-State Park open access protected land area,[10] as a control in case the presence of other parkland self-selects parks program supporters, and also in case other parkland acts as a substitute and thus decreases demand for State Parks. In all instances, these variables are defined as the shortest distance from the inside point of the block-group, log-transformed. The log-transformations of these distances are in accordance with practice in ecosystem services valuation (e.g., Pate & Loomis, 1997), where marginal effects of distance are understood to decrease with distance.

Finally, political ideology has been shown to predict environmental voting preference (Kahn & Matsusaka, 1997; Konisky, Milyo, & Richardson, 2008). Kahn and Matsusaka (1997) and others, however, have questioned the benefit of including pure ideology on top of economic variables. Assumedly, the socioeconomic implications of one's income, employment, and other factors should directly influence how one votes on a proposition, rather than party allegiance, as propositions are not directly endorsed by parties in the way that congressional candidates are.

[10] Excluding city parks and cemeteries. From the CPAD database. I use the log-distance from the inside point of the block-group polygon, to the nearest SP or non-SP protected land polygon. In an ArcGIS spatial join operation, used in this calculation, a distance value of zero is assigned if the inside point lies within a protected area. The log-distance is thus calculated from $\ln(Distance + 1)$, where distance is in meters, to exclude undefined $\ln(0) = -\infty$ values.

McGhee and Krimm (2012) demonstrated that political party registration in California is not an ideal measure of alignment along a "liberal" and "conservative" spectrum. While state voters register overwhelmingly for the Democratic Party, a substantial portion of registered Democrats identify as "conservative." In San Bernardino County, for example, 40% of Democrats are self-identified conservatives. Yet Democratic Party registration is in fact very closely geographically correlated to supporting votes for environmental propositions, as is visible in Figure 13. Such is the correlation that including party registration would probably amount to overcontrolling for variation, without getting at the underlying effects that I am interested in, such as income. Consequently, while I assembled the data on political party registration from the Statewide Database, and include it in the summary statistics, I elected to omit party registration from the model itself.

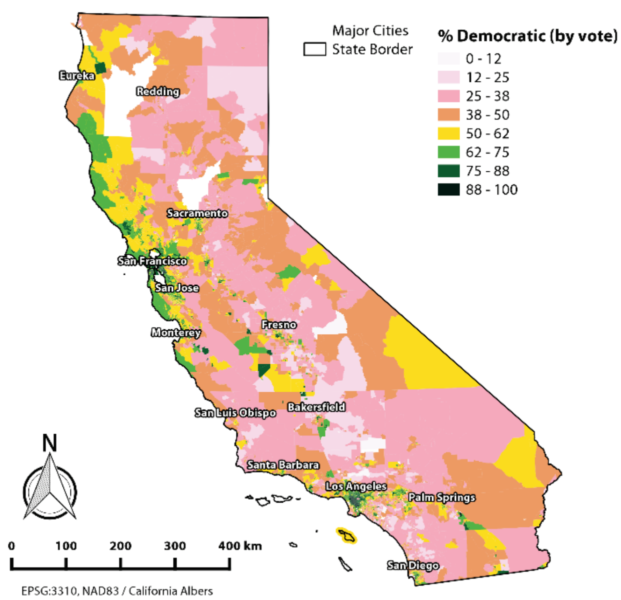

Figure 13. Party affiliation data for the 2010 general election. Percentage registered for the Democratic Party, out of all people total block-group population who reported their party affiliation and voted in the general election.

5.1 Summary Statistics

Census variables corresponding to year 2000 and 2010 are summarized in Table 1 and Table 3, respectively; for concision I focus on the 2010 Census data (Table 3) for presenting summary statistics. Geographic land and water areas are shown in Table 4. Block-group level voting percentages for each of the propositions are summarized in Table 5. Political party representation at the block-group level is summarized in Table 6.

Because the Census block-group designation is based on population (block-groups are designed to contain between 600 and 3000 people) rather than area, the data are heavily dominated by high-density areas. 94% are Census-classified as urban areas or urban clusters. The average block-group population density, in fact, is 98,125 people per square mile, while the average land area is only 0.61 square miles.

The average block-group's median household income is $67,871. On average, the most common income bracket is the $25,000 – $49,999 group, followed by those on either side. Average educational attainment was 30% of the block-group population having a bachelor's degree. Because of the dominance of urban areas, the average block-group has only 2% employment in agriculture and nearly 0% in mining and petroleum, while there exist block groups with up to 84% and 32% employment in these industries, respectively.

5.2 Geographic distributions of variables

Figure 14, below, shows the geographic distribution of median household income, my primary independent variable of interest. (The distributions of various demographic variables are shown in the Appendix, in Figure 21.)

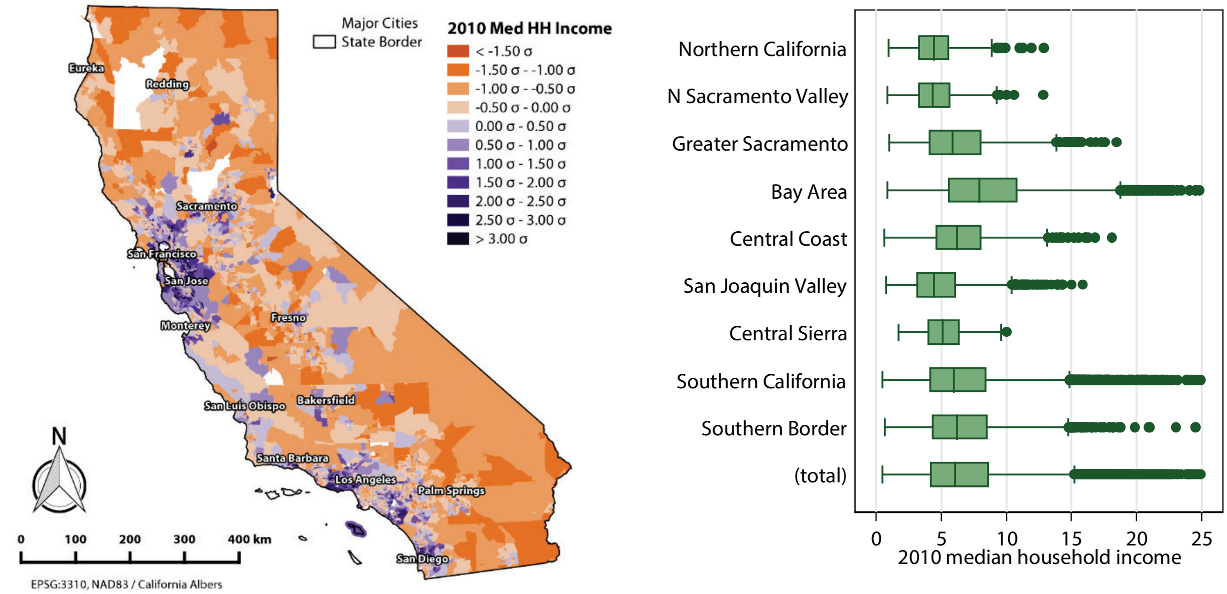

Figure 14. Distribution of 2010 median household income by block-group, (shown on map binned into standard deviations from the mean value).

High-income, well-educated block groups are concentrated in urban areas such as the San Francisco Bay Area, Sacramento, Los Angeles, and San Diego. The correlation between income and education ($\rho = 0.70$ in 2010) is visible in the clusters of both variables around these areas. Black and Hispanic/Latino populations are distributed very differently ($\rho = 0.06$ in 2010) in California. Block-groups with the highest black populations tend to be in the East Bay, Sacramento, and parts of Los Angeles. Block-groups with the highest Hispanic/Latino populations are concentrated in the San Joaquin and Salinas Valleys, and parts of Los Angeles. Agriculture-dominated block-groups are, unsurprisingly, spread across California's low-density regions. On the other hand, block-groups with mining- and petroleum employment include both rural and urban areas, though 94.5% have no reported mining and petroleum employment at all. For this reason I have combined the two industries into one variable throughout this paper.

6
THEORY OF EQUATIONS

6.1 Model I: Full quadratic model for optimization

Model I is designed to fully test the model fit benefits of GWR in comparison to its OLS counterpart, using all controls. I use the quadratic transformation of income in order to capture non-linearity as well as the turning point of high income found by Wu and Cutter (2011) and others.

$$\text{logit}(p_i) = \beta_{0i} + \beta_{1i}Income_i + \beta_{2i}Income_i^2 + \gamma_{1i}Education_i + \gamma_{2i}AgrMinEmp_i + \gamma_{3i}Black_i + \gamma_{4i}Hispanic_i + \gamma_{5i}Age35to64_i + \gamma_{6i}Age65plus_i + \gamma_{7i}\ln(Density_i) + \cdots + \epsilon$$

The ellipsis indicates additional variables for the distance to affected amenities for select propositions, namely:

(a) $\ln(DistCoast_i)$, the logged distance to the California coast (Proposition 50 and 84);
(b) $\ln(DistStation_i)$, the logged distance to the nearest high-speed rail station (Proposition 1A); and
(c) $\ln(DistSP_i)$ and $\ln(DistNonSP_i)$, the logged distances to the nearest State Park and non-State Park, respectively (Proposition 21).

I compare each proposition's range of GWR results for this first model to the corresponding results of a global OLS run, and evaluate the two models on the basis of fit and residuals.

6.2 Model II: Limited spline model for exploration

Model II is designed for investigating regional trends in the strength of the income effect, and determining how use-value versus altruistic-value impacts income effect. Several key changes are made to this model in order to better suit the explorative geographic interpretation of results. I omit $\ln(Density_i)$ and the distance variables from the second model. Population density was included in the model as a way to measure regional levels of urbanization. Meaningful variation in density as it should impact voting outcomes is on a regional scale, as metropolitan areas compared to rural areas have different economic interests that relate in different ways to the environment. Within a local area such as a section of a city, as in one of the localized regressions within GWR, there are fewer obvious reasons to suspect changes in block-group density to be related to voter turnout. Where applicable, I also omit the distance variables (coast, high-speed rail station, state parks, etc.): these are also regional-scale variables; controlling for these in Model II would control for geographic trends in income effect, which would be counterproductive for the goal of this section.

I also choose an alternate functional form for income. While the quadratic form provides information on the turning point in income effect, it obscures information on the magnitude of the income effect behind two coefficient estimates. Instead, I use a three-part spline model, split along terciles (3-quantiles) of median household income in the data, making the full model:

$$\begin{aligned}\text{logit}(p_i) = {} & \alpha_{1i} + \beta_{1i} Income_i + \alpha_{2i} TercileII_i + \beta_{2i}(Income_i \times TercileII_i) + \alpha_{3i} TercileIII_i \\ & + \beta_{3i}(Income_i \times TercileIII_i) + \gamma_{1i} Education_i + \gamma_{2i} AgrMinEmp_i + \gamma_{3i} Black_i \\ & + \gamma_{4i} Hispanic_i + \gamma_{5i} Age35to64_i + \gamma_{6i} Age65plus_i + \epsilon\end{aligned}$$

where $TercileII$ and $TercileIII$ are binary variables indicating the second and third terciles, with the first tercile as a base. This allows for the isolation of income effects for the three income terciles:

$$IE = \frac{\partial\, \text{logit}(p)}{\partial\, Income} = \begin{cases} \beta_1 & \text{for Tercile I} \\ \beta_1 + \beta_2 & \text{for Tercile II} \\ \beta_1 + \beta_3 & \text{for Tercile III} \end{cases}$$

The inclusion of binary variables for income terciles will necessitate a larger bandwidth for local regressions than in the quadratic model, to avoid local multicollinearity. This will no doubt decrease model fit statistics, but will provide estimates at a wider geographic scale for easier interpretation. Bandwidth is once again optimized by minimizing cross-validation.

7
RESULTS

For the full quadratic model with all controls (Model I), I begin by analyzing the global regression results, and how they align with similar past studies on environmental voting. Additionally, as a primary investigation of the effects of spatial aggregation across the state, I compare model fit statistics of this model's GWR run with those of its global run.

