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Whose Vote Is It Anyway? A Geospatial Analysis of the California Voter's Choice Act Ballot Drop Box Criteria in Santa Cruz County

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WHOSE VOTE IS IT ANYWAY?

Myra Eastman, 2009

JUDITH HEHER

MAY 2024

WHOSE VOTE IS IT ANYWAY?
A GEOSPATIAL ANALYSIS OF THE CALIFORNIA VOTER'S CHOICE ACT BALLOT DROP BOX CRITERIA IN SANTA CRUZ COUNTY

A Creative Project Report

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JUDITH HEHER

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LIST OF ABBREVIATIONS

AB: California Assembly Bill

ACS: American Community Survey

COVID-19: Corona Virus Disease 2019 or 2019 novel coronavirus

CSV: Comma separated values

GIS: Geographic Information System

GPS: Global Positioning System

GWR: Geographically Weighted Regression

HTML: Hyper Text Markup Language

NHGIS: National Historical GIS

PCA: Principal Component Analysis

PDF: Portable Document Format

SB: California Senate Bill

UCSC: University of California Santa Cruz

US United States

USPS: United States Postal Service

VCA: Voter's Choice Act

1. Introduction

The way Californians vote is changing. While some of the laws surrounding these changes are close to a decade old, the events of 2020 surrounding the November Presidential Election and the COVID-19 pandemic both accelerated and expanded the adoption of contactless voting approaches such as vote-by-mail and the ballot drop box. Neither tool is new to California voters. Vote-by-mail was introduced to the state in 1962 (CA Secretary of State, unknown) and ballot drop boxes were first used in 2014 (Sherman, 2020). In 2016 California Senate Bill 450 (SB-450, 2016) was signed into law. Also known as the Voters Choice Act (VCA), this bill introduced a new way for county election officials to run elections that included expanding in-person access and contactless voting services. Those counties that adopt the VCA, mail every registered voter a vote-by-mail ballot. Voters can use the United States Postal Service (USPS) to mail in their ballot, deliver it to a vote center, or place it in a ballot drop box which is maintained by the county elections department. In addition, voting in-person can be done at a vote center, a larger version of the traditional polling place.

The VCA's stated goal is to increase voter engagement and turnout by making voting more accessible – particularly among historically marginalized voters (Stein & Woodson, 2024). But, to date, many county elections officials report being uncertain as to whether their efforts have reached historically marginalized voters, including communities of color and low-income voters (Stein & Woodson, 2024). The VCA introduced a set of criteria county elections officials were to use to determine locations for ballot drop boxes

and vote centers in order to increase voter engagement in marginalized communities. This paper will model the demographic indicators of marginalization to identify ideal locations for ballot drop boxes and compare that with the placement of ballot drop boxes for the November 2020 Presidential Election in Santa Cruz County, thus providing a tool to improve voter engagement in future elections.

There are three types of ballot drop boxes – the unstaffed ballot drop box, the staffed ballot drop box (usually found inside buildings), and the temporary ballot drop box (usually used on election day at vote centers). With few exceptions noted in the methods section, this study is focused solely on the unstaffed ballot drop box and unless otherwise noted, the term "ballot drop box" will be used to represent only this type of ballot drop box.

Ballot drop boxes provide the security of walking into the elections office to deliver a ballot and the convenience of a mailbox. These boxes allow voters to cast their ballots in a mail-like fashion until the polls close on election day. The California Secretary of State is chartered to enforce the installation and implementation of ballot drop boxes (California Code of Regulations, n.d.). Many unstaffed boxes are available 24 hours a day and are designed to support both walk-up and drive-up enabling voters to stay in their cars as they drop off their ballots, much like a traditional USPS mailbox. These boxes are heavily weighted and bolted to the ground. Many are in well-lit locations, often monitored by security cameras, and designed with accessibility features to ensure all voters can use them with facility.

There is substantial research supporting the use of mail drop boxes, yet little has been focused on their placement. The VCA explicitly states 14 guidelines county elections officials are to consider when locating ballot drop boxes yet there is a dearth of research studying the ballot drop box use habits of voters reflected in those guidelines. The paper will use dimension reduction techniques to model the voters in Santa Cruz County CA and then assess how well the ballot box placement in the 2020 general election supported them.

Research Question: Does ballot drop box placement impact the voting habits of the California Voter's Choice Act target communities? Specifically, voters with low vehicle access, voters with disabilities, language minority voters, voters living in poverty and people who have not previously voted.

2. Literature Review

2.1 The VCA and brief history of voting in California

The VCA was passed in 2016 (SB-450, 2016). This law is designed to modernize the voting experience from how voters receive ballots to when and how votes are cast. The primary changes the VCA introduces are no-excuse vote-by-mail, county-wide vote centers as a replacement to the neighborhood polling places, and ballot drop boxes. From the perspective of voters, the act allowed voters to choose how they voted, when they voted, where they voted and have access to any number of voting-related services through the larger vote centers. (California Secretary of State, 2018) It was first implemented with five counties (Madera, Napa, Nevada, Sacramento, and San Mateo) for the June 2018 Gubernatorial Primary Election. Registrars of Voters in these counties were motivated by the promise of election efficiency and long-term cost savings (California State Association of Counties, 2018) and they all considered the new system a success. Most notably, they were impressed by the use of ballot drop boxes. Madera County noted that 20 percent of returned ballots were deposited in ballot drop boxes. Napa County recorded 25 percent of returned ballots were from ballot drop boxes. Alice Jarboe, Sacramento Registrar of Voters stated, “Ballot Drop boxes filled as quickly as we emptied them.” Mark Church, San Mateo Registrar of Voters shared “One of the biggest surprises was the high number of ballots dropped off at Vote Centers, City Halls and Ballot Drop-Off Locations.” All five Registrars of Voters saw the move to the VCA as positive citing cost savings, and increased turnout as major benefits. Santa Cruz County

Elections officials adopted portions of the VCA election model in 2020, completing full adoption in the 2022 election cycle. Most notably, Santa Cruz County instituted a VCA-style implementation of ballot drop boxes for the November 2020 general election.

2.2 Early VCA Studies

The primary goals of the VCA are to reduce the cost of elections and make voting more convenient. It was hoped that the increased convenience would lead to greater voter turnout. Many of the provisions in the act were included is specific response to increase participation by underrepresented eligible voters. McGhee et al., found that counties adopting the VCA in 2018 experienced a statistically significant increase in overall turnout over non-VCA counties, particularly with Latinx and young voters (McGhee et al., 2023), They compared the overall turnout of the five counties which adopted the VCA in 2020 against the remaining 53 counties using the 2014 election as a baseline. They then investigated the impact of the VCA on young, Latinx, and Asian-American voters, considering their voting behavior in 2010, 2014 and 2018. The investigators recognized the VCA-adopting counties were generally small (Madera, Napa, Nevada, Sacramento and San Mateo) leading to small groups of voters, and with only a single year of VCA data, their results could be seen as preliminary only. A greater longitudinal study is warranted for better understanding of this law's impact on voters. McGhee's team looked only at overall voter turnout and did not consider how the different modes of voting (in-person, by mail, and ballot drop box) could have uneven impact on

underrepresented voters. In addition, they did not study the impact of the VCA on many of the groups, the law writers hoped to motivate to vote.

