Appendix A

Map Folio of results for Tulalip Bay area and each county within the study area.

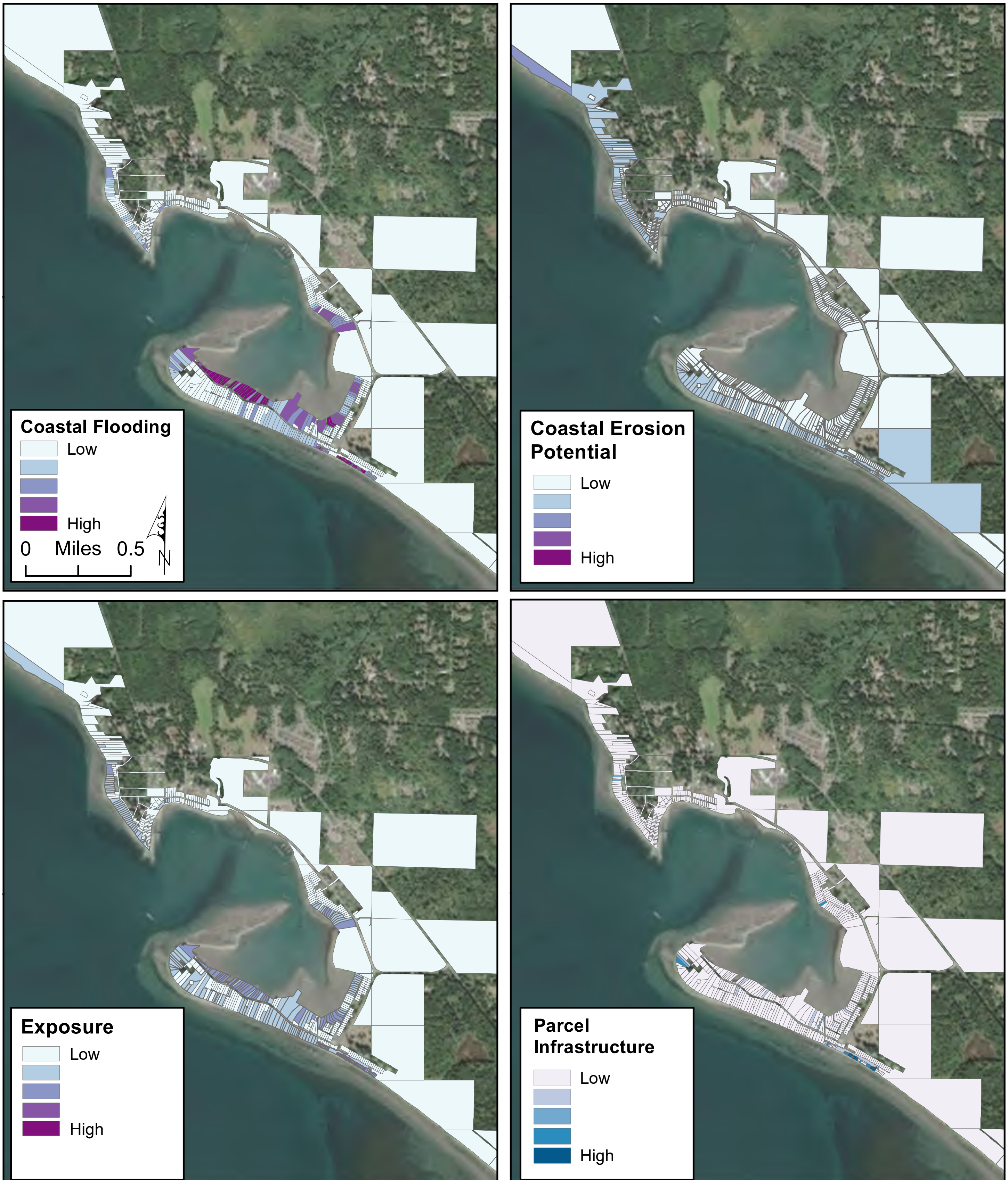

Figure 1. Coastal Flooding, Coastal Erosion Potential, Exposure, and Parcel Infrastructure Scoring for Tulalip Bay.

Aerial Imagery: ArcGIS Basemap.

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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Figure 2. Accessibility Reduction, Agricultural Lands, Infrastructure, and Habitat Sensitivity Scoring for Tulalip Bay.

Aerial Imagery: ArcGIS Basemap.

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

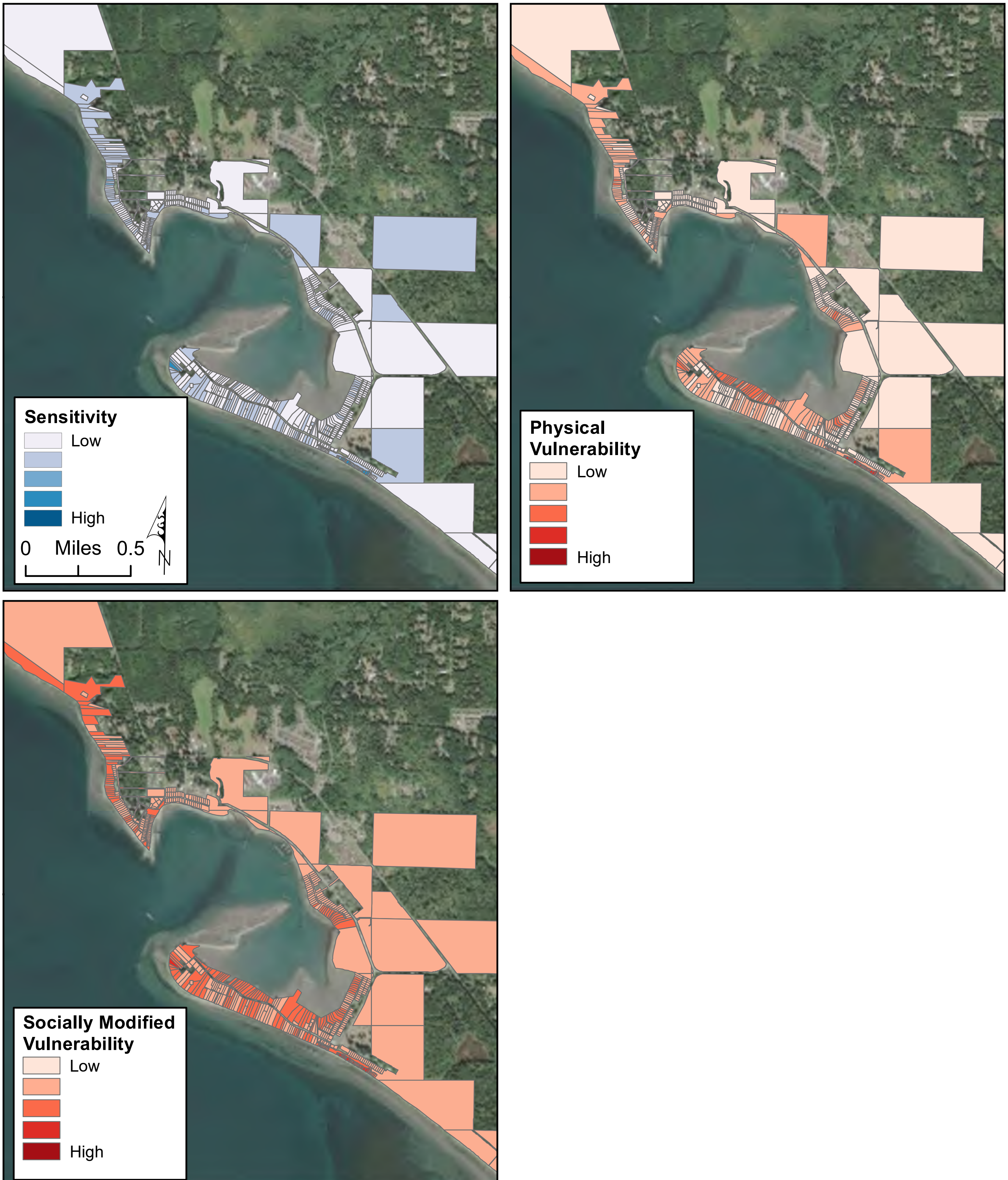

Figure 3. Sensitivity, Physical Vulnerability, and Socially Modified Vulnerability Scoring for Tulalip Bay.

Aerial Imagery: ArcGIS Basemap.

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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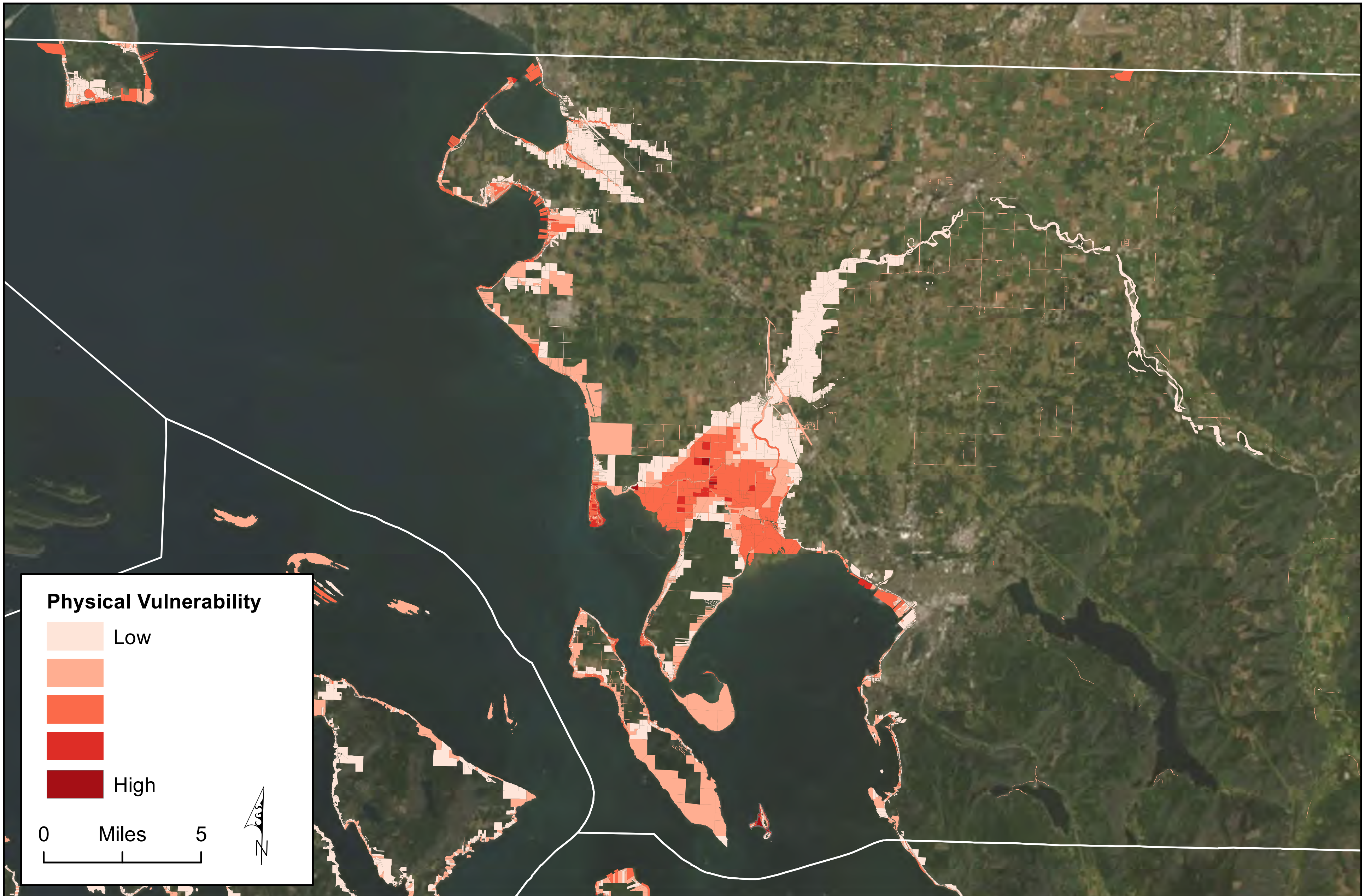

Figure 4. Physical Vulnerability Whatcom County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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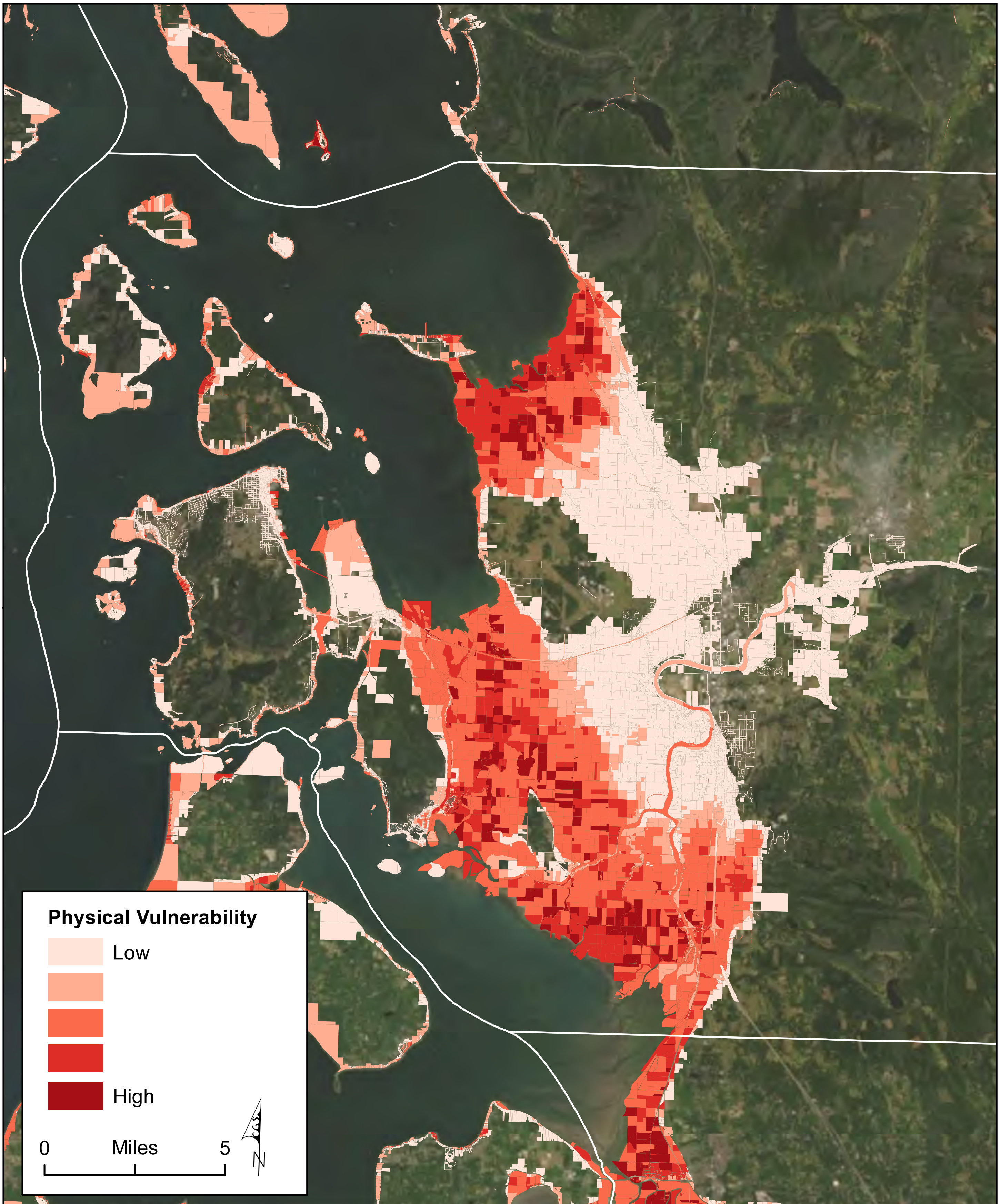

