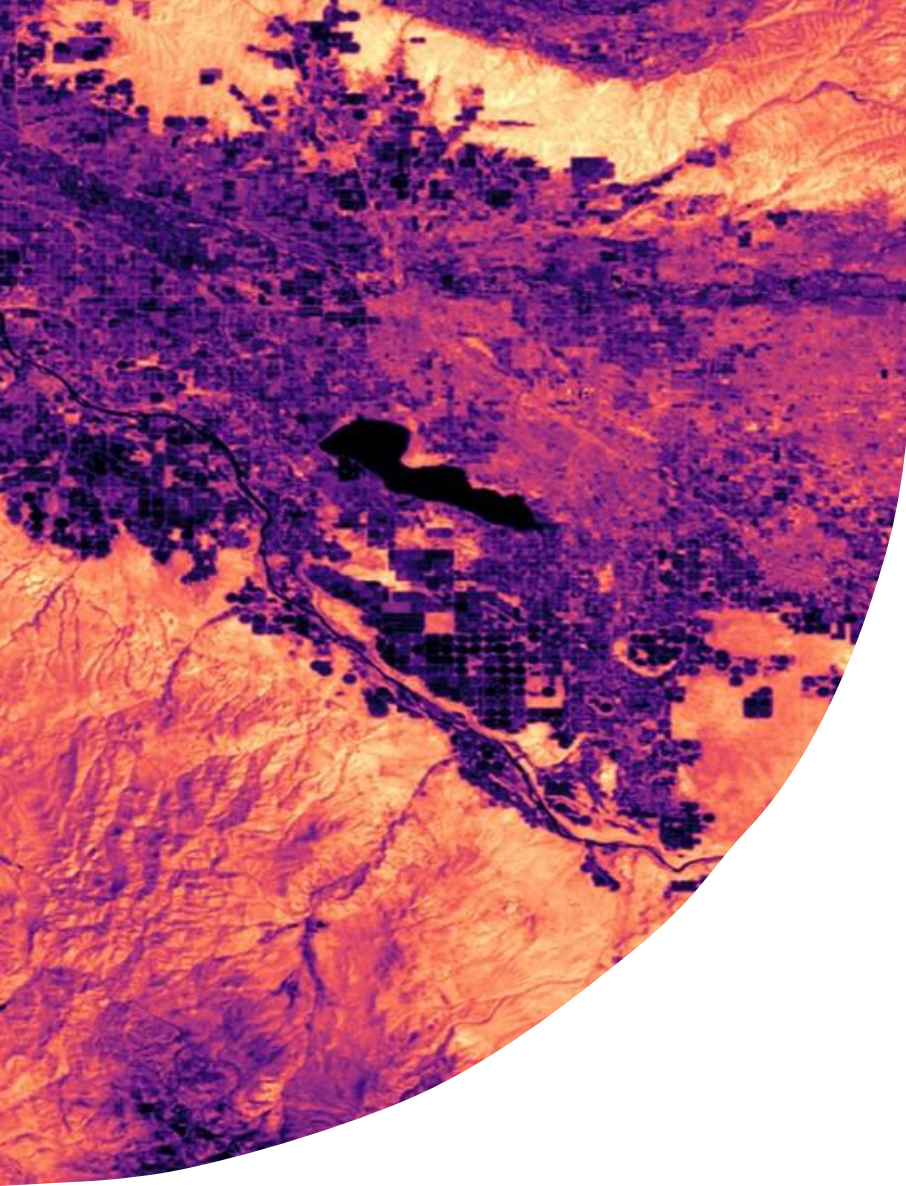




National Aeronautics and
Space Administration



Treasure Valley Health & Air Quality

Analyzing Urban Heat Trends in the Context of
Rapid Expansion in Treasure Valley, Idaho