2.2.1 Distance to voting location influences.

Cantoni (2020) studied how the distance from the polling place impacted voting. Studying each side of a precinct boundary Cantoni created an environment where the voters were observationally identical apart from their polling locations. He found that a 0.245-mile increase in distance to a precinct polling place reduced turnout by one to three percent. In high-minority areas, a one-mile increase in distance to the polling place reduced turnout even more. Cantoni's results suggests that providing closer polling places to high-minority areas could increase participation by as much as 11 – 12 percent. This finding is substantiated by Brady and McNulty (2011), as they found a one-mile increase in distance to the polling place reduced in-person voting by as much as four percentage points.

Dyck & Gimpel (2005) take their study of distance from the polling place and early voting structures can stimulate participation in an election. Using multivariate analysis with independent variables being the distance from a voter's home address and their designated polling site, and distance from that same address and the closest early voting location. Outcome categories were nonvoting (baseline), early voting, vote-by-mail, and election-day voting They recognize that easier voting is used by those who would have voted at their traditional polling place but question how much expanded access motivates the nonvoter. They found that distance is a clear factor in both early voting and election-

day turnout; both activities drop significantly as distance increases. Non-voting increases as the distance of a voting location increases. It's noted that when the distance to any kind of polling place is extreme (i.e., over 20 miles) mail-in ballots are overwhelming the preferred form of voting.

These studies primarily focused on voters going to a building that required them to enter and, possibly wait in line and interact with elections officials or other voters. The ballot drop box is often available as a drive-up box and voters interact with it much like a mailbox. These characteristics may improve their use.

2.2.2 Early voting

Schroedel et al (2020) took advantage of an emergency injunction that granted two of four Nevada Indian reservations on-site early voting for the 2016 general election. Reservation bound Native Americans face more significant voting costs that any other people group in the country. They often must travel to locations that have been historically hostile to Native Americans to register and vote (Massey 2015; United States Commission on Civil Rights 2011). These substantial costs further reduce the likelihood of voting (Aldrich, 1993) By comparing the four reservations voting behavior they were able to discern that on-site early voting increased voter turnout on the two reservations on which it was available. They conclude that providing convenient locations and early voting opportunities increases voter turnout in groups with limited means and low government trust. These findings provide support for the VCA writers to consider how

language-minority and others who may not trust the government respond to the placement of ballot drop boxes.

In their study, Kaplan and Yuan (2020) an extra day of early voting increased turnout by 0.218 percentage points. They leveraged the homogenization of early voting across the state of Ohio to study voters in a one-mile block that was split by a county line. They found that those voters rearing children, working full-time, and women responded most strongly to early voting opportunities. Their results indicate that expansion of early voting can have a substantive de-polarizing effect on the electorate because independent voters are more positively impacted by early voting opportunities than registered Democrat or Republican voters.

The demographic findings of Kaplan report are intriguing but extend beyond the scope of this study. Kaplan and Yuan's finding of increased turnout presents promise yet, again it is not focused on ballot drop boxes and how they influence voting behavior.

2.2.3 All-mail voting

In 2005, the state of Washington gave counties the discretion to move to an all-mail election format. This provided Gerber, Huber, and Hill (2013) the opportunity to study the impact on turnout in all-mail elections. Use of aggregate and individual-level data in a differences-in-differences approach allowed them to examine the effects of small-scale local changes as well as measure the effects of statewide changes in voting rules. Observations of note from this study include all-mail elections increase aggregate turnout

by two to four percentages in elections following the switch. Increased participation by nonhabitual registered voters, younger registered voters is even greater.

This study, along with Berinsky, Burns and Traugott (2001) support the perspective that voting by mail is more appealing to voters than other, in-person approaches and discount earlier work of Magleby (1987) who reported mixed results on turnout in smaller scale elections. Gerber, Huber, and Hill's topic is more closely related to the study at hand in that submitting a ballot by mail is similar to using a ballot drop box but the differences. Many voters prefer mistrust the United States Postal Service (USPS) with sensitive dataset such as their signature behind a pull-off tab or fear the ballot will be tampered with. The concerns of late delivery or a ballot getting lost in the mail are also valid (Cybersecurity and Infrastructure Security Agency (CISA) Elections Infrastructure Government Coordinating Council and Sector Coordinating Council's Joint COVID Working Group). These characteristics could make ballot drop boxes more attractive than USPS mailboxes to those people group targeted by the VCA.

2.2.4 General ballot drop box efficacy.

Collingwood et al. (2018) determined that proximity to ballot drop boxes increase voter turnout, but the effect of that increase depends on the election type and the sociodemographic characteristics of voters (gender, age, income, race). But, their study assumed voters used the closest drop box to their home. A cursory review of ballot return data under study indicate that may not be the case. It's possible that ballot drop boxes near a voter's place of work or local shopping area could be a significant influencer. This

study will address the home precincts of the ballots that were found in each ballot drop off box to test the theory voters used the closest ballot drop box.

3. Whose Vote Is It Anyway?

A Geospatial Analysis of the California Voter's Choice Act Ballot Drop Box Criteria in Santa Cruz County

3.1 Research Question

Does ballot drop box placement impact the voting habits of the California Voter's Choice Act target communities?