Figure 5. Physical Vulnerability Skagit County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

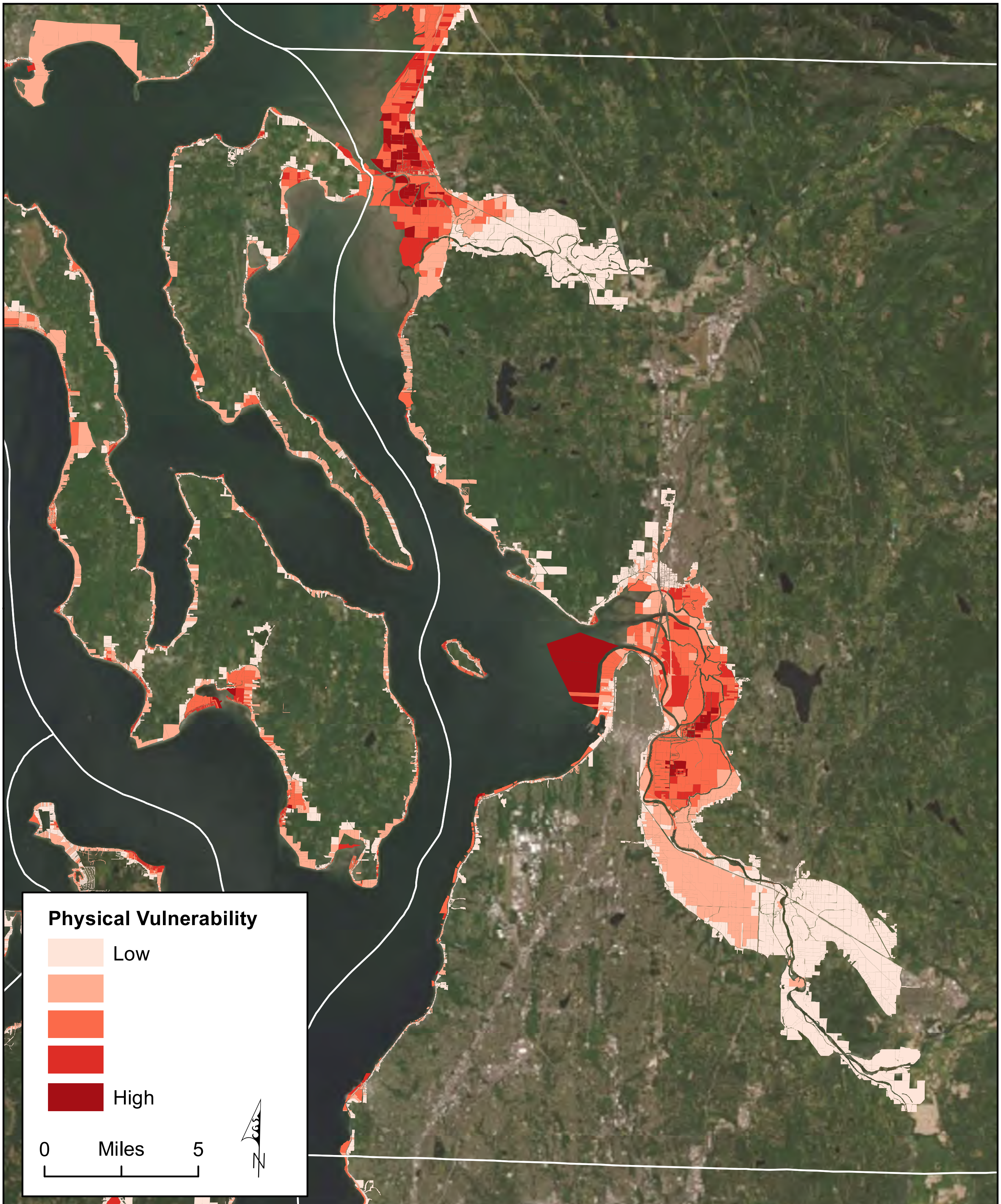

Figure 6. Physical Vulnerability Snohomish County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

COASTAL GEOLOGIC SERVICES

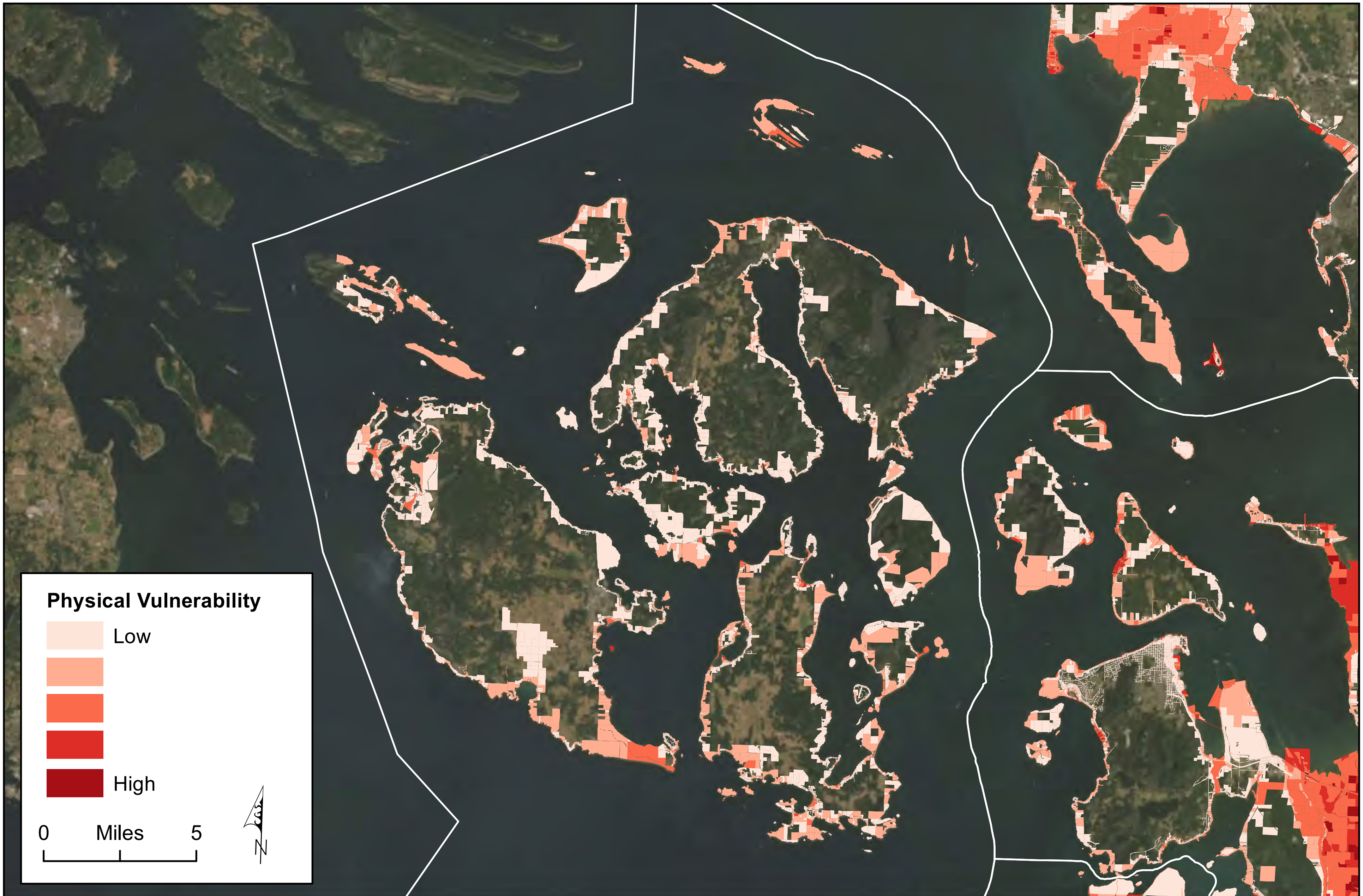

Figure 7. Physical Vulnerability San Juan County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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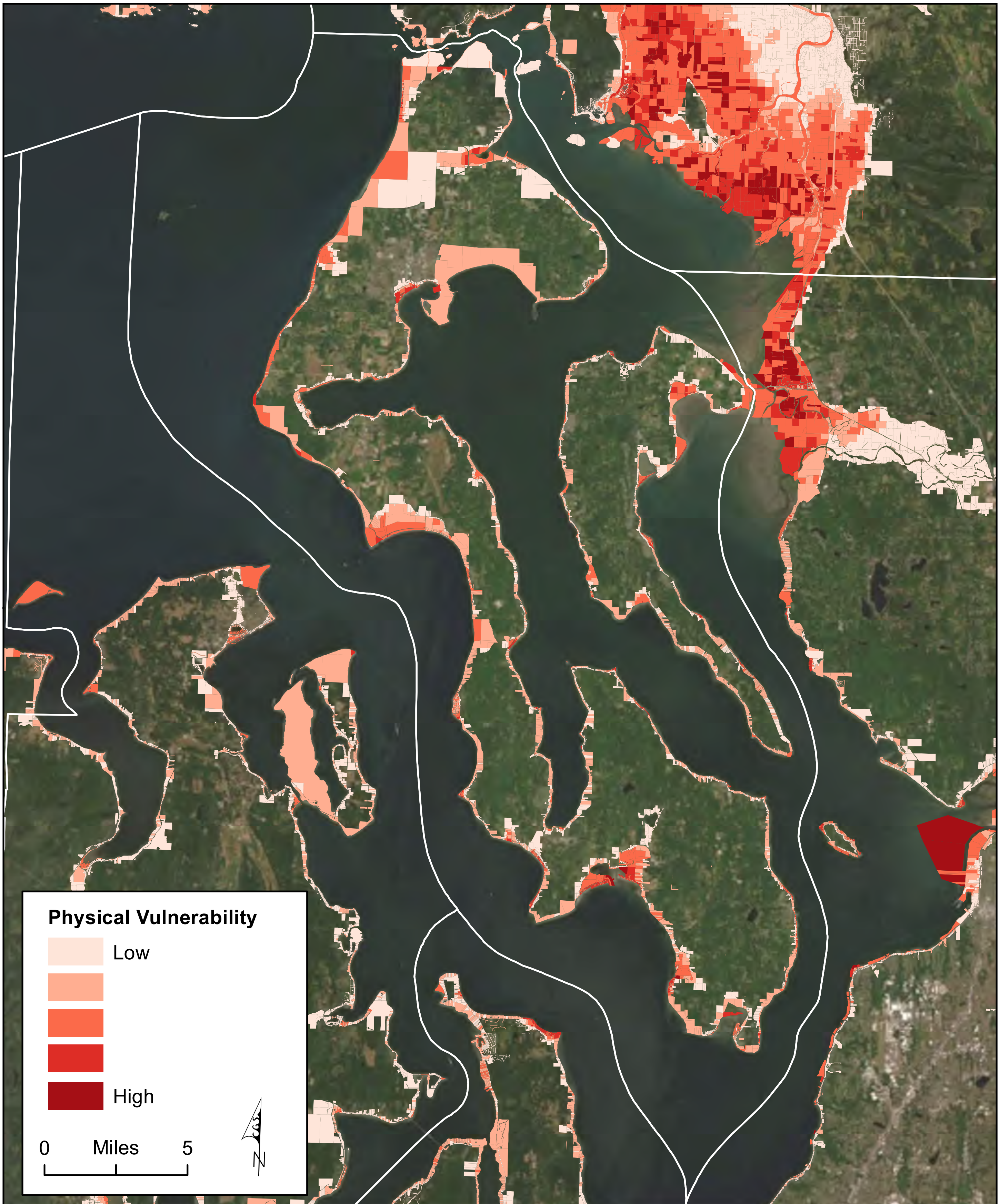

Figure 8. Physical Vulnerability Island County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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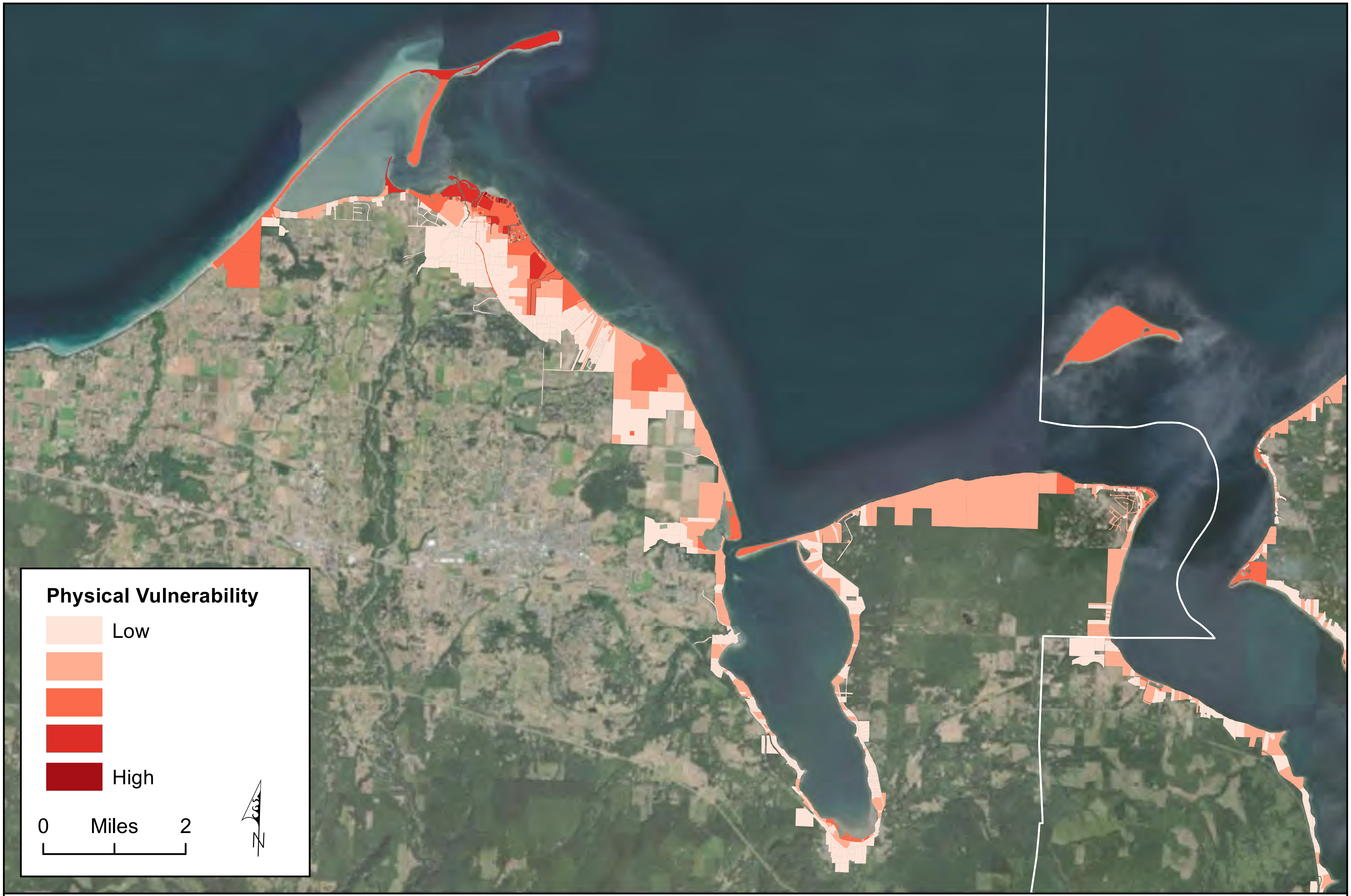

