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A Complementary Social Vulnerability Assessment to Support Sea Level Rise Planning in the Puget Sound Region of Washington State

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A Complementary Social Vulnerability Assessment to Support Sea Level Rise Planning in the Puget Sound Region of Washington State

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Gina M. Raimondo Secretary	Richard W. Spinrad Administrator	Nicole LeBoeuf Assistant Administrator

Seattle Space Needle. Credit: no attribution required

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Sailboats at Bainbridge Island. Credit: Seann Regan, CSS, NOAA

Executive Summary

Coastal communities are increasingly vulnerable to climate-driven impacts, such as sea level rise and coastal erosion. To address these risks in the Puget Sound region of Washington State, Washington Sea Grant and Coastal Geologic Services (CGS) are leading a sea level rise (SLR) vulnerability assessment for use by coastal managers, decision-makers and restoration practitioners. In support of this effort, researchers at the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Coastal Ocean Science (NCCOS) partnered with Washington Sea Grant and CGS, with support from the Puget Sound Partnership, to develop a complementary social vulnerability assessment for communities within the Puget Sound region. To assess social vulnerability, the authors applied part of NCCOS's vulnerability assessment framework through application of a regionally-modified Social Vulnerability Index (SoVI) for Zip Code Tabulation Areas (ZCTAs) within the Puget Sound drainage basin. A principal components analysis (PCA) on 50 chosen variables was used to determine the components and variables to include in the final index. The final index included 36 variables, and resulted in seven components. Each component was named to capture the underlying essence of the statistically grouped variables, also incorporating spatial trends as appropriate. Components included:

- Diversity and Urbanity;
- Income and Education;
- Age and Housing Occupancy;
- Isolation, Access to Social Services, and Dependence on Extractive Industries;
- Housing and Infrastructure;
- Institutional Inequities; and
- Life Satisfaction and Belonging.

These components were adjusted for directionality and placed in an equal-weighted additive model to achieve a single, community-level social vulnerability index score. The final composite social vulnerability index was then integrated into the SLR vulnerability assessment led by Washington Sea Grant and CGS as an optional modifier for identification of co-benefits. Beyond its integration with the larger vulnerability assessment, this social vulnerability assessment can be used as a stand-alone product to inform other efforts in the Puget Sound region and offers a tool for communities and other users to summarize needs and advocate for resources for environmental justice action and adaptation in the face of climate change and SLR.

Downtown Seattle and Space Needle. Credit: no attribution required

Chapter 1: Introduction

Coastal communities are increasingly vulnerable to climate-driven effects, such as coastal flooding and coastal erosion exacerbated by sea level rise. To assist in planning for these climate-driven hazards in the Puget Sound region of Washington State, Washington Sea Grant and Coastal Geologic Services (CGS) are leading a sea level rise (SLR) vulnerability assessment for use by coastal managers, decision-makers and restoration practitioners: Near-term Action 2018-0685, "PRIORITIZING SEA LEVEL RISE EXPOSURE AND HABITAT SENSITIVITY ACROSS PUGET SOUND" (Puget Sound Partnership 2021a). Localized relative sea level rise projections have been integrated with elevation data and a parcel layer to assess sea level rise and erosion exposure at the parcel scale in Puget Sound. Habitat and infrastructure sensitivity analyses were conducted and integrated with exposure scores for an overall assessment of vulnerability. The resulting outputs will primarily be used to inform habitat restoration activities. In support of this effort, researchers at the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Coastal Ocean Science (NCCOS) partnered with Washington Sea Grant and CGS, with support from the Puget Sound Partnership, to integrate human dimensions data to strengthen the resulting vulnerability assessment. To accomplish this, NCCOS researchers applied part of NCCOS's Integrated Vulnerability Assessment Framework (Fleming et al. 2020; Fleming et al. 2017; Messick and Dillard 2016) to assess social vulnerability for communities within Puget Sound.

Puget Sound is located in northwestern Washington state within the southern portion of the Salish Sea Bioregion (Puget Sound Partnership 2021b) (Figure 1.1). It contains about two-thirds of Washington's population (Washington DE n.d., Puget Sound) and is the ancestral home to a number of federally recognized

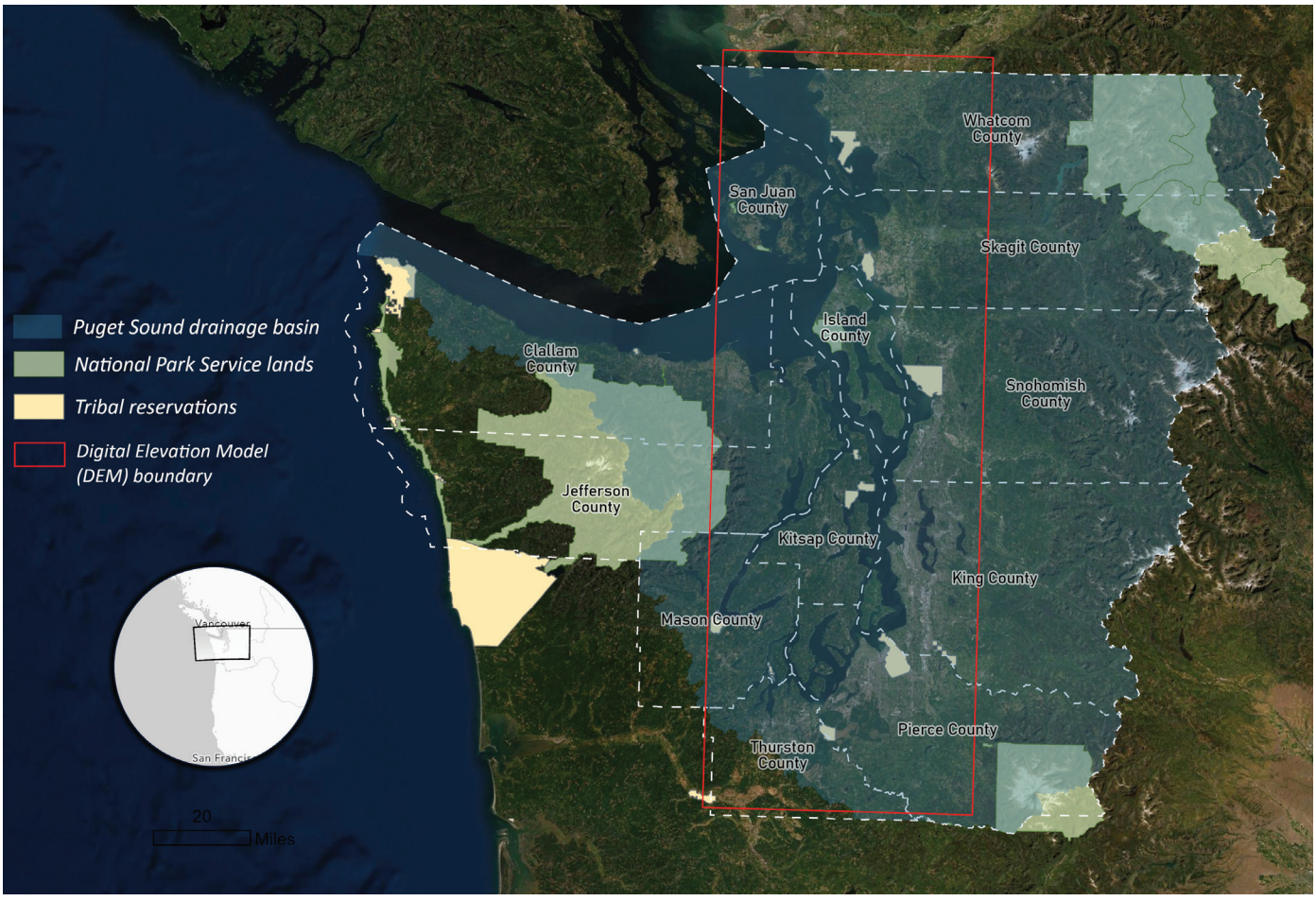


Figure 1.1. Overview map of the Puget Sound region, including the Puget Sound drainage basin (transparent blue), Near-term Action 2018-0685 study area (red outline), Puget Sound counties (dashed white), tribal lands (yellow), and national park service lands (green).

tribes and tribal nations (Puget Sound Partnership 2021b). This region is the nation's second largest marine estuary and is impacted by population growth and development patterns that have resulted in habitat loss and pollution (Washington DE n.d., Puget Sound). Mirroring national and global trends (IPCC 2021; IPCC 2014), Puget Sound's ecosystems and human populations are at risk from climate change impacts, such as inundation and erosion from SLR and extreme weather events, impacts to water supply from drought and salt water intrusion, and changes to ocean chemistry from ocean acidification (Washington DE n.d., Climate Change).

To monitor these types of risks and overall quality of Puget Sound, the Puget Sound Partnership tracks a series of integrated vital signs to better understand ecosystem health. In 2011, the Puget Sound Partnership set ecosystem recovery targets (e.g., abundant water quality, thriving species and food web, healthy human population) for the year 2020 that are now being reexamined and evaluated to inform the next set of targets (Puget Sound Partnership 2021b). The SLR vulnerability assessment from the Near-term Action 2018-0685 project and the present, accompanying social vulnerability assessment are additional resources to help the Puget Sound Partnership and other regional partners with climate-informed decision making.

The present assessment estimates relative community-level social vulnerability as opposed to resilience or adaptive capacity. The International Panel on Climate Change (IPCC) defines vulnerability as "the propensity or predisposition to be adversely affected" (2018, 560). By contrast, adaptive capacity is "the ability of systems…to adjust to potential damage, take advantage of opportunities, or to respond to consequences" (IPCC 2018, 542) and resilience is "the capacity of…systems to cope with a hazardous…disturbance" while "maintain[ing] their essential function…[and] the capacity for adaptation, learning, and transformation" (IPCC 2018, 557). While there is some conceptual overlap, the present assessment evaluated the potential predisposition for community-level social vulnerability related to natural hazards (including SLR), and did not directly evaluate the ability for communities to respond to, address, or rebound from SLR-related impacts.

While the study area for the Near-term Action 2018-0685 project (red outline in Figure 1.1) was bounded by available digital elevation model (DEM) data (Tyler et al. 2020), the accompanying social vulnerability assessment aligns with the Puget Sound Partnership's recognized drainage basin boundary (Puget Sound Partnership 2013) (transparent blue shading in Figure 1.1) to support other planning efforts associated with Puget Sound restoration.

Birds enjoying the waters of Puget Sound. Credit: no attribution required

Bainbridge Island pier. Credit: Seann Regan, CSS, NOAA

Chapter 2: Methods

NCCOS's Integrated Vulnerability Assessment Framework uses indicators and stakeholder feedback to integrate a variety of coastal and climate-driven hazards with aspects of vulnerability (Fleming et al. 2020; Fleming et al. 2017; Messick and Dillard 2016). To assess social vulnerability, the framework has used a regionally-modified Social Vulnerability Index (SoVI), an index that uses factor analysis to organize and reduce explanatory variables that are known to contribute to community-level social vulnerability in regard to environmental hazards (Cutter, Boruff, and Shirley 2003). SoVI is generally calculated at the county scale and includes variables that the academic literature suggests contribute to vulnerability in an event of an environmental hazard (29 variables in the latest iteration, SoVI 2010-14) (HVRI 2016). In previous NCCOS framework assessments, the unit of analysis was downscaled from the county to Census Blocks or Block Groups for improved resolution of data products. After conversing with regional partners, the team chose Zip Code Tabulation Areas (ZCTAs) for the unit of analysis in Puget Sound, and included all ZCTAs that intersected with the Puget Sound drainage basin (transparent blue shading in Figure 1.1.) ZCTAs better aligned with existing regional social science research (e.g., Watkinson-Schutten and Poe forthcoming) and resulted in more uniformed spatial representation across the Puget Sound drainage basin (Puget Sound Partnership 2013). ZCTAs with null Census data, such as the SeaTac airport complex and Camp Murray National Guard Station, were removed, for a total of 260 ZCTAs used in the analysis (Figure 2.1).