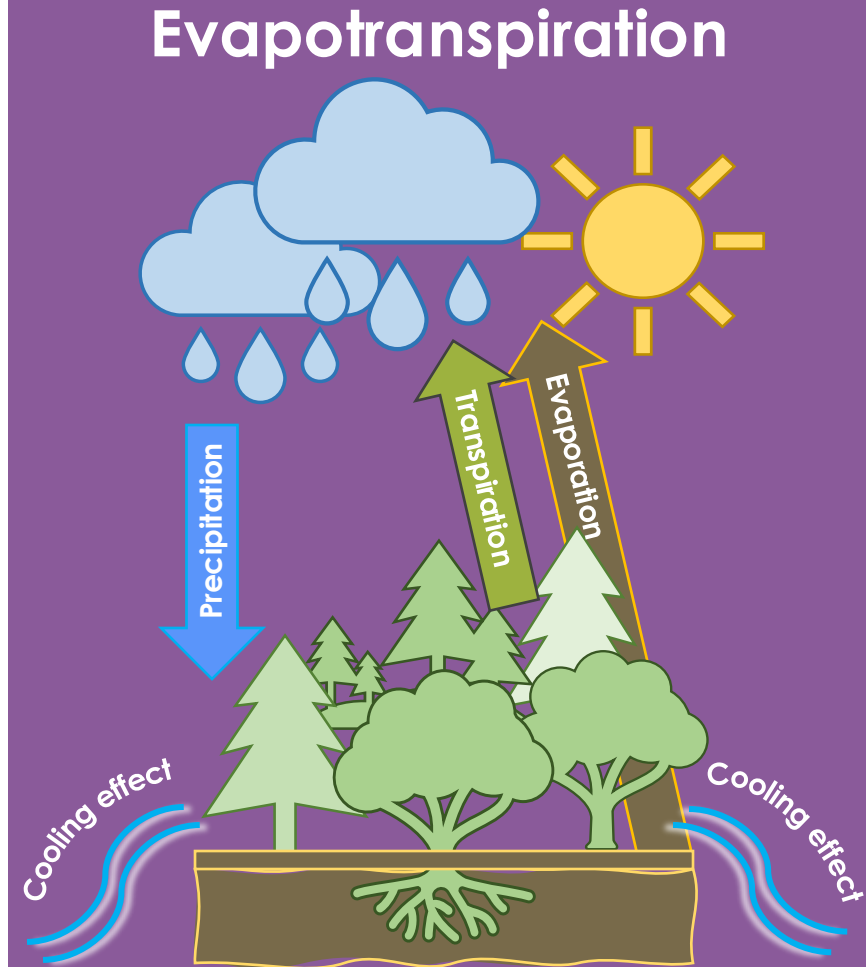
Adrian O. Croland, Ben DeWitt, & Dova
Castaeña Zilly (Analytical Mechanics
Associates)

Idaho – Pocatello | Summer 2025

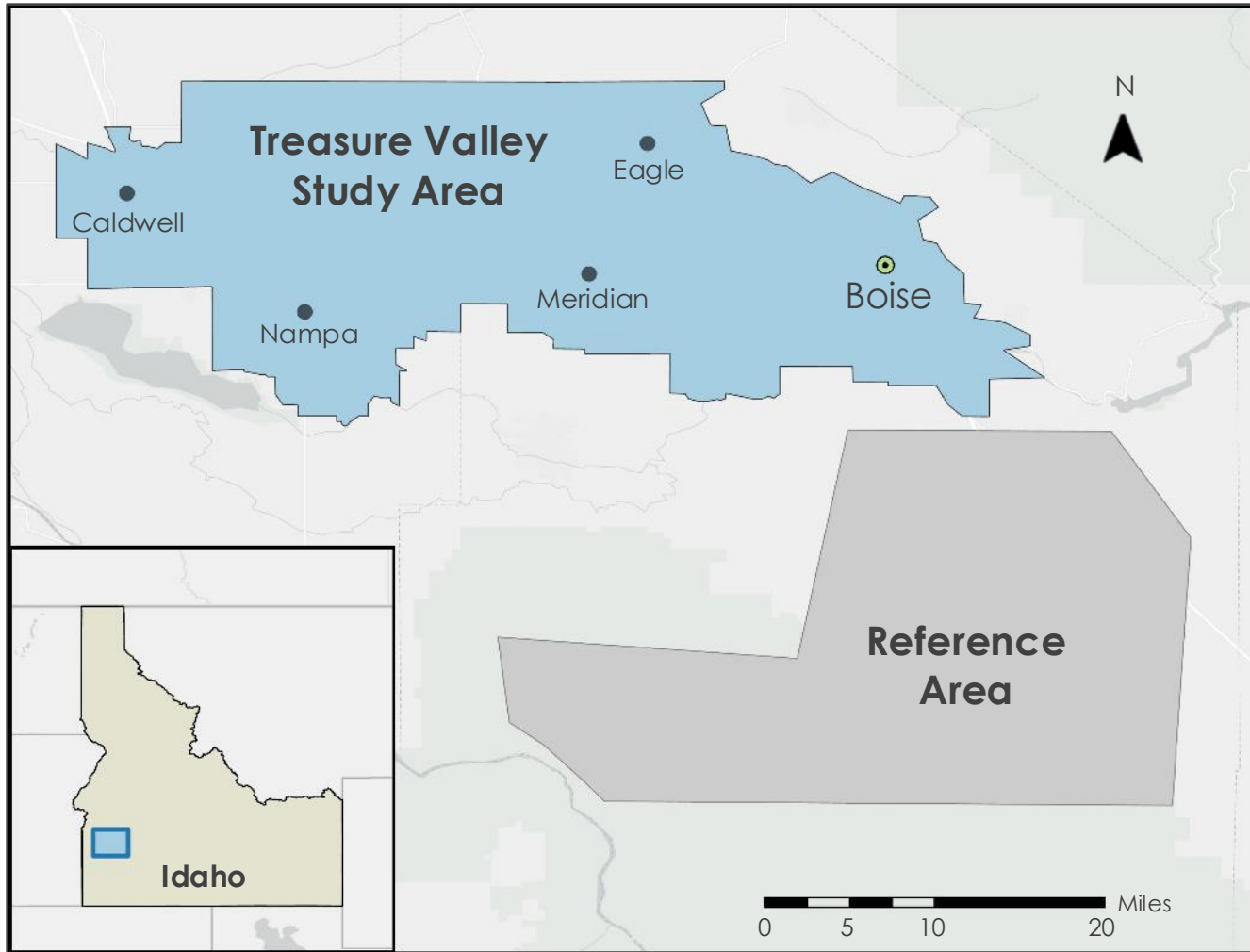


Background

- Urban areas face rapid development with the creation of impervious surfaces, including asphalt and concrete. These materials reduce precipitation intake and absorb solar heat. This results in the **urban heat island (UHI) effect**.
- Tree canopy and vegetation coverage lessen the UHI effect through **evapotranspiration (ET)**. ET combined with tree shade cools surrounding areas.