For the spline model (Model II), I briefly review the global results to compare estimates with the full quadratic model, before diving into the GWR results. As I believe the spline model to be better suited for GWR (as it lacks the strongly spatially-autocorrelated variables and provides easily-mapped income effect magnitudes for the three terciles), the Model II GWR results form the backbone of my analysis. I present maps of the Model II income effect estimates across the state, and investigate the patterns behind these geographic distributions.

7.1 Model I

Estimates from the global quadratic model (Table 7) were largely consistent across the different propositions, and consistent with past literature (in particular, Wu & Cutter, 2011) as well. The estimated income effect was negative and decreasing in magnitude until a turning point (between a median income of $120,000 and $200,000 depending on the proposition) after which the marginal negative effect of income on environmental support was positive (Table 9). In other words, environmental public goods are inferior goods for voters below this turning point income level, and normal goods for those above this level. Figure 15 shows this marginal income effect visually:

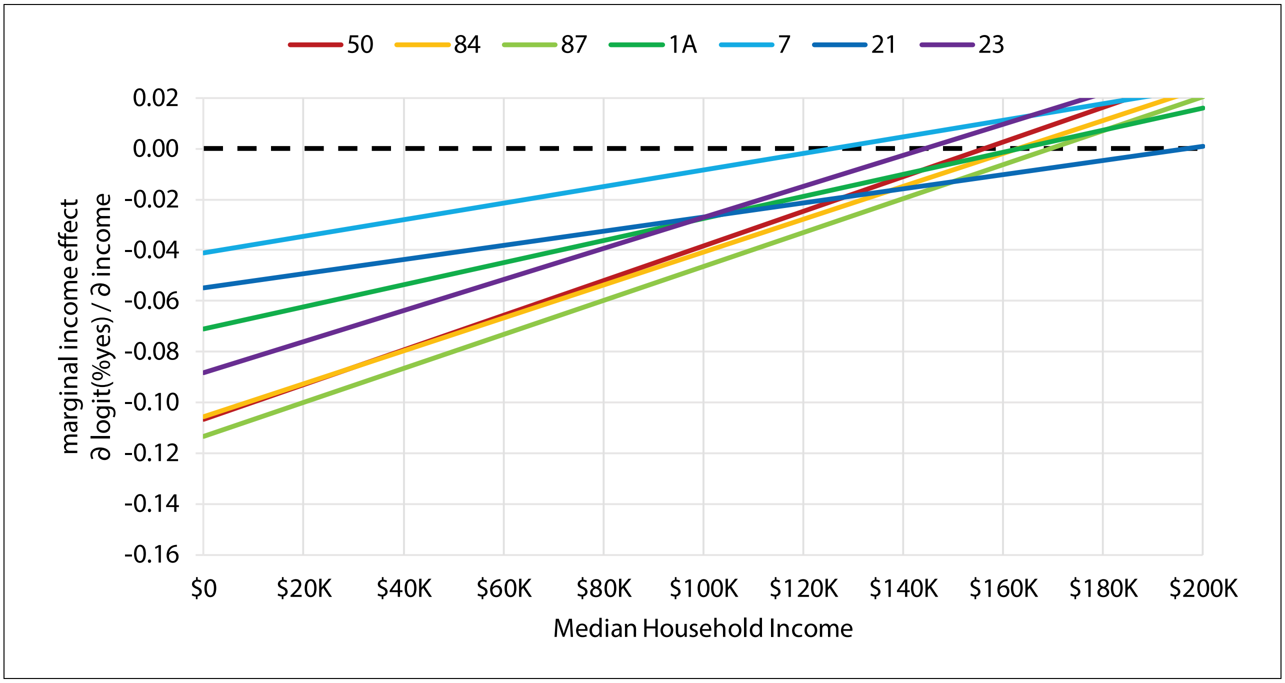

Figure 15. Graph showing the shape of the linear (continuous) marginal income effect function, calculated from the global run of Model I (the quadratic model).

College-educated voters were more likely to support all propositions except for Proposition 7, the heavily criticized Renewable Portfolio Standards measure that also received very low overall support. Employment in agriculture and mining in most cases predicted lower environmental support, with the exception of Proposition 1A, the High-Speed Rail referendum, likely due to support from agriculture-oriented population centers like Bakersfield. Black and Hispanic/Latino voters were in all cases more likely than others to vote for the propositions. Young voters (34 and younger) were more likely than older voters to support all propositions except for the water bonds (Propositions 50 and 84), which had more support from older voters. As expected, population density strongly increased the odds of a supporting vote, as did proximity to the coast, rail stations, and state parks for the respective relevant propositions. For the State Parks proposition (Proposition 21), proximity to non-State Parks, such as National Parks and National Forests, was also positively correlated support, a finding which may capture preferences for living in areas with protected land.

Model I, the full model with all controls, performed consistently better than the global model in all cases, indicating that GWR was able to capture spatially localized unobservables that were otherwise obscured by statewide averaging. Model fit measured via adjusted R^2 improved in many cases by a factor of two, and AICc (corrected Akaike information criterion) were consistently reduced as well (Table 14). Improvement in reduction of residuals was statistically significant in all cases (Table 16). Evidence for heterogeneity of income effects across the state is strong, as coefficient estimates vary widely (Table 12). The bandwidth of local regression optimizes to a very small geographic scale, typically between 100 to 200 block-groups. In other words, even with all the demographic controls, locality remains a strong determinant of demand for environmental goods.

7.2 Model II

The Model II specification omitted localized variables, including density (for all propositions) and distance to the coast, rail stations, or parks (for specific propositions). In global runs, Model I substantially surpassed Model II according to fit statistics, owing to its inclusion of density and other covariates. In local runs, however, the difference in performance between Model I and Model II all but vanished. This result suggests that the inclusion of density and other location-based covariates were also controlling for spatial heterogeneity, but to a much lesser extent than GWR.

Global results from Model II (Table 8), the spline model, largely agreed with those from Model I, the quadratic.). Income effects were negative to neutral across the income terciles for all the propositions. Negative income effects were consistently the strongest for the lowest tercile of income, after which effects became more neutral. In almost no cases were income effects ever positive in the global model (Table 10). Figure 16 shows this marginal income effect visually:

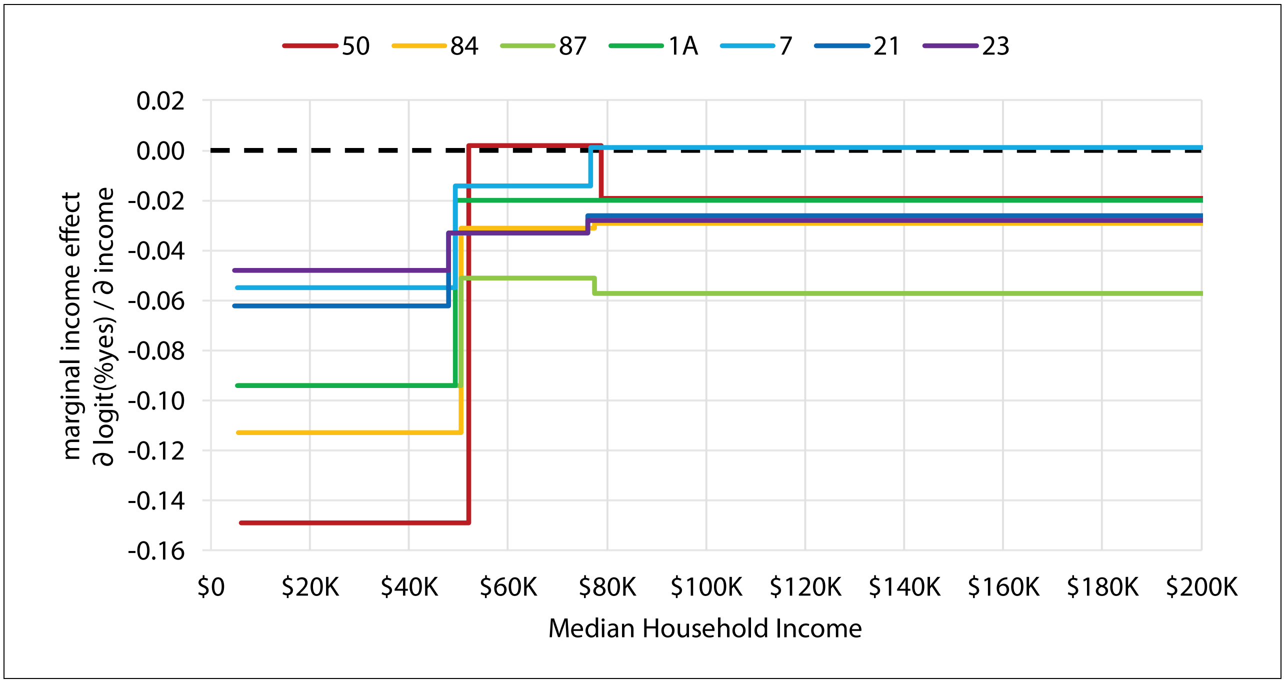

Figure 16. Graph showing the shape of the piecewise (step) marginal income effect function, calculated from the global run of Model II (the spline model). The two divisions between the income terciles are around $50,000 and $80,000 respectively, with minor variation depending on the year.

Model II estimates for covariates were more consistent across the different propositions. College education had a positive impact on support for all propositions (no anomaly for Proposition 7), while employment in resource-extractive industries had a negative effect in all cases (no anomaly with the High-Speed Rail measure). In addition, young voters were shown to be consistently more supportive, even in the case of the two water bonds (50 and 84), suggesting that controlling for coastal proximity in the previous model may have impacted the previous result.

Local parameter estimates from the GWR run of Model II however, suggest more heterogeneity in parameters that is lost in the global estimates of either model. (GWR estimates are mapped and plotted by region in the Appendix: Figure 22 through Figure 28.) The low-income tercile showed the strongest negative income effects across the propositions in the global runs. While much of the state, including many parts of dense Los Angeles, show negative income effects in the GWR run, other regions including a large portion of the Bay Area show consistently positive income effects in the low-income tercile, across all propositions. At the middle-income tercile, which in the global run remained negative, we start seeing in the GWR results large areas of positive income effects in the San Joaquin Valley. By the high-income tercile, the San Joaquin Valley and even more so Northern California tend to have strong positive income effect estimates.

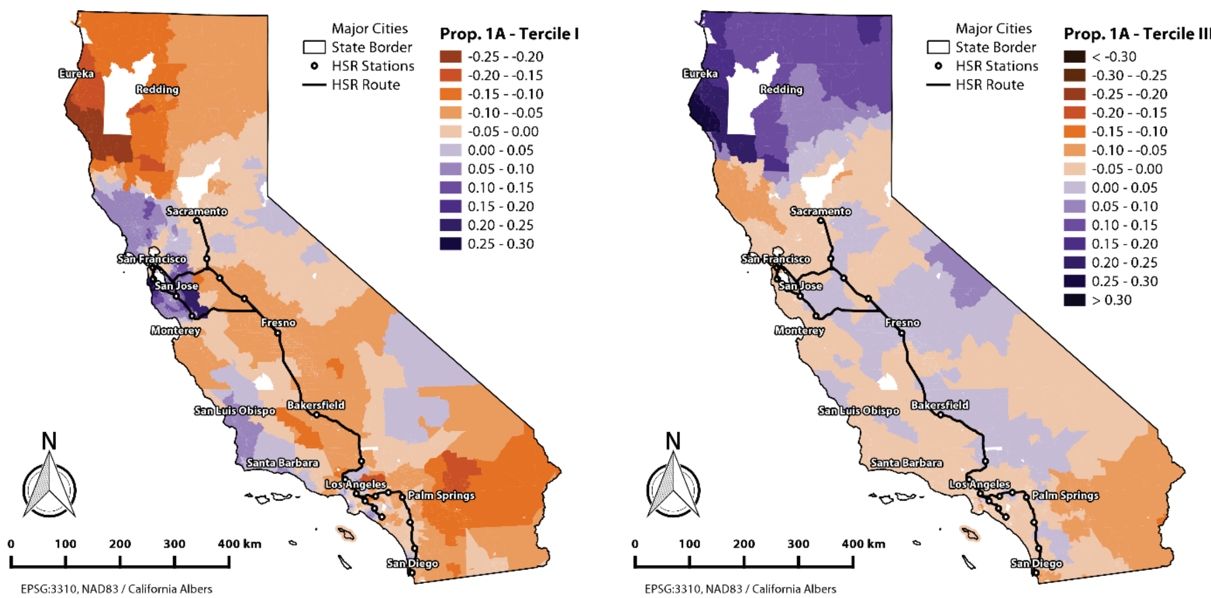

Figure 17. A characteristic example of income effect distributions from the GWR results. The maps shown here depict the low income (Tercile I) and high income (Tercile III) income effect estimates for Proposition 1A. Results for all three terciles, for all propositions, are shown in the Appendix.