In their 2017 report, the United Nations Development Program provided an overview of social vulnerability assessment methodologies and tools, and described 17 vulnerability themes that relate to vulnerability and resilience (Table 2.1) (Katic 2017). NCCOS scientists examined the original list of 17 vulnerability themes and relied upon academic literature and existing indices to identify variables to support each theme. These

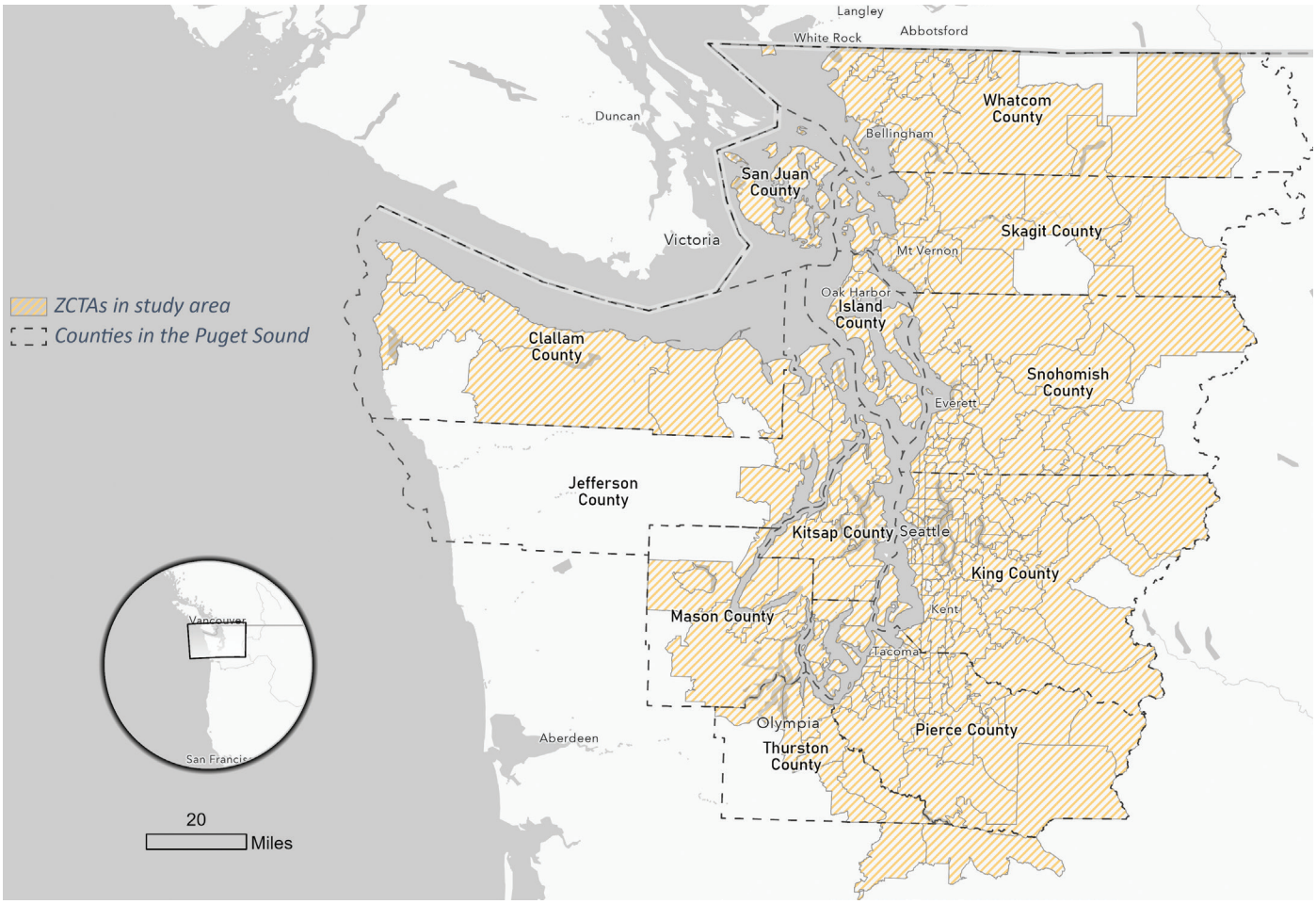


Figure 2.1. Final 260 Zip Code Tabulation Areas (ZCTAs) included in analysis with counties for reference.

Table 2.1. Vulnerability themes and indicators for analysis.

Number	Indicator/Theme	Chosen Variables	Variable_ID
1	Socioeconomic Status	Median income	Med_In
		Per capita income	Cap_In
		% of households living in poverty	HH_pov
		% of households earning greater than $200,000 annually	HH_O200
2	Gender	% females	Female
3	Race and Ethnicity	% race other than white alone	NW_Race
		% population foreign born	Foreign
		% speaking English as a second language with limited English proficiency	Lim_Engl
		% Hispanic	Hispanic
4	Age	Median Age	Med_Age
		% population under 5 years old	Pop_U5
		% population over 64 years old	Pop_O64
5	Commercial and Industrial Development	% impervious surface	Imperv
		Total Sales volume (in millions)	Bus_sales
6	Employment Loss	Unemployment rate	rUnemp
7	Rural/Urban	% urban population	Pop_Urb
8	Residential Property	% mobile homes	Mob_H
		% vacant housing units	V_Units
		Zillow home value index	H_value
9	Infrastructure and Lifelines	% of housing units with no vehicle	No_Veh
		% households without a computer	No_Comp
		% households without internet subscription	No_Int
		% households lacking plumbing facilities	No_Plum
		Critical infrastructure density	Crit_Infra
10	Renters	% renter-occupied housing units	R_Units
11	Occupation	% female participation in labor force	Fem_Lab
		% employment in extractive industries	Emp_Extr
		% employment in service industry	Emp_Serv
12	Family Structure	Average family size	Av_Fam
		% female householders with children, no spouse present	Fem_noS
		% family households	Fam_HH
		% male householders with children, no spouse present	Male_noS
		% households with people over 59	HH_O59
13	Education	% population 25 years or older with less than 12th grade education	No_Dip
		% population 25 years or older with Bachelor degree or higher	oBach
14	Population Growth	Population from American Community Survey	Pop_ACS
		Population change from American Community Survey and Census	Pop_Change
15	Medical Services	Hospital proximity	Hosp_prox
		Emergency medical services facility density	EMS_dens

Table 2.1 cont. Vulnerability themes and indicators for analysis.

Number	Indicator/Theme	Chosen Variables	Variable_ID
16	Social Dependence	% households receiving social security	HH_Soc
		% households receiving food stamps or supplemental nutrition assistance program (SNAP) benefits	HH_SNAP
		% population participating in labor force	Pop_labor
		% new to current residence from outside current metropolitan statistical area (MSA) in the past year	New_res
17	Special Needs Population	% population living in nursing and skilled-nursing facilities	Pop_nurs
		% population without health insurance	No_Health
		% population experiencing homelessness	Pop_home
		% households with a disability	HH_disab
		% population living in correctional facilities	Pop_prision
18	Puget Sound Connections to Place and Community	Average sense of place	Sense_Place
		Average overall life satisfaction	Life_Sat

vulnerability themes, and the variables identified to inform each theme, have all been shown to contribute to vulnerability (either directly or inversely) in the event of a natural hazard (e.g., Katic 2017; Cutter, Boruff, and Shirley 2003; HVRI 2016). At the suggestion of project partners, an 18th theme was included that considered connections to community and place within the Puget Sound region, as these concepts were thought to be regionally influential.

The latest iteration of SoVI (2010-14) uses the 2010 U.S. Decennial Census and the 2010-2014 American Community Survey (ACS) 5-Year Estimates (HVRI 2016). In the present analysis, data were primarily derived from the 2015-2019 ACS 5-Year Estimates[1], with supplementary sources including the 2010 Decennial Census, National Land Cover Database, ESRI, Zillow, and the Washington State Geospatial Open Data Portal, Department of Health, and Department of Commerce (for a full list of data and data sources, see Appendix A). Variables to support the 18th regional theme were derived from the Puget Sound Vital Signs project coordinated by the Puget Sound Partnership (Puget Sound Partnership 2021b). Tabular and spatial data were collected and processed by the research team, and all available datasets were considered for each variable. Data were collected at the ZCTA level when possible and at the smallest unit of analysis available when more resolute data were unavailable. Geospatial processing included aggregation of point data within ZCTAS, calculation of zonal statistics from raster-based land cover data, and re-calculation of data to the ZCTA when only available at the county level. Census data were combined (e.g., count of persons with a 12th grade education but no diploma was combined with count of persons with below a 12th grade education) and/or reclassified (e.g., count of persons without a diploma was divided by total count of persons to create a percentage) when necessary and organized within in a master spreadsheet (file codes and calculation notes are provided in Appendix A).

This effort resulted in 50 variables for consideration in measuring social vulnerability in the Puget Sound region (Table 2.1).

2.1 PRINCIPAL COMPONENTS ANALYSIS

Following the general SoVI approach to analysis, a principal components analysis (PCA) on the full suite of 50 variables was used to reduce the number of variables and determine the components to include in the final index.[2] Each variable was normalized from 0-1 before running the PCA. The PCA analysis used a Varimax rotation with 25 iterations (with convergence in 14) and a required factor loading of at least 0.50. There were no cross-loading variables, with the exception of one inverse cross-loading.[3] The Kaiser-Meyer-

[1] This assessment was unable to utilize newly collected 2020 Census data due to delayed release from the U.S. Census Bureau.
[2] PCA is a variable reduction technique that is frequently used in indicator and index development. It is designed to reduce the number of variables to the smallest number of key components that explain the most variance in the data (Thompson 2008).
[3] Variables can contribute to up to two components, but only if they contribute inversely.

Olkin Measure of Sampling Adequacy was 0.765, and the Bartlett's Test of Sphericity was significant ($p \leq 0.001$), indicating that the data were suitable for factor analysis and there was sufficient sampling adequacy. The final number of components was determined using a combination of the Kaiser Criterion and Cattell's Scree Plot (Costello and Osborne 2005; Fabrigar et al. 1999). Detailed PCA outputs are shown in Appendix B.

The final components were adjusted for directionality and placed in an equal-weighted additive model to achieve a single social vulnerability index score.[4] The social vulnerability index score for each ZCTA is presented as a relative score using min-max normalization,[5] such that block groups closer to a value of 1 are more socially vulnerable compared to other block groups within the study area. All spatial data were projected to NAD (North American Datum) 1983 UTM (Universal Transverse Mercator) Zone 11N and clipped to the present study area. All final deliverables were reprojected to WA State Plane HARN (High Accuracy Reference Network) South Feet to align with spatial datasets used the Near-term Action 2018-0685 assessment.

Puget Sound beach. Credit: no attribution required

[4] The authors explored implementing a variance-explained weighted additive index, but literature suggests equal weighting as the acceptable practice (Cutter and Emrich 2017).

[5] Min-max normalization scaling is when the normalized value of xi for variable X in the i-th row is calculated as: Normalized (xi) = xi – Xmin / (Xmax – Xmin), where Xmin = the minimum value for variable X, and Xmax = the maximum value for variable X (Salzman 2003).

Railroad infrastructure in Puget Sound. Credit: no attribution required.

Bainbridge Island pilings. Credit: Seann Regan, CSS, NOAA

Chapter 3: Results

The final social vulnerability index was comprised of 36 variables[6] that grouped into seven components (Table 3.1). Each component was named to capture the underlying essence of the statistically grouped variables (Cutter and Emrich 2017), also incorporating spatial trends as appropriate (see component maps in the subsections below). These components collectively explained 62.86% of the variance in the total dataset for the ZCTAs within the study area. Table 3.1 shows the variables and components that explained the majority of variance in the data (Suhr 2006; Tabachnick and Fidell 2001). For example, Diversity and Urbanity explained more variance than the other components alone, but the seven components combined provided a better measurement of social vulnerability for the Puget Sound region. Table 3.1 also shows component directionality, where positive components contribute to increased vulnerability and negative components contribute to decreased vulnerability, as well as variable loading. Variable loading refers to the degree that each individual variable loads with each rotated component. For example, EMS facility density loads on component 1 with a value of 0.816, representing a high correlation between the variable and the varimax rotated score for component 1. While all variables interact with each other and the resulting components at some capacity, variable loadings with coefficients less than 0.5 were suppressed from the output tables.

Index components are shown spatially in Figures 3.1-3.8.

[6] As PCA is a data reduction technique, some of the initial 50 variables did not load at the threshold value (0.5) and therefore did not contribute to the final components.

Downtown Seattle waterfront. Credit: no attribution required

Table 3.1. Results from principal components analysis for Puget Sound study area.

Component Number and Name	% Variance Explained	Component Directionality [a]	Variable [b]	Variable Loading
1: Diversity and Urbanity	20.17	+	EMS facility density	0.816
			% speaking English as a second language with limited English proficiency	0.791
			% population foreign born	0.726
			Population from ACS	0.725
			% race other than white alone	0.7
			% impervious surface	0.646
			% urban population	0.635
			Total Sales volume (in millions)	0.623
			Hospital proximity	0.597
2: Income and Education	14.9	-	% of households earning greater than $200,000 annually	0.926
			Median income	0.876
			Per capita income	0.86
			Zillow home value index	0.845
			% population 25 years or older with Bachelors degree or higher	0.747
3: Age and Housing Occupancy	9.14	+	Median Age	-0.857
			% population over 64 years old	-0.837
			% HHs with people over 60	-0.827
			Average family size	0.623
			% vacant housing units	-0.593
			% population participating in labor force	-0.563
4: Isolation, Access to Social Services, and Dependence on Extractive Industries	5.33	+	% HHs without a computer	0.802
			% HHs without internet subscription	0.759
			% employment in extractive industries	0.62
			% households receiving food stamps or SNAP	0.558
			% households with a disability	0.522
			% of households living in poverty	0.512
5: Housing and Infrastructure	5.196	+	% family households	-0.862
			% of housing units with no vehicle	0.739
			Critical infrastructure density	0.717
			% renter-occupied housing units	0.576
			% population participating in labor force	0.505
6: Institutional Inequities	4.22	+	% population living in correctional facilities	0.798
			Unemployment rate	0.681
			% Hispanic	0.618
7: Life Satisfaction and Belonging	3.91	-	Average overall life satisfaction	0.84
			% population experiencing homelessness	-0.731
			Average sense of place	0.705

[a] Positive components contribute to increased vulnerability and negative components contribute to decreased vulnerability.