Figure 9. Physical Vulnerability Clallam County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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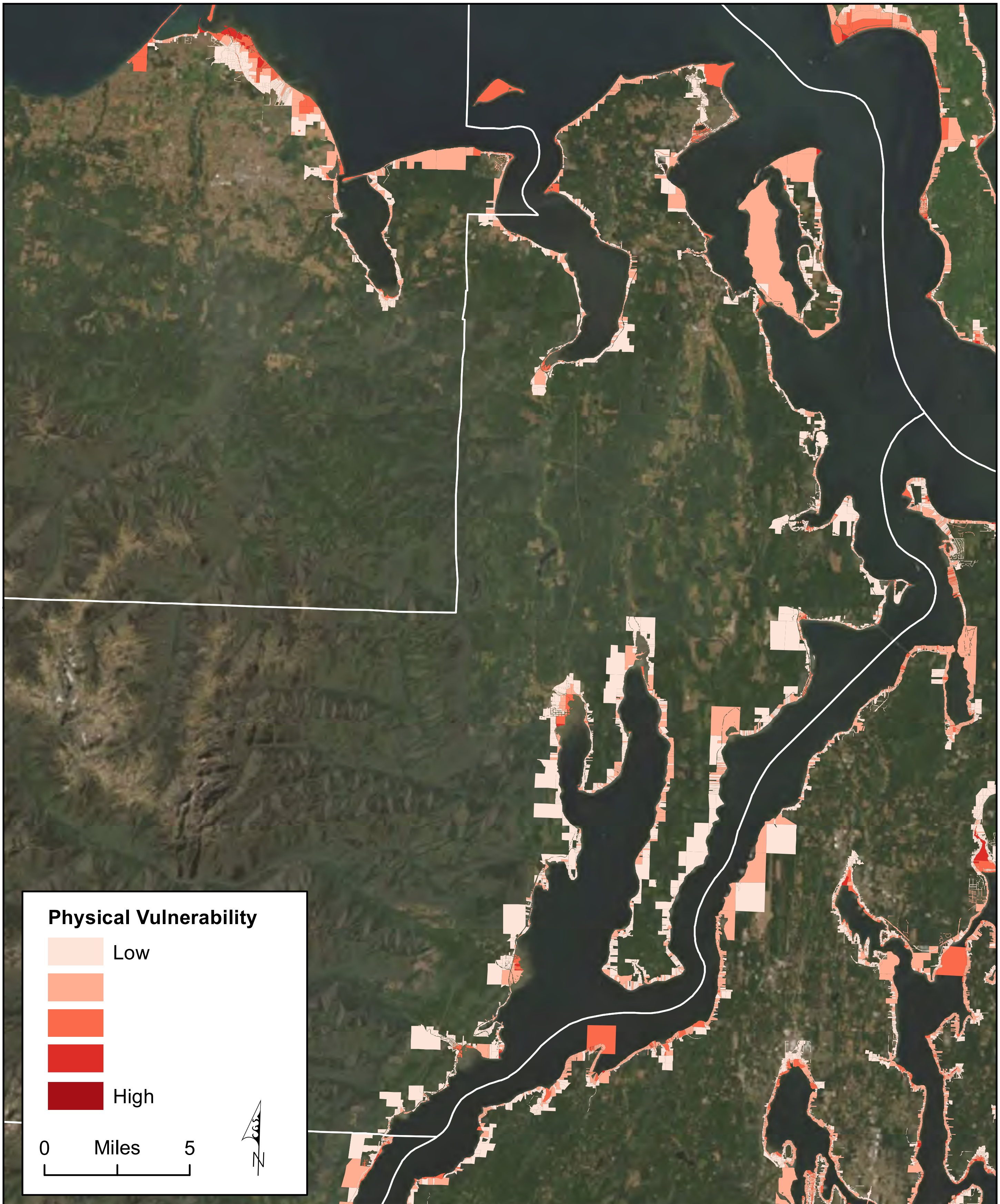

Figure 10. Physical Vulnerability Jefferson County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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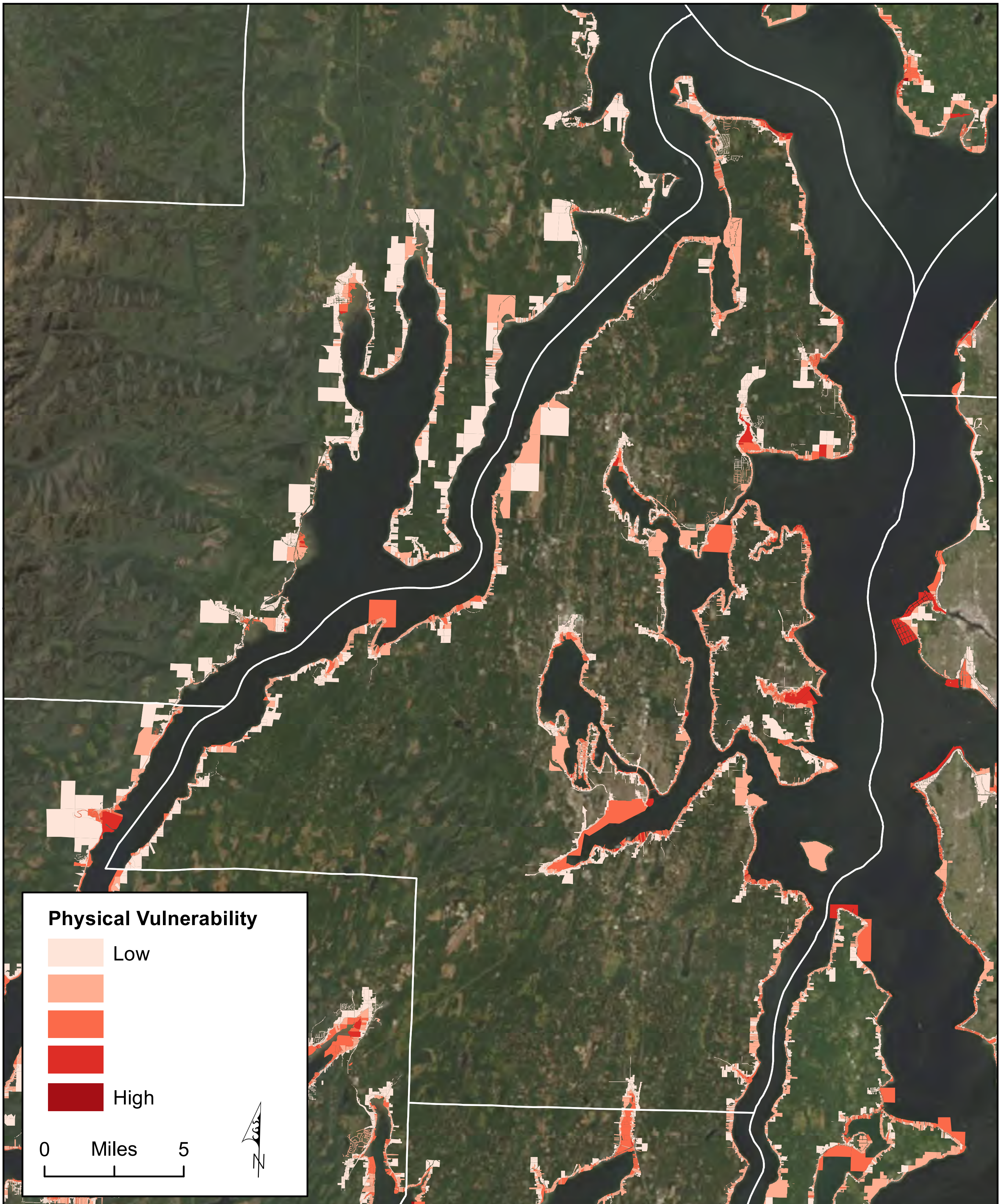

Figure 11. Physical Vulnerability Kitsap County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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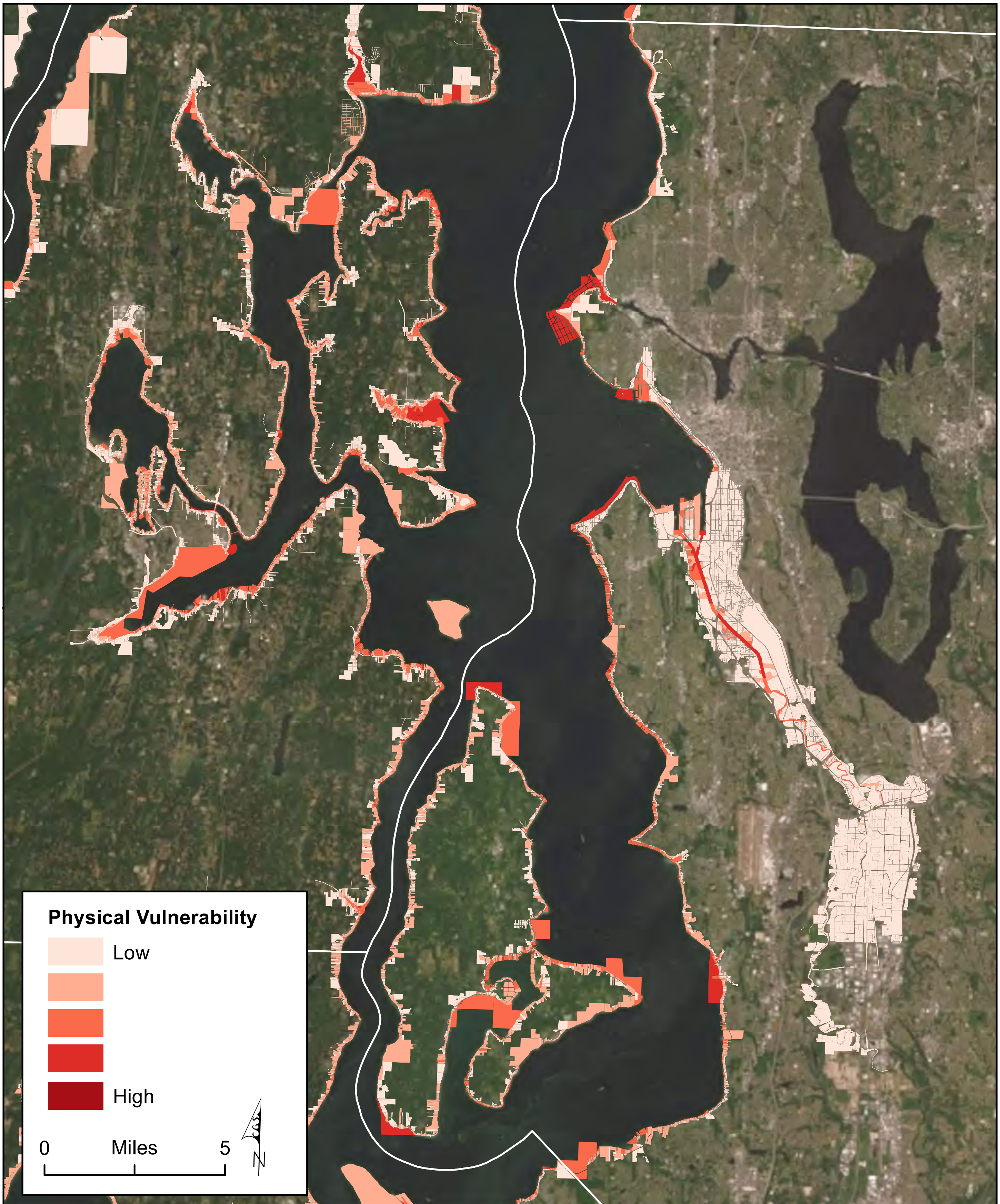

Figure 12. Physical Vulnerability King County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