Study Area & Reference Area



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Study Area

- **Treasure Valley, Idaho**
- Includes the Boise, Nampa, Caldwell, Meridian, and Eagle municipalities
- **Land area** of 317.7 sq. miles
- **Population:** 623,080 (2024)
- **Reference Area:** 271.5 sq. miles
 - Range land
 - Limited vegetation and impervious surfaces

Time Period

- June – September from 2019 to 2024



Image Credit: Charles Knowles

Project Partners

- **Treasure Valley Canopy Network (TVCN)**
 - Local non-profit
 - Works to sustainably expand and support the region's urban tree canopy
 - Focus on community engagement, resiliency
- **City of Boise, Climate Action Division**
 - Carbon Neutral by 2050
 - Urban tree canopy focus area



Community Concerns

- **Urban Heat Islands**
 - Urbanization, population growth, increasing temperatures
- **Public health concerns** such as increased heat-related illnesses
- **Disparate** tree canopy and tree planting efforts



Image Credit: Alex Indigo



Image Credit: Treasure Valley Canopy Network



Image Credit: FunGi_ (Trading)



Project Objectives

Map land surface temperature, urban heat islands, and tree canopy

Image Credit: Nicholas D.



Image Credit: Charles Knowles

Quantify the impacts of urbanization and tree canopy on urban heat patterns over time

Visualize spatial distribution of heat patterns at the city and neighborhood-scale