Due to the high population density, cities are represented by many discrete Census block-groups within a small geographic space. Indeed, this high density implies that urban estimates tend to drive the global results, while relationships in the rural parts of the state are obscured. At the same time, at all income terciles, there is also substantial variation within and between urban areas. Many parts of the Bay Area and Los Angeles Metropolitan Area have consistently strong income effect trends in the positive direction, while other parts have consistently strong negative income effect trends. These heterogeneities are lost when considering only statewide averages.

Heterogeneity can also be quantified and systematized by dividing the state into predetrmined regions for analysis. For post-estimation analysis of Model II's results, I use the nine economic regions defined by the California Economic Strategy Panel, as depicted in Figure 3. Their delineation takes into account a number of factors including population centers, commute patterns, land ownership, industrial composition, employment rates, industrial employment differentials, and physical geography (California Economic Strategy Panel, 2006).

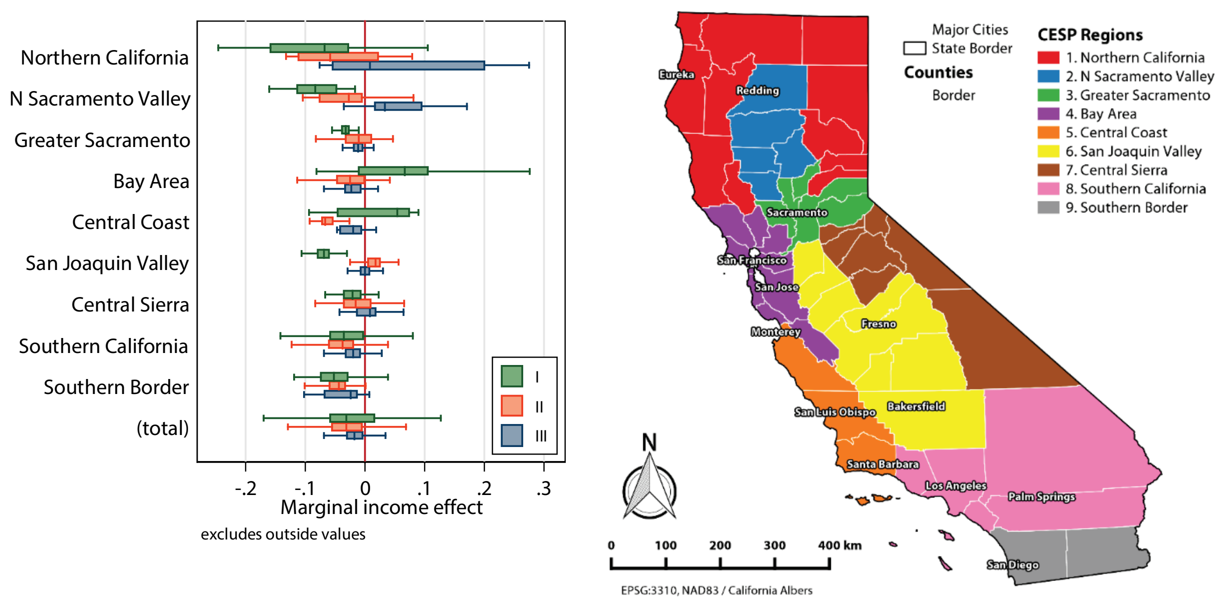

Figure 18. A characteristic example of income effect distributions from the GWR results, split by economic region (the map of which is shown as well). Results shown here are for Proposition 1A. Results for all propositions are shown in the Appendix.

Breaking apart the local GWR income effect estimates by region confirms the distinct differences in income effect estimates across space. I conducted pairwise F-tests for correlation between regions, using the Tukey-Kramer method to account for problems with multiple comparisons (Kirk, 1998). These pairwise correlation tests between each of the nine regions were significant in the supermajority of pairings (Table 18).

7.3 Statistical significance (Model II)

Only a fraction of the GWR parameter estimates were statistically significant after applying Byrne's correction for multiple hypothesis testing and geographic dependence (proportions significant are listed in Table 11). Education and race/ethnicity are among the most consistently significant variables. Significance of the income effect estimates for the spline model is only somewhat informative, however; joint significance of the multiple parameter estimates involved in an income effect estimates would be more informative. Importantly, anomalous regional results, such as the positive income effect in the Bay Area, are indeed statistically significant. The map in Figure 19, for example, maps only the 95%-significant lower-tercile income effect estimates for Proposition 1A, and the regional differences become even clearer.

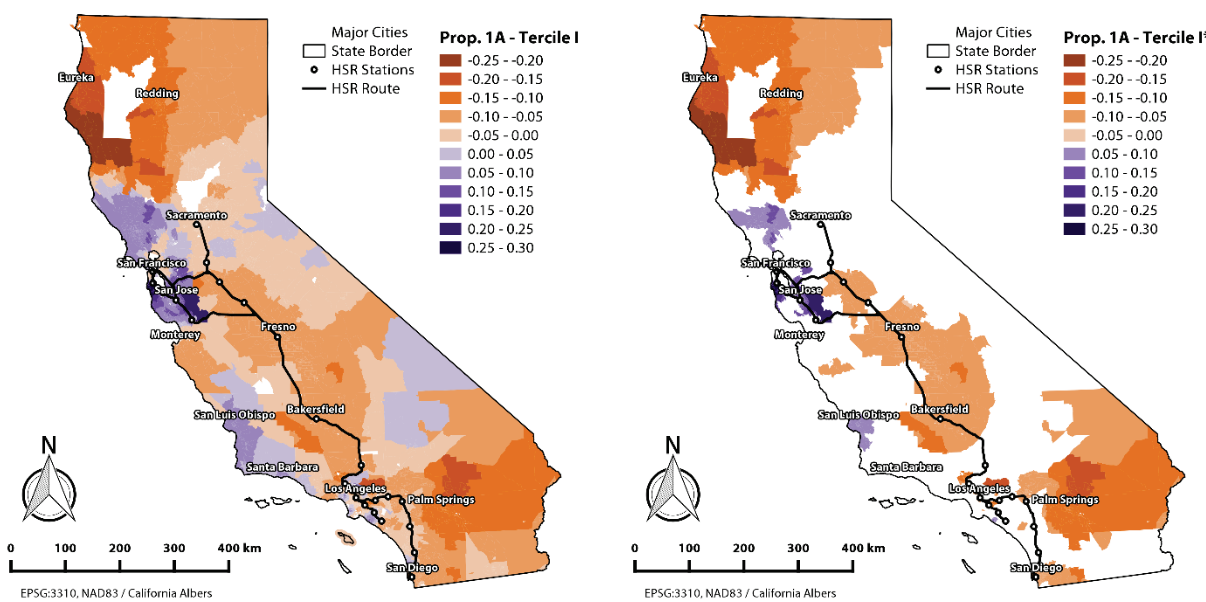

Figure 19. Geographic distribution of Proposition 1A income effect for the first tercile of income, showing all estimates (left) and only estimates that are significant to the Byrne-corrected 95% confidence level (right).

8
Discussion

8.1 Comparing global results to past studies

Results from the global run of Model I were congruous with those of previous studies. This is particularly true of Wu and Cutter's (2011) which was based on propositions a decade earlier but included a quadratic model specification almost identical to my own. My results tended to have a more negative linear term and a similar quadratic term, leading to higher turning points in the negative income effects (on average), but the differences are not particularly substantial. There were some minor differences in estimates for other variables as well. This previous study found, in the case of water bonds, an anomalous negative effect of the proportion identifying as Hispanic on environmental support (attributed to the fact that watershed and flood protection would disproportionately benefit the North, while Hispanic-identifying populations are concentrated in the South); my results for water bonds (Propositions 50 and 84) did not replicate this anomaly.

My global results from Model I are more notable for their estimates on the distance-based variables (coast, HSR stations, and parks) on relevant propositions (50/84, 1A, and 21, respectively). That proximity to the coast is a predictor of support for propositions dealing with coastal and watershed protection is consistent with multiple contingent valuation studies (Pate & Loomis, 1997; Sutherland & Walsh, 1985), which found that willingness-to-pay for wetlands protection and water quality control declined with distance.[11] That proximity to high-speed rail stations is a predictor of support for the high-speed rail bond is consistent with Deacon and Shapiro (1975) who found that voters in the BART (Bay Area Rapid Transit) district were more supportive of a transit funding measure. No previous voting studies have considered proximity to open space as a predictor of support for conservation,[12] so my finding of a positive relationship

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[11] This global result for Propositions 50 and 84 should be interpreted with caution, however, because this significance may simply pick up the coastal-versus-inland cultural differences (part of the reasoning behind using a spatial rather than global model).

[12] A number of studies, as reviewed by Brander and Koetse (2011), have, however, demonstrated that proximity to open space is valued in the real estate market.

between proximity to State Parks (and non-State Parks) and support for State Parks program funding is novel, though unsurprising.

8.2 *The regional narrative*

A key component of this study, and indeed its inspiration, was the narrative of California's distinct cultural regions—formally hypothesized by Woodard (2011), but widely understood to be true by Californians who talk of geographic cultural divides in terms of "NorCal" versus "SoCal," or coast versus inland. Examining the voting patterns for the seven propositions in this paper (summarized in Section 2), it is easy to see how environmental politics plays out along these regional lines. In fact, the coastal North is consistently the most supportive for all environmental propositions (with the exception of Prop 7), and this region of strong support almost perfectly follows the boundary of the fifteen California counties within Woodard's "Left Coast" region.

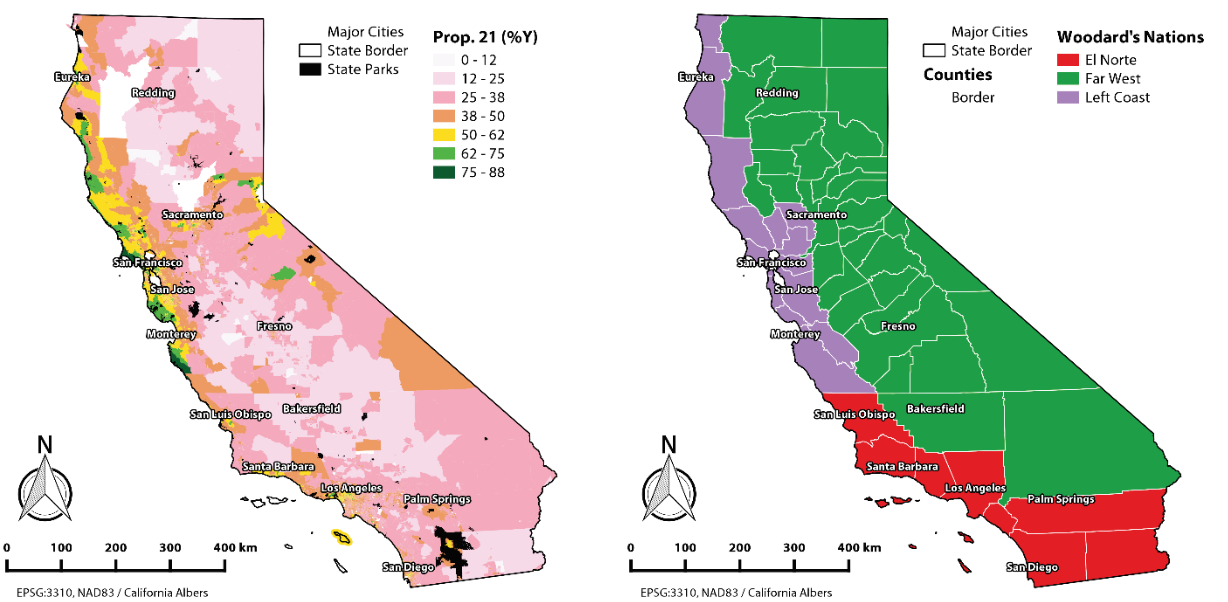

Figure 20. Left: Map of support for Proposition 21, the State Parks proposition. Right: Boundaries of regions from *American Nations* (Woodard, 2011).