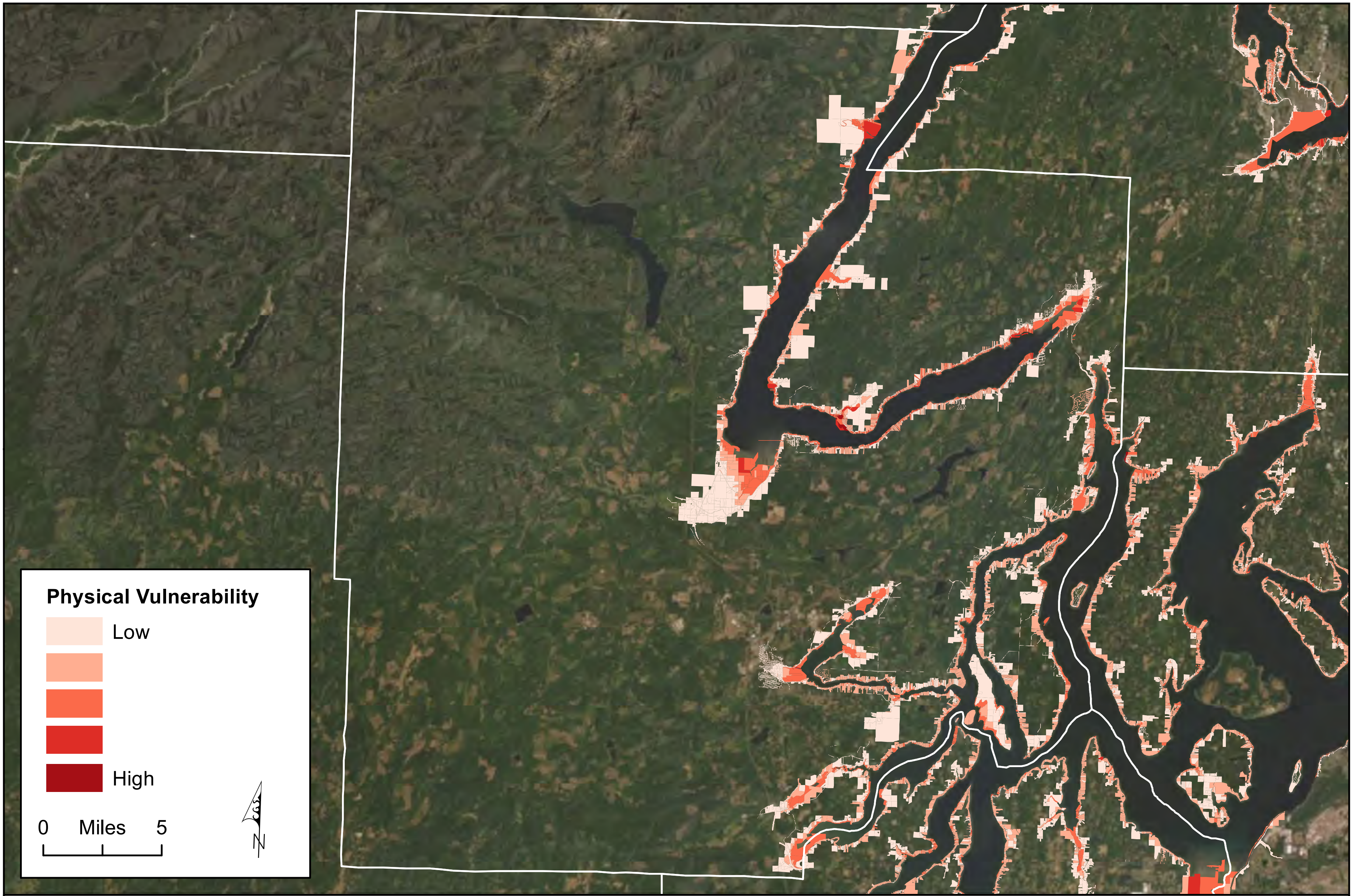

Figure 13. Physical Vulnerability Mason County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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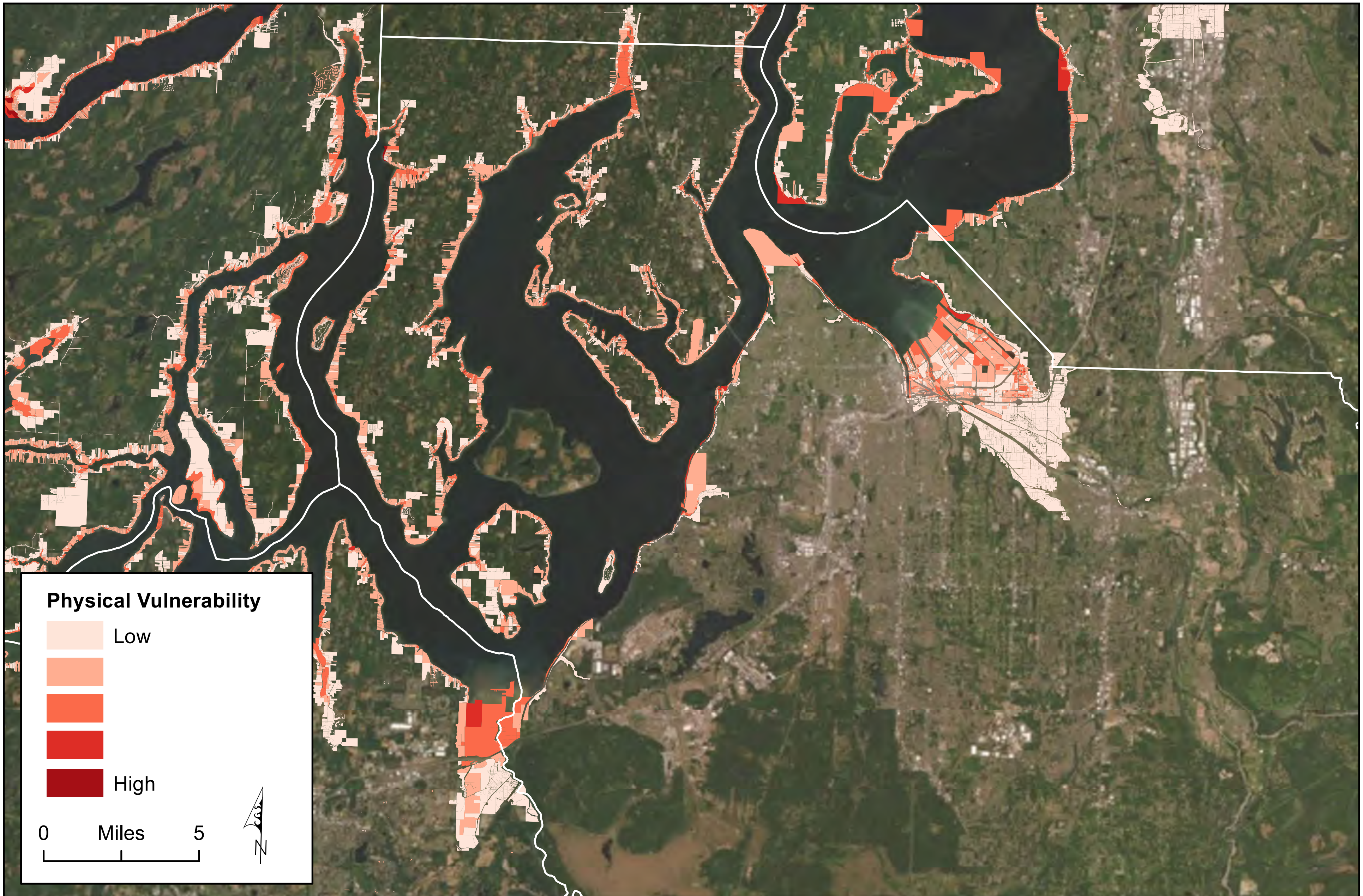

Figure 14. Physical Vulnerability Pierce County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

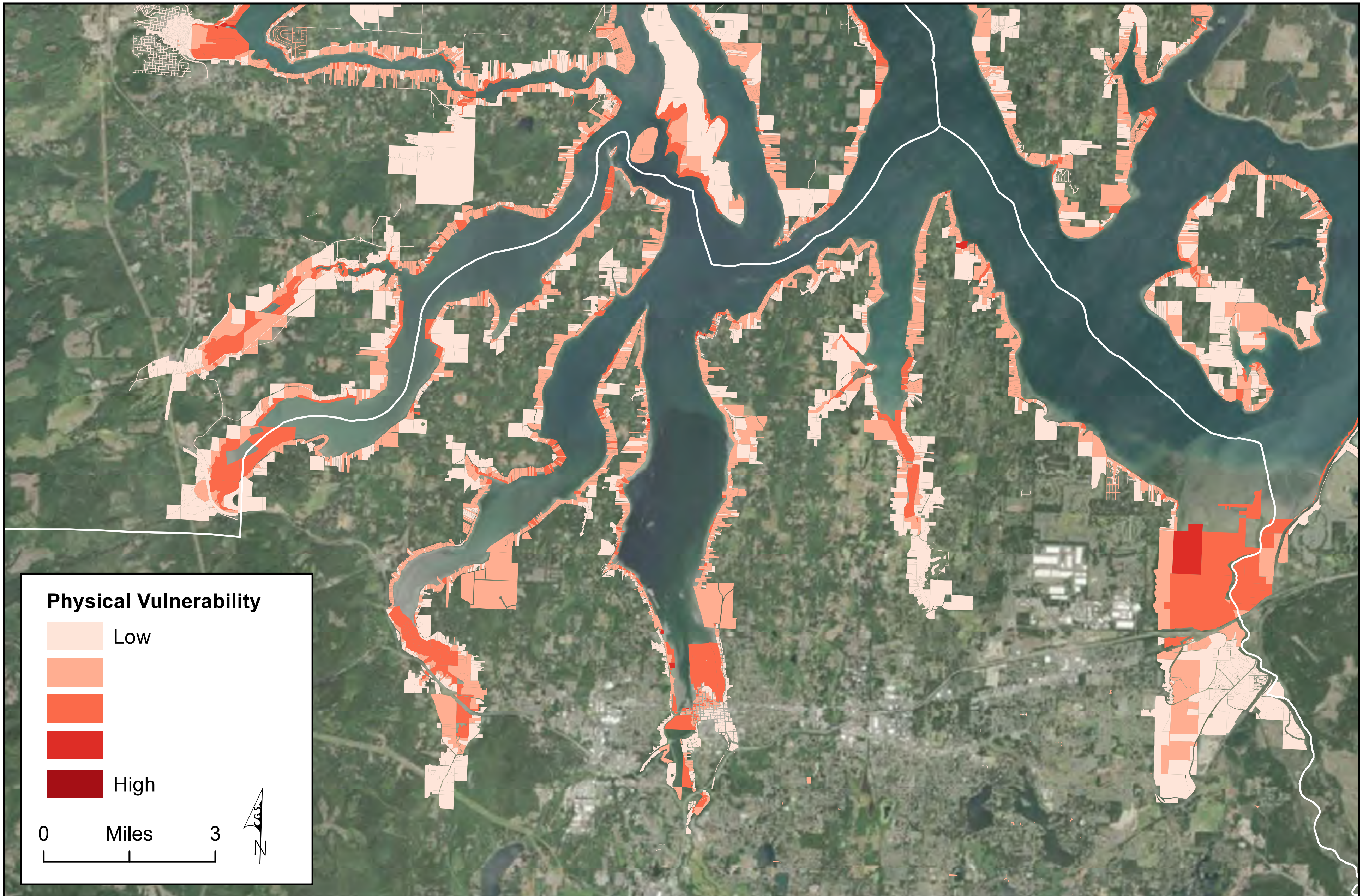

Figure 15. Physical Vulnerability Thurston County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

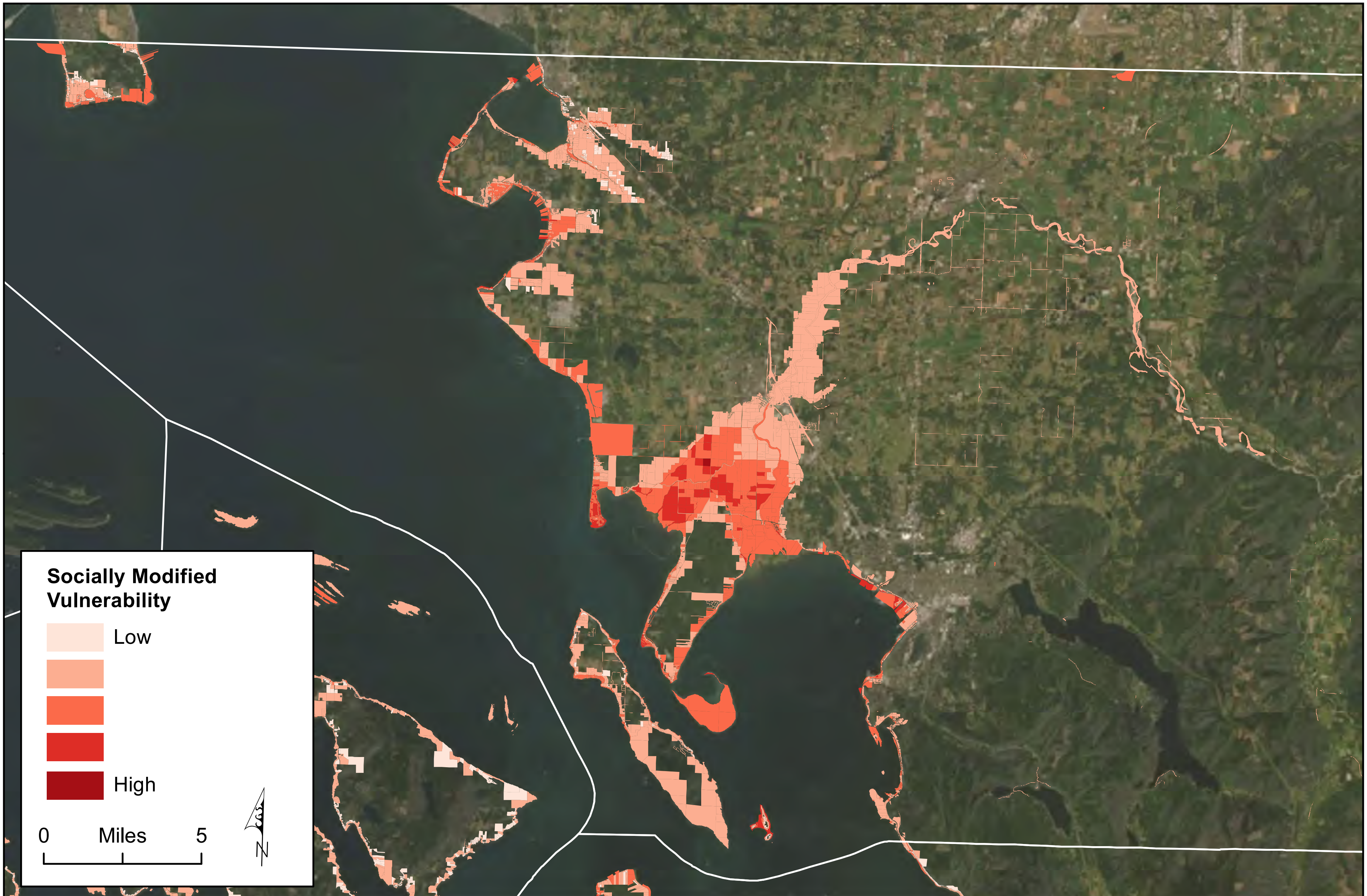

Figure 16. Socially Modified Vulnerability Whatcom County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

COASTAL GEOLOGIC SERVICES

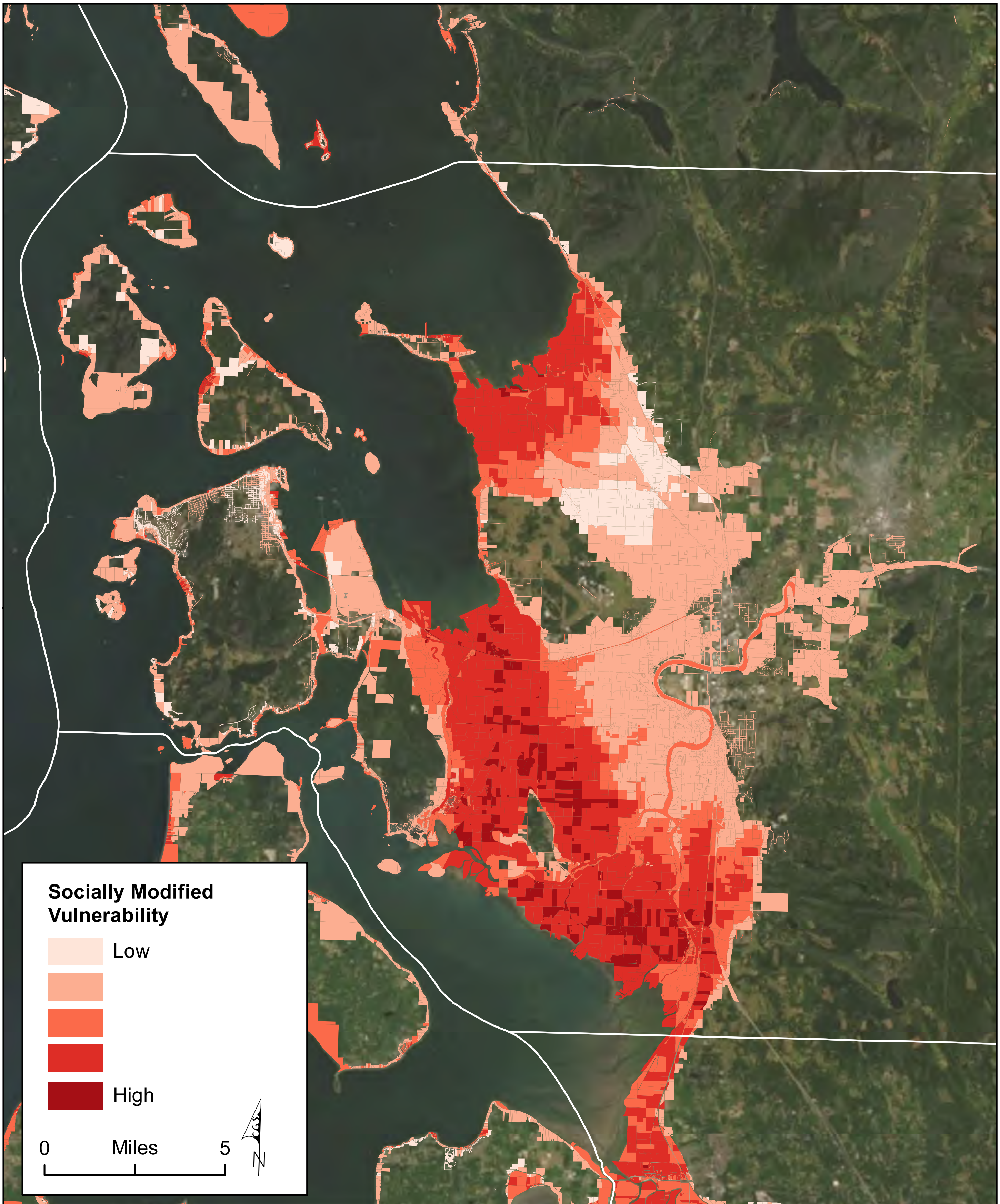

Figure 17. Socially Modified Vulnerability Skagit County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