Image Credit: Scott Ableman



Earth Observations

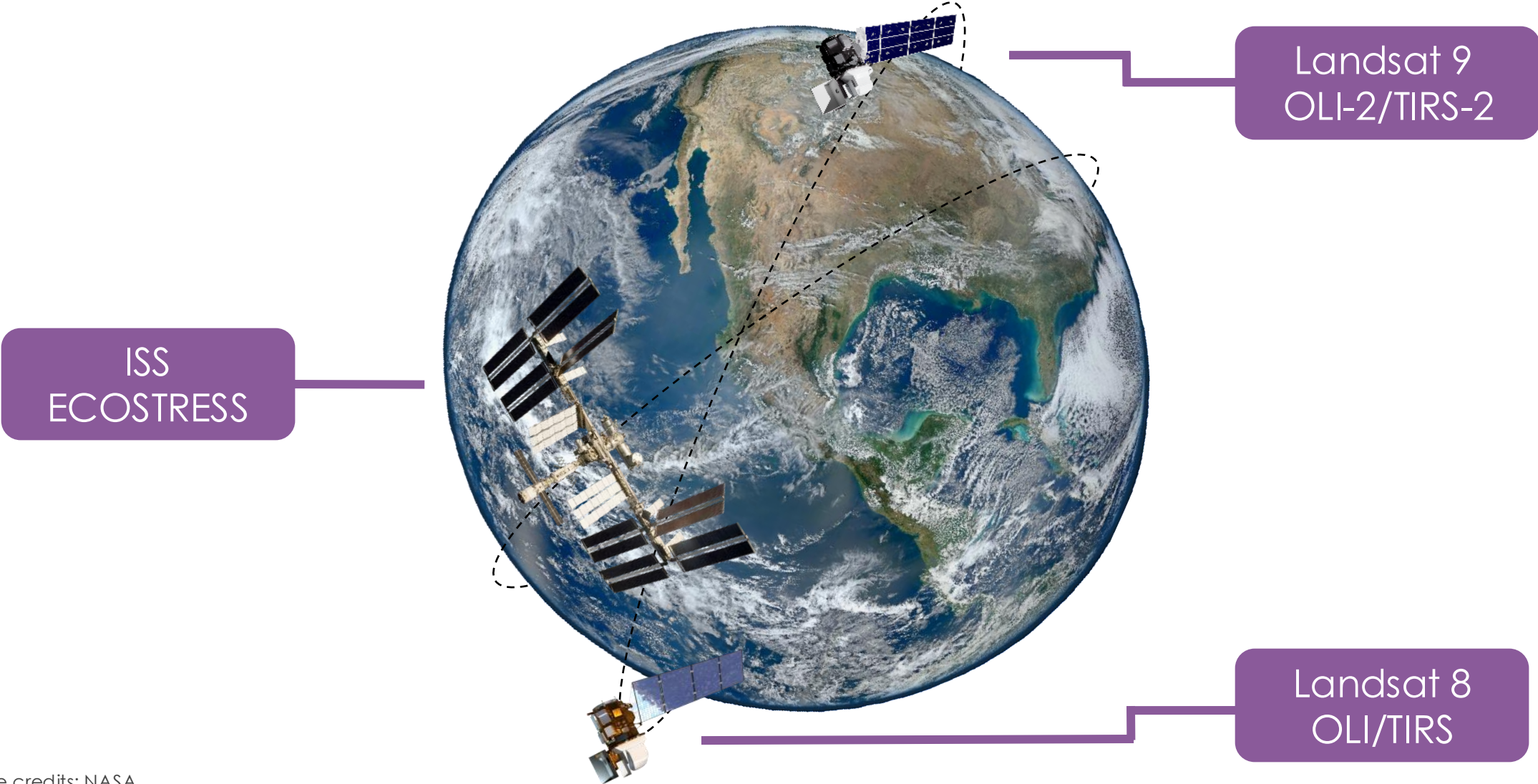


Image credits: NASA

Methodology

Data Acquisition

USGS Earth Explorer

- Landsat 8 TIRS
- Landsat 9 TIRS-2
- NAIP (2019, 2023)

NASA Earthdata Search

- ISS ECOSTRESS

COMPASS – City
Boundaries

Daymet – Temperature
Maximums

Data Processing

Data Analysis



Methodology

Data Acquisition

USGS Earth Explorer

- Landsat 8 TIRS
- Landsat 9 TIRS-2
- NAIP (2019, 2023)

NASA Earthdata Search

- ISS ECOSTRESS

COMPASS – City
Boundaries

Daymet – Temperature
Maximums

Data Processing

- Cloud Masking & Image Selection
- Median LST Composites
- Resample Landsat
- Mosaic NAIP Imagery
- Deep Learning Land Cover Classification

Data Analysis



Methodology

Data Acquisition

USGS Earth Explorer