My statistical analyses reveal the extent to which these regional differences persist at a deeper level: whether the characteristics of the income effect for environmental public goods also varies along these regional lines. Observing the maps of effect estimates, it is clear that at this level, regional variations are more nuanced across the state. While it is beyond the scope of this study to speculate on the reasons for all the variations, the consistent outlier appears to be the San Francisco Bay Area. Focusing on the income effect among the lowest tercile of income, where in the rest of the state environmental support decreased with income, in the Bay Area it increased. In other words, only in the Bay Area are environmental public goods considered normal goods; only in the Bay Area is wealth a positive predictor of environmental support. While the rest of the state's local income effect estimates are in the same direction as the aggregate result from the global model, the Bay Area's stand apart, suggesting that global model estimates should not be assumed to accurately reflect the political climate of the Bay Area.[13] Furthermore, the wide variation in estimates in the Bay Area reflects a complicated situation that is worthy of its own, separate study.

Based on anecdotal evidence of California regional politics, the result in the Bay Area is not surprising. Elsewhere in the state, wealthier people are less likely to support environmental propositions. In many places, like the industrial areas of the Los Angeles basin, it is low-income communities of color who most actively push for the enactment of environmental regulations; this is a response to the disproportionate burden of toxic contamination in industrial corridors, where low-income communities lack the political clout to successfully lobby for local NIMBY ("not in my backyard") regulations. Wealthier communities in other parts of the state may be less concerned with environmental issues, because they lack the immediate impacts on day-to-day life.

In contrast, the San Francisco Bay Area's liberal progressivism, which is largely a phenomenon of middle-to-high income populations, has made environmental support

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[13] Looking at the geographic distribution of *statistically significant* estimates, as in Figure 19, makes the difference even clearer.

fashionable. Indeed, the Bay is one of the epicenters of the modern environmental movement, with a history extending back to the work of Berkeley native David Brower. Today, the vogue of environmental causes among middle-to-high income Bay Area residents is evidenced by the ubiquity of hybrid vehicles on local freeways. Low-income residents in the region are dealing with an array of issues—including ongoing gentrification associated with growing industry in Silicon Valley, as well as toxics exposure issues near the Richmond oil refineries and Port of Oakland—but may not match higher-income residents' environmentalism at the polls.

8.3 Limitations of this study

Multicollinearity of covariates is a potential issue with this model, and difficult to remedy given the interconnectedness of socioeconomic and demographic variables caused by common-sense associations (e.g. the correlation of education with income) and entrenched societal inequities (e.g. the differences in income and education by race and ethnicity). Additionally, the small bandwidth window in the optimal GWR models increases the risks of local outlying observations drastically changing local estimates. More advanced analyses are possible that would help to verify these exploratory results. The risks posed by multicollinearity of covariates could be reduced by using geographically weighted ridge regression,[14] while robustness of estimates to outliers could be verified using novel "robust GWR" techniques pioneered by Harris and colleagues (2010).

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[14] e.g. using David Wheeler's gwrr R package: https://cran.r-project.org/package=gwrr

9
CONCLUSION

This study provides initial evidence that political geography may indeed play a considerable role in determining voter preferences, on a deeper level than can be reflected in and controlled for through demographic and socioeconomic characteristics of voters.

Extending the global income effect characteristics estimated in this study to apply beyond the State of California is difficult. The very finding of geographic heterogeneity in income effect parameters asserts that models estimated in one area cannot be assumed to apply elsewhere—even within California, the demand function for environmental public goods in the San Francisco Bay Area is vastly different from that of the San Joaquin Valley or even Los Angeles.

It is safe to conclude, however, that if a similar study was conducted elsewhere in the United States, across a similarly diverse region as California, that we would also see a diverse range of estimates. While more advanced variants of the GWR model could better verify the extent of this heterogeneity, and how much of an effect it has on global models, the evidence suggests that economic parameters are not universal across space, and that—in any study of economic trends across a diverse area—researchers must take care to consider political geography and regional culture.

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TABLES

Table 1. Summary statistics for 2000 Census Bureau block group variables.

VARIABLE	MEAN	STD. DEV.	MIN	MAX
median HH income (modeled in $10,000)	71,863	35,690	3,408	272,761
% HH income < $24,999 (base)	26%	17%	0%	200%
% $25,000 < HH income < $49,999	27%	10%	0%	225%
% $50,000 < HH income < $74,999	19%	8%	0%	100%
% $75,000 < HH income < $99,999	12%	7%	0%	100%
% $100,000 < HH income < $124,999	7%	6%	0%	44%
% $125,000 < HH income < $149,999	4%	4%	0%	100%
% $150,000 < HH income	7%	10%	0%	100%
% with bachelor's degree (age > 25)	26%	19%	0%	100%
% employed in agriculture/forestry (age>16)	2%	5%	0%	70%
% employed in mining/petroleum (age>16)	0%	1%	0%	26%
% black (age>18)	6%	12%	0%	99%
% Hispanic/Latino (age>18)	30%	26%	0%	100%
% age 35 to 64	52%	11%	0%	100%
% age 65 and older	15%	10%	0%	95%
population density (per square mile)	94,105	103,474	1	1,895,819

Table 2. Summary statistics for 2000 Census Bureau block-group variables

Variable	Mean	Std. Dev.	Min	Max
median HH income (×$10,000)	7.19	3.57	0.34	27.28
% with bachelor's degree (age > 25)	26.00%	19.39%	0.00%	100.00%
% employed in agri./mining (age>16)	10.43%	7.41%	0.00%	85.71%
% black (age>18)	6.47%	12.26%	0.00%	99.23%
% hispanic/Latino (age>18)	30.18%	26.20%	0.00%	100.00%
% age 35 to 64	51.59%	10.54%	0.00%	100.00%
% age 65 and older	15.00%	9.79%	0.00%	95.29%
population density (per square mile)	8,742.65	9,613.03	0.13	176,127.30

Table 3. Summary statistics for 2010 Census Bureau block-group variables.

Variable	Mean	Std. Dev.	Min	Max
median HH income (×$10,000)	6.79	3.52	0.47	24.98
% with bachelor's degree (age > 25)	30.29%	21.71%	0.00%	100.00%
% employed in agri./mining (age>16)	2.62%	7.64%	0.00%	84.35%
% black (age>18)	6.14%	10.54%	0.00%	94.47%
% hispanic/Latino (age>18)	32.93%	26.08%	0.00%	99.88%
% age 35 to 64	52.17%	8.27%	0.06%	100.00%
% age 65 and older	15.90%	9.02%	0.00%	91.36%
population density (per square mile)	9,116.16	9,749.51	0.00	203,937.40

Table 4. Geographic summary statistics used in this analysis.

Variable	Mean	Std. Dev.	Min	Max
distance to coast (mi)	28.26	32.89	0.00	205.45
distance to nearest HSR station (mi)	18.83	28.94	0.06	269.73
distance to nearest park15 (mi)	1.48	1.34	0.	18.06
— state parks only (mi)	7.12	6.75	0.	90.62
— state parks excluded (mi)	1.53	1.38	0.	18.06

[15] Open-access protected lands in the CPAD database, excluding city parks and cemeteries

Table 5. Summary statistics for voting on propositions of interest, by block group. Also indicated are the popular election results.

Proposition	Year	Popular vote	passed?	Mean	Std. Dev.	Min	Max
50	2002	55.4%	✓	58%	14%	0%	100%
84	2006	53.8%	✓	57%	13%	0%	100%
87	2006	45.3%		47%	14%	0%	100%
1A	2008	52.6%	✓	54%	11%	0%	100%
7	2008	35.6%		37%	7%	0%	84%
10	2008	40.6%		43%	10%	0%	100%
21	2010	42.7%		43%	12%	0%	86%
23	2010	38.5%		63%	12%	0%	100%

Table 6. Summary statistics for party registration in general elections of interest, by block group. Base group is Democratic Party.

party registration	Year	Mean	Std. Dev.	Min	Max
republican party	2002	36%	17%	0%	100%
	2006	33%	17%	0%	100%
	2008	29%	15%	0%	100%
	2010	31%	16%	0%	100%
independent or 3rd party	2002	4%	5%	0%	67%
	2006	4%	2%	0%	25%
	2008	4%	2%	0%	33%
	2010	4%	2%	0%	30%

Table 7. Global regression results for Model I. * $p<0.05$; ** $p<0.01$

	50	84	87	1A	7	21	23
[constan t]	0.114	0.094	-1.040	0.073	-0.025	0.511	-0.613
	(2.61)**	(2.38)*	(28.49)**	(1.63)	(1.31)	(12.91)**	(17.06)**
Income	-0.106	-0.109	-0.097	-0.077	-0.040	-0.061	-0.074
	(34.08)**	(37.90)**	(28.15)**	(27.02)**	(22.76)**	(22.07)**	(22.93)**
Income2	0.003	0.003	0.002	0.002	0.002	0.002	0.002
	(24.31)**	(24.02)**	(9.67)**	(16.71)**	(19.63)**	(11.57)**	(11.06)**
% college educ	1.432	1.458	2.505	1.326	-0.044	1.393	1.870
	(53.33)**	(63.27)**	(93.81)**	(61.29)**	(3.33)**	(65.91)**	(77.49)**
% agri / mining	-0.799	-0.734	-1.220	0.047	-0.503	-0.275	-0.394
	(16.96)**	(17.28)**	(23.86)**	(1.18)	(20.44)**	(7.37)**	(9.17)**
% black	1.734	1.610	1.268	1.035	0.100	0.156	1.443
	(70.68)**	(70.46)**	(46.42)**	(43.38)**	(6.78)**	(6.14)**	(48.94)**
% hisp / latino	1.623	1.292	0.964	0.631	0.384	0.127	0.692
	(90.83)**	(82.07)**	(50.91)**	(39.21)**	(39.54)**	(8.02)**	(37.58)**
% age 35 – 64	0.247	0.118	-0.102	-0.681	-0.773	-0.402	-0.023
	(6.10)**	(3.02)**	(2.15)*	(17.06)**	(31.37)**	(10.13)**	(0.49)
% age 65+	0.330	0.350	-0.445	-0.683	-0.976	-0.576	-0.125
	(10.03)**	(11.45)**	(12.09)**	(21.65)**	(50.08)**	(17.70)**	(3.31)**
ln(pop dens)	0.090	0.075	0.072	0.074	0.014	0.066	0.089
	(43.97)**	(40.55)**	(33.54)**	(38.57)**	(12.37)**	(34.71)**	(40.63)**
ln(dist coast)	-0.107	-0.087	—	—	—	—	—
	(49.51)**	(45.91)**	—	—	—	—	—
ln(dist hsr)	—	—	—	-0.033	—	—	—
	—	—	—	(12.64)**	—	—	—
ln(dist state park)	—	—	—	—	—	-0.120	—
	—	—	—	—	—	(50.97)**	—
ln(dist other park)	—	—	—	—	—	-0.019	—
	—	—	—	—	—	(11.65)**	—
R^2	0.64	0.62	0.48	0.46	0.50	0.44	0.40
N	22,716	22,749	22,752	22,780	22,773	22,799	22,798