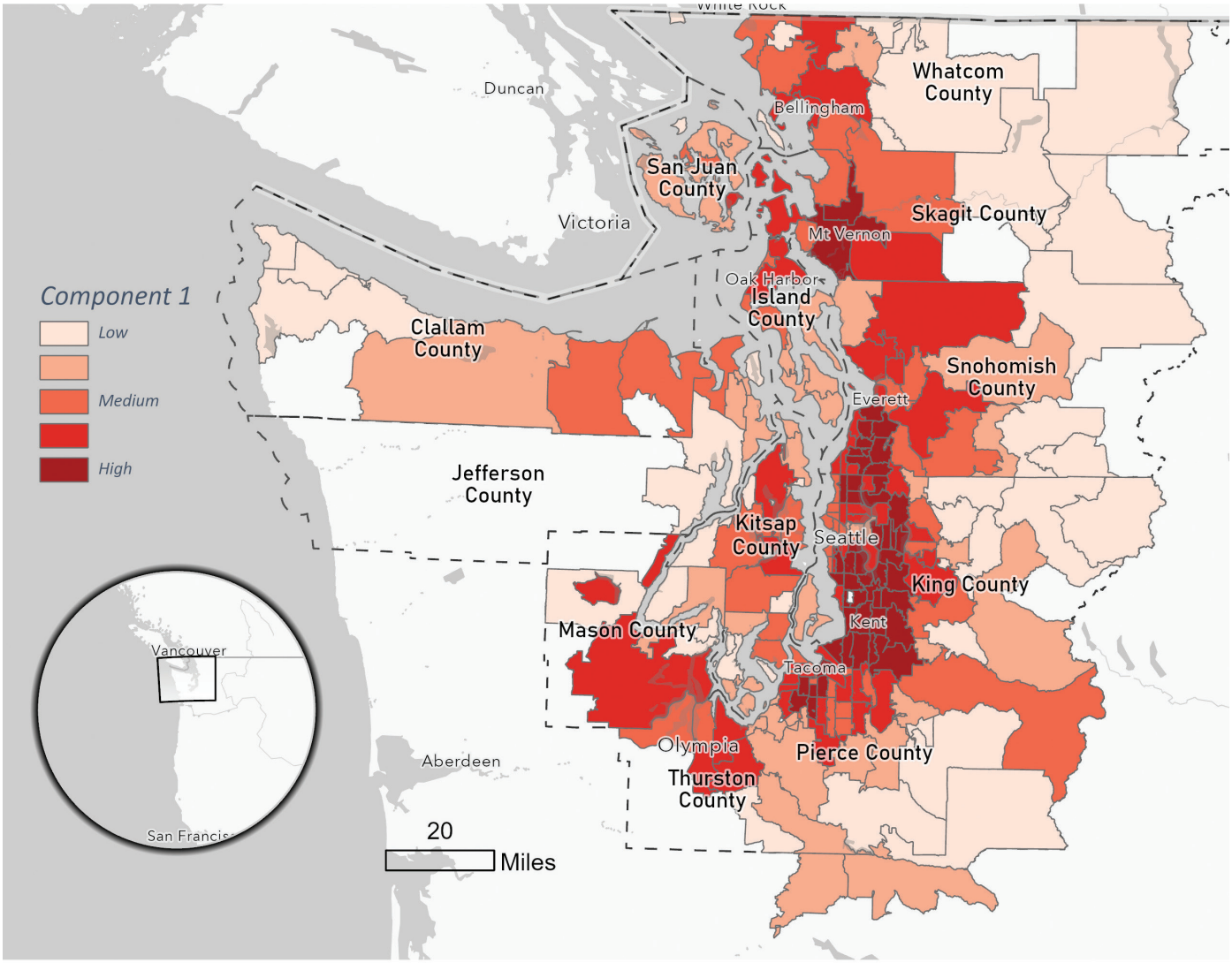
[b] Analysis was conducted using proportions, but are presented and discussed as percentages for ease of communication.

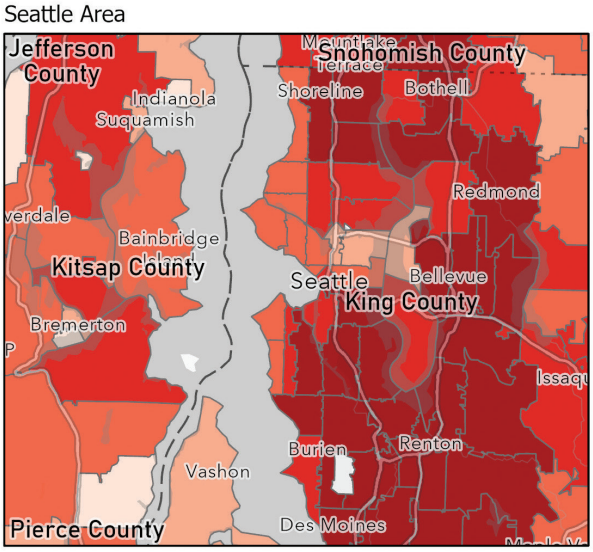
Point Robinson lighthouse. Credit: no attribution required

3.1 COMPONENT 1 - DIVERSITY AND URBANITY

Figure 3.1 shows areas of relative community-level social vulnerability related to metrics of diversity and urbanity. Higher vulnerability is found throughout urban areas in the Seattle to Tacoma region of the South Puget Sound, the majority of which are found in western King County and southeastern Snohomish County. These areas tend to have increased population size, higher percentages of foreign-born residents, higher percentages of non-White individuals, and higher percentages of English spoken as a second language and with limited proficiency. These areas also tend to be more urban, have increased impervious surface coverage, and higher EMS facility density, hospital proximity, and total sales volume. Areas shown in dark red tend to correlate with highly populated and racially and linguistically diverse places, as well as some historically more marginalized communities. This component shows vulnerability linked to higher densities of people and structural resources at risk to environmental hazards. Increased EMS density, hospital proximity, and business sales mean these systems are more likely to be impacted or interrupted in the event of an environmental hazard.

Downtown Seattle waterfront. Credit: no attribution required





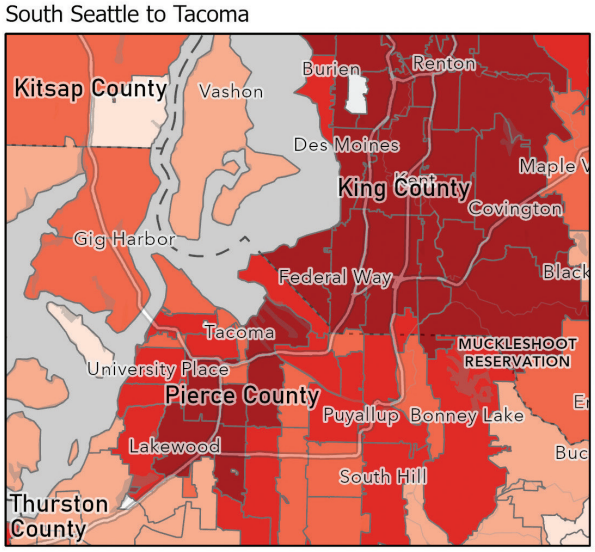


Figure 3.1. Areas of low to high community-level social vulnerability: Component 1 – Diversity and Urbanity.

Figure 3.2 shows areas of relative community-level social vulnerability related to metrics of income and education. In contrast to component 1, higher vulnerability is found in more rural areas, primarily in parts of Skagit, Clallam, and Mason Counties, as well as parts of Southern Puget Sound. These areas tend to have lower median and per capita income, lower percentages of households earning over $200,000 annually, lower home value, and lower educational attainment.

Ferry cruising in Puget Sound. Credit: no attribution required

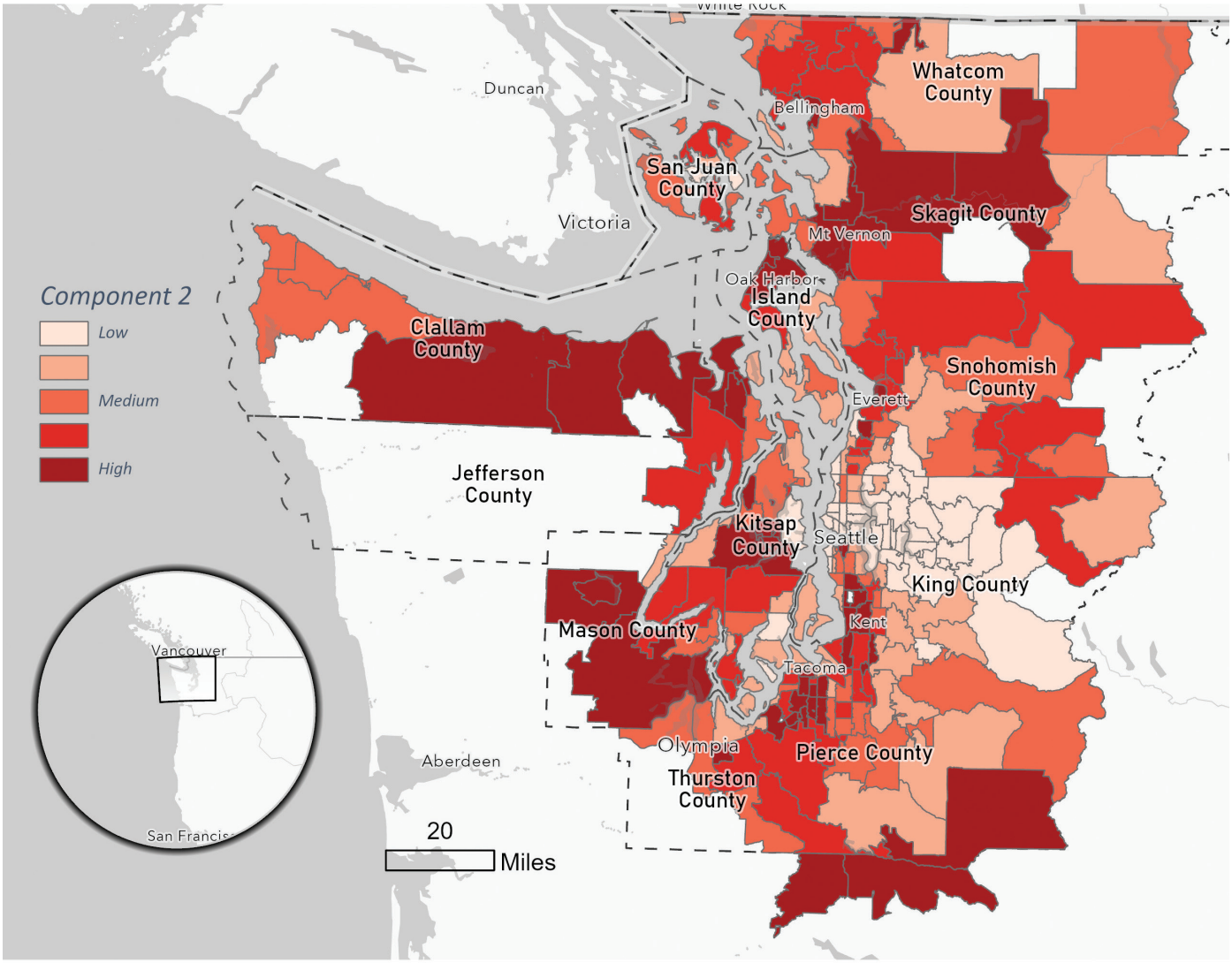
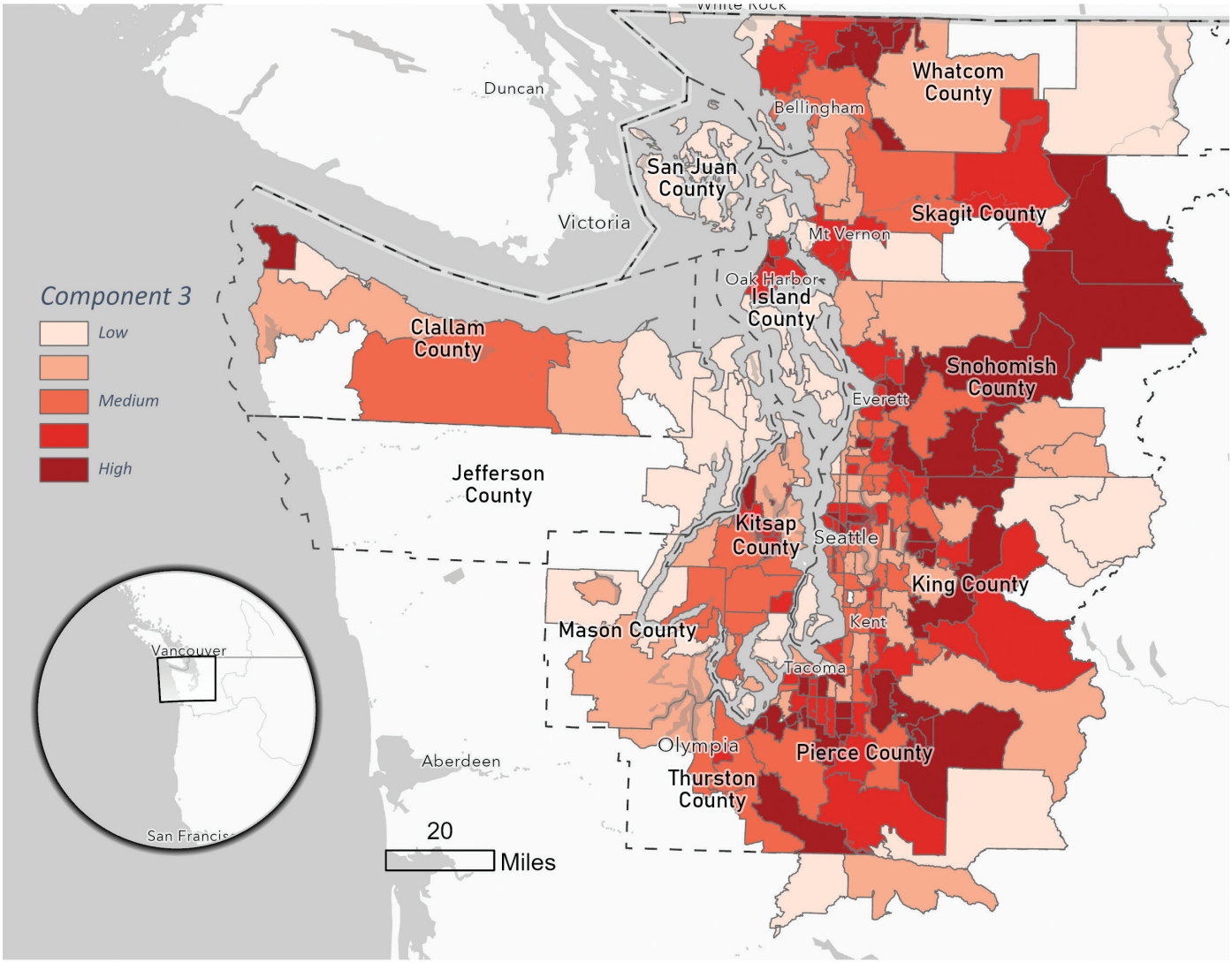