3.2 Methodological Design

3.2.1 Study Area

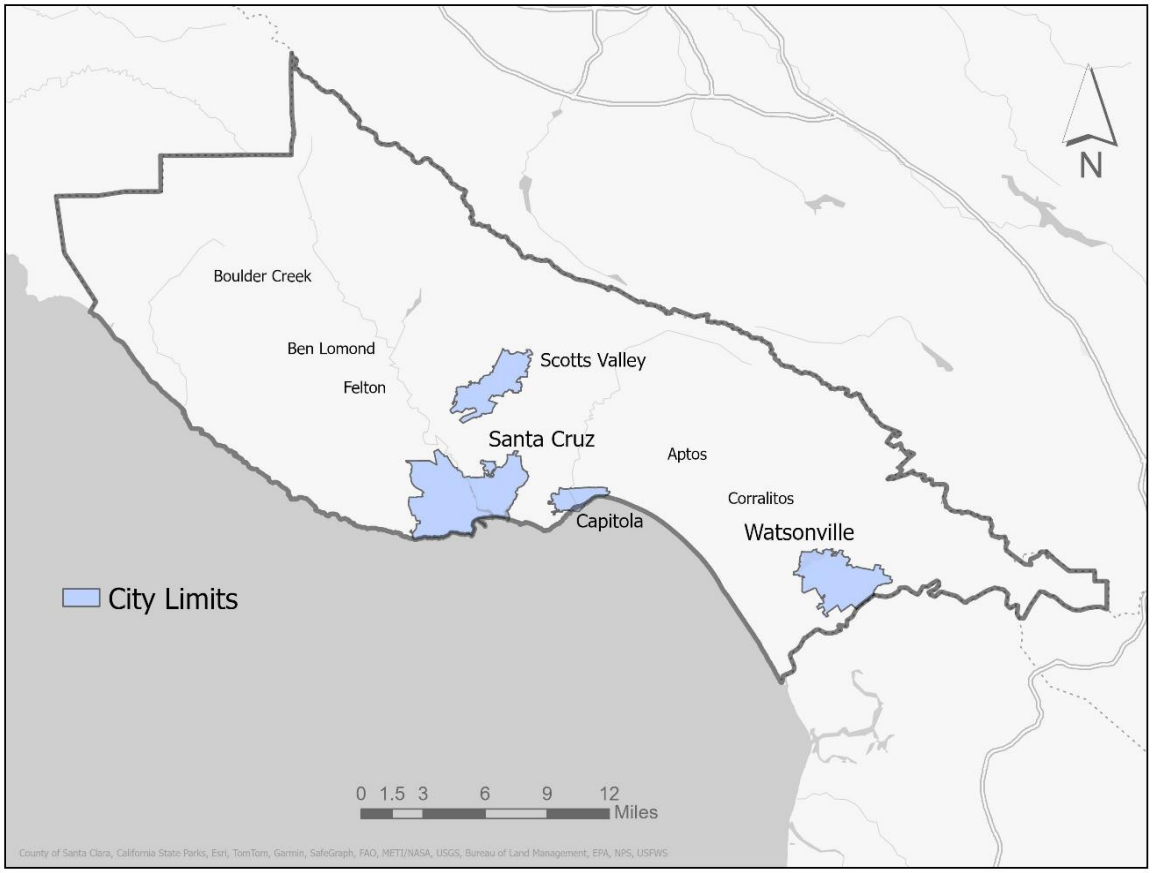
Located on the north end of Monterey Bay and south of Silicon Valley, Santa Cruz County is the second smallest of the 58 California counties. The county can be roughly categorized into four demographic themes: Silicon Valley commuters, agricultural workers, mountain residents, and university students and faculty. The University of California Santa Cruz (UCSC) is the county's largest employer.

Before the establishment of UCSC, Santa Cruz County was primarily agricultural. The City of Santa Cruz was primarily a haven for retirees; the Santa Cruz Wharf bustled with fishing related businesses run by the children of Italian immigrants. The advent of UCSC and Silicon Valley changed the north end of the county raising the population, reducing the median age, increasing diversity, and changing political leanings.

Demographic analysis at the US Census block group level was completed to better understand the socioeconomic makeup of Santa Cruz County. While there is a detailed

discussion of these factors in the Results section, a summary of the county's demographics is provided here to provide context. Language minority homes, those households whose primary language is not English, are largely situated in the agricultural south county. Historically, migrant workers from Mexico and Central America came to pick produce in the Watsonville area and many stayed to make homes. The City of Watsonville and its neighboring town, Pajaro, have embraced this heritage and many can live comfortably without speaking English. Those that claim Hispanic origins are further consolidated in the south county and along the coast. Some block groups in the Watsonville area are almost 100% of Hispanic origin.

Figure 1 Santa Cruz County Cities.
The cities of Santa Cruz County are in center of the county and southeast. The northwest end of the county is mountainous and heavily forested. Small towns line the only main route, State Hwy 9.



Residents with low incomes are more distributed throughout the county indicating that people of varied incomes live in proximity. Census block groups with a large percentage of households with at least one disabled resident are spread throughout the county. The census blocks that have the highest rates of nonvoters are in the south county

as well. The south county and the forested north county are home to the largest percentage of those over 24 years of age who have less than a bachelor's degree.

3.2.2 Data

3.2.2.1 Ballot Drop Boxes

Prior to the 2020 November General Election, Santa Cruz County installed 12 exterior ballot drop boxes. Esri's ArcMap (Esri, 2020) was originally used to geolocate the 12 ballot drop box locations used in the 2018 primary elections. Addresses were obtained through the Santa Cruz County Elections Department web site, www.votescount.com. Once the addresses were geolocated, actual ballot drop box locations were refined by visiting each site and recording GPS coordinates closer to the actual ballot drop box site. The ballot drop boxes were installed into concrete and in many cases the remnants of the ballot drop box installation were obvious making an accurate reading of longitude and latitude straightforward. Geocoded locations along with addresses and other salient attributes were stored in an GIS feature class.

In May of 2020, the County Elections Department announced that, in response to the COVID-19 pandemic, it was expanding the ballot drop box effort. It would place a ballot drop box in every live-in senior care center (four in total). In the same month, also in response to the COVID-19 pandemic, Governor Gavin Newsom signed an executive order, Assembly Bill 680, requiring that all California voters receive a postage-paid mail-in ballot for the November 2020 Presidential Election (Ellison, 2020). In August 2020, the USPS warned that almost every state in the nation was at risk of not delivering all