Table 8. Global regression results for Model II. * $p<0.05$; ** $p<0.01$

	50	84	87	1A	7	21	23
[constant]	0.273	0.073	-0.271	0.605	0.210	-0.133	0.203
	(7.69)**	(2.31)*	(7.66)**	(19.97)**	(11.74)**	(4.22)**	(5.79)**
income	-0.149	-0.113	-0.094	-0.094	-0.055	-0.062	-0.048
	(24.75)**	(20.96)**	(15.65)**	(17.98)**	(17.92)**	(11.12)**	(7.81)**
[tercile ii]	-0.740	-0.395	-0.198	-0.345	-0.185	-0.144	-0.105
	(15.10)**	(9.49)**	(4.26)**	(8.79)**	(7.96)**	(3.52)**	(2.32)*
[tercile ii] × income	0.151	0.082	0.043	0.074	0.041	0.029	0.015
	(17.05)**	(10.57)**	(5.00)**	(9.95)**	(9.35)**	(3.69)**	(1.69)
[tercile iii]	-0.589	-0.446	-0.205	-0.392	-0.301	-0.257	-0.207
	(18.78)**	(16.37)**	(6.72)**	(15.15)**	(19.71)**	(9.56)**	(6.94)**
[tercile iii] × income	0.130	0.084	0.037	0.074	0.056	0.036	0.020
	(21.04)**	(15.24)**	(5.95)**	(13.91)**	(17.77)**	(6.40)**	(3.09)**
% college educ	1.973	1.957	2.676	1.551	-0.027	1.787	2.094
	(68.83)**	(81.25)**	(99.36)**	(70.61)**	(2.10)*	(81.34)**	(85.99)**
% agri / mining	-1.792	-1.684	-1.811	-0.682	-0.636	-1.044	-1.006
	(35.27)**	(38.18)**	(36.73)**	(17.52)**	(27.65)**	(27.76)**	(24.14)**
% black	2.174	1.969	1.443	1.234	0.121	0.437	1.654
	(81.53)**	(79.74)**	(52.26)**	(50.22)**	(8.34)**	(16.07)**	(54.86)**
% hisp / latino	2.034	1.649	1.192	0.920	0.424	0.342	0.936
	(107.39)**	(100.89)**	(65.22)**	(59.34)**	(46.33)**	(21.00)**	(51.83)**
% age 35 – 64	-0.678	-0.587	-0.562	-1.173	-0.868	-0.656	-0.480
	(15.88)**	(14.14)**	(12.11)**	(29.13)**	(36.49)**	(15.66)**	(10.33)**
% age 65+	-0.001	0.057	-0.675	-0.954	-1.021	-0.733	-0.424
	(0.02)	(1.73)	(18.22)**	(29.43)**	(53.34)**	(21.10)**	(11.00)**
R^2	0.55	0.53	0.45	0.41	0.50	0.33	0.36
N	22,716	22,749	22,752	22,780	22,773	22,799	22,798

Table 9. Characteristics of quadratic income effect estimates from Model I. For raw estimates, see Table 7.

	50	84	87	1A	7	21	23
Raw coefficient estimates:							
Income	-0.1067	-0.1056	-0.1134	-0.0710	-0.0411	-0.0548	-0.0883
$Income^2$	0.0034	0.0032	0.0033	0.0022	0.0016	0.0014	0.0031
turning pt	15.61	16.28	16.93	16.31	12.56	19.65	14.42
(in $10,000; the income level above which the marginal income effect is positive)							

Table 10. Characteristics of spline income effect estimates from Model II. For raw estimates, see Table 8.

	50	84	87	1A	7	21	23
Raw coefficient estimates:							
[constant]	0.273	0.073	-0.271	0.605	0.210	-0.133	0.203
income	-0.149	-0.113	-0.094	-0.094	-0.055	-0.062	-0.048
[tercile ii]	-0.740	-0.395	-0.198	-0.345	-0.185	-0.144	-0.105
[tercile ii] × income	0.151	0.082	0.043	0.074	0.041	0.029	0.015
[tercile iii]	-0.589	-0.446	-0.205	-0.392	-0.301	-0.257	-0.207
[tercile iii] × income	0.130	0.084	0.037	0.074	0.056	0.036	0.020
Constant differences between income terciles:							
I to II	-0.740	-0.395	-0.198	-0.345	-0.185	-0.144	-0.105
II to III	0.151	-0.051	-0.007	-0.047	-0.116	-0.113	-0.102
Magnitudes of income effect within income terciles:							
income effect I	-0.149	-0.113	-0.094	-0.094	-0.055	-0.062	-0.048
income effect II	0.002	-0.031	-0.051	-0.020	-0.014	-0.033	-0.033
income effect III	-0.019	-0.029	-0.057	-0.020	0.001	-0.026	-0.028

Table 11. Proportions of local GWR estimates that are statistically significant, using Byrne's corrected 95% confidence.

	50	84	87	1A	7	21	23
[constant]	12%	15%	25%	24%	21%	22%	25%
income	54%	42%	44%	29%	27%	22%	7%
[tercile ii]	11%	5%	6%	9%	2%	1%	2%
[tercile ii] × income	14%	7%	11%	15%	5%	3%	4%
[tercile iii]	34%	23%	15%	12%	17%	9%	9%
[tercile iii] × income	34%	25%	22%	23%	19%	10%	12%
% college educ	74%	77%	90%	82%	32%	63%	64%
% agri / mining	33%	33%	24%	25%	26%	12%	12%
% black	71%	71%	60%	76%	59%	24%	48%
% hisp / latino	95%	99%	71%	93%	64%	27%	71%
% age 35 – 64	25%	27%	44%	48%	71%	41%	22%
% age 65+	21%	14%	54%	39%	87%	33%	16%
N	22,716	22,749	22,752	22,780	22,773	22,799	22,798

Table 12. Model I ranges of GWR estimates of quadratic income effect parameters/characteristics, compared to global results.

		MIN	P25	P50	P75	MAX	(GLOBAL)
50	income	-1.031	-0.139	-0.074	-0.022	0.820	-0.106
	$income^2$	-0.133	0.000	0.002	0.006	0.090	0.003
	turning pt	-29791.00	5.70	9.91	16.17	37491.00	15.61
84	income	-0.533	-0.099	-0.056	-0.016	0.465	-0.109
	$income^2$	-0.076	0.000	0.002	0.004	0.049	0.003
	turning pt	-18554.00	5.36	10.45	16.02	8455.00	16.28
87	income	-0.811	-0.100	-0.047	-0.001	0.467	-0.097
	$income^2$	-0.056	-0.001	0.001	0.005	0.068	0.002
	turning pt	-34337.00	4.13	8.24	13.73	16745.00	16.93
1A	income	-0.638	-0.079	-0.040	-0.003	0.313	-0.077
	$income^2$	-0.034	0.000	0.002	0.004	0.068	0.002
	turning pt	-6264.00	5.66	8.98	13.12	11804.00	16.31
7	income	-0.882	-0.067	-0.034	-0.006	0.209	-0.04
	$income^2$	-0.027	0.000	0.002	0.004	0.093	0.002
	turning pt	-8575.00	5.54	8.53	12.52	14329.00	12.56
21	income	-0.413	-0.055	-0.025	0.004	0.336	-0.061
	$income^2$	-0.038	-0.001	0.001	0.003	0.045	0.002
	turning pt	-23634.00	4.79	8.70	13.12	3621.00	19.65
23	income	-0.630	-0.048	-0.010	0.028	0.687	-0.074
	$income^2$	-0.075	-0.002	0.000	0.002	0.063	0.002
	turning pt	-7888.00	4.33	7.39	11.82	12361.00	14.42

Table 13. Model II ranges of GWR estimates of within-tercile income effect magnitudes, compared to global results.

	Income tercile	min	p25	p50	p75	max	(global)
50	(i) low	-0.232	-0.121	-0.090	-0.043	0.363	-0.149
	(ii) med	-0.378	-0.089	-0.048	-0.009	0.146	0.002
	(iii) high	-0.493	-0.039	-0.022	-0.005	0.751	-0.019
84	(i) low	-0.219	-0.099	-0.072	-0.037	0.307	-0.113
	(ii) med	-0.167	-0.068	-0.046	-0.016	0.079	-0.031
	(iii) high	-0.170	-0.038	-0.022	-0.008	1.053	-0.029
87	(i) low	-0.285	-0.121	-0.075	-0.032	0.204	-0.094
	(ii) med	-0.280	-0.074	-0.047	-0.012	0.066	-0.051
	(iii) high	-0.726	-0.058	-0.035	-0.018	1.186	-0.057
1A	(i) low	-0.245	-0.058	-0.031	0.016	0.295	-0.094
	(ii) med	-0.142	-0.055	-0.031	-0.005	0.082	-0.020
	(iii) high	-0.736	-0.030	-0.017	-0.004	0.414	-0.020
7	(i) low	-0.167	-0.051	-0.027	0.005	0.212	-0.055
	(ii) med	-0.172	-0.027	-0.015	-0.003	0.086	-0.014
	(iii) high	-0.238	-0.010	-0.001	0.006	0.381	0.001
21	(i) low	-0.266	-0.086	-0.055	-0.022	0.395	-0.062
	(ii) med	-0.312	-0.045	-0.021	0.002	0.085	-0.033
	(iii) high	-3.004	-0.027	-0.014	-0.002	1.775	-0.026
23	(i) low	-0.207	-0.027	0.005	0.045	0.358	-0.048
	(ii) med	-0.326	-0.046	-0.018	0.008	0.122	-0.033
	(iii) high	-7.060	-0.038	-0.020	-0.005	1.362	-0.028

Table 14. Model fit statistics for Model I, global and GWR runs.

	Model	N (bandwidth)	CV	R^2	Adj R^2	AICc
Proposition 50	Global	22,716	222.68	65.6%	65.6%	187253.66
	GWR	176	76.98	92.1%	90.2%	161514.80
Proposition 84	Global	22,749	175.73	62.6%	62.6%	182141.42
	GWR	229	71.03	89.2%	87.4%	159578.18
Proposition 87	Global	22,752	258.34	46.6%	46.6%	190972.56
	GWR	325	69.36	88.8%	87.4%	157178.90
Proposition 1A	Global	22,780	181.72	47.9%	47.9%	183324.01
	GWR	324	42.57	90.9%	89.7%	145370.87
Proposition 7	Global	22,773	72.69	50.5%	50.5%	162438.30
	GWR	328	31.93	83.3%	81.2%	140061.81
Proposition 21	Global	22,799	193.30	49.9%	49.9%	184713.41
	GWR	166	47.61	92.5%	90.6%	150045.17
Proposition 23	Global	22,798	268.43	40.1%	40.1%	192238.13
	GWR	321	58.57	90.0%	88.7%	152657.17

Table 15. Model fit statistics for Model II, global and GWR runs

	Model	N (bandwidth)	CV	R^2	Adj R^2	AICc
Proposition 50	Global	22,716	283.33	56.3%	56.2%	192724.80
	GWR	991	103.69	85.3%	84.7%	169290.50
Proposition 84	Global	22,749	219.65	53.3%	53.3%	187215.13
	GWR	993	87.25	82.9%	82.2%	165777.98
Proposition 87	Global	22,752	262.45	45.7%	45.7%	191291.86
	GWR	993	86.98	83.4%	82.8%	165669.82
Proposition 1A	Global	22,780	204.77	41.3%	41.3%	185875.65
	GWR	842	55.92	85.5%	84.8%	155631.05
Proposition 7	Global	22,773	74.41	49.3%	49.3%	162753.40
	GWR	842	38.41	76.5%	75.4%	146896.51
Proposition 21	Global	22,799	233.62	39.5%	39.4%	189032.55
	GWR	511	61.69	86.3%	85.2%	157825.91
Proposition 23	Global	22,798	283.30	36.8%	36.7%	193416.83
	GWR	511	70.74	86.7%	85.6%	160644.04

Table 16. ANOVA tables comparing error of global and GWR runs for Model I.