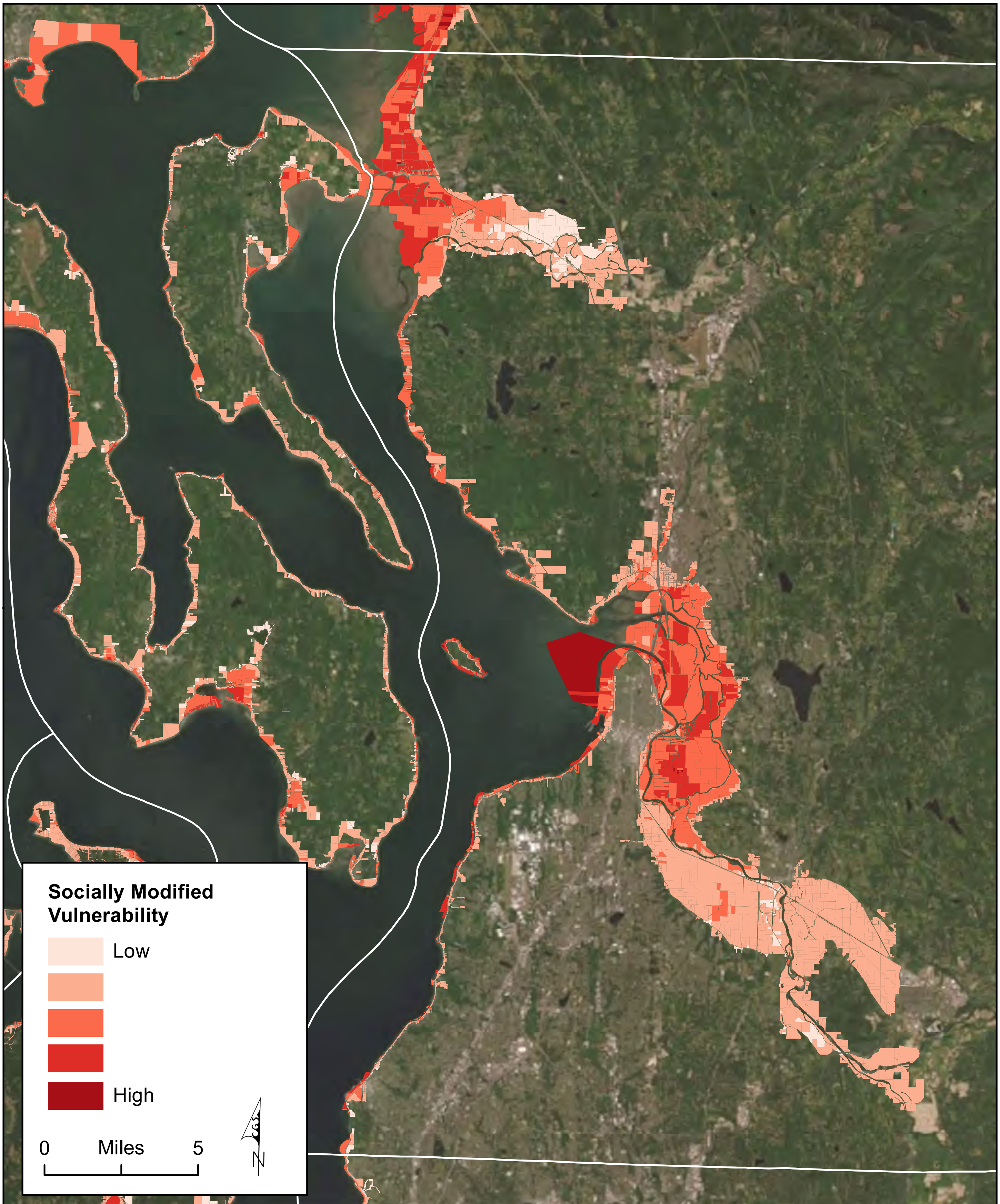

Figure 18. Socially Modified Vulnerability Snohomish County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

COASTAL GEOLOGIC SERVICES

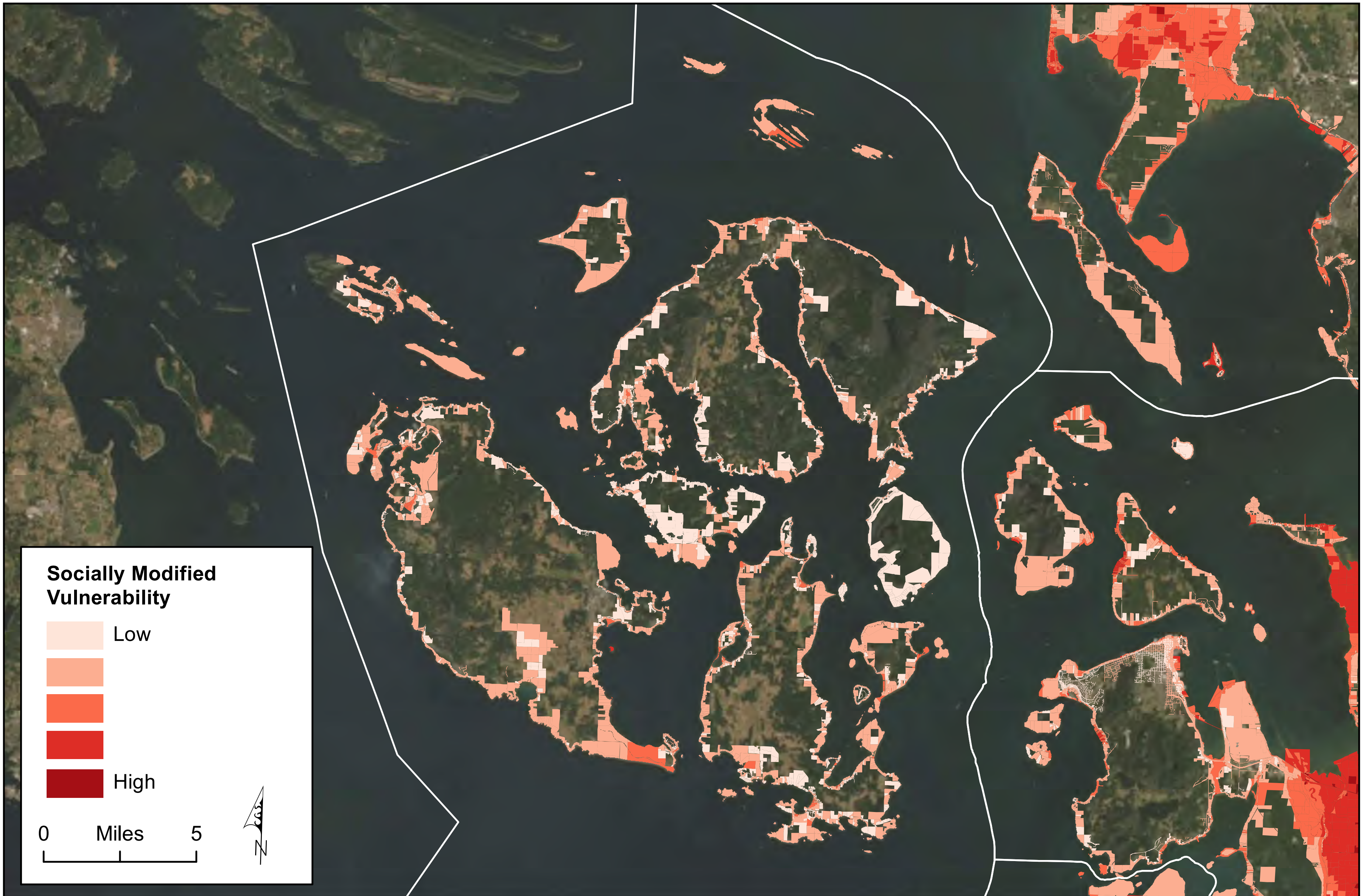

Figure 19. Socially Modified Vulnerability San Juan County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

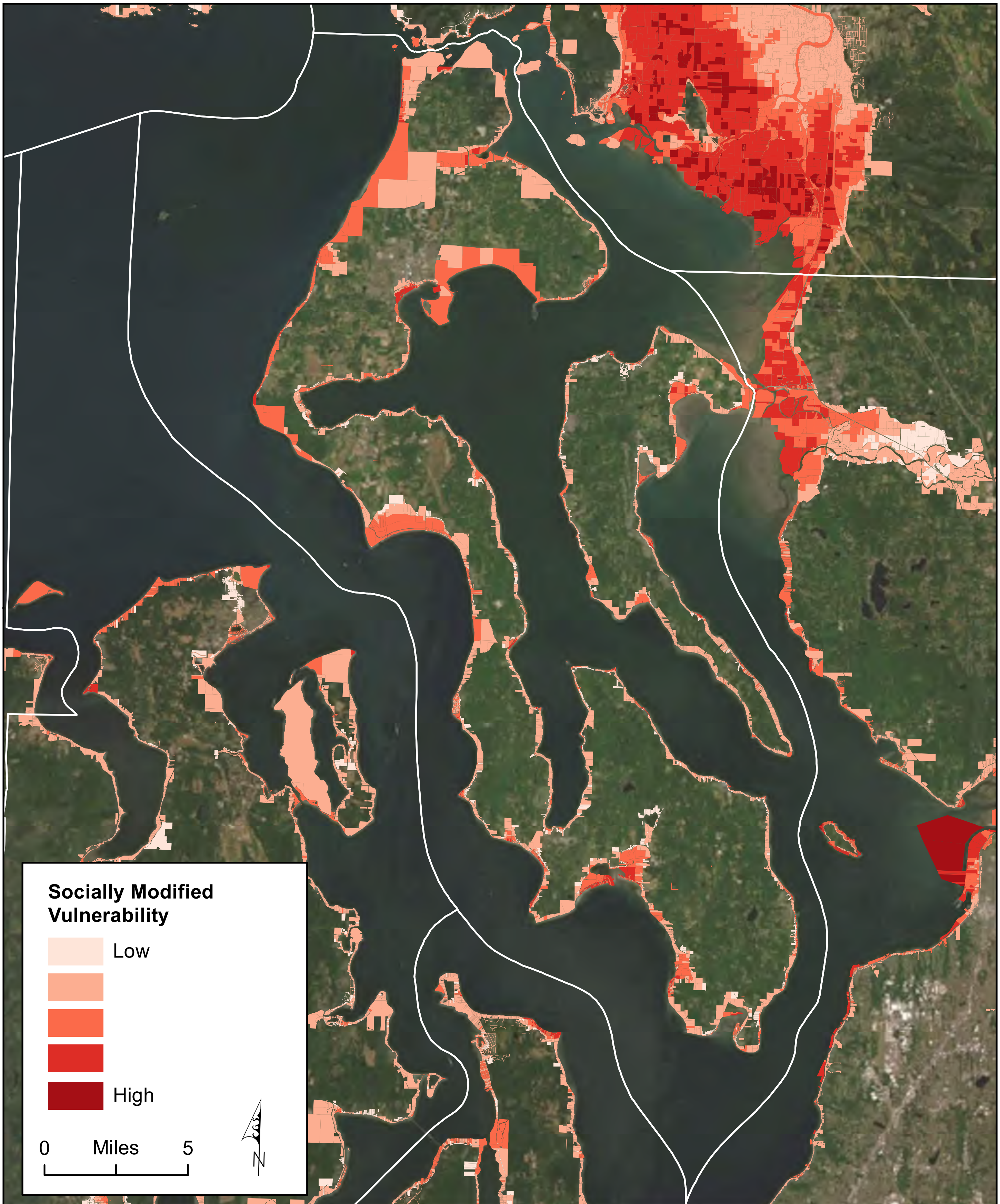

Figure 20. Socially Modified Vulnerability Island County.
Aerial Imagery: ArcGIS Basemap
Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

Figure 21. Socially Modified Vulnerability Clallam County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

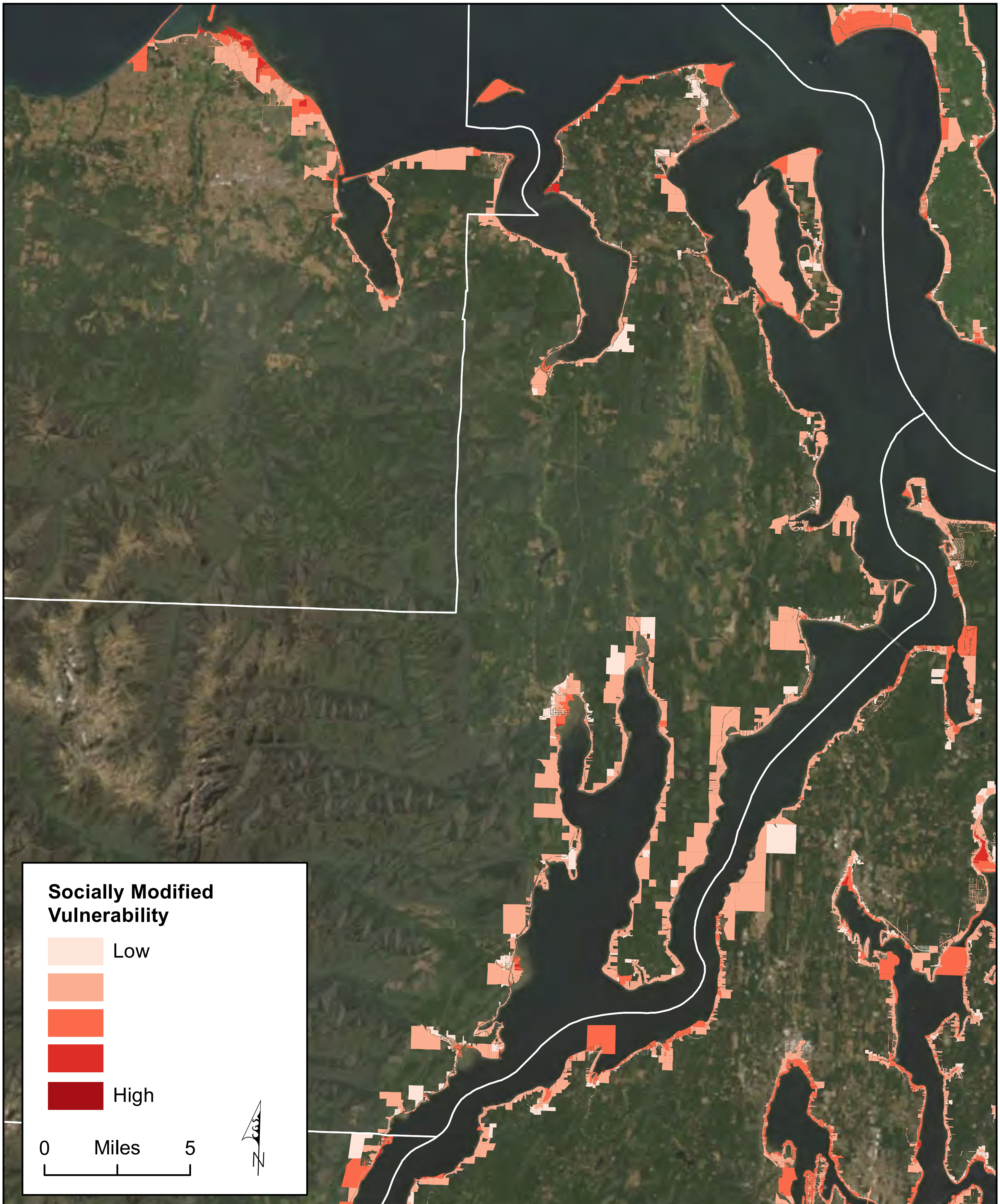

Figure 22. Socially Modified Vulnerability Jefferson County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