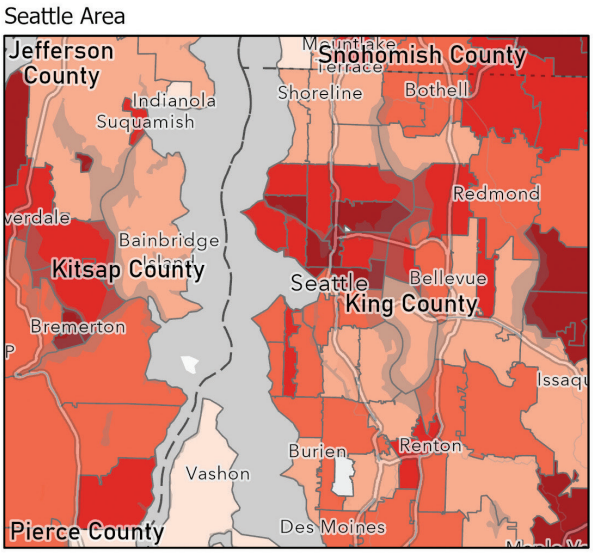
Figure 3.2. Areas of low to high community-level social vulnerability: Component 2 – Income and Education.

3.3 COMPONENT 3 – AGE AND HOUSING OCCUPANCY

Figure 3.3 shows areas of relative community-level social vulnerability related to metrics of age and housing occupancy. Similar to component 2, higher vulnerability is again found outside urban areas. Higher vulnerability is largely located in the eastern and southern parts of the study area, with notable portions of Snohomish and Pierce Counties but pockets of included ZCTAs in most Puget Sound counties as well, with the exception of San Juan, Jefferson, and Mason. Parts of Clallam County are identified as highly vulnerable for this component of social vulnerability. Dark red areas are likely to have relatively increased age, higher percentages of populations over 64 years and households with people over 60, smaller family size, fewer vacant housing units, and decreased participation in the labor force.

Lopez Island. Credit: no attribution required





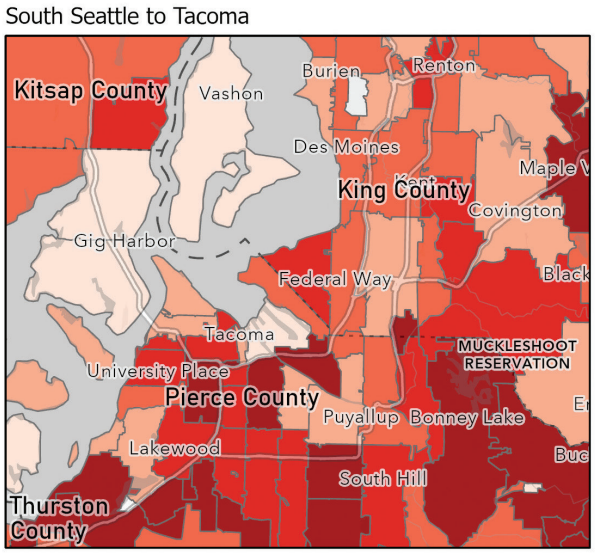
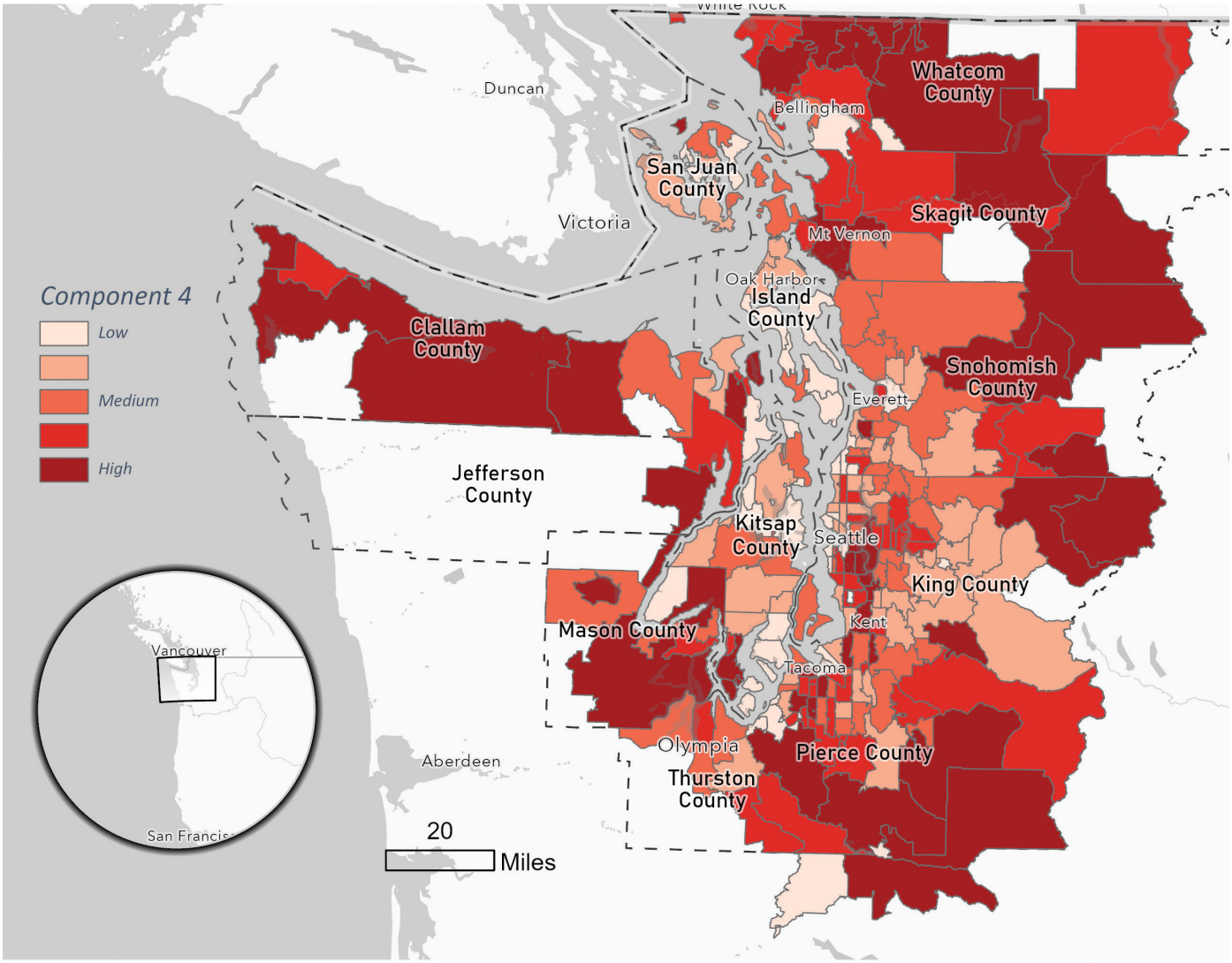


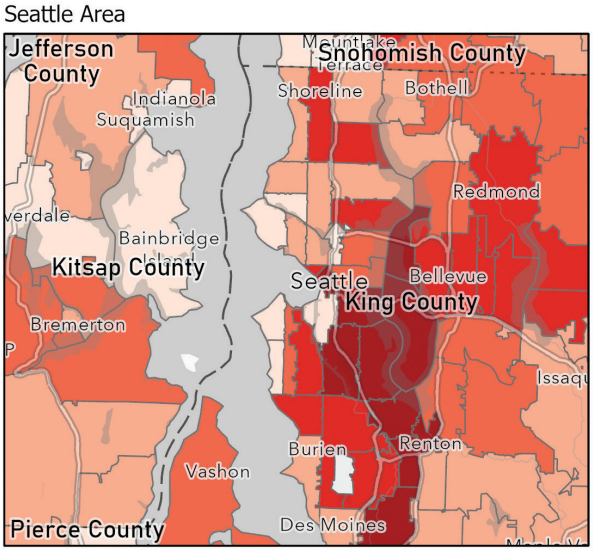
Figure 3.3. Areas of low to high community-level social vulnerability: Component 3 - Age and Housing Occupancy.

3.4 COMPONENT 4 - ISOLATION, ACCESS TO SOCIAL SERVICES, AND DEPENDENCE ON EXTRACTIVE INDUSTRIES

Figure 3.4 shows areas of relative community-level social vulnerability related to metrics of isolation, access to social services, and dependence on extractive industries. Higher vulnerability is found scattered throughout the study area. With the exception of Island and Kitsap Counties, all included portions of the remaining counties have pockets of vulnerable populations. Communities within these identified areas are more likely to lack access to computers and internet in the home, receive SNAP benefits, have one or more disabled persons in the home, and live below the poverty line. These areas also tend to have increased employment in extractive industries, such as agriculture, forestry, fishing, hunting, mining, quarrying, and oil and gas extraction.