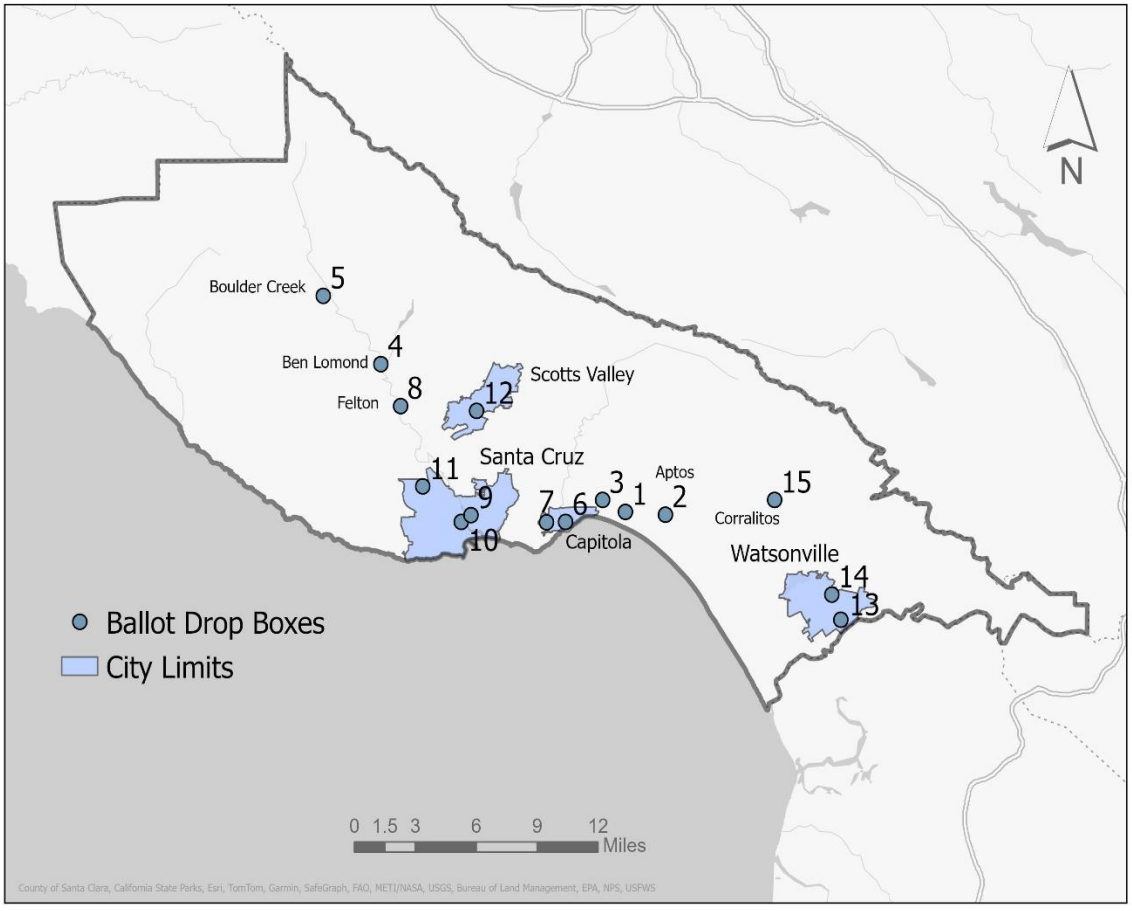
mail-in ballots to local election officials in accordance with current election rules (Kaufman, 2020).

In response to the combination of increased access to mail-in ballots, historically high interest in this election (Galston, 2020) and concern over possible USPS delivery delays, the County Elections Department increased the exterior, publicly accessible, drop box count from 13 to 15.

Finally, in October 2020, the California Republican Party installed unofficial ballot drop-off boxes in Los Angeles, Orange, and Fresno Counties, creating a nation-wide concern over the security and safety of ballots submitted in ballot drop boxes (Associated Press, 2020). In an effort to provide additional security for ballot drop boxes and reassure its citizenry, the Santa Cruz County Elections Department installed five additional ballot drop boxes inside public buildings, many of which already had a ballot drop box near the building's exterior. These interior boxes were available only during the normal business hours of the host organization/business.

These two new types of ballot drop boxes (those located in live-in senior centers and those located inside buildings) were initially considered for inclusion in this study. It was determined the drop boxes located at live-in senior centers were not applicable to this study as only residents and employees of those centers had access, and the residents

Figure 2 Santa Cruz County Ballot Drop Boxes 2020
Ballot drop boxes in Santa Cruz County were placed primarily on county- or city-owned property. Exceptions included UC Santa Cruz (11), Cabrillo College (3), Corralitos Community Center (15) and Capitola Mall (7).



could access only the ballot drop box in their facility. If an interior ballot drop-off box was at the same address as an exterior one, or if they were separated by a parking lot, it was assumed the exterior drop box would have been used had there not been increased

safety concerns for this election. As such, returns for each interior ballot drop box that met this criterion were combined with the associated exterior ballot drop box. In total, three of the nine interior ballot drop boxes were included in this study.

The two additional exterior ballot drop box sites (Capitola Mall and Corralitos Community Center) were geocoded and added to the ballot drop box feature class.

Table 1 Summary of ballot drop boxes used in this study.

Number on Map	Address	Year Initially Installed	Impacted by Events of 2020	Comments
1	Aptos Public Library 7659 Soquel Dr., Aptos	Prior to 2018	No	
2	Aptos Polo Grounds Park 2255 Huntington Dr., Aptos	Prior to 2018	No	
3	Cabrillo College Parking Lot R 3732 Cabrillo College Dr., Aptos	Prior to 2018	No	Required by SB 240 (Lee et al., 2013) Located in parking lot near football stadium
4	Highlands Park 8500 Hwy 9, Ben Lomond	Prior to 2018	No	
5	Boulder Creek Public Library 13390 W. Park Ave., Boulder Creek	Prior to 2018	Yes	CZU Complex Fire burned the outskirts of Boulder Creek in August 2020. Many Boulder Creek residents were still displaced during the 2020 election season

Number on Map	Address	Year Initially Installed	Impacted by Events of 2020	Comments
6	Capitola City Hall 420 Capitola Ave., Capitola	Prior to 2018	Yes	An interior ballot drop box was installed in City Hall foyer in 2020. It was available only during normal business hours.
7	Capitola Mall 1855 41st Ave., Capitola	2020	Yes	One of two additional exterior ballot drop boxes installed in response to COVID-19 pandemic election modifications
8	Felton Covered Bridge Park Graham Hill Rd. and Mt. Hermon Rd, Felton	Prior to 2018	No	
9	Santa Cruz County Government Building 701 Ocean St., Santa Cruz	Prior to 2018	Yes	An interior ballot drop box was installed in the County Clerk/Elections Office on the third floor of the County Building in 2020. It was available only during normal business hours.
10	Santa Cruz Public Library 212 Church St., Santa Cruz	Prior to 2018	No	
11	University of California Santa Cruz Quarry Plaza	Prior to 2018	No	Required by SB 240 (Lee et al., 2013) The sole walk-up-only ballot drop box, There is no reasonable way to drive-up and drop off a ballot

Number on Map	Address	Year Initially Installed	Impacted by Events of 2020	Comments
12	Scotts Valley City Hall 1Civic Center Dr., Scotts Valley	Prior to 2018	Yes	An interior ballot drop box was installed in foyer of the City Hall in 2020. It was available only during normal business hours.
13	Watsonville Parking Lot 14 316 Rodriquez St., Watsonville	Prior to 2018	No	
14	Santa Cruz County Health Services Office 1430 Freedom Blvd., Watsonville	Prior to 2018	No	
15	Corralitos Community Center 35 Browns Valley Rd., Corralitos	2020	Yes	One of two additional exterior ballot drop boxes installed in response to COVID-19 pandemic election modifications

Ballot drop box returns for the 2020 Presidential Election were obtained via an email request to the Santa Cruz County Clerk's Office. It is important to note that results did not include votes cast by confidential voters in the county, Same Day, or provisional ballots cast by voters (Pellerin 2020). The original excel file was saved as a comma separated value (csv) file and scrubbed as follows:

- All live-in senior center ballot drop box data was deleted.
- Ballot drop box returns for the interior Santa Cruz City Clerk box were combined with the 701 Ocean St parking lot box.