- Landsat 8 TIRS
- Landsat 9 TIRS-2
- NAIP (2019, 2023)

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COMPASS – City
Boundaries

Daymet – Temperature
Maximums

Data Processing

- Cloud Masking & Image Selection
- Median LST Composites
- Resample Landsat
- Mosaic NAIP Imagery
- Deep Learning Land Cover Classification

Data Analysis

- UHI Locations
- Day-Night LST Difference
- Tree Canopy Analysis
- Change Detection
- Zonal Statistics
- Paired Samples Comparison



Results

**Land Surface
Temperature
(LST) and
Urban Heat
Island (UHI)**

**Day-Night
LST
Difference**

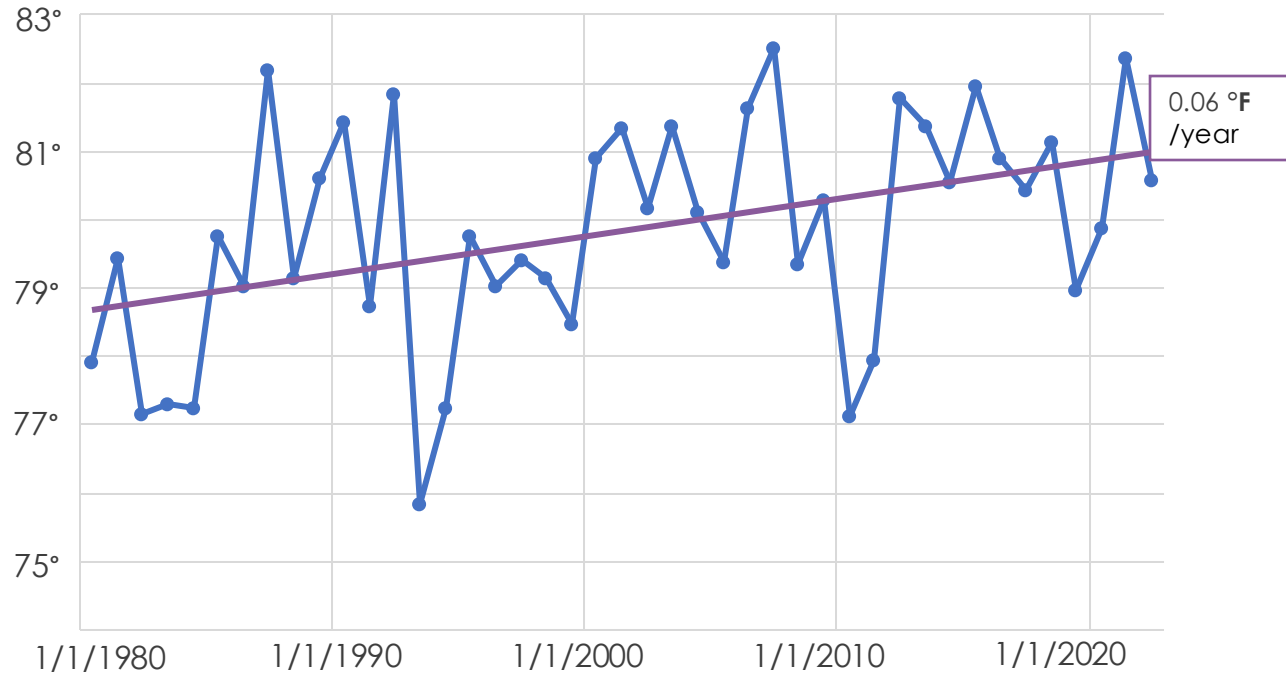
Tree Canopy

**Paired
Samples
Comparison**



Historical Temperature Trend - Daymet

Mean max. temperature (in °F) during growing season (Apr. – Sep.)