Waterside shed with artwork. Credit: Seann Regan, CSS, NOAA





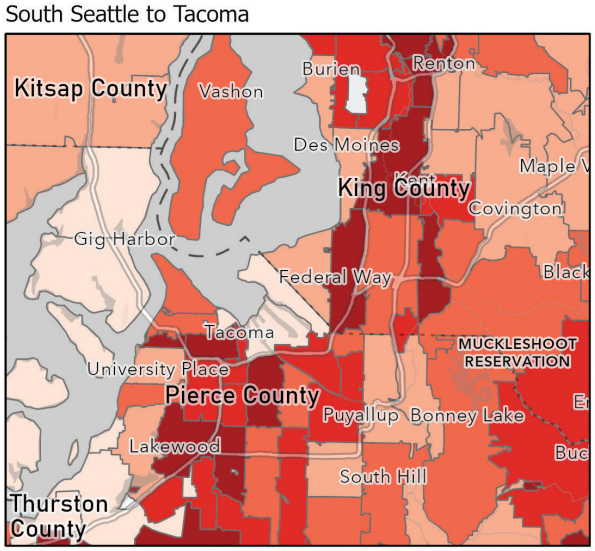
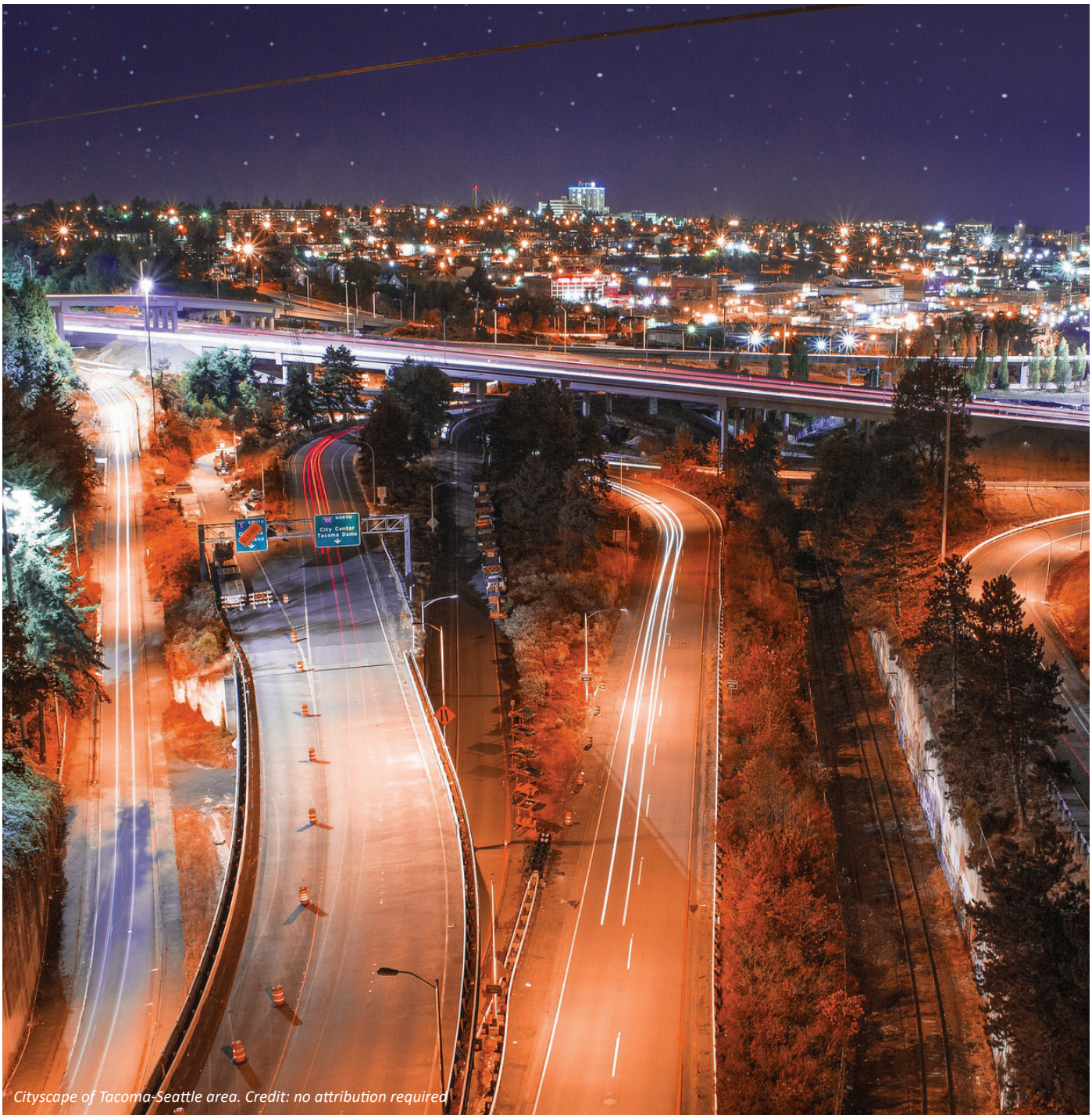


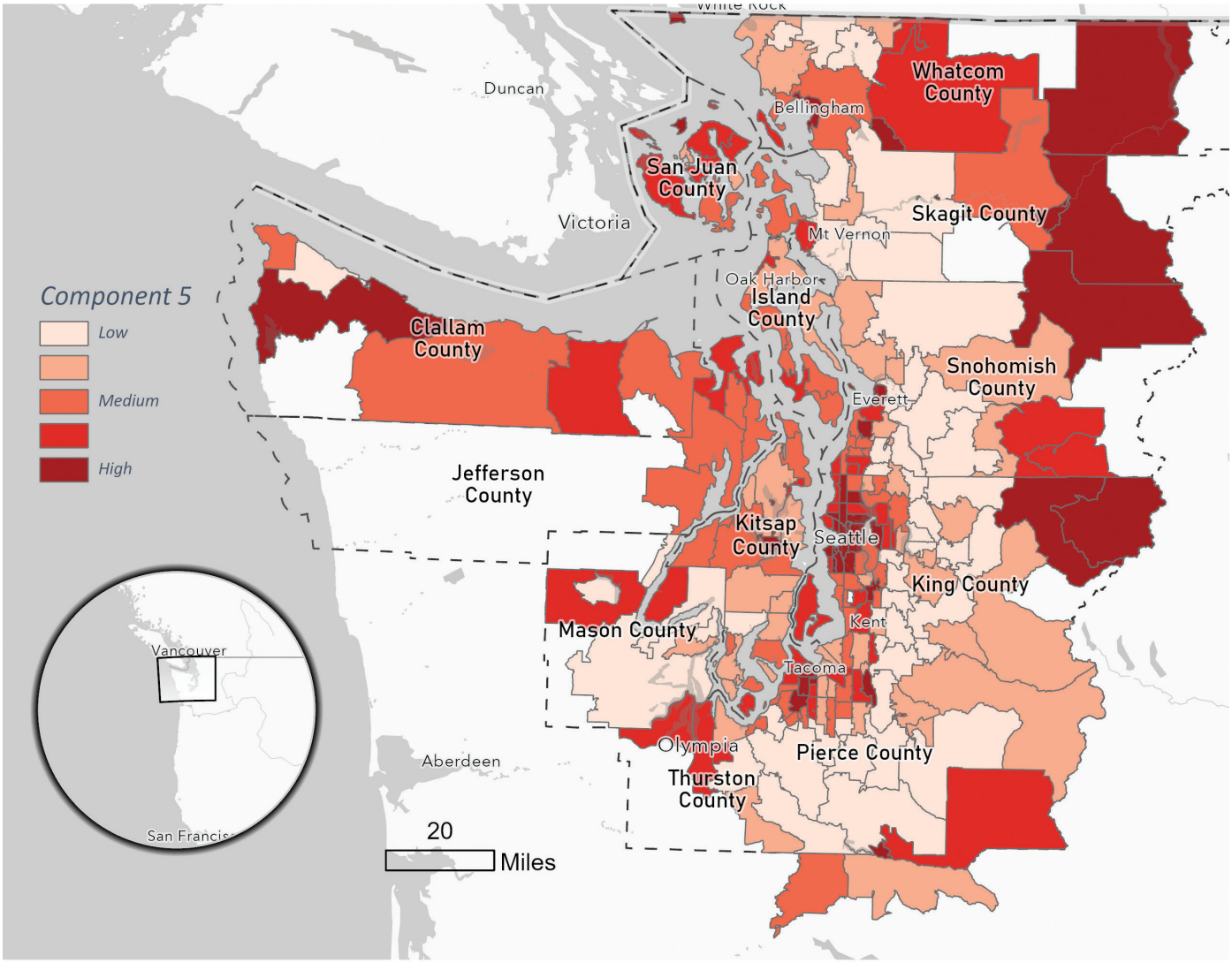
Figure 3.4. Areas of low to high community-level social vulnerability: Component 4 - Isolation, Access to Social Services, and Dependence on Extractive Industries.

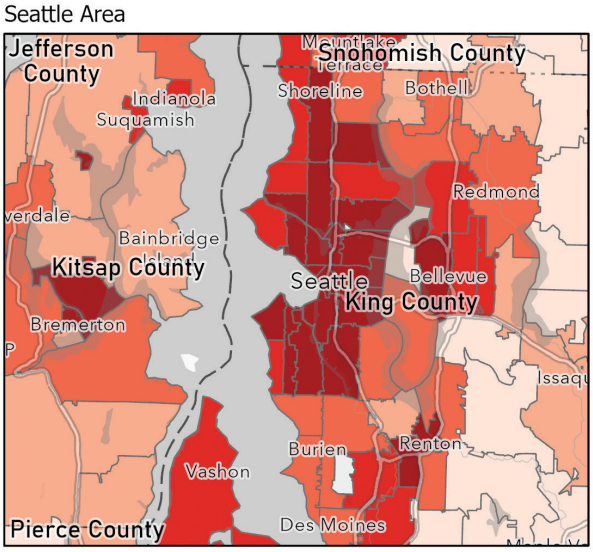
3.5 COMPONENT 5 – HOUSING AND INFRASTRUCTURE

Figure 3.5 shows areas of relative community-level social vulnerability related to housing and infrastructure. Higher vulnerability is found in both urban areas and more rural areas. These areas include urban parts of King, Pierce, and Snohomish Counties, but also rural areas of Whatcom, Skagit, Snohomish, King, Pierce, and Clallam. San Juan County also has increased vulnerability. In contrast, more suburban areas are identified as less vulnerable. Areas of higher vulnerability are less likely to be comprised of family households, but more likely to have increased participation in the labor force, increased density of critical infrastructure, and a higher percentage of rental units. These areas are also more likely to have households without access to a vehicle. Similar to component 1, increased critical infrastructure density means more important resources at increased risk of impact or interruption in the event of an environmental hazard. This component may also be communicating a dichotomy between urban and rural areas, where both are identified as vulnerable but for different underlying reasons.



Cityscape of Tacoma-Seattle area. Credit: no attribution required





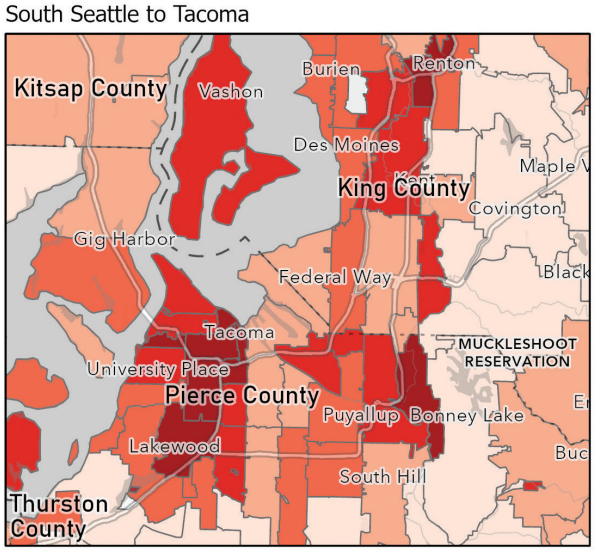


Figure 3.5. Areas of low to high community-level social vulnerability: Component 5 - Housing and Infrastructure.

3.6 COMPONENT 6 – INSTITUTIONAL INEQUITIES

Figure 3.6 shows areas of relative community-level social vulnerability related to institutional inequities. Higher vulnerability is found in various urban, suburban, and rural areas throughout the study area. These areas are located throughout much of Whatcom, Skagit, and Mason Counties, as well as in pockets of Clallam, Snohomish, King, and Jefferson Counties. Areas of higher vulnerability tend to have higher populations of incarcerated persons, higher unemployment rates, and higher percentages of Hispanic individuals. Areas that are not in the urban south sound that score high on this component may be areas of high agricultural use, and some correspond with locations of prisons and thus incarcerated persons. Agricultural areas in both Skagit and Whatcom Counties are highlighted.

Puget Sound sunset from ferry deck. Credit: Seann Regan, CSS, NOAA.