- Ballot drop box returns for the interior Scotts Valley City Hall box were combined with the Scotts Valley City Hall parking lot box.
- Ballot drop box returns for the interior Capitola City Clerk box were combined with the Capitola City Hall parking lot box.
- Voting Center drop box returns were deleted. These drop boxes were located outside Voting Centers allowing voters to submit their ballots without entering the building. These drop boxes were available only as a convenience to voters coming to the vote centers and do not fall within the purview of this study.
- All other forms of mail-in ballot (i.e., FAX, mail, mail-other) were deleted.

All other shapefiles (see Table 2) were obtained from the Santa Cruz County GIS Department's open data portal.

Table 2 GIS Data Sources

External Data Item	Data Type	Source
Statement of Vote, November 3, 2020, Presidential General Election	Adobe Acrobat (pdf) file	Santa Cruz County Clerk
2020 General Election ballot drop box returns	Excel file	Santa Cruz County Clerk
Santa Cruz County shapefile	GIS shapefile	Santa Cruz County GIS Department
Santa Cruz County City Limits shapefile	GIS shapefile	Santa Cruz County GIS Department

3.2.2.2 Criteria from the Voter's Choice Act and Other Sources

The Voter's Choice Act (VCA) explicitly identifies14 criteria to be considered when determining a location to place a ballot drop box (all criteria are listed in Table 3).

Some criteria represent two different perspectives on a theme (i.e., time to travel to a ballot drop box and distance to travel to a ballot drop box) while others are seemingly contradictory (i.e., proximity to populations centers versus geographically isolated locations). In addition, the Santa Cruz County Elections Department required all ballot drop boxes be placed on either county or city property for every election prior to the 2020 Presidential Election. The 2020 placement of a new ballot drop box in a shopping mall parking lot and a community center marked a notable change in this regard. Finally, SB 240 requires a ballot drop box be placed on the campus of every University of California, California State, and California Community College campus (Lee et al., 2013).

Table 3 VCA & Santa Cruz County Elections criteria use summary

Factor	Criterion	Data Source
Socioeconomic	Proximity to voters with disabilities	2021 American Community Survey (ACS) 5-year estimate percent households with 1+ person with disability
	Proximity to low vote by mail	2020 United States (US) Census decennial voting behavior
	Proximity to language minority communities	2020 US Census percent language minority households
	Proximity to low car ownership	2021 ACS 5-year estimate percent households with access to no more than 1 vehicle
	Proximity to low-income communities	2020 US Census percent households with income below the poverty level
Mobility (not included in this study)	Proximity to geographically isolated communities	
	Proximity to population centers	
	Distance voter must drive to ballot drop box	

Factor	Criterion	Data Source
	Time voter must use driving to get to ballot drop box	
	Proximity to public transit	
	Time voter must use traveling on public transit to get to ballot drop box	
	Distance voter must travel on public transit to ballot drop box	
Not Used	Free parking	Not used – all ballot drop box sites have free parking
	Proximity to same day registration need	Not used – ballot drop boxes cannot meet that need

After reviewing reliable data sources at the block group level, it was determined that four of the VCA criteria were socioeconomic and would be geospatially analyzed. The VCA criteria analyzed were:

- Proximity to low vote by mail. This criterion was studied using the 2020 United States (US) Census decennial voting behavior. This data indicates the likely demand for voting in the future. The provided percentage was subtracted from 100% to obtain a percent low vote value.
- Proximity to language minority communities. This criterion was represented by the 2020 US Census percent language minority households demographic. The value was determined by dividing the sum of all "Speak English 'not well'" and Speak English 'not at all'" attributes for the ages 18 and over and dividing it by the sum of "18 to 64 years" and "65 years and over"

- Proximity to voters with disabilities. This criterion was represented by the 2021 American Community Survey (ACS) five-year estimates of Households with One^{+} Person with a Disability Percent
- Proximity to low car ownership. To develop this criteria proxy, the following four 2021 ACS 5-year estimates demographics were considered: percent owner households with 0 vehicles available, percent owner households with 1 vehicle available, percent renter households with 0 vehicles available, and percent renter households with 1 vehicle available. For both the owner and renter categories I determined the total number of owner/renter households in the block group using the following equation:

$$\%LVA = \frac{VA_{O_0} + VA_{O_1} + VA_{R_0} + VA_{R_1}}{Total\ VA}$$

Where: $LVA = Low\ Vehicle\ Access$
$VA_{x_y} = Vehicle\ Access_{Owner/Renter_{0/1}}$

In addition to the VCA criteria it was determined that the socioeconomic demographics of educational attainment (those with less than a bachelor's degree) and Hispanic origin should be added to the model.

Table 4 Data developed for this study.

Data Item	Data Type	Source
Ballot drop box locations	GIS feature class	Santa Cruz County Clerk, Judith Heher
Poverty demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, US Census Bureau Judith Heher

Data Item	Data Type	Source
Minority demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, IPUMS National Historical GIS (NHGIS) Judith Heher
Voting demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, US Census Bureau Judith Heher
Disability demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, US Census Bureau Judith Heher
Vehicle access demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, US Census Bureau Judith Heher
Hispanic demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, IPUMS NHGIS, Judith Heher
Education demographic data by block group	GIS feature class	Santa Cruz County GIS Dept, IPUMS NHGIS, Judith Heher

A block-group-based feature class for each socioeconomic criterion was created to support its individual mapping and geospatial analysis. Data from these individual layers were combined to create input for Principal Component Analysis (PCA). PCA was used to reduce the dimensionality of the data sets being used in this study.

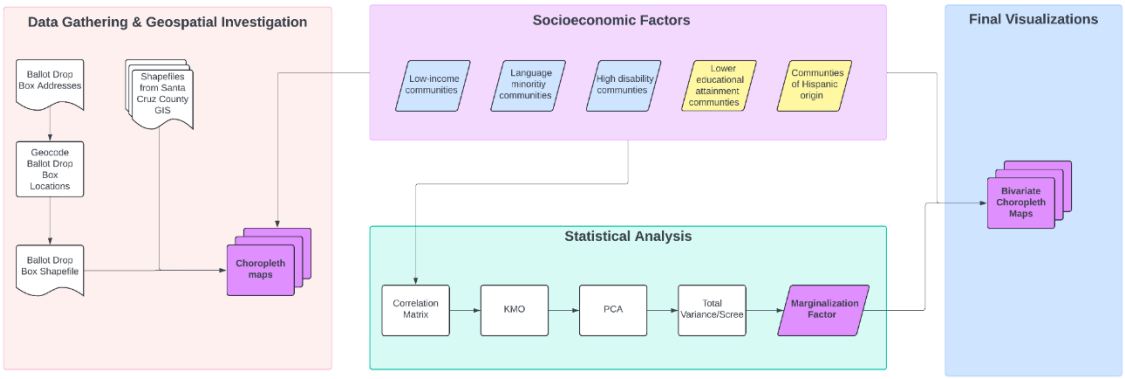
An ArcGIS notebook was developed to run the PCA and display pertinent data, some of which is presented in this report.