	Source	SS	DF	MS	F
Proposition 50	Global Residuals	5,051,218.8	22,705.0		
	GWR Improvement	3,883,061.2	4,193.6	926.0	
	GWR Residuals	1,168,157.6	18,511.4	63.1	14.67
Proposition 84	Global Residuals	3,992,435.2	22,738.0		
	GWR Improvement	2,836,931.3	3,277.2	865.6	
	GWR Residuals	1,155,503.9	19,460.8	59.4	14.58
Proposition 87	Global Residuals	5,869,485.3	22,740.0		
	GWR Improvement	4,642,385.9	2,546.6	1,822.9	
	GWR Residuals	1,227,099.4	20,193.4	60.8	30.00
Proposition 1A	Global Residuals	4,133,501.1	22,767.0		
	GWR Improvement	3,413,979.8	2,736.9	1,247.4	
	GWR Residuals	719,521.4	20,030.1	35.9	34.72
Proposition 7	Global Residuals	1,652,538.5	22,761.0		
	GWR Improvement	1,094,068.9	2,540.4	430.7	
	GWR Residuals	558,469.6	20,220.6	27.6	15.59
Proposition 21	Global Residuals	4,400,701.6	22,787.0		
	GWR Improvement	3,744,073.0	4,753.0	787.7	
	GWR Residuals	656,628.7	18,034.0	36.4	21.63
Proposition 23	Global Residuals	6,110,951.8	22,786.0		
	GWR Improvement	5,088,557.7	2,606.2	1,952.5	
	GWR Residuals	1,022,394.1	20,179.8	50.7	38.54

Table 17. ANOVA tables comparing error of global and GWR runs for Model II.

	Source	SS	DF	MS	F
Proposition 50	Global Residuals	6,426,249.2	22,704.0		
	GWR Improvement	4,270,659.1	888.8	4,805.2	
	GWR Residuals	2,155,590.1	21,815.2	98.8	48.63
Proposition 84	Global Residuals	4,989,538.7	22,737.0		
	GWR Improvement	3,159,479.3	889.4	3,552.5	
	GWR Residuals	1,830,059.3	21,847.6	83.8	42.41
Proposition 87	Global Residuals	5,962,986.3	22,740.0		
	GWR Improvement	4,143,114.5	889.5	4,657.9	
	GWR Residuals	1,819,871.8	21,850.5	83.3	55.93
Proposition 1A	Global Residuals	4,658,561.6	22,768.0		
	GWR Improvement	3,509,390.7	1,050.9	3,339.4	
	GWR Residuals	1,149,170.9	21,717.1	52.9	63.11
Proposition 7	Global Residuals	1,691,425.0	22,761.0		
	GWR Improvement	906,929.7	1,050.6	863.3	
	GWR Residuals	784,495.3	21,710.4	36.1	23.89
Proposition 21	Global Residuals	5,318,590.2	22,787.0		
	GWR Improvement	4,117,400.2	1,693.8	2,430.9	
	GWR Residuals	1,201,190.1	21,093.2	56.9	42.69
Proposition 23	Global Residuals	6,448,436.5	22,786.0		
	GWR Improvement	5,088,842.3	1,693.7	3,004.5	
	GWR Residuals	1,359,594.2	21,092.3	64.5	46.61

Table 18. Significance of pairwise comparisons in income effect estimates (for income terciles I through III) between each of the nine regions.[16]

		PAIRWISE COMPARISONS			
	income tercile	significant	insignificant	total	% significant
Proposition 50	i	33	3	36	92%
	ii	29	7	36	81%
	iii	34	2	36	94%
Proposition 84	i	28	8	36	78%
	ii	32	4	36	89%
	iii	33	3	36	92%
Proposition 87	i	31	5	36	86%
	ii	32	4	36	89%
	iii	26	10	36	72%
Proposition 1A	i	32	4	36	89%
	ii	33	3	36	92%
	iii	34	2	36	94%
Proposition 7	i	31	5	36	86%
	ii	31	5	36	86%
	iii	33	3	36	92%
Proposition 21	i	32	4	36	89%
	ii	32	4	36	89%
	iii	22	14	36	61%
Proposition 23	i	33	3	36	92%
	ii	34	2	36	94%
	iii	15	21	36	42%

[16] Post-hoc pairwise comparisons were tested using the Tukey-Kramer method (Kirk, 1998) which tests against critical values of a studentized range distribution. This method is designed to account for problems with multiple comparisons by accounting for the familywise error rate. Implemented using the tkcomp package for Stata, written by IDRE Statistical Consulting Group. More information at http://www.ats.ucla.edu/stat/stata/faq/pairwise.htm

Appendix
Additional Figures

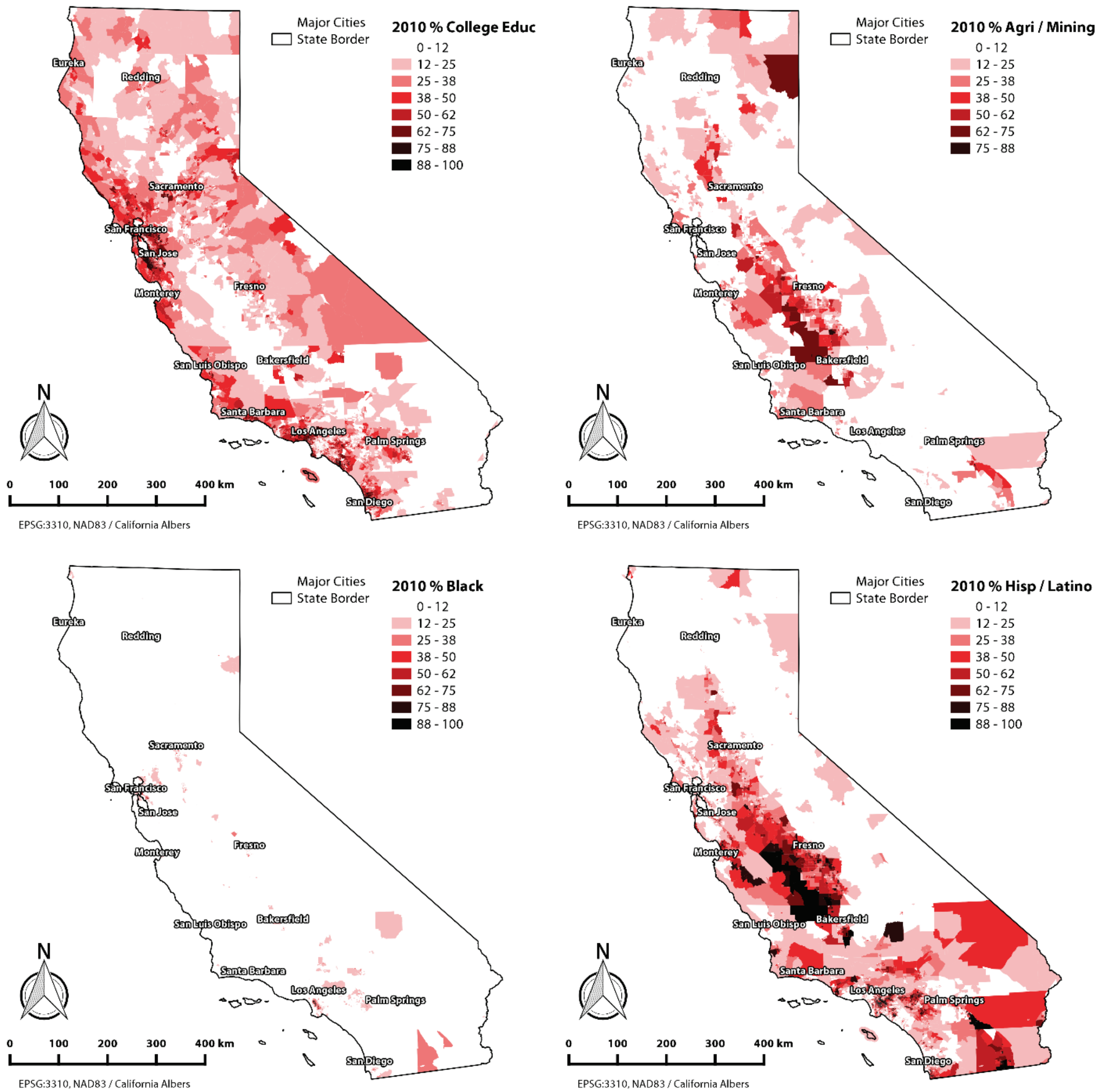

Figure 21. Geographic distribution of block-group percentages of four 2010 demographic variables: proportion with a bachelor's degree or higher, proportion employed in agriculture/mining, proportion identifying to the Census as Black, and proportion identifying to the Census as Hispanic.

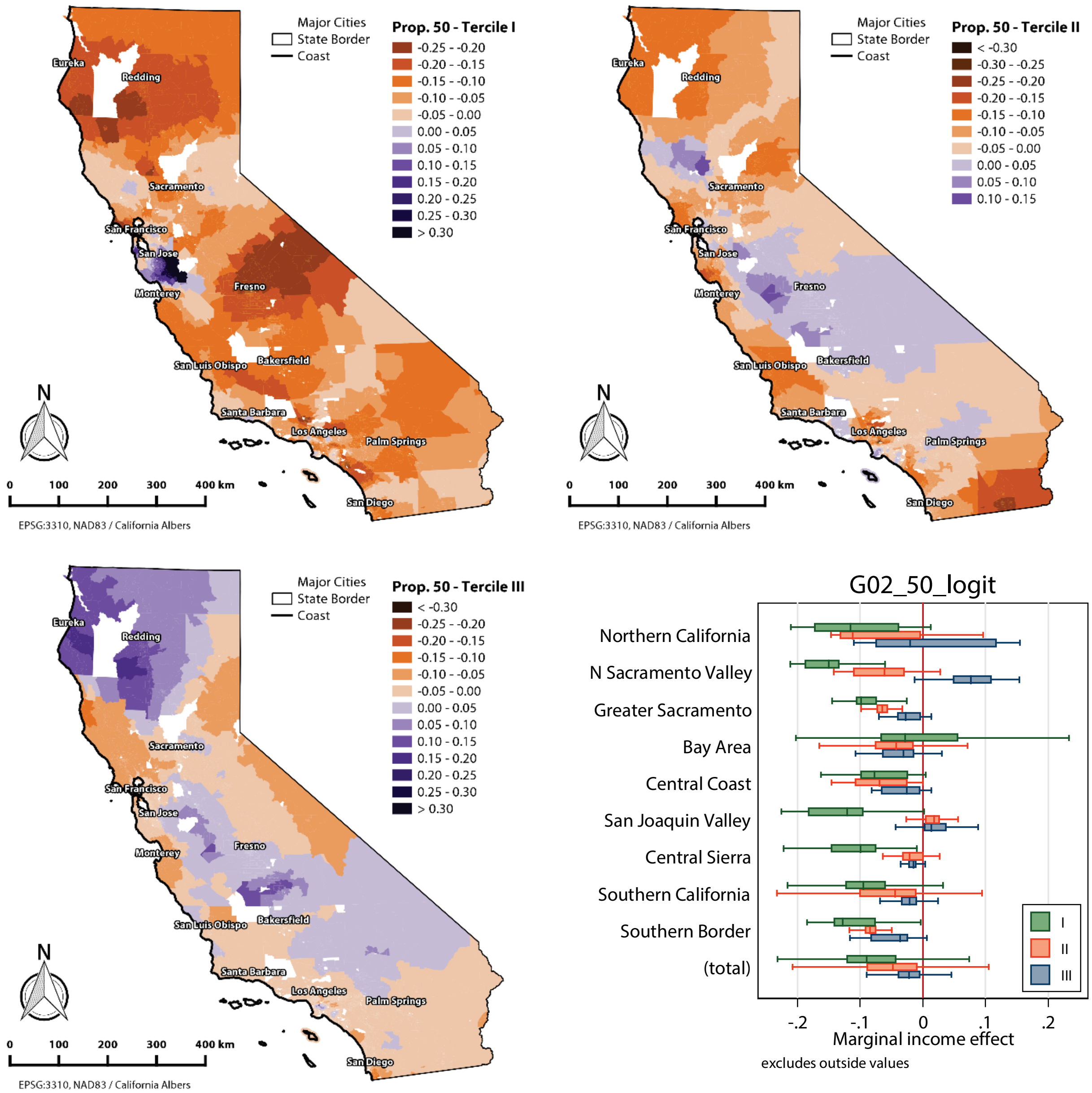

Figure 22. Marginal income effect estimates for Proposition 50.