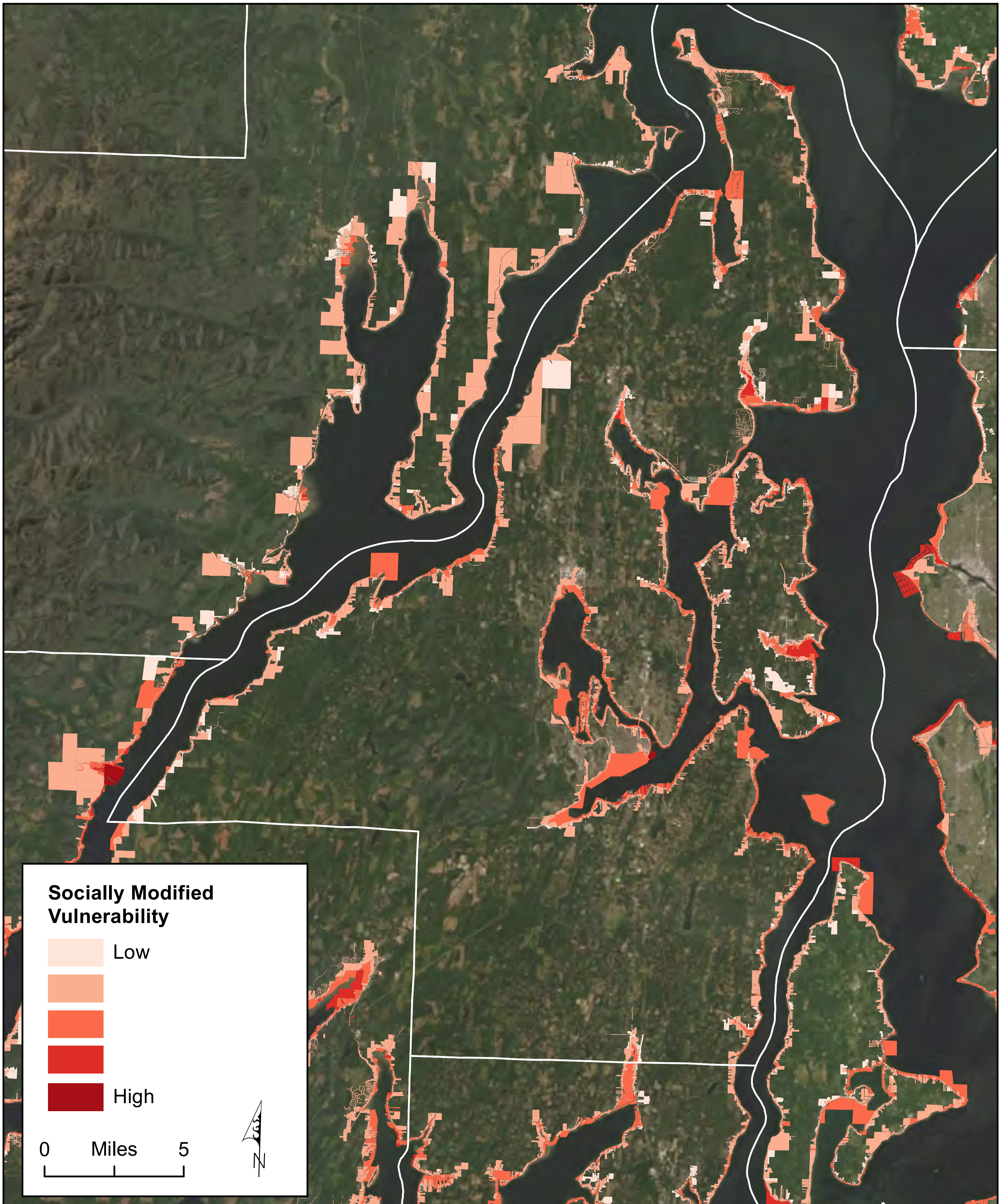

Figure 23. Socially Modified Vulnerability Kitsap County.

Aerial Imagery: ArcGIS Basemap

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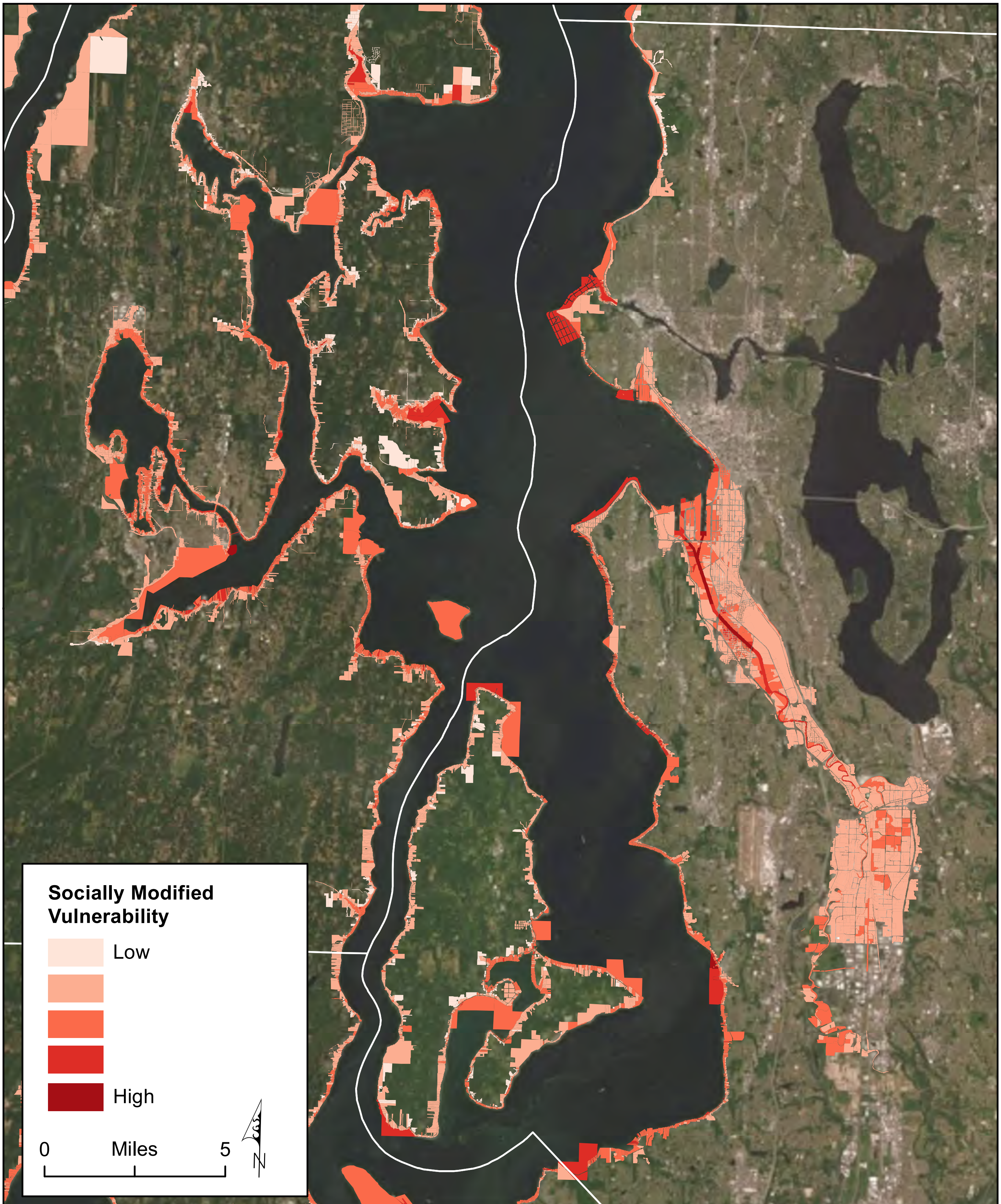

Figure 24. Socially Modified Vulnerability King County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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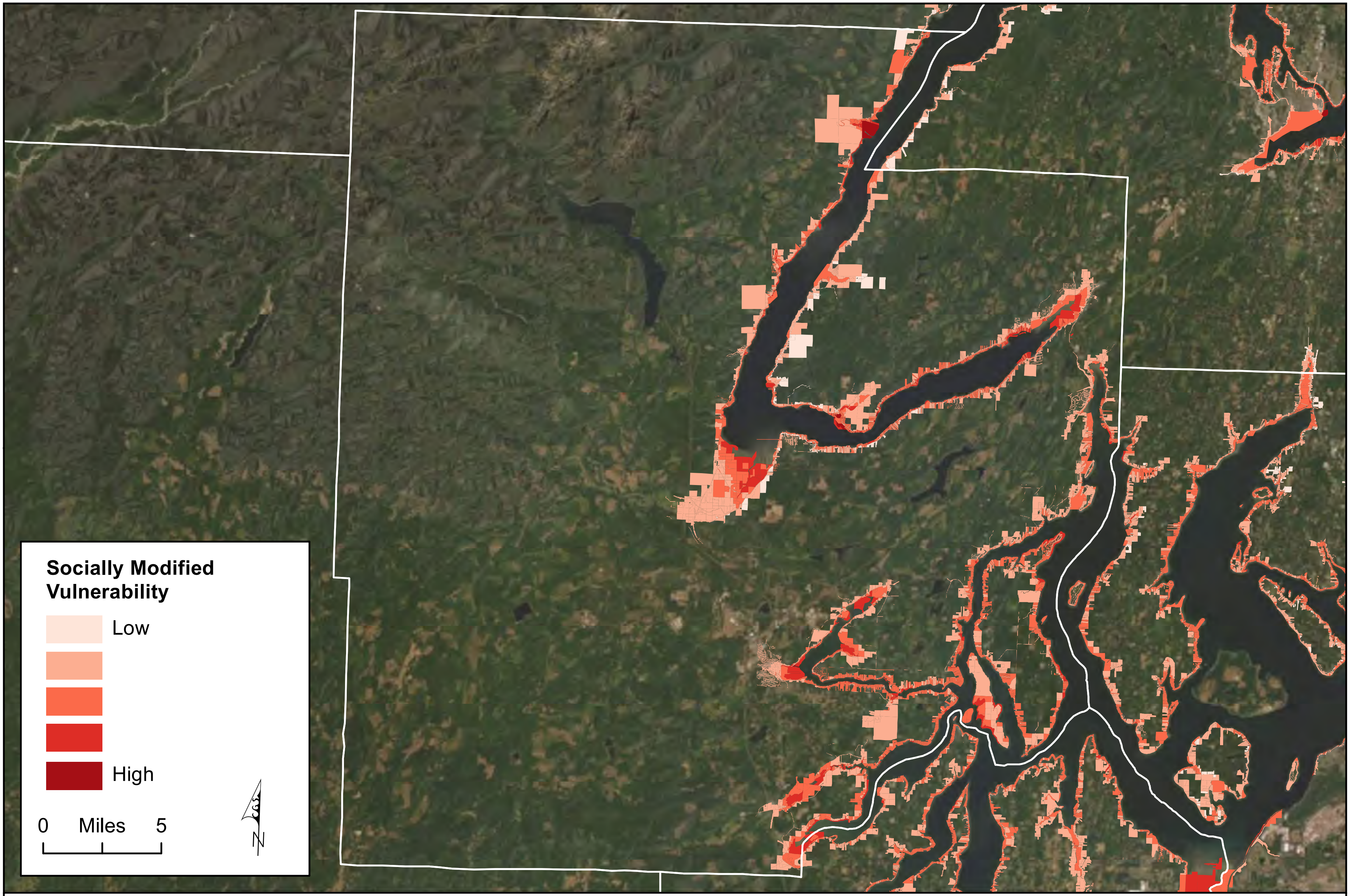

Figure 25. Socially Modified Vulnerability Mason County.

Aerial Imagery: ArcGIS Basemap

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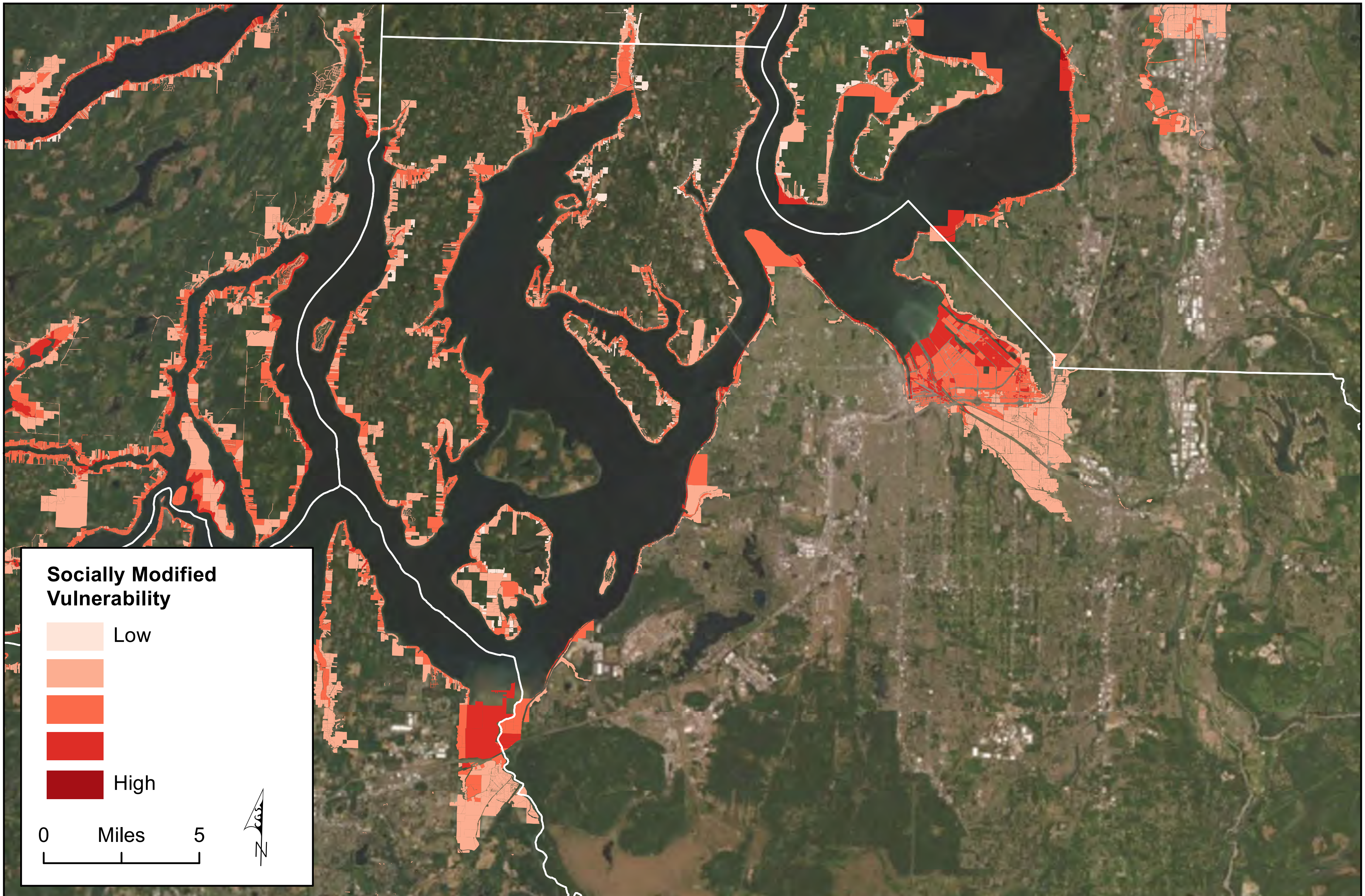

Figure 26. Socially Modified Vulnerability Pierce County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

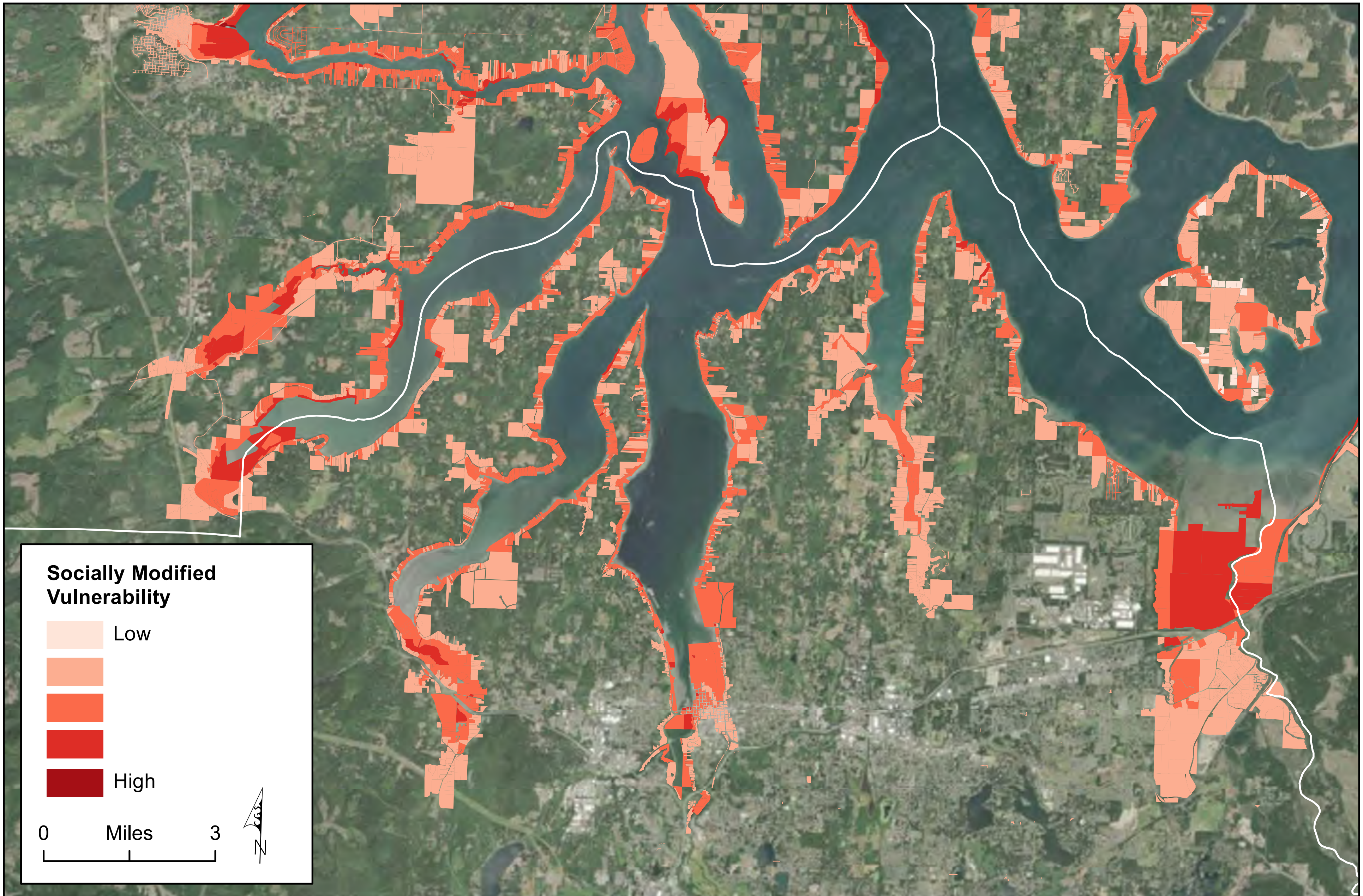

Figure 27. Socially Modified Vulnerability Thurston County.