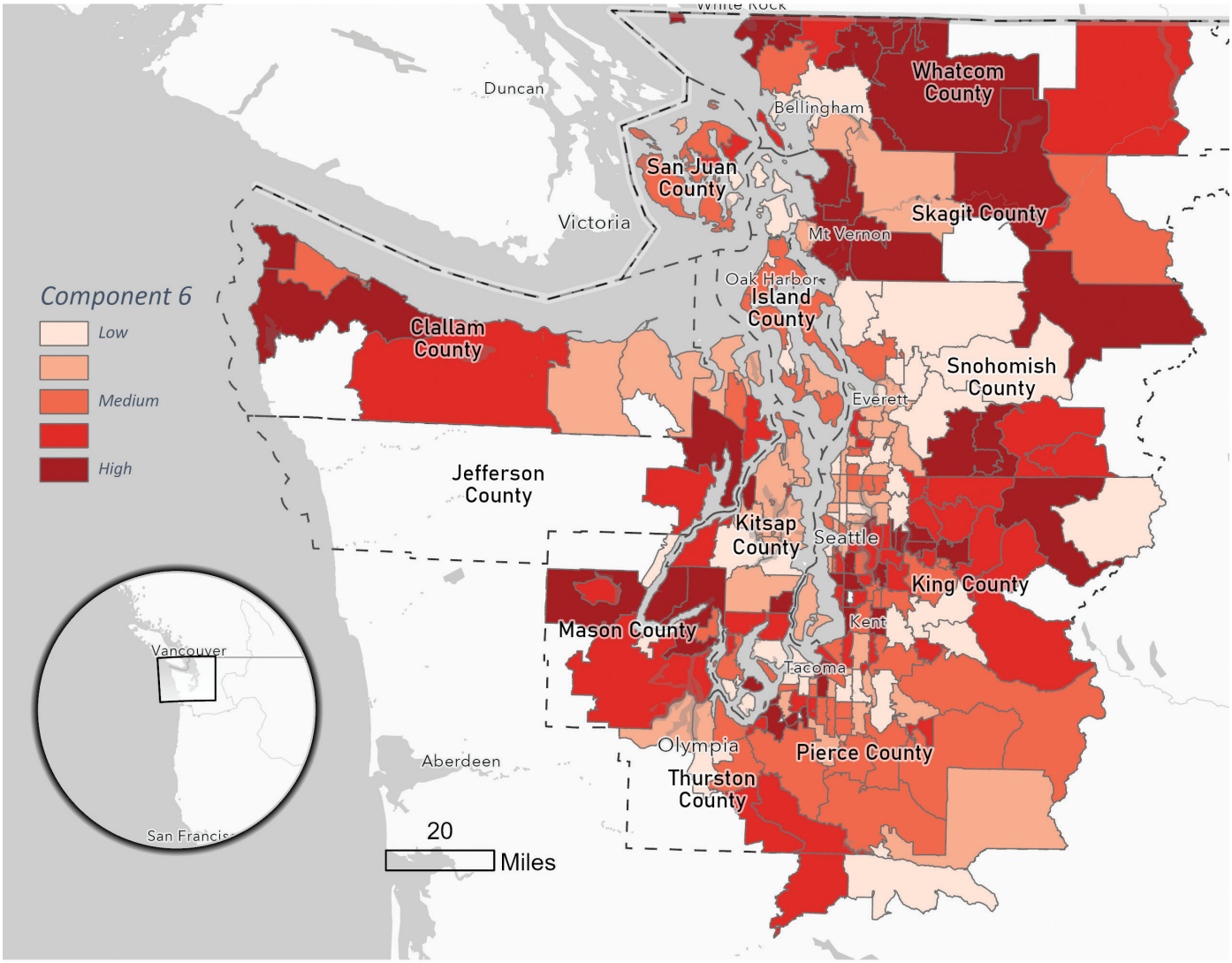
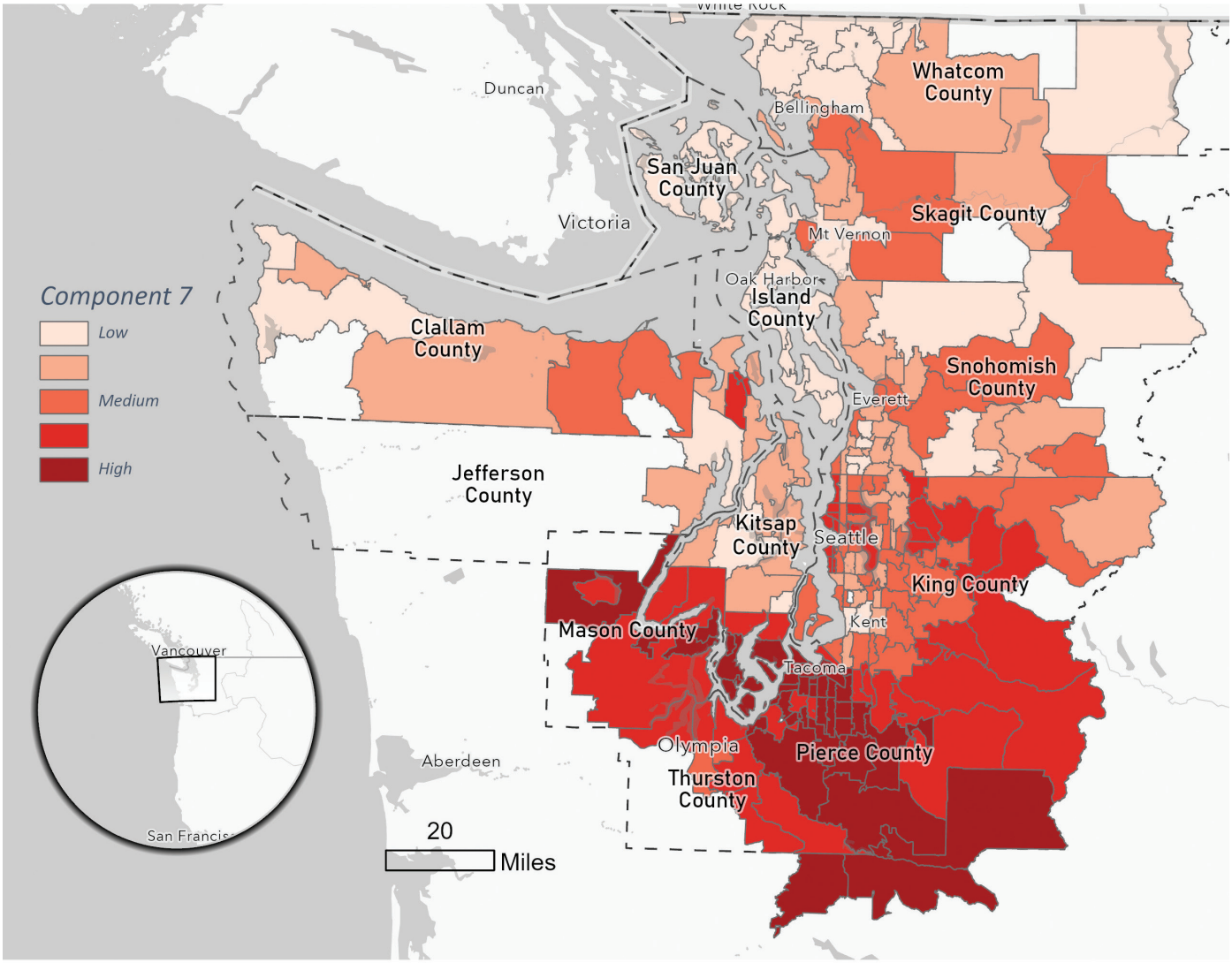


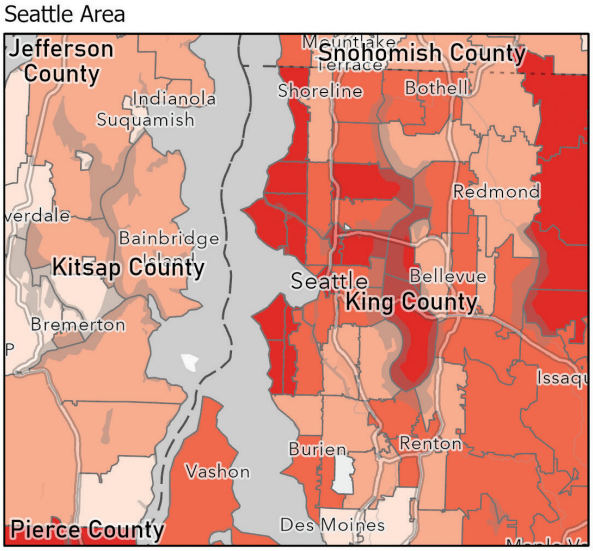
Figure 3.6. Areas of low to high community-level social vulnerability: Component 6 - Institutional Inequities.

3.7 COMPONENT 7 – LIFE SATISFACTION AND BELONGING

Figure 3.7 shows areas of relative community-level social vulnerability related to metrics of life satisfaction and belonging, the final component of this social vulnerability assessment. Higher vulnerability is found in the southern portion of the study area, in large swaths of Pierce and Mason Counties, followed by King and Thurston Counties. These areas are more likely to have decreased life satisfaction and sense of place as well as higher percentages of persons experiencing homelessness. While various parts of the northern Sound are vulnerable in the preceding components, northern communities seem to have higher life satisfaction and belonging.

Paddleboarder in downtown Seattle. Credit: no attribution required





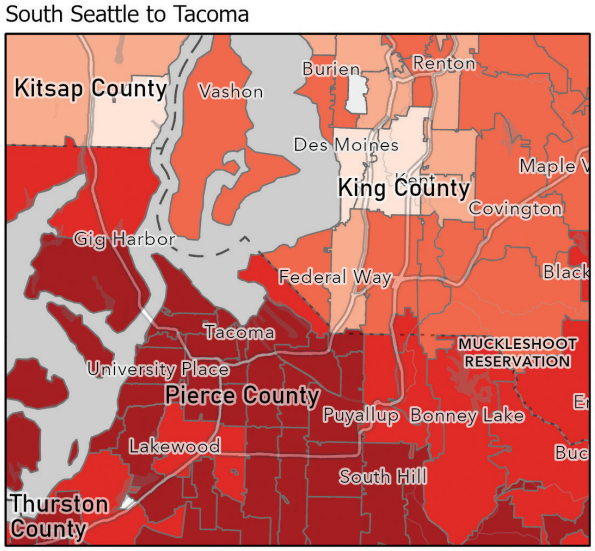


Figure 3.7. Areas of low to high community-level social vulnerability: Component 7 - Life Satisfaction and Belonging

3.8 COMPOSITE SOCIAL VULNERABILITY

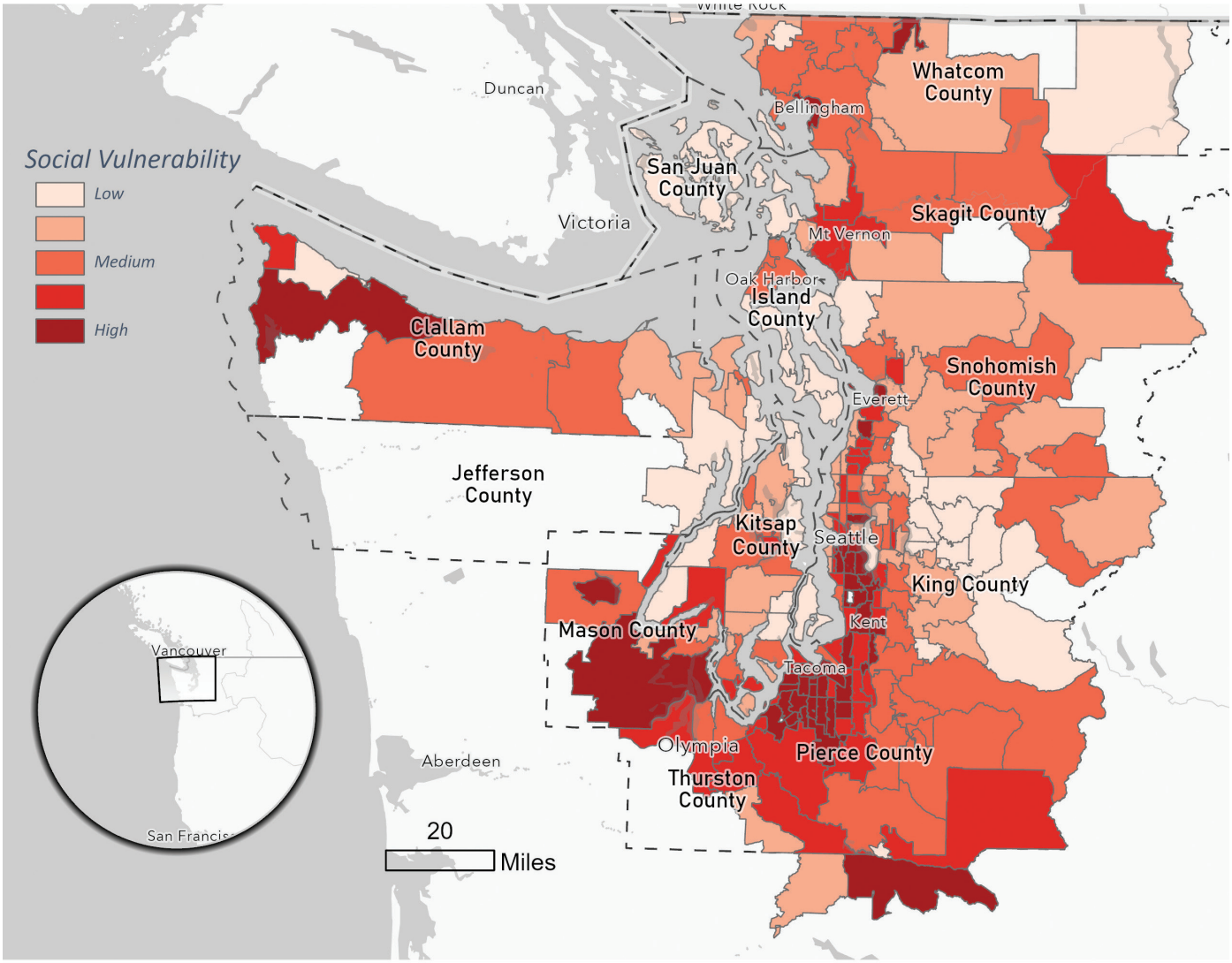
Finally, Figure 3.8 shows the composite community-level social vulnerability index for the Puget Sound region. This composite measure is a combination of components one through seven and shows relative community-level social vulnerability for the study area. Overall, areas of highest social vulnerability are gathered in the southern Sound and the northwestern Olympic peninsula. Urban areas in western King and Pierce Counties are identified, but also more rural areas in Mason and Thurston Counties, as well as western parts of Clallam. There are also pockets of high potential social vulnerability in Whatcom, Snohomish, and Skagit Counties. Relatively speaking, San Juan, Island, Kitsap, and the included portion of Jefferson Counties have low overall social vulnerability.