—●— Study and Reference Area

Average temperature of 1980s: **78.9 °F**

Average temperature of 2010s: **80.2 °F**

Mann-Kendall Test for Temperature Trend

Zone	Score Mean	P-value Mean
SA & RA	262.12	0.012

Zone	Score St. Dev.
SA & RA	40.15

Day & Night Median LST 2019

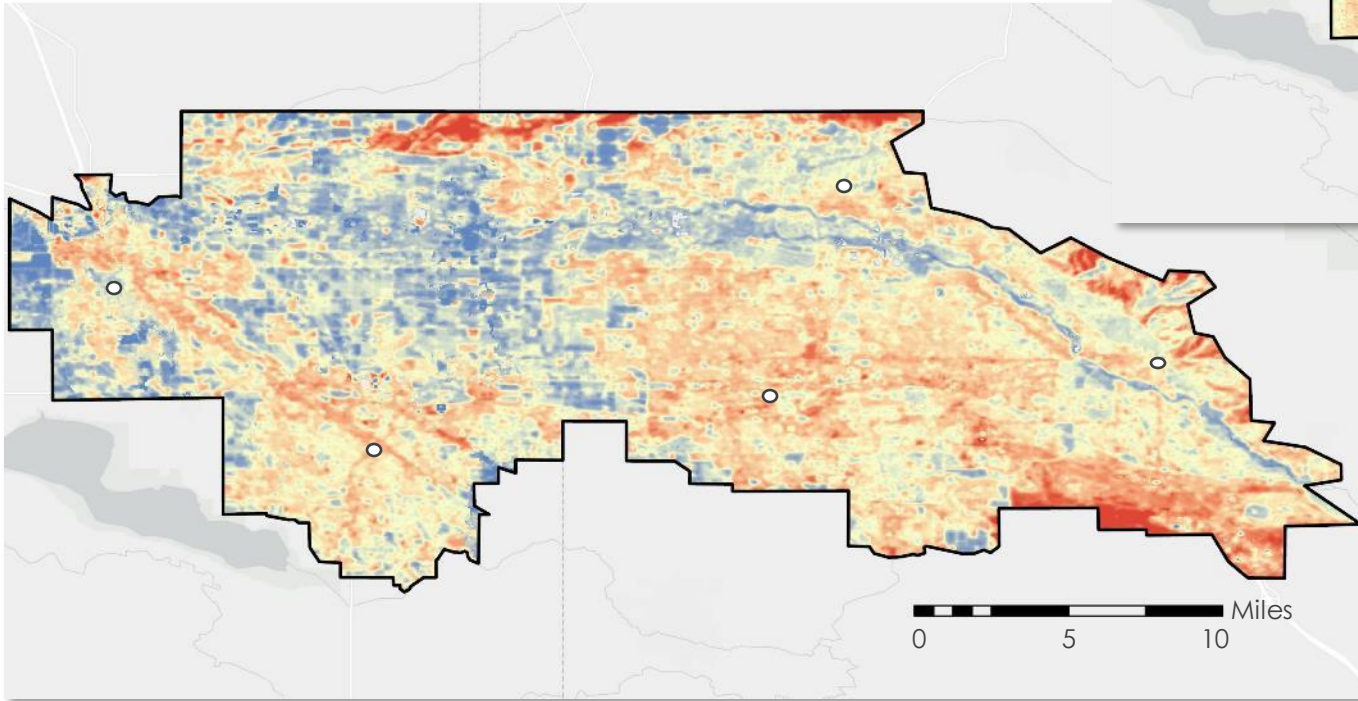
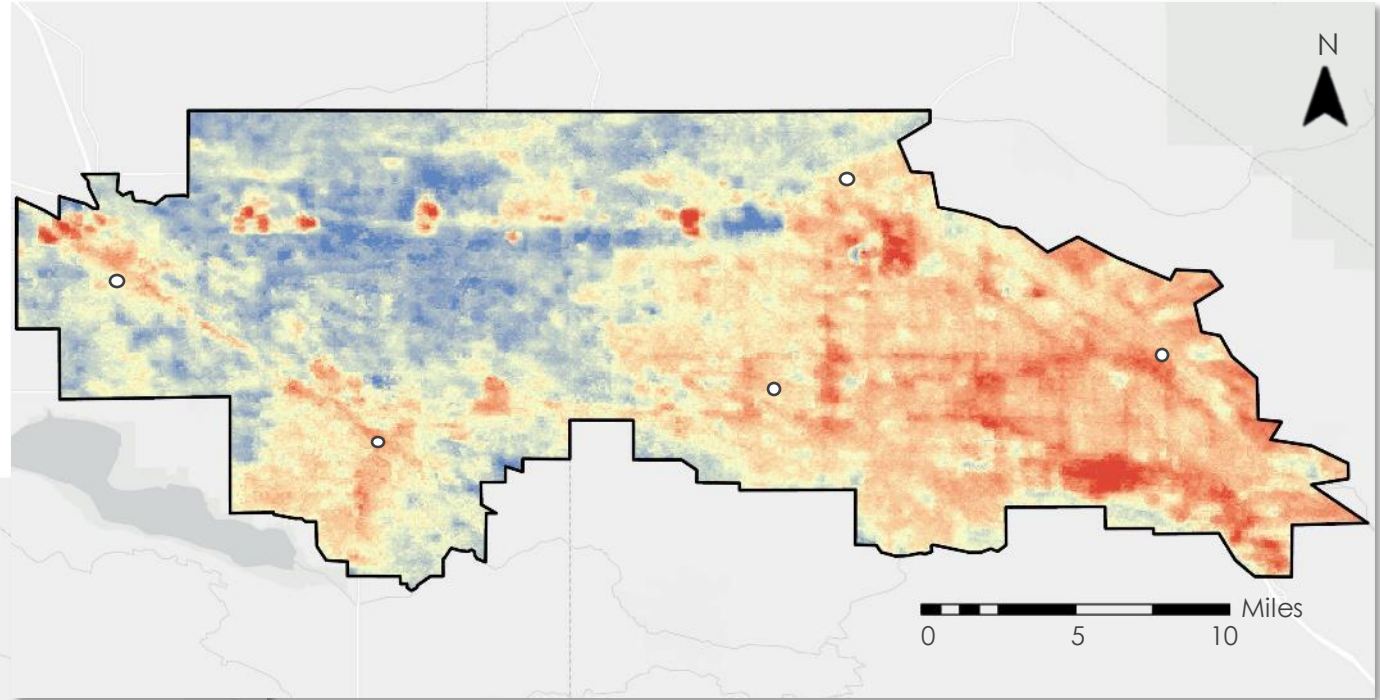
Day