3.3 Procedures

Data reflecting the 2020 socioeconomic factors of interest was gathered and investigated through a geospatial lens to determine possible correlations between them. A correlation matrix was developed to further justify the use of Principal Component Analysis to reduce the dimension of the elements of interest from five to one without

losing variability. This final variable was compared with non-voting behavior using a bivariate choropleth map to validate its use.

Figure 3 Research Process



3.3.1 Methodological Priorities

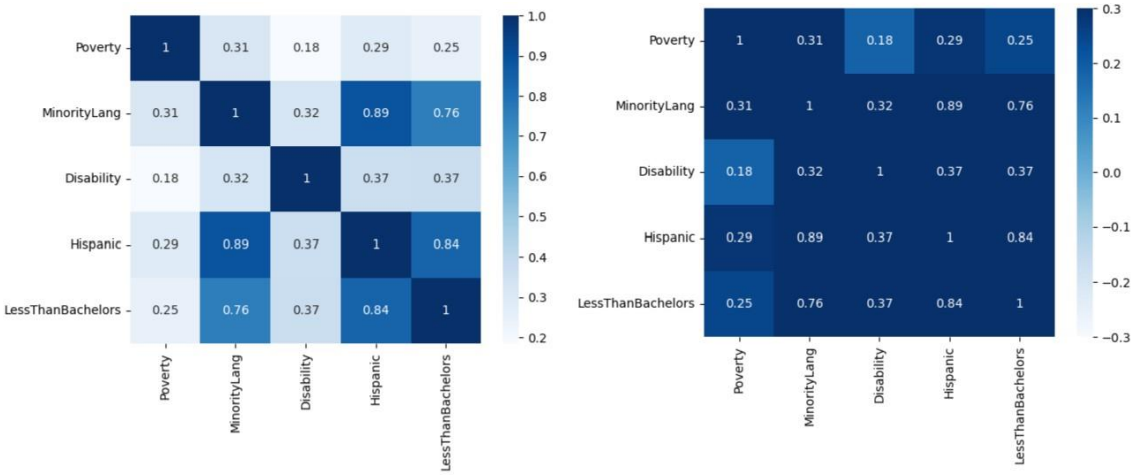
A major priority of this project was ensuring there is a clear path from the original data used in this study to the final analysis. The Notebook tool in ArcGIS Pro was used to document all the steps taken to distill the original data into a set of actionable, verifiable, and reproducible observations. The combination of HTML-based “cells,” that support extended discussion, and Python 3 scripting cells provide an environment that kept discussion of the motivations behind the code and coding results in-line with the code. Reviewing a well-documented ArcGIS Pro Notebook gives both the non-programmer and programmer a clear understanding of what was done when completing a complex geospatial analysis effort.

3.3.2 Principal Component Analysis

Due to the number of socioeconomic criteria, a composite representing a linear combination of these criteria was obtained through principal component analysis (PCA), a linear transformation approach to reduce multiple variables into a few (Jolliffe & Cadima, 2016). The factor created through PCA is valid if it has a strong linear correlation with the input variables (Muro & Liu, 2022).

PCA was used to develop the marginalized composite factor from the three socioeconomic criteria, educational attainment, and Hispanic origin demographics. The pairwise correlations tests are present in Figure 4. Table 5 summarizes the description statistics.

Figure 4 Pairwise Correlation of Socioeconomic Indicators.
The table on the right, with all correlations less than -0.3 or greater than 0.3 in dark blue, demonstrates the strength of the correlations.



4. Results

As initial correlations indicated the socioeconomic variables were highly correlated, the PCA process continued to support that the dimensions of the socioeconomic elements could be reduced without sacrificing variability.

Table 5 Descriptive Statistics.

Indicator	Value	Interpretation
Chi squared value	687.9598871741243	
p value	6.839141740983849e-137	Statistically significant
KMO model	0.8522998530792464	KMO greater than 0.8 is ideal

The Eigenvalues, loadings (Table 5), and scree plot (
Figure 5) confirm that only the first component is needed to explain almost 60% of the variance of the 5 original socioeconomic variables.

Table 6 Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Square Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.995	59.894	59.894	2.995	59.895	59.894
2	0.872	17.433	77.327			
3	0.796	15.923	93.250			
4	0.245	4.891	98.141			
5	0.093	1.359	100.00			

Figure 5 Principal Component Scree Plot.

The well-defined elbow of the scree plot indicates only one component is needed to represent the original five socioeconomic factors. The 2.9 eigenvalue (see Table 6) for the first component further supports its exclusive use.