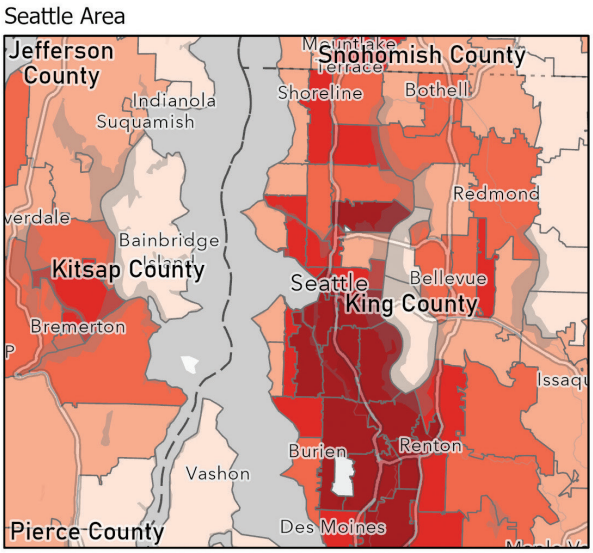
These patterns are directly related to the individual components of community-level social vulnerability, and they provide insight related to differences in urban, rural, and suburban areas. In this final map, there are dark red areas spanning the spectrum from urban to rural. Despite shared community-level social vulnerability, these areas are socially vulnerable in different ways. For example, two of the highest socially vulnerable areas on this final map, the northwestern Olympic Peninsula and the southeastern shore of Puget Sound in Pierce County, are more heavily influenced by different components. The first is identified among the most vulnerable areas within components 4, 5, and 6, whereas the second has pockets identified among the most vulnerable within most components (though, component 7 is most striking). Component 5 highlights these dichotomies within a single component, and these examples underscore that while there are shared areas of social vulnerability, the underlying causes and therefore relevant mitigation strategies are and should vary, respectively.

This final map is meant as a relative, first-look guiding tool for those engaged in hazard-related planning, adaptation, and mitigation efforts in response to a changing climate and other natural and social phenomena. While the composite is useful within certain contexts and highlights relative and potential priority areas, the preceding component maps or even individual variables may be of interest for other purposes. For example, San Juan County has the lowest relative social vulnerability composite score despite it containing a few pockets of highest vulnerability within components 4 and 5, and mid-level vulnerability within components 1, 2, and 6. One of the variables contributing to component 4 is dependence on extractive industries. If these industries are tied to current climatic conditions, the highlighted portion of San Juan County may still experience vulnerability despite not being listed as such on the final composite map.

Additionally, this final map, and the component maps preceding it, do not imply that all individuals living within highly vulnerable areas are vulnerable, nor that all individuals in less vulnerable areas are not vulnerable. These are community-level metrics based on available secondary data, and Census-defined boundaries are often not definitive delineations of population metrics.

Downtown Seattle waterfront. Credit: no attribution required





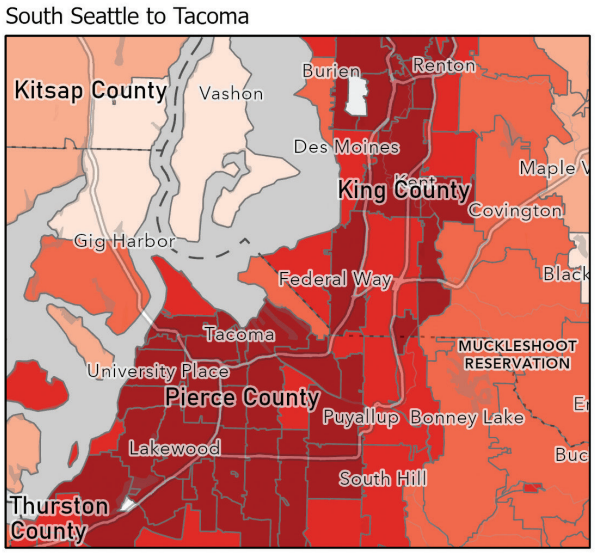


Figure 3.8. Areas of low to high community-level social vulnerability: Composite Social Vulnerability.

Puget Sound coastline. Credit: Seann Regan, CSS, NOAA

Chapter 4: Integration, Limitations, and Next Steps

The social vulnerability assessment presented here supports the SLR vulnerability assessment completed for Near-term Action 2018-0685 by Washington Sea Grant and CGS. In that assessment, SLR vulnerability was calculated as a function of exposure and sensitivity scores for each parcel within that study area, such that:

SLR Vulnerability Index = Exposure Score + (Habitat Sensitivity Score + Infrastructure Sensitivity Score)

The composite social vulnerability presented in Figure 3.8 was normalized and integrated with the SLR vulnerability index as an optional modifier. Integrating social data with finer data streams is challenging and has the potential to reveal personally identifiable information (PII), especially when the desired scale is the parcel-level. To avoid PII issues, all parcels within a given ZCTA were given the same social vulnerability score. Since there were differences in spatial extent between the two vulnerability assessments, where the Near-term Action 2018-0685 assessment included only parcels within a narrow coastal buffer fringing Puget Sound and the present assessment included all ZCTAs within the Puget Sound drainage basin (see Figure 1.1), the socially modified SLR vulnerability index utilized the relative social vulnerability index as calculated for the entirety of the Puget Sound drainage basin. This extrapolation from a wider study area to a smaller study area is a limitation of this research and socio-ecological integration more generally. Without primary data collection efforts, social data is often unavailable or unreliable (i.e., high margins of error) at smaller units. Efforts to downscale these types of data to smaller scales have occurred (e.g., Yee, Paulukonis, and Buck 2020; Wan et al. 2022), but the results are often still at coarser scales than available for many physical and ecological datasets. Methodological issues related to integration of datasets are also often more pronounced when research designs do not initially plan for the integration of social data, as was the case in the Near-term Action 2018-0685 assessment.

When applied, the integrated socially modified SLR vulnerability index can be used to inform restoration activities and other uses by the Puget Sound Partnership and regional stakeholders by identifying areas where co-benefit of adaptation, mitigation, and environmental justice may occur. More information on the SLR vulnerability index, integration methodology, and resulting comparison maps are available in Coastal Geologic Services et al. (2022).

Beyond its integration with the larger vulnerability assessment, this social vulnerability assessment can be used as a stand-alone product to inform other efforts in the Puget Sound region, including areas that span beyond the Near-term Action 2018-0685 assessment study area. For example, the northwestern Olympic Peninsula is identified as highly vulnerable. Other areas of highest vulnerability within this assessment are primarily found within southern Sound, including portions of Mason, King, and Pierce Counties. Some of these areas, such as the Duwamish River waterway in King County, have historically experienced environmental justice issues, leading the EPA to designate the Duwamish River a Superfund Site in 2001 (EPA 2021). This assessment offers a tool for these and other communities to summarize needs and advocate for resources for environmental justice action and adaptation in the face of climate change and SLR. In addition to the final maps included in this report, the full dataset and all component data are also available to practitioners and researchers to further investigate social vulnerability or environmental justice themes within the Sound. This assessment's findings are limited by the availability of the input data within the study area. Despite this report's publication date, this assessment was unable to utilize newly collected 2020 Census data due to delayed release from the U.S. Census Bureau. Instead, this assessment primarily used the most recent ACS data. Due to the nature of ACS 5-year estimates data, these results should not be compared directly to ACS data from the previous or following years as these data are collected on a rolling basis and are sampled both spatially and temporally. However, not all desired data are captured within ACS estimates. In these cases, the research team determined that dated data were better than data omissions, and 2010 Decennial Census data were used instead (see Appendix A). This decision likely influenced final results. For example, project

partners noted the closure of a corrections facility that was likely captured within 2010 Census data, but may no longer be fully operational.[7]

Resulting measures of vulnerability are also relative to the universe of data included in this assessment, where vulnerability among ZCTAs is only in comparison to other included ZCTAs and not those external to the study area. Similarly, with the exception of the 7th component, the regional scale of the study area relied on national assumptions of factors generally known to influence vulnerability. It is possible that some metrics known to contribute to vulnerability nationally have a weaker or inverse relationship in parts of Puget Sound. While the results of the present assessment generally align with trends established in other assessment tools (e.g., socioeconomic factors layer of the Washington Environmental Health Disparities Map (Washington DH n.d.), the Center for Disease Control Social Vulnerability Index (ATSDR 2021)), further ground-truthing of assessment results, statistical comparisons to other regional tools, and exploration of continued downscaling of data may be useful next steps. Similarly, future investigations within identified hotspots might also consider data unavailable at the regional scale such as data specific to the shoreline or specific to one county or governing body.

Lastly, all data provided in this report are used to measure community-level social vulnerability (as opposed to resilience or adaptive capacity) and may not represent the individually-lived experience. More nuanced investigation at smaller spatial scales may be beneficial if PII concerns can be properly addressed.

[7] https://www.seattletimes.com/seattle-news/doors-closing-at-mcneil-island-prison-after-135-years/, last accessed 27 January 2022.

Paddleboarders. Credit: Seann Regan, CSS, NOAA

Downtown Seattle. Credit: Seann Regan, CSS, NOAA

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Orcas enjoyed Puget Sound. Credit: no attribution required

Aerial view of Seattle. Credit: Seann Regan, CSS, NOAA

Appendix A

Table A1. Variable Overview: Descriptions, Resolution, Year, Source, File code, and Calculation notes

Variable	Variable Description	Resolution	Year	Data Source	Census File Code	Calculation Notes
Median income	Median household income in the past 12 months (in 2019 inflation-adjusted dollars)	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S1903	Estimate - C03_001E
Per capita income	Per capita income in the past 12 months (in 2019 inflation-adjusted dollars)	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B19301	Estimate - 001E
% households living in poverty	Percent of households with income in the past 12 months below poverty level	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2201	Estimate, then Calculated - C01_021E / 001E
% households earning greater than $200,000 annually	Percent of households that earn $200,000 or more annually	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S1901	Estimate - S1901_ C01_011E
% females	Percent of population that is female	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S0101	Estimate, then Calculated - C05_001E / C01_001E
% race other than white alone	Percent of population other than white alone of population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2301	Estimate, then Calculated - C01_012E / C01_001E
% population foreign born	Percent of population foreign born	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0093PE
% speaking English as a second language with limited English proficiency	Percent of population 5 years and over that speaks a language other than English at home and speaks English less than “very well”	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0114PE
% Hispanic	Percent of Hispanic or Latino origin of population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2301	Estimate, then Calculated - C01_019E / C01_001E
Median Age	Median age	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B01002	Estimate - 001E
% population under 5 years old	Percent of total population under 5 years of age	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S0101	Estimate, then Calculated - C01_002E / C01_001E
% population over 64 years old	Percent of total population 55 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S0101	Estimate, then Calculated - C01_030E / C01_001E

Table A1 cont. Variable Overview: Descriptions, Resolution, Year, Source, File code, and Calculation notes

Variable	Variable Description	Resolution	Year	Data Source	Census File Code	Calculation Notes
% impervious surface	Percent impervious surface	30-meter	2016	National Land Cover Database	N/A	Percent of ZCTA covered in impervious surfaces (all types)
Total sales volume (in millions)	ESRI business location data (annual sales volume in millions)	Point level data	2016	ESRI Business location data (2016 release)	N/A	Aggregated to ZCTAs, normalized 0-1
Unemployment rate	Unemployment rate for population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2301	Estimate - C04_001E
% urban population	Percent of population that is urban, based on 2010 Census definition	Census ZCTA	2010	US Census Bureau, 2010 Decennial Census of Population and Housing	SF1 a P and H Tables	Estimate
% mobile homes	Percent of mobile homes based on units per household	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B1101	Estimate - 0014PE
% vacant housing units	Percent vacant housing units	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP04	Estimate - 0003PE
Zillow home value index	Zillow Home Value Index (ZHVI): A smoothed, seasonally adjusted measure of the typical home value and market changes across a given region and housing type.	ZCTA	2019	Zillow Research Group	N/A	N/A
% housing units with no vehicle	Percent of owner and renter occupied housing units with no vehicle available	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP04	Estimate - 0058PE
% HHs without a computer	Percent of total households without a computer	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2801	Estimate, then Calculated - C01_011E / C01_001E
% HHs without internet subscription	Percent of total households without an Internet subscription	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2801	Estimate, then Calculated - C01_019E / C01_001E
% HHs lacking plumbing facilities	Percent owner occupied and renter occupied households lacking plumbing facilities	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B25049	Estimate, then Calculated - (007E + 004E) / 001E

Table A1 cont. Variable Overview: Descriptions, Resolution, Year, Source, File code, and Calculation notes

Variable	Variable Description	Resolution	Year	Data Source	Census File Code	Calculation Notes
Critical infrastructure density	Hospitals, airports, schools, communication, electric power, natural gas, oil, potable water, wastewater, bus, rail facilities, police, medical care, fire station, and emergency operations centers	Point	2019	Federal Emergency Management Agency (FEMA) Hazus database; WA State Geospatial Open Data Portal	N/A	Point in Polygon analysis, density of points per square mile within ZCTAs
% renter-occupied housing units	Percent renter-occupied housing units	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP04	Estimate - 0047PE
% female participation in labor force	Percent female participation in employment of the civilian employed population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2403	Estimate, then Calculated - C04_001E / C01_001E
% employment in extractive industries	Percent employment in extractive industries (including agriculture, forestry, fishing, hunting, mining, quarrying, and oil and gas extraction) of civilian employed population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2403	Estimate, then Calculated - C01_002E / C01_001E
% employment in service industry	Percent employment in the service industry (including retail trade, administrative and support services, waste management services, arts, entertainment and recreation, accommodation and food services, and other services, except public administration) of the civilian employed population 16 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2403	Estimate, then Calculated - (008E + 019E + 023E + 026E) / 001E
Average family size	Average family size for all households	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0017E
% female householders with children, no spouse present	Percent of households with female householder, no spouse/partner present, and children of the householder under 18 years	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0011PE
% family households	Percent family households	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B11011	Estimate, then Calculated - 002E / 001E