○ Major City

Temperature (°F)

70.72

48.54



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Night

Temperature (°F)

129.32

56.26



2019 LST	Day	Night	Change
Study Area	99.22	59.32	39.30
Reference Area	117.41	57.02	60.39

Day & Night Median LST 2024

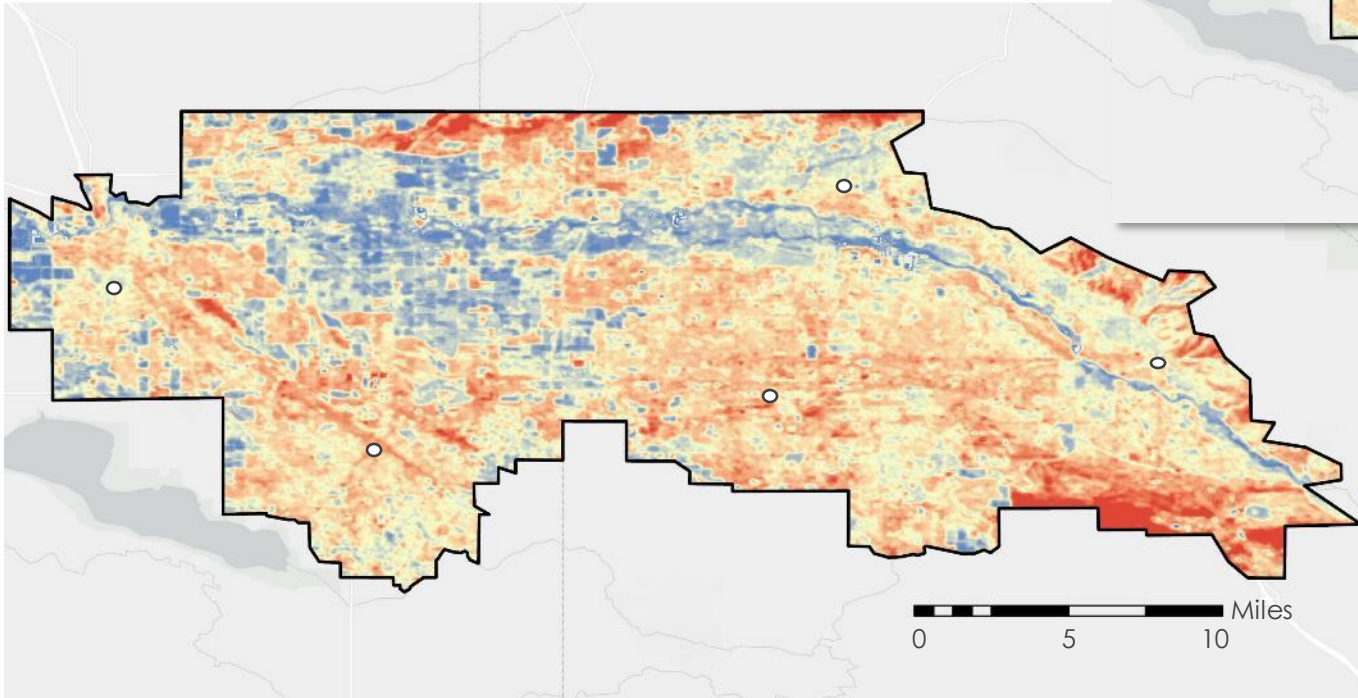
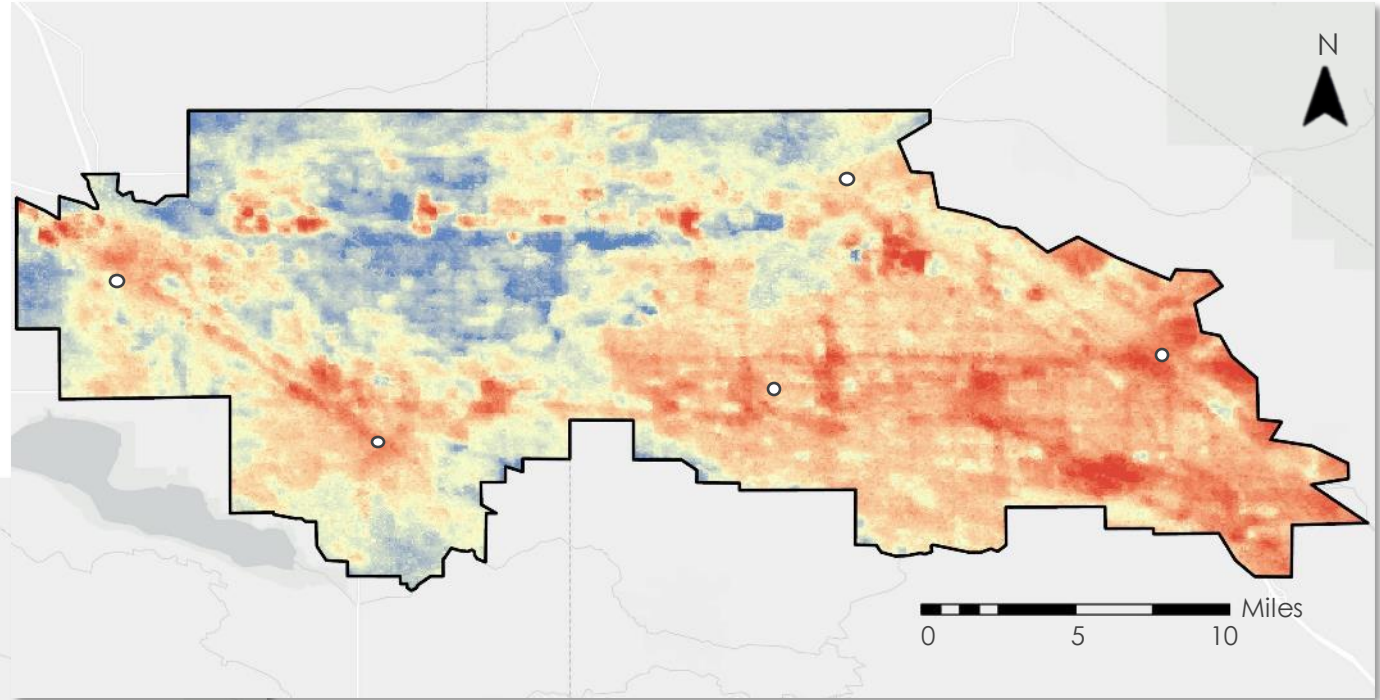
Day

○ Major City

Temperature (°F)

69.94

46.45



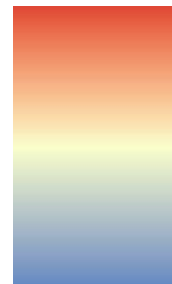
Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Night

Temperature (°F)