Aerial Imagery: ArcGIS Basemap

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound

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Appendix B

Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Geodatabase User Guide (February 2022).

A detailed description of geodatabase and possible applications.

Appendix B. Geodatabase User Guide

Overview

The purpose of this document is to serve as a user guide for the Geodatabase created for the *Prioritizing Sea Level Rise Exposure and Habitat Sensitivity Across Puget Sound* project. The overarching focus of the project was to couple recently developed localized sea level rise (SLR) projections for Washington State (Miller et al., 2018) with land elevation data (Tyler et al., 2020) in GIS to assess sea level rise vulnerability of Puget Sound shorelines. The outcome of this project was the development of a quantitative framework to calculate SLR vulnerability and a geodatabase including all input data and scores. This project relied only on existing data and did not include gathering any new field data.

This guidance document includes geospatial information, a table of layers within the geodatabase, and a table of attributes within the project parcel layer. Many of the layers within the geodatabase are interim layers used within specific steps of the analysis. We include these to make our work transparent and for potential use in additional assessments. This document also details how to use this geodatabase in conjunction with the WDFW Estuary and Salmon Restoration Program (ESRP) *Beach Strategies* geodatabase and describes some possible applications of the geodatabase. More information including methods can be found in the Final Technical Report (Coastal Geologic Services et al., 2022).

The contents of the project geodatabase include on ESRI ArcGIS 10.8.1 geodatabase, consisting of a set of 35 features classes and 5 rasters. Also included is one ArcGIS layer files for each score calculated (ending in the .lyr extension with in the layer_files folder), containing specifications for data presentation in the few ArcGIS Explorer (as well as ArcMap and ArcDesktop). Lastly, there is a short README file with basic information such as geographic coordinate system and suggested citation.

Geospatial Information

Study Area

The study area for this project is bounded by the extent of the USGS's 1-m resolution topobathymetric model of Puget Sound (Tyler et al., 2020). The approximate bounds are Port Roberts and Blaine in the north, Olympia in the south, and Dungeness Spit in the west.

Coordinate System and Vertical Datum

The geodatabase produced for this project has the following geospatial properties:

Horizontal Datum	NAD 83 HARN
Vertical Datum	NAVD 88
Projection System	Lambert Conformal Conic
Coordinate System	Washington State Plane Coordinates
Coordinate Zone	South
Coordinate Units	U.S. Survey Feet
Vector Import Format	Shapefile, File Geodatabase
Raster Import Format	TIFF
Metadata	Federal Geographic Data Committee (FDGC) Metadata Content Standards

Input Data

Acceptance Criteria

The acceptance criteria for datasets in this analysis are described in detail in the *Quality Assurance Project Plan* (Miller et al., 2020), and are summarized as follows:

- Publicly available or are intended to be released for public use
- Cover the entire study area
- Obtained from authoritative sources that have undergone a documented quality assessment
- Less than 10-years old, if possible
- Resolution that is appropriate to the scale of the project

We did not have the capacity to build new datasets, collect field data, or compile datasets from counties, cities, municipalities, or similar entities.

Resolution of input datasets were appropriate for the scale of the analysis. Datasets included were presented to the Advisory Group for review during interim technical updates and/or monthly updates. Input datasets are accompanied with their original source metadata (when available) in the geodatabase.

Geodatabase Layers

Table 1 details all existing datasets incorporated into the vulnerability assessment as well as interim data layers we used in analysis which we thought may be valuable to a future user. Here we include the layer name within the geodatabase, the source of the data, and the type of data (raster, polygon, or point). Note that the USGS Topobathymetric model of Puget Sound is not included in this geodatabase as it very large and already hosted on the USGS's Science-based Catalog[1].

The geodatabase contains both raster and vector (points, polygons, polyline) data. To keep these types of data organized, all vector datasets are located with the feature dataset "Vector_Data", which is a folder within the geodatabase. All raster layers are found in the main geodatabase.

Parcel Attributes

Table 2 details the attributes within the project parcel layer "SLRExpSens_Parcels" which contains all scores related to vulnerability as well as other metrics used to calculate the scores. The table is arranged in the same order the attributes are listed within the parcel attribute table, from left to right. The first letters of the attribute relate to the score:

- CF = Coastal Flooding Score
- CEP = Coastal Erosion Potential Score
- EI = Exposure Score
- PI = Parcel Infrastructure Score
- AR = Accessibility Reduction Score
- AL = Agricultural Lands Score
- INF = Infrastructure Sensitivity Score
- HS = Habitat Sensitivity Score
- SI = Sensitivity Score
- VI = Physical Vulnerability Score
- WAV = Social Vulnerability Score (from NCCOS)
- VI_WAV = Socially Modified Vulnerability Score

[1] https://www.sciencebase.gov/catalog/item/5d72b5dfe4b0c4f70cffa775

Table 1. Layers within the geodatabase. Project parcel layer with vulnerability scores bolded.

Layer Name within Geodatabse	Description	Source	Type
HsFT_IDW	1st Percentile Significant Wave Height interpolated from PNNL point data to a raster (200 FT resolution) using IDW interpolation method in ArcGIS.	CGS, PNNL (Yang et al., 2019)	Raster
RCP85_p50_2050HARN_WASPS50xy	Relative Sea Level Rise in inches for 2050, 50% exceedance, RCP 8.5. Reprojected to project coordinate system with cell size of 50 FT.	The Washington Coastal Resilience Project (WCRP) (Miller et al., 2018)	Raster
RCP85_p01_2050HARN_WASPS50xy	Relative Sea Level Rise in inches for 2050, 1% exceedance, RCP 8.5. Reprojected to project coordinate system with cell size of 50 FT.	The Washington Coastal Resilience Project (WCRP) (Miller et al., 2018)	Raster
RCP85_p50_2100HARN_WASPS50xy	Relative Sea Level Rise in inches for 2100, 50% exceedance, RCP 8.5. Reprojected to project coordinate system with cell size of 50 FT.	The Washington Coastal Resilience Project (WCRP) (Miller et al., 2018)	Raster
RCP85_p01_2100HARN_WASPS50xy	Relative Sea Level Rise in inches for 2100, 1% exceedance, RCP 8.5. Reprojected to project coordinate system with cell size of 50 FT.	The Washington Coastal Resilience Project (WCRP) (Miller et al., 2018)	Raster
AR_Parcel_Buffer	Parcel buffer used in the Accessibility Reduction score. Buffer size (DistBuff) depends on if the parcel is categorized as urban (Urban = 1) or rural (Urban = 0).	CGS	Polygon
BeachStrat_Parcels	Beach Strategies parcel layer, which includes shoretypes for parcels and armor length.	Beach Strategies (Coastal Geologic Services, 2017)	Polygon

Connected_Inundation_MHHW_plus20year_GTpt5	Connected inundation extent for the MHHW plus 20-year storm scenario, depths >0.5 FT	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus12050_GTpt5	Connected inundation extent for the MHHW plus 20-year storm plus 2050 1% exceedance SLR scenario, depths >0.5 FT	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus12050_SLR	Connected inundation extent for the MHHW plus 20-year storm plus 2050 1% exceedance SLR scenario	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus12100_GTpt5	Connected inundation extent for the MHHW plus 20-year storm plus 2100 1% exceedance SLR scenario, depths >0.5 FT	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus12100_SLR	Connected inundation extent for the MHHW plus 20-year storm plus 2100 1% exceedance SLR scenario	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus502050_GTpt5	Connected inundation extent for the MHHW plus 20-year storm plus 2050 50% exceedance SLR scenario, depths >0.5 FT	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus502050_SLR	Connected inundation extent for the MHHW plus 20-year storm plus 2050 50% exceedance SLR scenario	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus502100_GTpt5	Connected inundation extent for the MHHW plus 20-year storm plus 2100 50% exceedance SLR scenario, depths >0.5 FT	CGS	Polygon
Connected_Inundation_MHHW_plus20year_plus502100_SLR	Connected inundation extent for the MHHW plus 20-year storm plus 2100 50% exceedance SLR scenario	CGS	Polygon
Connected_Inundation_MHHW_plus20year_SLR	Connected inundation extent for the MHHW plus 20-year storm scenario	CGS	Polygon
CritInf_Buildings	Building footprints with critical infrastructure facility information joined from HAZUS and WA Geospatial data	CGS	Polygon
gis_osm_roads_free_1	OpenStreetMaps roads data for Washington State	OpenStreetMaps	Polyline
MarshMigration_502050	Modeled habitat areas for 2050 50% exceedance scenario	CGS, NOAA Office for Coastal Management	Polygon
MarshMigration_502100	Modeled habitat areas for 2100 50% exceedance scenario	CGS, NOAA Office for Coastal Management	Polygon

MarshMigration_CurrentConditions	Modeled habitat areas for current conditions or 0 FT sea level rise	CGS, NOAA Office for Coastal Management	Polygon
MarshMigration_12050	Modeled habitat areas for 2050 1% exceedance scenario	CGS, NOAA Office for Coastal Management	Polygon
MarshMigration_12100	Modeled habitat areas for 2100 1% exceedance scenario	CGS, NOAA Office for Coastal Management	Polygon
RCP_85_p01_2050_poly	Relative Sea Level Rise in feet (attribute SLR_FT) for 2050, 1% exceedance, RCP 8.5. Derived from WCRP layer *RCP85_p01_2050*, with spatial gaps filled in by CGS.	CGS, WCRP	Polygon
RCP_85_p01_2100_poly	Relative Sea Level Rise in feet (attribute SLR_FT) for 2100, 1% exceedance, RCP 8.5. Derived from WCRP layer *RCP85_p01_2100*, with spatial gaps filled in by CGS.	CGS, WCRP	Polygon
RCP_85_p50_2050_poly	Relative Sea Level Rise in feet (attribute SLR_FT) for 2050, 50% exceedance, RCP 8.5. Derived from WCRP layer *RCP85_p50_2050*, with spatial gaps filled in by CGS.	CGS, WCRP	Polygon
RCP_85_p50_2100_poly	Relative Sea Level Rise in feet (attribute SLR_FT) for 2050, 1% exceedance, RCP 8.5. Derived from WCRP layer *RCP85_p50_2100*, with spatial gaps filled in by CGS.	CGS, WCRP	Polygon
RdParcelBuffer_Inundation_plus12050GTpt5	Road sections inundated by >0.5 FT for 2050 1% exceedance scenario	CGS, OpenStreetMaps	Polyline
RdParcelBuffer_Inundation_plus12100GTpt5	Road sections inundated by >0.5 FT for 2100 1% exceedance scenario	CGS, OpenStreetMaps	Polyline
RdParcelBuffer_Inundation_plus20yearGTpt5	Road sections inundated by >0.5 FT for MHHW plus 20-year scenario	CGS, OpenStreetMaps	Polyline
RdParcelBuffer_Inundation_plus502050GTpt5	Road sections inundated by >0.5 FT for 2050 50% exceedance scenario	CGS, OpenStreetMaps	Polyline
RdParcelBuffer_Inundation_plus502100GTpt5	Road sections inundated by >0.5 FT for 2100 50% exceedance scenario	CGS, OpenStreetMaps	Polyline

RoadsInParcelBuffer	All road sections within the parcel buffer (layer AR_Parcel_Buffer)	CGS, OpenStreetMaps	Polyline
SLRExpSens_Parcels	Project parcel layer which contains all scores and interim values for score calculations. See the *Parcel Attributes* sections for more details.	CGS, Rogers and Cooke, 2012	Polygon
Urban_Census2010	Urban areas	US Census, 2010	Polygon
Washington_Buildings	Building footprints within Washington State.	Microsoft, 2018	Polygon
Washington_Buildings_200SFplus	Building footprints used for Parcel Infrastructure score. This layer modified from the original Microsoft data by splitting the polygons along the parcel boundaries and eliminating any buildings <200 SF.	CGS, Microsoft, 2018	Polygon
WAV_ZCTAs_Social_vul	Social vulnerability scores for zip code tabulated areas within Puget Sound watershed.	NCCOS (Fleming and Regan, 2022)	Polygon
WSDACrop_2020	Agricultural areas with crop type (CropGroup).	WSDA, 2020	Polygon

Table 2. Attributes for project parcel layer "SLRExpSens_Parcels". Main scores bolded.

Attribute	Description
PolyID	Parcel ID number. This is the same parcel identifier as used in Beach Strategies and thus can be used to join this layer to the Beach Strategies parcel layer.
CF_Parcel_Area	Total area of parcel in square feet (SF).
CF_IndArea_CC	Area (SF) of parcel inundated under current conditions (MHHW plus 20-year extreme still water level).
CF_IndArea_502050	Area (SF) of parcel inundated from MHHW plus 20-year extreme still water level plus 2050 50% exceedance SLR scenario.
CF_IndArea_12050	Area (SF) of parcel inundated from MHHW plus 20-year extreme still water level plus 2050 1% exceedance SLR scenario.
CF_IndArea_502100	Area (SF) of parcel inundated from MHHW plus 20-year extreme still water level plus 2100 50% exceedance SLR scenario.
CF_IndArea_12100	Area (SF) of parcel inundated from MHHW plus 20-year extreme still water level plus 2100 1% exceedance SLR scenario.
CF_Score_Raw	Raw Coastal Flooding Exposure Score or the SUM(% parcel inundated for 5 scenarios).
CF_Score_Norm	Normalized **Coastal Flooding Exposure Score**. Score normalized from 0-5 using a min-max normalization equation.
CEP_ShoreType_Value	Shoretype value used in the Coastal Erosion Potential score. See Table 5 in the Final Technical Report for more information.
CEP_Hs_FT	Wave height in feet used for Coastal Erosion Potential score. Wave height derived from PNNL data.
CEP_Score_Raw	Raw Coastal Erosion Potential Score or the Shoretype value x Wave height value in feet.
CEP_Score_Norm	Normalized **Coastal Erosion Potential Score**. Score normalized from 0-5 using a min-max normalization equation.
EI_Score_Raw	Raw Exposure Score or Coastal Flooding Score + Coastal Erosion Potential Score.
EI_Score_Norm	Normalized **Exposure Score**. Score normalized from 0-10 using a min-max normalization equation.
PI_BuildSF	Total area (SF) of buildings within parcel.
PI_BuildSF_502050	Area (SF) of building inundated by >0.5 FT within parcel from MHHW plus 20-year extreme still water level plus 2050 50% exceedance scenario.
PI_BuildSF_12050	Area (SF) of building inundated by >0.5 FT within parcel from MHHW plus 20-year extreme still water level plus 2050 1% exceedance scenario.
PI_BuildSF_502100	Area (SF) of building inundated by >0.5 FT within parcel from MHHW plus 20-year extreme still water level plus 2100 50% exceedance scenario.