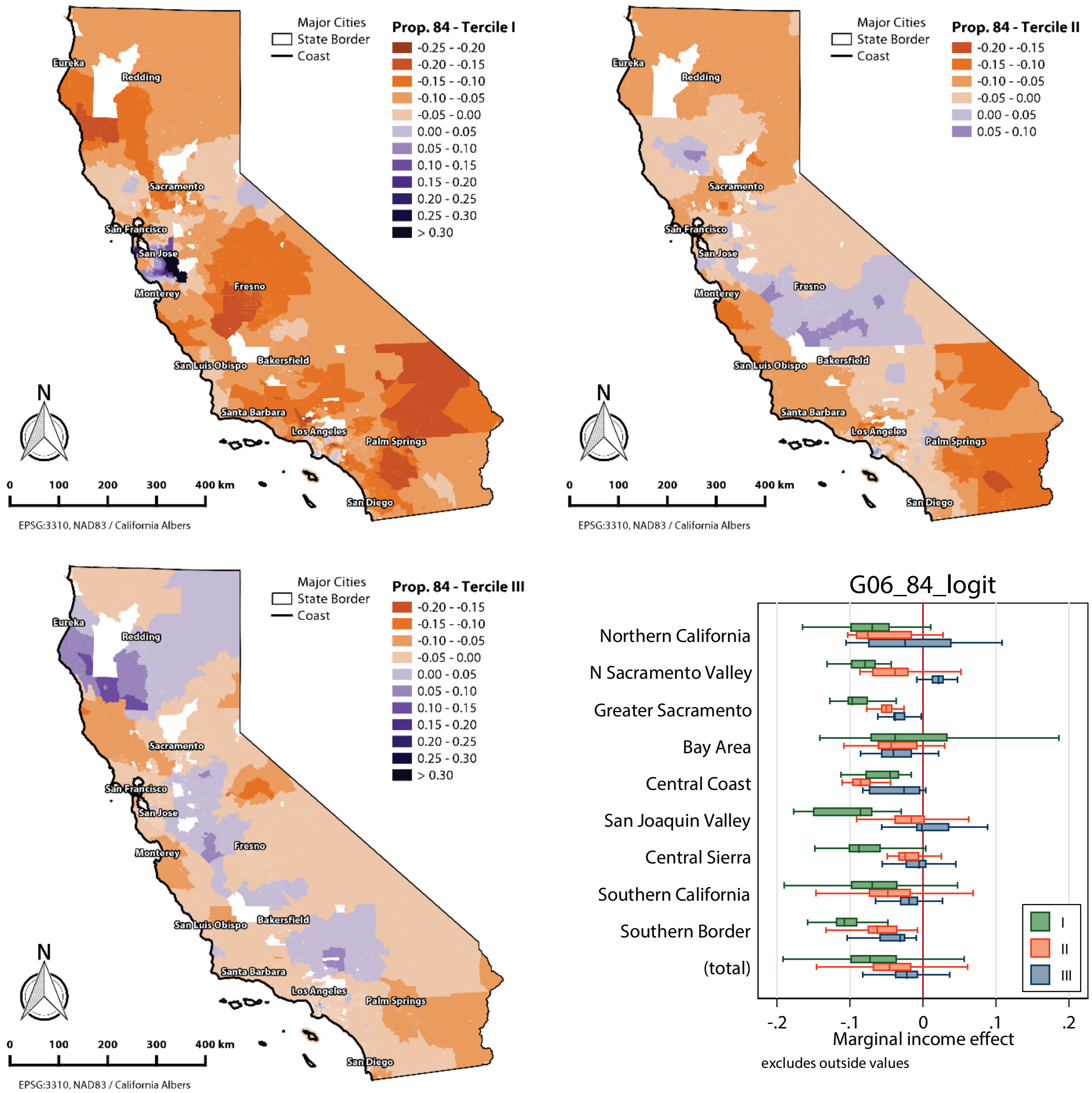

Figure 23. Marginal income effect estimates for Proposition 84.

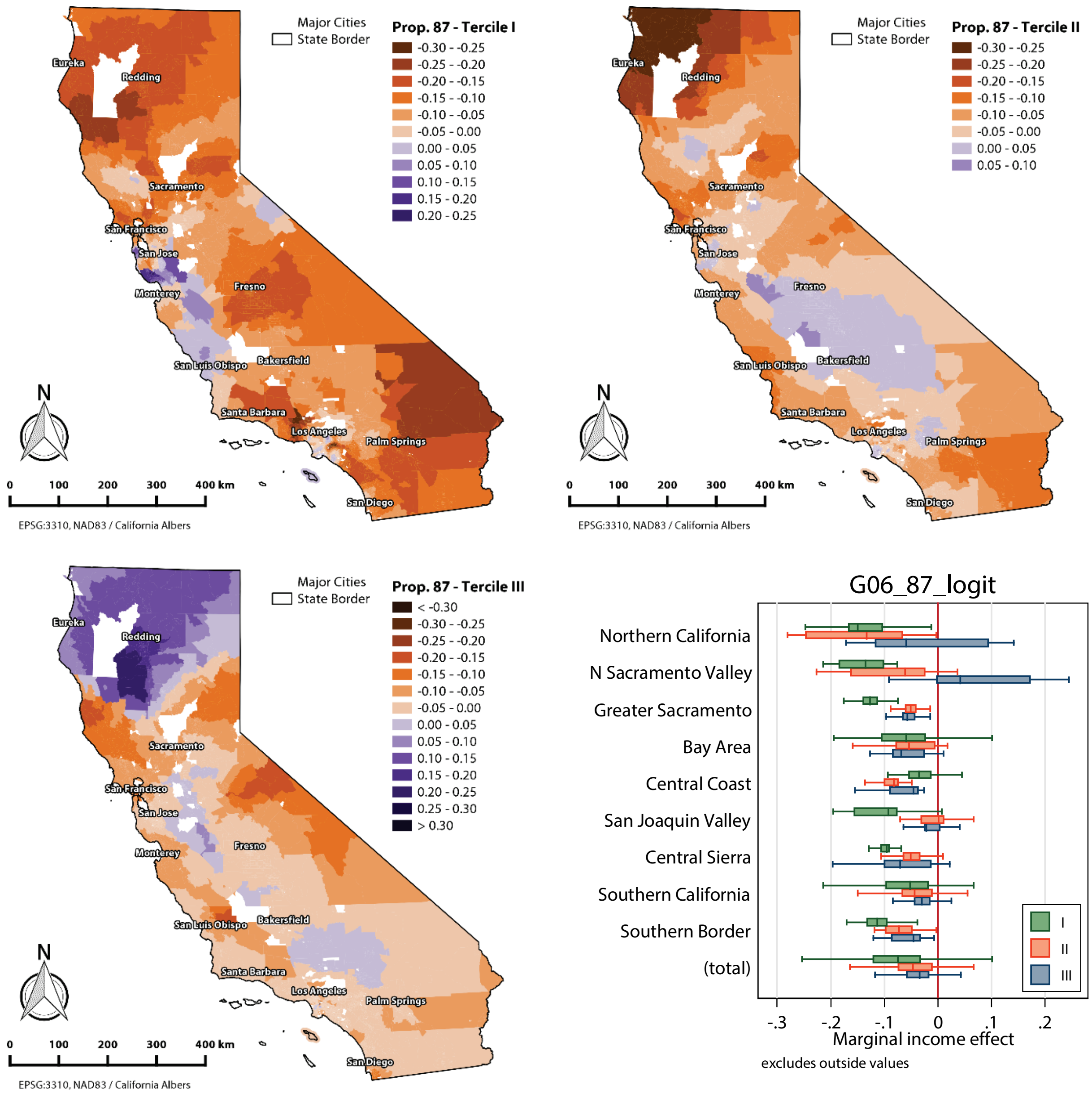

Figure 24. Marginal income effect estimates for Proposition 87.

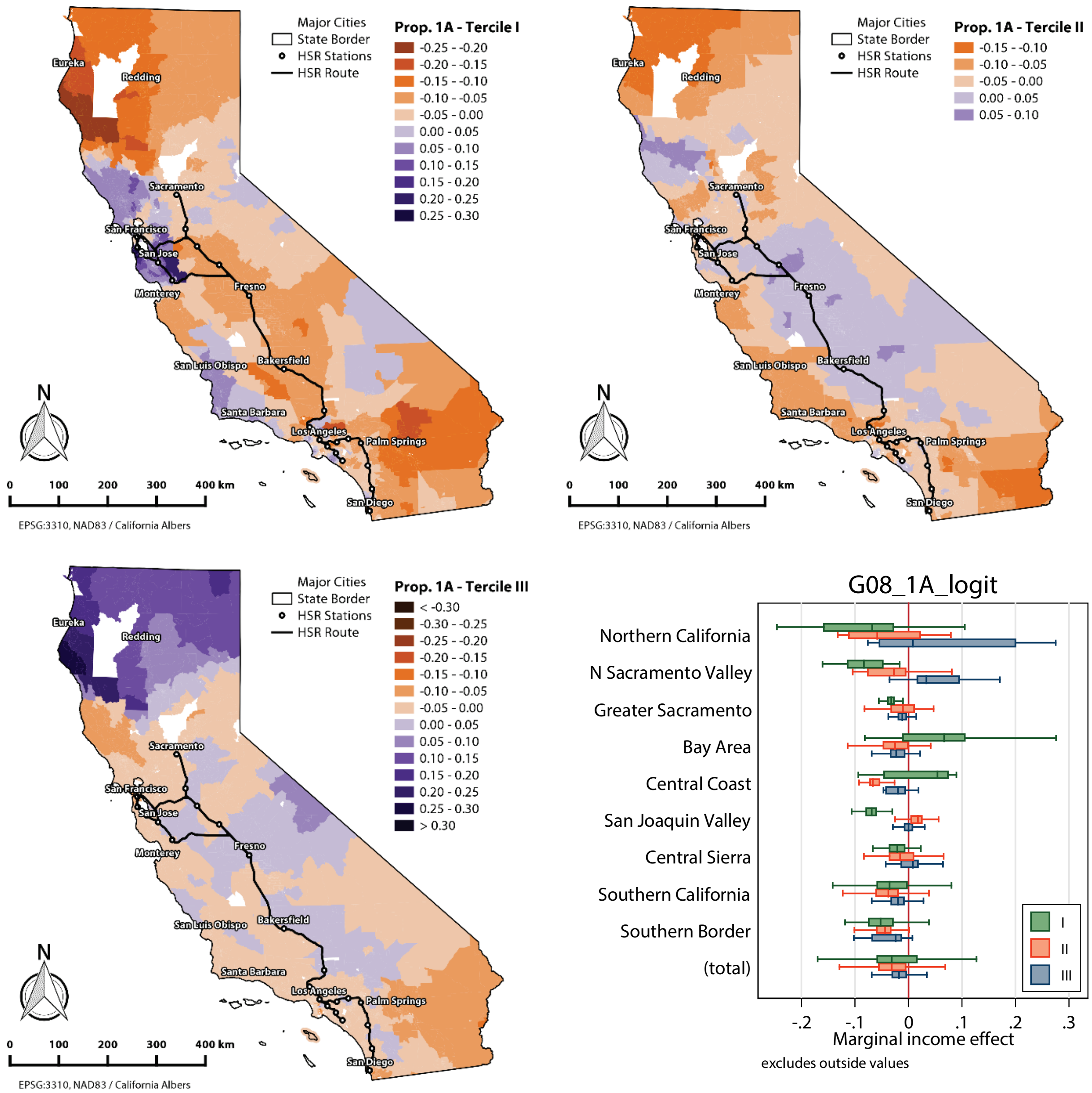

Figure 25. Marginal income effect estimates for Proposition 1A.