Table A1 cont. Variable Overview: Descriptions, Resolution, Year, Source, File code, and Calculation notes

Variable	Variable Description	Resolution	Year	Data Source	Census File Code	Calculation Notes
% male householders with children, no spouse present	Percent of households with male householder, no spouse/partner present, and children of the householder under 18 years	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0007PE
% HHs with people over 59	Households with one or more people 60 years and over	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2201	Estimate, then Calculated - C01_002E / C01_001E
% population 25 years or older with less than 12th grade education	Percent of population aged 25 years and older with 12th grade education but with no diploma, and below	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate, then Calculated - (0060E + 0061E) / 0059E
% population 25 years or older with Bachelors degree or higher	Percent of population aged 25 years and older with Bachelor's degree or higher	Census ZCTA	2019	American Community Survey, 5 Year Estimates	DP02	Estimate - 0068PE
Population from ACS	Total Population according to American Community Survey	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S0101	Estimate - C01_001E
Population from ACS/ Census	Total Population change from 2010 (Census) to 2019 (American Community Survey)	Census ZCTA	2010-2019	American Community Survey, 5 Year Estimates and 2010 census	S0601/ S0101	(Estimate C01_001E – Estimate B010001e1)
Hospital proximity	Proximity to primary care hospitals	Point	2021	Washington State Department of Health	N/A	Distance from ZCTA centroid to nearest hospital
EMS facilities	Density of EMS facilities within 10 miles	Point	2021	Washington State Department of Health	N/A	Density of EMS facilities within each ZCTA using a distance threshold of 5 miles to limit edges effects and crossing of Puget Sound
% households receiving social security	Percent of households with social security income	Census ZCTA	2019	American Community Survey, 5 Year Estimates		(B17015e2/ B17015e2)
% of households receiving food stamps or SNAP	Estimate!!Percent households receiving food stamps/SNAP!!Households	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2201	Estimate - C04_011E

Table A1 cont. Variable Overview: Descriptions, Resolution, Year, Source, File code, and Calculation notes

Variable	Variable Description	Resolution	Year	Data Source	Census File Code	Calculation Notes
% of pop participating in labor force	Percent of population participating in civilian labor force	Census ZCTA	2019	American Community Survey, 5 Year Estimates		Estimate, then Calculated - B23025e2/ B23025e1
% new to current residence from outside current MSA in the past year	Percent of householders who have moved to their current residence from a different state or from abroad within the last year	Census ZCTA	2019	American Community Survey, 5 Year Estimates	B07013	Estimate, then Calculated - (013E + 016E) / 001E
% of population living in nursing and skilled-nursing facilities	Percent of population living in nursing or skilled-nursing facilities	Census ZCTA	2010	US Census Bureau, 2010 Decennial Census of Population and Housing	PCT20	IDB014/ S0101
% of population without health insurance	Percent of noninstitutionalized population without insurance	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2701	Estimate - C05_001E
% of population experiencing homelessness	Percent of population unstably housed or homeless	County	2020	Washington State Department of Commerce	N/A	County-level data aggregated to the ZCTA
% households with a disability	Percent of households with one or more people with a disability	Census ZCTA	2019	American Community Survey, 5 Year Estimates	S2201	Estimate, then Calculated - C01_023E / 001E
% population living in correctional facilities	Percent of population living in adult or juvenile correctional facilities	County	2010	US Census Bureau, 2010 Decennial Census of Population and Housing	PCT20	IDB003/ S0101
Average sense of place	Vital signs sense of place index, averaged	County	2018	Puget Sound Vital Signs	N/A	Average of sense of place indicators, aggregated from County to nearest ZCTA
Average overall life satisfaction	Vital signs overall life satisfaction, averaged	County	2018	Puget Sound Vital Signs	N/A	Average of sense of place indicators, aggregated from County to nearest ZCTA

Puget Sound. Credit: Seann Regan, CSS, NOAA

Appendix B

Table B1. Principal components analysis key output: rotated component matrix

	1	2	3	4	5	6	7
EMS_dens	0.816						
Lim_Engl	0.791						
Foreign	0.726						
Pop_ACS	0.725						
NW_Race	0.7						
Imperv	0.646						
Pop_Urb	0.635						
Bus_sales	0.623						
Hosp_prox	0.597						
Mob_H							
HH_O200		0.926					
Med_In		0.876					
Cap_In		0.86					
H_value		0.845					
oBach		0.747					
Med_Age			-0.857				
Pop_O64			-0.837				
HH_O59			-0.827				
Av_Fam			0.623				
V_Units			-0.593				
Pop_labor			-0.563		0.505		
Pop_U5							
No_Comp				0.802			
No_Int				0.759			
Emp_Extr				0.62			
HH_SNAP				0.558			
HH_disab				0.522			
HH_pov				0.512			
Fam_HH					-0.862		
No_Veh					0.739		
Crit_infra					0.717		
R_Units					0.576		
Pop_Prison						0.798	
rUnemp						0.681	
Hispanic						0.618	
Life_sat							0.84
Pop_ Homep							-0.731
Sense_ place							0.705
HH_soc							

Table B1 cont. Principal components analysis key output: rotated component matrix

	1	2	3	4	5	6	7
No_Dip							
Pop_ Change							
Fem_Lab							
Female							
Pop_Nurse							
Emp_Serv							
No_Plum							
New							
No_Health							
Fem_noS							
Male_noS							

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 14 iterations.

Table B2. Principal components analysis key output: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.765
Bartlett's Test of Sphericity	Approx. Chi-Square	10788.166
	df	1225
	Sig.	0

Table B3. Principal components analysis key output: total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.085	20.171	20.171	10.085	20.171	20.171	5.921	11.842	11.842
2	7.448	14.896	35.067	7.448	14.896	35.067	5.387	10.773	22.616
3	4.572	9.144	44.211	4.572	9.144	44.211	5.126	10.253	32.868
4	2.667	5.334	49.545	2.667	5.334	49.545	3.709	7.419	40.287
5	2.593	5.186	54.731	2.593	5.186	54.731	3.563	7.125	47.412
6	2.109	4.217	58.948	2.109	4.217	58.948	2.623	5.247	52.659
7	1.957	3.913	62.862	1.957	3.913	62.862	2.457	4.914	57.573
8	1.592	3.183	66.045	1.592	3.183	66.045	2.266	4.532	62.105
9	1.422	2.844	68.889	1.422	2.844	68.889	2.181	4.361	66.467
10	1.36	2.72	71.609	1.36	2.72	71.609	1.627	3.254	69.721
11	1.232	2.464	74.073	1.232	2.464	74.073	1.563	3.126	72.847
12	1.131	2.262	76.335	1.131	2.262	76.335	1.524	3.048	75.895
13	1.069	2.139	78.474	1.069	2.139	78.474	1.289	2.578	78.474
14	0.89	1.78	80.253						
15	0.829	1.658	81.911						
16	0.787	1.574	83.484						
17	0.676	1.352	84.837						
18	0.602	1.203	86.04						
19	0.577	1.153	87.193						
20	0.522	1.044	88.238						
21	0.508	1.017	89.254						
22	0.475	0.95	90.205						
23	0.447	0.895	91.099						
24	0.405	0.809	91.909						
25	0.371	0.742	92.651						
26	0.361	0.721	93.372						
27	0.322	0.643	94.015						
28	0.302	0.605	94.62						
29	0.279	0.558	95.177						
30	0.251	0.501	95.679						
31	0.229	0.458	96.137						
32	0.215	0.429	96.566						
33	0.201	0.403	96.969						
34	0.17	0.341	97.309						
35	0.155	0.31	97.619						
36	0.135	0.27	97.889						
37	0.131	0.261	98.15						
38	0.125	0.249	98.399						
39	0.114	0.227	98.626						
40	0.105	0.21	98.836						

Table B3 cont. Principal components analysis key output: total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
41	0.098	0.196	99.033						
42	0.091	0.183	99.216						
43	0.084	0.168	99.384						
44	0.071	0.141	99.525						
45	0.06	0.12	99.645						
46	0.047	0.094	99.738						
47	0.037	0.075	99.813						
48	0.035	0.07	99.883						
49	0.032	0.064	99.947						
50	0.027	0.053	100						

Extraction Method: Principal Component Analysis.

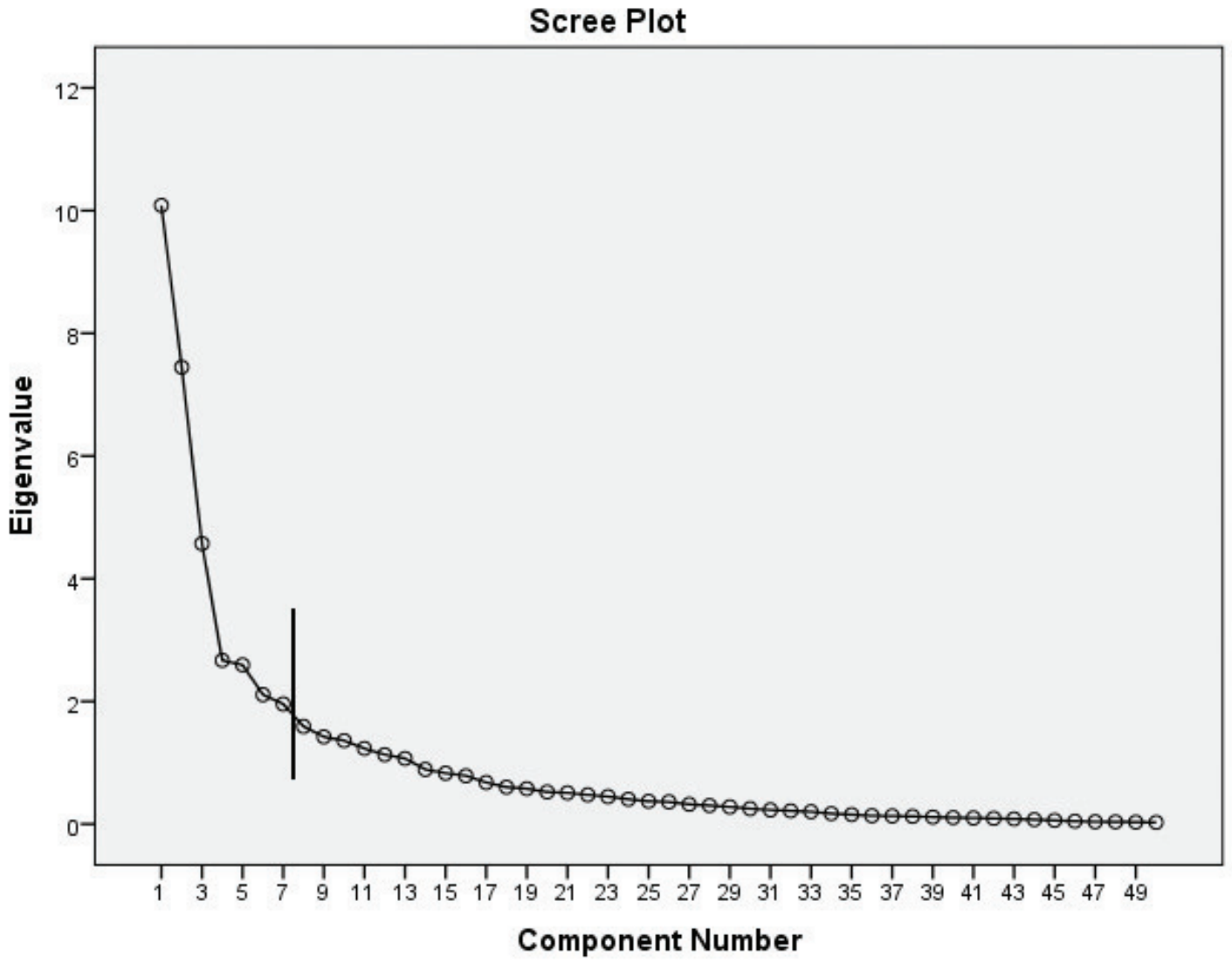


Figure B1. Scree Plot

Winslow Wharf Marina on Bainbridge Island. Credit: Seann Regan, CSS, NOAA

U.S. Department of Commerce

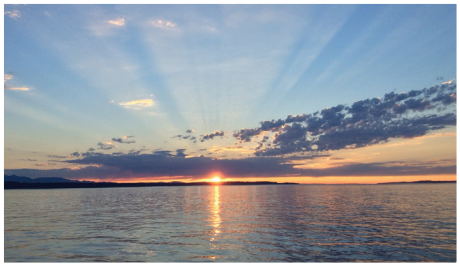
Gina M. Raimondo, *Secretary*

National Oceanic and Atmospheric Administration

Richard W. Spinrad, *Administrator*

National Ocean Service

Nicole Leboeuf, *Assistant Administrator*



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