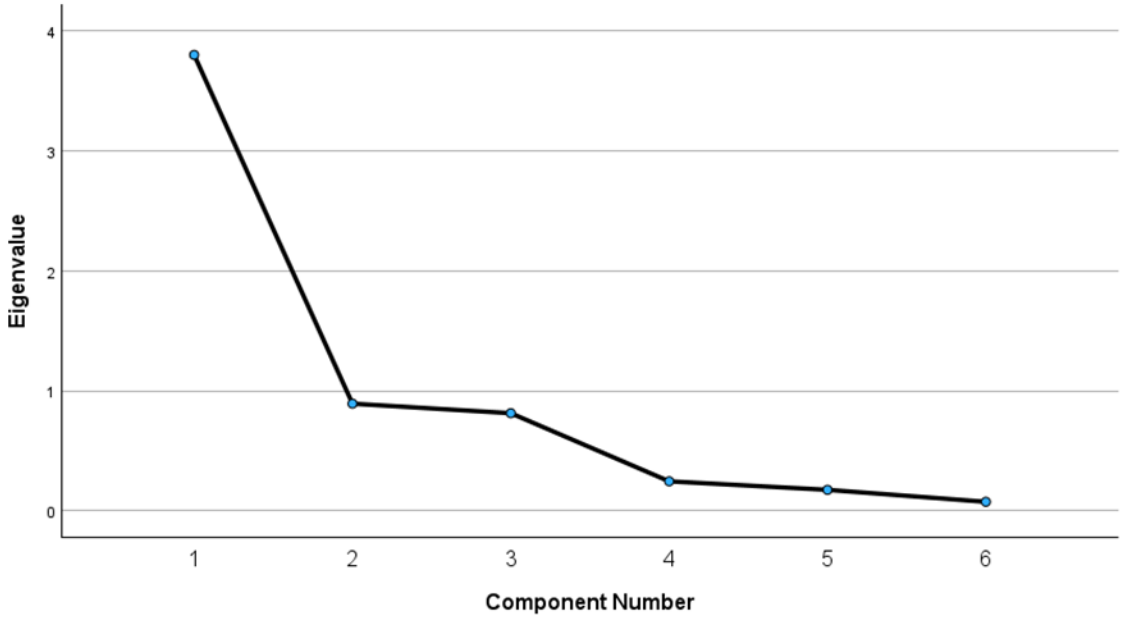
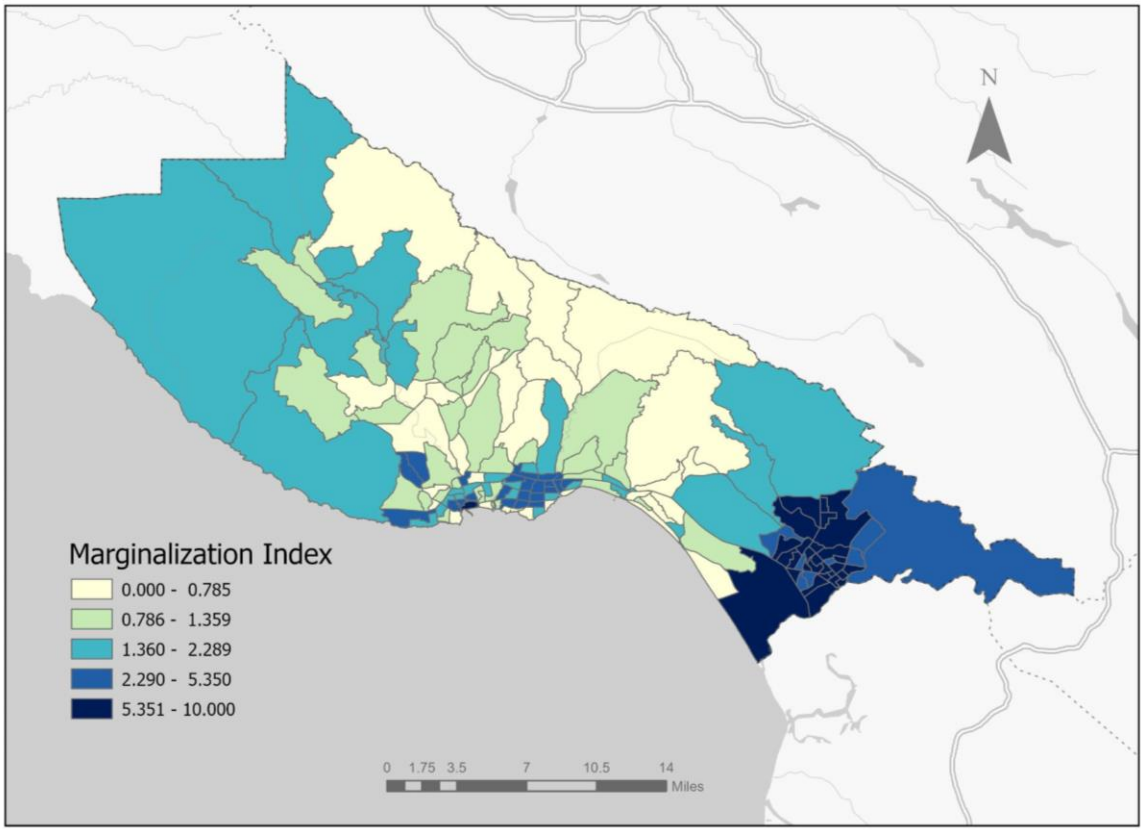


Figure 6 Marginalization Index by block group.



The Pearson Correlation between the marginalization index and non-voting behavior was significant at the 0.01 level (2-tailed). This gives the study confidence that the marginalization index can serve as a proxy to the identified socio-economic ballot drop box placement criteria outlined in the VCA.

Figure 7 Bivariate Choropleth Map Comparing Non-Voting Behavior with Marginalization Index.

Paying attention to the center diamonds of the legend show a notable alignment between the developed marginalization index and non-voting behavior.