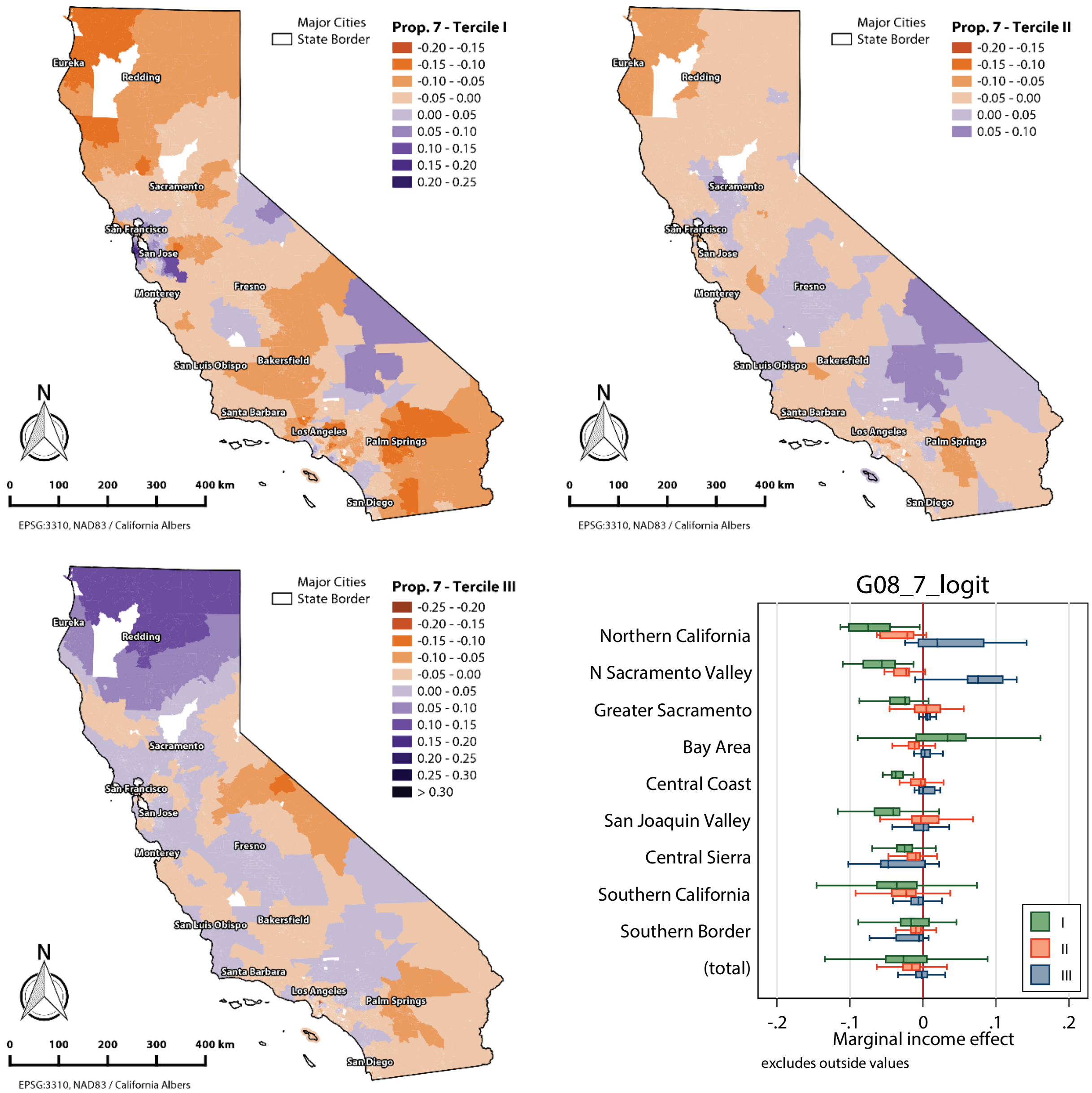

Figure 26. Marginal income effect estimates for Proposition 7.

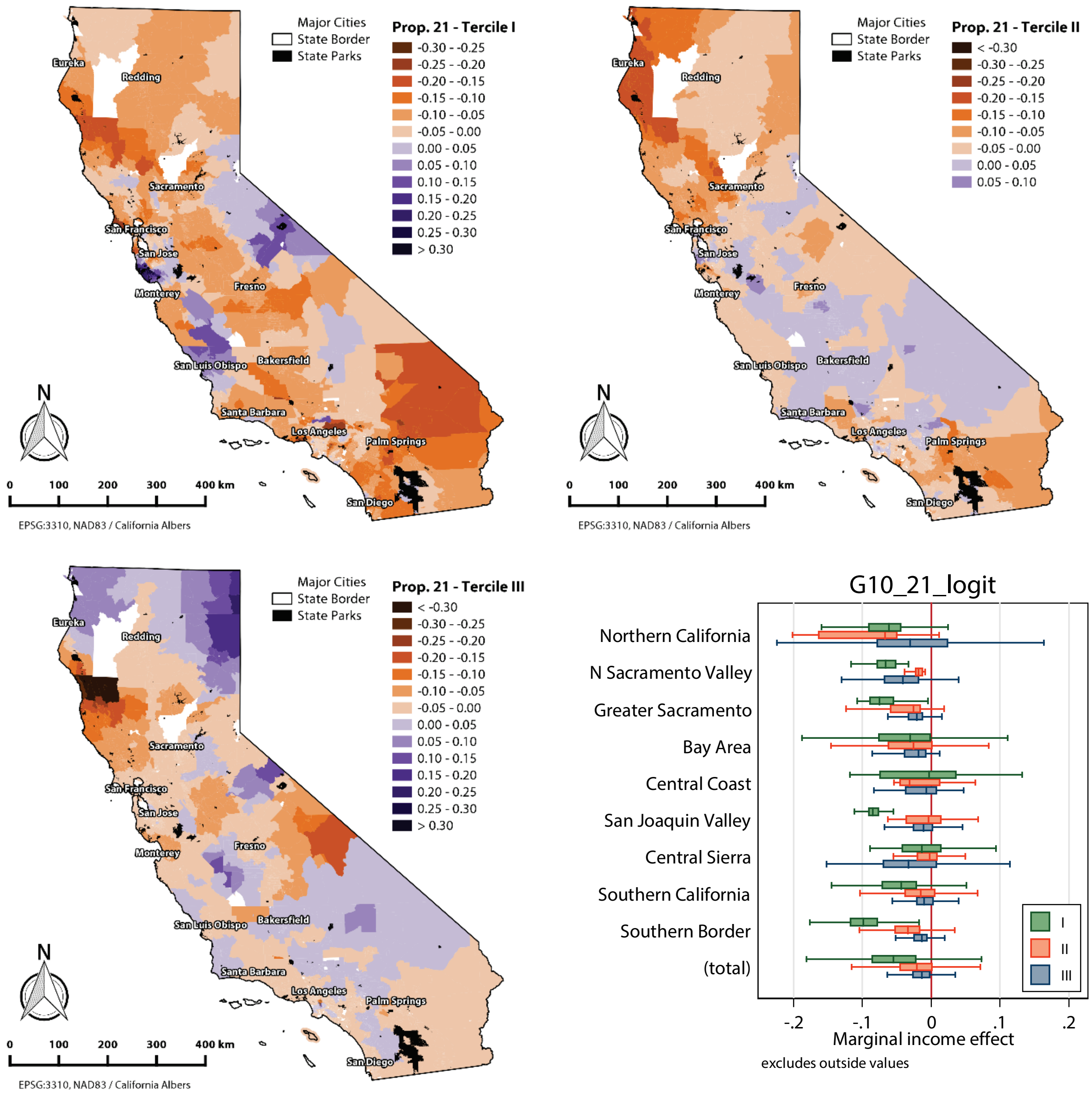

Figure 27. Marginal income effect estimates for Proposition 21.

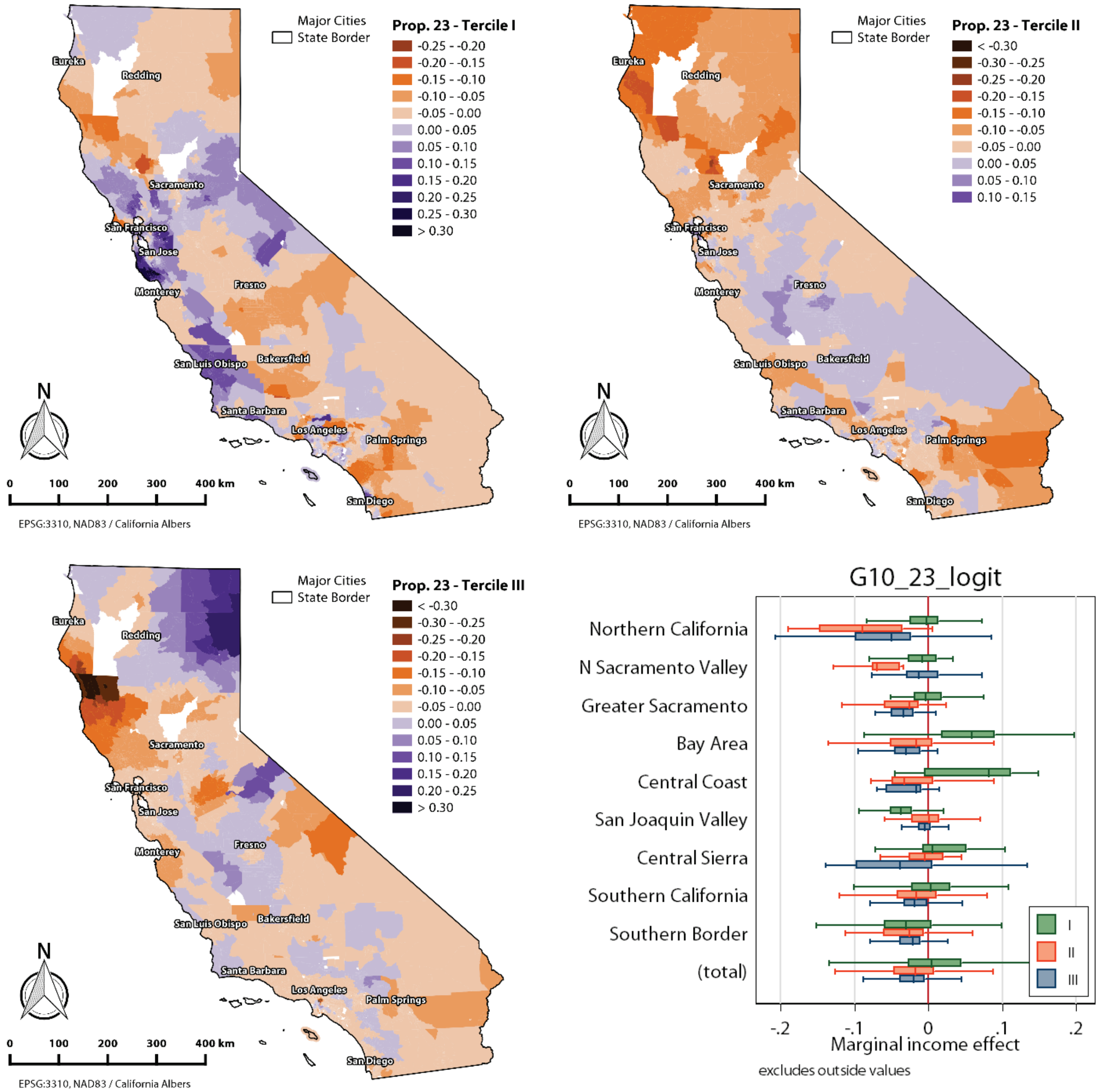

Figure 28. Marginal income effect estimates for Proposition 23.