PI_BuildSF_12100	Area (SF) of building inundated by >0.5 FT within parcel from MHHW plus 20-year extreme still water level plus 2100 1% exceedance scenario.
PI_CritInf	Critical infrastructure classification. If parcel contains critical infrastructure = 1, if not = 0.
PI_Score_Raw	Raw Parcel Infrastructure score or the sum(%buildings area inundated for 5 scenarios).
PI_Score_Bonus	Normalized Parcel Infrastructure score with critical infrastructure bonus applied for parcel that include critical in structure. Normalized score x 1.1. Score normalized from 0-3 using a min-max normalization equation.
PI_Score_Norm	Normalized **Parcel Infrastructure Score**, i.e., normalized PI_Score_Bonus. Score normalized from 0-3 using a min-max normalization equation.
AR_Urban	Urban classification. Urban = 1, rural = 0.
AR_RoadInd	Total road length (FT) within parcel buffer (AR_Parcel_Buffer).
AR_RoadInd_CC	Road length (FT) within parcel buffer inundated by >0.5 FT under current conditions or MHHW plus 20-year extreme still water level.
AR_RoadInd_502050	Road length (FT) within parcel buffer inundated by >0.5 FT under MHHW plus 20-year extreme still water level plus 2050 50% exceedance scenario.
AR_RoadInd_12050	Road length (FT) within parcel buffer inundated by >0.5 FT under MHHW plus 20-year extreme still water level plus 2050 1% exceedance scenario.
AR_RoadInd_502100	Road length (FT) within parcel buffer inundated by >0.5 FT under MHHW plus 20-year extreme still water level plus 2100 50% exceedance scenario.
AR_RoadInd_12100	Road length (FT) within parcel buffer inundated by >0.5 FT under MHHW plus 20-year extreme still water level plus 2100 1% exceedance scenario.
AR_Score_Raw	Raw Accessibility Reduction score or sum(% roads inundated for 5 scenarios).
AR_Score_Norm	Normalized **Accessibility Reduction Score**. Score normalized from 0-1 using a min-max normalization equation.
AgLand	Agricultural land classification. Agricultural =1, nonagricultural = 0.
AL_Score_Raw	Raw Agricultural Lands score or sum(% parcel inundated for 5 scenarios). Inundation areas used in calculation are the same as the Coastal Flood Exposure score inputs.
AL_Score_Norm	Normalized **Agricultural Lands Score**. Score normalized from 0-1 using a min-max normalization equation.
INF_Score_Raw	Raw Infrastructure Sensitivity score or the sum of the normalized scores for Parcel Infrastructure, Accessibility Reduction, and Agricultural Lands indices.
INF_Score_Norm	Normalized **Infrastructure Sensitivity Score**. Score normalized from 0-5 using a min-max normalization equation.
HS_Armored	Armored classification. Armored = 1, unarmored = 0.
HS_Developed	Developed (contains building) classification. Developed = 1, undeveloped =0.

HS_Bluff	Bluff shoretype classification. Bluff shoretype = 1, nonbluff shoretype = 0.
HS_HabArea_CC	Habitat area (SF) within parcel during current conditions. See *MarshMigration_CurrentCondition* layer within geodatabase for spatial extent.
HS_HabArea_502050	Habitat area (SF) within parcel during MHHW plus 20-year extreme still water level plus 2050 50% exceedance scenario. See *MarshMigration_502050* layer within geodatabase for spatial extent.
HS_HabArea_12050	Habitat area (SF) within parcel during MHHW plus 20-year extreme still water level plus 2050 1% exceedance scenario. See *MarshMigration_12050* layer within geodatabase for spatial extent.
HS_HabArea_502100	Habitat area (SF) within parcel during MHHW plus 20-year extreme still water level plus 2100 50% exceedance scenario. See *MarshMigration_502100* layer within geodatabase for spatial extent.
HS_HabArea_12100	Habitat area (SF) within parcel during MHHW plus 20-year extreme still water level plus 2100 1% exceedance scenario. See *MarshMigration_12100* layer within geodatabase for spatial extent.
HS_Score_Raw	Raw Habitat Sensitivity score or sum(% change in area from current conditions).
HS_Score_Norm	Normalized Habitat Sensitivity score (HS_Score_Raw). Score normalized from 0-5 using a min-max normalization equation.
HS_Score_Rev	Reversed scaled normalized Habitat Sensitivity score (Hs_Score_Norm). This step was completed so that high scores related to high sensitivity and low scores to low sensitivity.
HS_Score_Raw_Bonus	Habitat Sensitivity score (HS_Score_Rev) with bonus score applied. See Table 10 in the Final Technical report for details on bonus scoring.
HS_Score_RevNorm	Normalized **Habitat Sensitivity Score** with bonus applied (HS_Score_Raw_Bonus). Score normalized from 0-5 using a min-max normalization equation.
SI_Score_Raw	Raw Sensitivity score or the sum of Infrastructure Sensitivity (INF_Score_Norm) and Habitat Sensitivity (Hs_Score_RevNorm) scores.
SI_Score_Norm	Normalized **Sensitivity Score**. Score normalized from 0-10 using a min-max normalization equation.
VI_Score_Raw	Raw Physical Vulnerability score or the sum of Exposure (EI_Score_Norm) and Sensitivity (SI_Score_Norm) scores.
VI_Score_Norm	Normalized **Physical Vulnerability Score**. Score normalized from 0-20 using a min-max normalization equation.
WAV_Score	**Social Vulnerability Score** from NCCOS project (Fleming and Regan, 2022) normalized from 0-10 using a min-max normalization equation.
VI_WAV_Score	**Socially Modified Vulnerability Score** or the sum of Exposure (EI_Score_Norm), Sensitivity (SI_Score_Norm), and Social Vulnerability (WAV_Score) scores.
County	Parcel county.

Compatibility with Beach Strategies

The *Prioritizing Sea Level Rise and Habitat Sensitivity Across Puget Sound Geodatabase* is designed to be compatible with the WDFW Estuary and Salmon Restoration Program *Beach Strategies Geodatabase* (Coastal Geologic Services, 2017)*,* which was defined as a requirement in the project scope. The original parcel identifier (PolyID) from the Washington Statewide Parcel Database was retained in both the *Beach Strategies* parcel layer as well as this projects parcel layer. This enables the user to have the ability to join the attributes within the *Beach Strategies* database in ArcGIS using the "Join" feature. Additionally, both geodatabases have the same spatial projection making them easily overlayed and compared.

Data Applications

The scores and data layers within the geodatabase can be used as a standalone dataset with the scores applied as-is, however we have identified a few basic additional analyses that can be applied using the parcel scores within the geodatabase, described below:

- **Finding the relative scores for a particular group of parcels**– If a user is interested in a certain group of parcels (e.g., county, city, neighborhood), the scores in the geodatabase can be renormalized so that the scores are relative to just the desired parcels. Below details on one possible way to accomplish this:
    1. Select the parcels of interest and export to a new shape layer. If it is a specific county of interest, use the *Select By Attributes* tool to select using the "County" attribute field within the parcel layer (e.g., County = 'Island')
    2. Renormalize the scores.
        a. Find the minimum and maximum "raw" score values (e.g., EI_Score_Raw) for a particular score using the sort descending and ascending tools.
        b. Using the *Field Calculator* tool for the normalized score field, input the min-max normalization equation with the minimum and maximum values for the raw scores and the desired minimum and maximum scores using the following equation:

$$Normalized\ Score = \frac{m - r_{min}}{r_{max} - r_{min}} \times (t_{max} - t_{min}) + t_{min}$$

m = "raw" score
r_{min} = minimum range of measurements
r_{max} = maximum range of measurements
t_{max} = minimum of the range of the desired target scaling
t_{min} = maximum of the range of the desired target scaling

- **User Defined Vulnerability Components –** If a user is only interested in, for example, exposure and social vulnerability, the vulnerability score can be recalculated using only those components. Below are steps to accomplish this:
    1. Create new field in parcel attribute layer, making sure the type is either double or float so that it can house decimal places.
    2. Use the *Field Calculator* tool under the new field and enter in:

EI_Score_Norm + WAV_Score

3. If desired create a new field and renormalize scores based on the above steps for normalization.

- **User Defined Weighting –** If a user wants to analyze the vulnerability of a set of parcels, with a focus on certain components more than others, a simple weighting scheme can be applied. For example, if the focus of an analysis was exposure one could apply a greater weight to Exposure by using the *Field Calculator* to recalculate the score. Below is an example where the Exposure Score = 4 and the Sensitivity Score = 5 for equal weighting and exposure weighted 50% greater.
    - Scenario 1: Equal weighting
        - Physical Vulnerability = (1 x EI_Score_Norm) + (1 x SI_Score_Norm)
        - Physical Vulnerability = (1 x 4) + (1 x 5) = 9
    - Scenario 2: Exposure weighted
        - Physical Vulnerability = (1.5 x EI_Score_Norm) + (0.5 x SI_Score_Norm)
        - Physical Vulnerability = (1.5 x 4) + (1.5 x 5) = 7.5

Limitations

Input data may not represent real world conditions as it was not within our project capacity to collect or validate existing spatial data. Parcel mapping should not be confused with the legal boundaries a licensed surveyor would provide. Finally, this dataset is not intended for any use outside of planning.

References

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Appendix C

Reviewer comments and responses.

Appendix C. Reviewer Comments and Responses

Comments from Bobbak Talebi, Senior Coastal Planner, Shorelands & Environmental Assistance Program, WA State Department of Ecology:

- Recommendation to add more detail about exploring the availability of regional datasets during this project here or in a non-technical summary.
  - **Response:** This is addressed in the Spatial Data Selection section and will be further discussed in the final project report.
- Suggestion to use footnotes for links rather than hyperlinks to be consistent with formatting.
  - **Response:** Footnotes added.
- Recommendations to state that this vulnerability assessment focused on the direct/primary impacts rather than indirect impacts.
  - **Response:** Included this caveat into the vulnerability assessment description.
- Suggestion to use “shoreline modification” rather than “armor” to keep terms broad.
  - **Response:** Terminology changed accordingly.
- Suggestion to include more narrative describing why the NCCOS social vulnerability was a valuable alternative to adaptive capacity to use in this study and/or make a stronger link between social vulnerability and adaptive capacity. And to note why social vulnerability is important to consider when evaluating habitat sensitivity.
  - **Response:** Additional description of the benefits of social vulnerability added to the section. As this is a technical document, the discussion is kept brief and refers reader to NCCOS report. The final project report will likely go into this in more detail.
- Request to specify if we are referring to hard armor or not, or any information on type of armor and configuration if possible.
  - **Response:** Clarified that we are referring to hard armor as that is what was mapped for Beach Strategies. There is no information on configuration or elevation, as the armoring was mapped along the ShoreZone shoreline which was noted.
- Suggestion to acknowledge what we know and don’t know about broader sediment dynamics and the implications this could have on erosion in the assumptions or limitations as it pertains to coastal erosion.
  - **Response:** A brief discussion of this was added to the assumptions section. Reader should understand that this is a simplistic way to rank coastal erosion with only two main factors involved, while there are many processes at play.
- Recommendation to simplify the statement that describes how we are treating shore armor and development as it relates to habitat migration.
  - **Response:** Simplified assumption for shore armor.
- Suggestion to state that this study is a snapshot in time in the Policy Implications section.
  - **Response:** Added to the Policy Implications section and explained that these results show us what could happen, and which parcels are most vulnerable if we do not change our behavior or policy.
- Suggestion to consider breaking the Assumptions section into technical vs management assumptions.
  - **Response:** Assumptions here all pertain to technical assumptions. The Policy Implications section identified management assumptions.

- Recommendation to acknowledge that monitoring and analysis to build shore change dataset for greater Puget Sound to understand how habitats are changing will inform restoration efforts and appropriate policy/management response.
  - **Response:** Added this into the Potential Beneficial Data section.
- Question of if we have enough science around the impacts of sea level rise and precipitation events on coastal bluff erosion/landslides as it could be helpful for establishing regulation and setbacks.
  - **Response:** Added to the Potential Beneficial Data section as there has not been a formal evaluation or understanding of how sea level or precipitation events will change erosion rates Puget Sound wide.
- Question of whether the Policy Implications section more appropriate for a non-technical report.
  - **Response:** Including a policy implications section was in the scope of work for this report and is therefore included. We also have a separate Policy Implication Memo and will have a Final Project Report that has more of a discussion of policy than in this technical document.

Comments from Chloe Fleming, Coastal and Marine Social Scientist & Policy Specialist, CSS, Inc. under contract of NOAA, National Centers for Coastal Ocean Science

- Question of whether Table 1 is the full list of Advisory Group members.
  - **Response:** This is the full formal list of Advisory Group members; however, several others were copied on the emails for additional support and feedback.
- Request for source of adaptive capacity description and clarifying discussion around armoring and adaptive capacity.
  - **Response:** Aligned the example of adaptive capacity to the description of adaptive capacity given in the citation by the US Climate Toolbox.
- Recommendation to use the term "complementary" rather than "supplementary" for NCCOS assessment to align with their updated terminology.
  - **Response:** Changed to complementary.
- Suggestions to reframe relative scores to relative trends when discussing how selection of sea level rise projections affect scores, as the scores may shift depending on chosen projections, but the trends would likely remain the same.
  - **Response:** Changed to relative trends rather than scores.
- Request for source to back claim that modeled wave height is a better metric to evaluate erosion potential than fetch distance.
  - **Response:** Revised to state that is a more directly applicable metric rather than better, as waves are a primary mechanism of coastal erosion rather than using a fetch (wind) as a proxy. As this is an assumption, we do not feel that a citation is necessary here and do not know that one exists for this specific statement.
- Suggestions to make clear throughout the report that we are discussing coastal flooding and erosion only (i.e., not inland).
  - **Response:** Added coastal when describing flooding and erosion throughout the document.
- Recommendation to keep consistent with index terminology for physical vulnerability index.
  - **Response:** Changed to physical to keep consistent.

- Suggestion to clarify the 12 scores and which are from NCCOS.
    - **Response:** Clarified the two social vulnerability scores, the Social Vulnerability Index directly from NCCOS and the Socially Modified Vulnerability Score which incorporates the Social Vulnerability Index into the Physical Vulnerability Score.

Comments from John Lovie, ETI Consulting and Habitat Strategic Initiative Advisory Team

- Suggestion for future consideration of inland flooding as areas not physically connected to the Sound may flood.
    - **Response:** This project specifically evaluated vulnerability due to sea level rise and not inland flooding. Future climate change vulnerability assessments should include all major changes and hazards associated with climate change including heavy precipitation events and rain on snow, which causes inland flooding.
- Suggestion for future consideration of dairies and other CAFOs as they were hit very hard due to recent atmospheric rivers (not sea level rise).
    - **Response:** Similarly, to above, this project specifically evaluated vulnerability to sea level rise and no other climate change related events/conditions but will be kept in mind for future efforts.