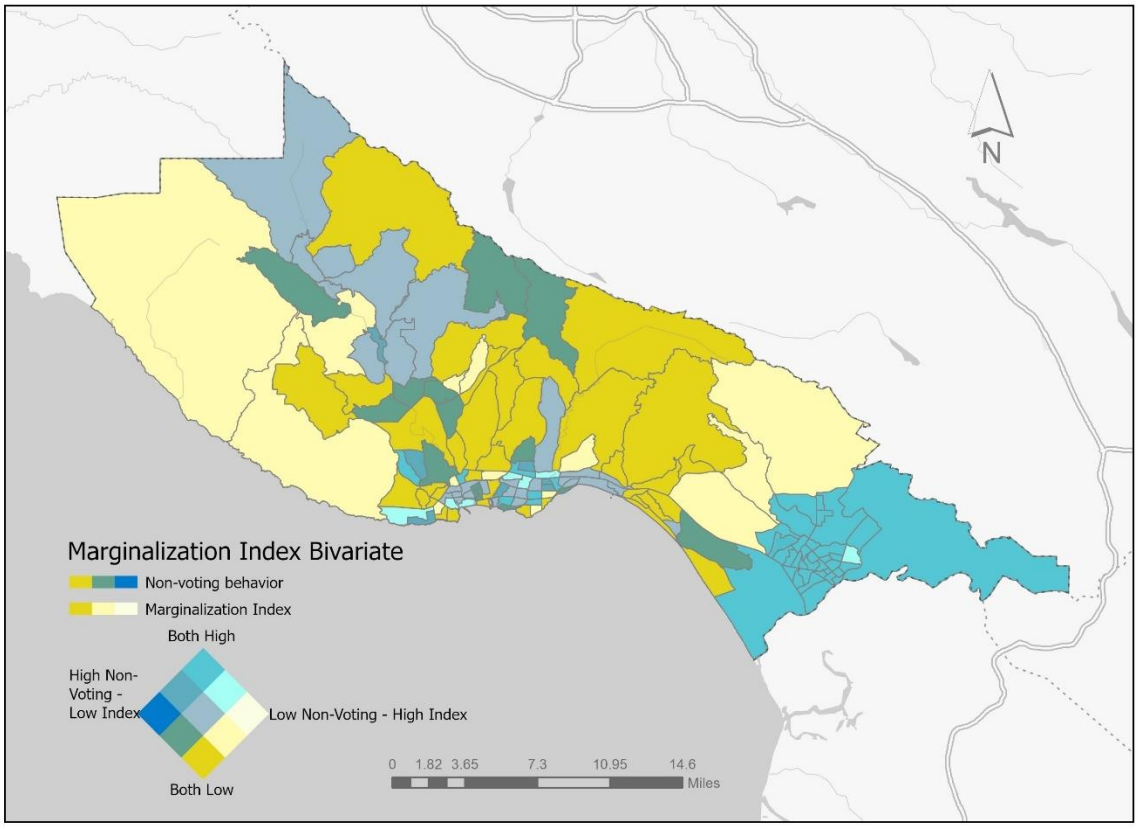
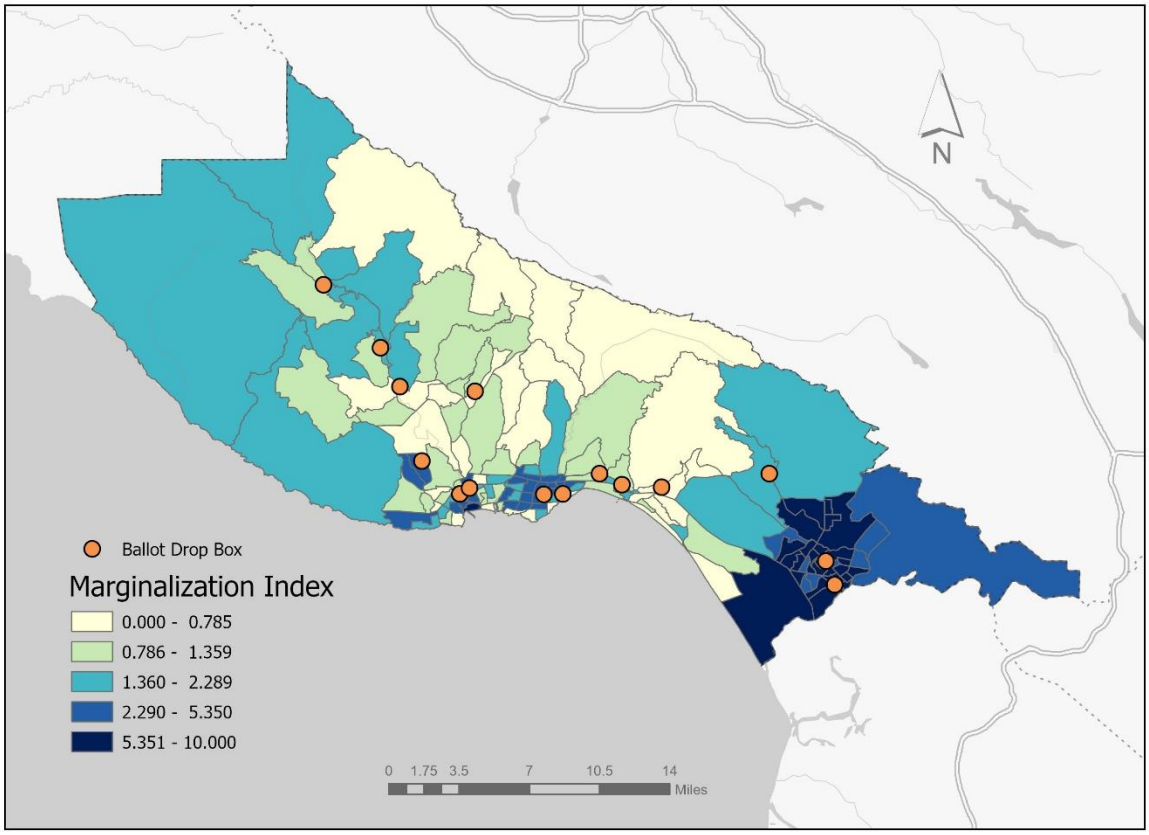


Figure 8 Santa Cruz County Marginalization Index and 2020 Ballot Drop Box Locations.

A visual review of the ballot drop boxes and the marginalized areas of Santa Cruz County indicates there are several marginalized areas without ready access to a ballot drop box. Many ballot drop boxes are located in areas experiencing less marginalization.



5. Discussion

2020 was an unusual year for Santa Cruz County in many ways and may impact the insights developed in this study with respect to long team voting behaviors. A longitudinal study that considers influences outside the socioeconomic realm would better serve that goal. Specifically, though, there were several elements that made the 2020 general election unique.

5.1 COVID-19

As noted earlier in this study, the 2019 novel coronavirus, or COVID 19, created an international pandemic that impacted every part of life. Election officials had to pivot, providing additional no-touch services that would increase the health safety of voters and elections workers (California Secretary of State, 2020). The pandemic itself may have reduced voter turnout had it not been for the contentious and issue-rich campaign for the President of the United States.

5.2 CZU Lightning Complex Fire

A dry lightning storm on August 15 -16, 2020 ignited a series of fires that would come to be known as the CZU Lightning Complex Fire. It burned for 37 days and destroyed over 86,000 acres in the Santa Cruz and San Mateo counties (NWS Sacramento/Monterey, 2022). Over 70,000 people were under evacuation orders and over 900 homes were destroyed (Santa Cruz County Museum of Art and History, 2020). The town of Boulder Creek, site of ballot drop off box #5 was hit especially hard. Many of the

town's evacuees did not return until after the election. Their temporary relocation could impact not only the Boulder Creek ballot drop off box, but others in the county those evacuees may have used for the 2020 general election.

5.3 Ben Lomond shooting

On June 7, 2020, the mountain town of Ben Lomond was the site of a shooting the took the life of a Sheriff's Deputy and injured two other law enforcement officers (Letang & Copitch, 2020). Santa Cruz County Health Officer Dr. Gail Newell was one of the targets of this shooter (Barry-Jester, 2022). The vitriolic environment surrounding management of the COVID-19 pandemic escalated into violence. Newell, and other high-ranking public servants, were advised not to attend public meetings. Many ended up having police escorts (Barry-Jester, 2022). This event heightened community fear surrounding activities involving public officials supporting COVID-19 protocols including County Clerk Gail Pellerin. These events could have had both negative and positive impacts on voting behavior with some not voting out of fear, while others making a point to vote.

5.4 Further Research

There are several avenues for additional research into this topic. A more expansive study integrating mobility data could provide a more complete picture of voting behavior in Santa Cruz County in 2020. Expanding that research into a longitudinal study would provide deeper insights into voting behavior and provide a stronger predictor of future behavior.

Applying the insights from this study through placing ballot drop boxes in identified regions of significance will test these theories and develop greater understanding into how the placement of ballot drop boxes influences voting behavior.

Taking the lessons learned and applying them to another California county will test if the insights from this study are unique to Santa Cruz or may have a broader reach.

6. Conclusions

One must be cautious about overstating the implications of nascent work, but it is evident this approach to investigating the efficacy of ballot drop box placement against the plethora of criteria the VCA proposes can reduce the complexity of such work to the point county election officials see it as a useful tool both in assessing prior election turnout and in future ballot drop box placement planning.

Ballot drop box placement is a complex process involving myriad stakeholders, property rights, and trust. There is no single system that can consider all the perspectives and generate a set of perfect placement locations. This tool, as it stands, reduces some of the complexity and provides the Santa Cruz County elections office with an easily understandable visual indicator of how well placement of their ballot drop boxes meet the needs of the marginalized members of Santa Cruz County.

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