128.20

66.42

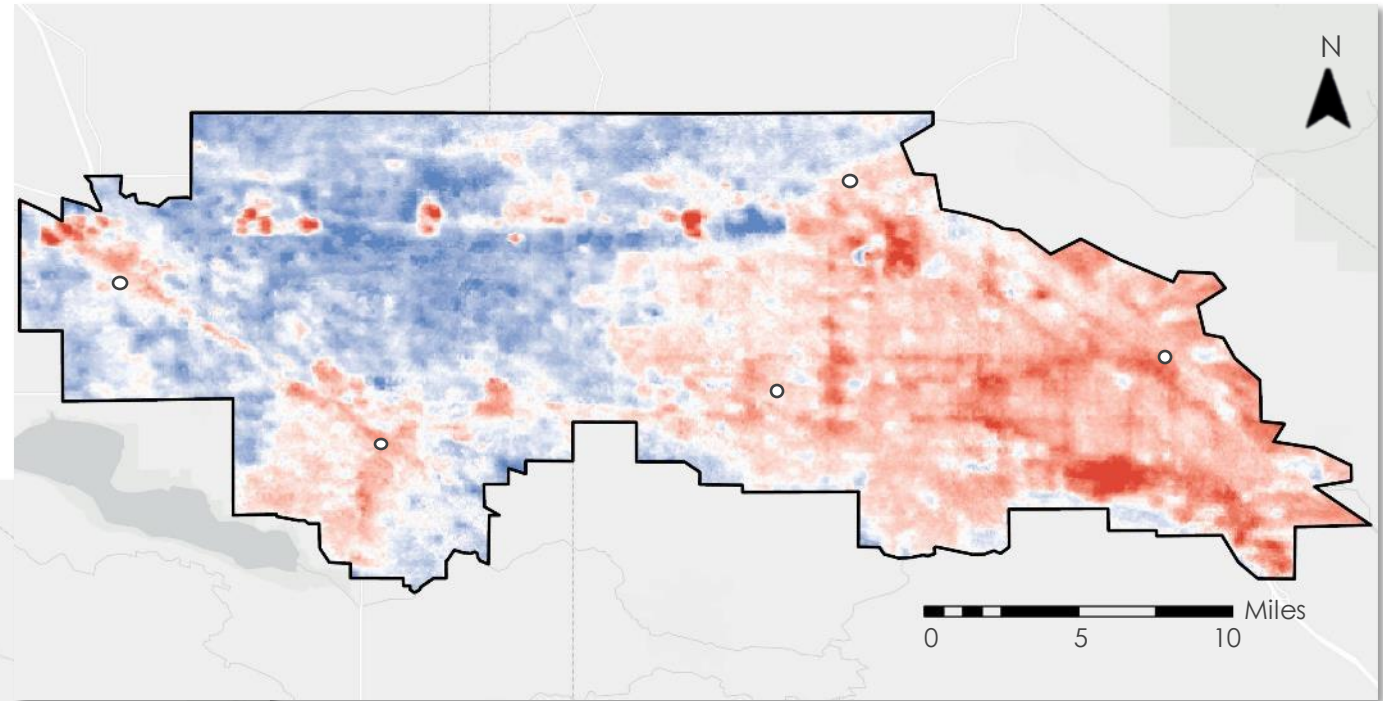
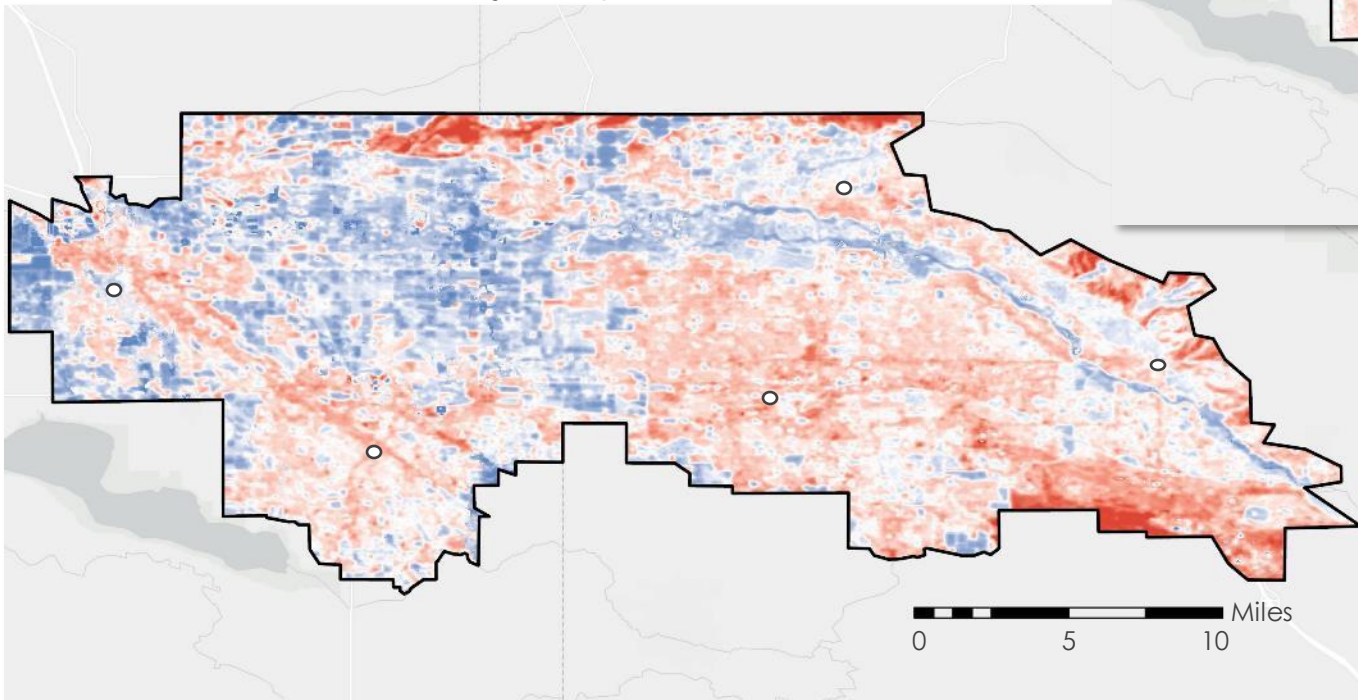


2024 LST	Day	Night	Change
Study Area	102.11	59.6	42.52
Reference Area	119.89	56.81	63.09

Day & Night Median UHI 2019

Day

○ Major City



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

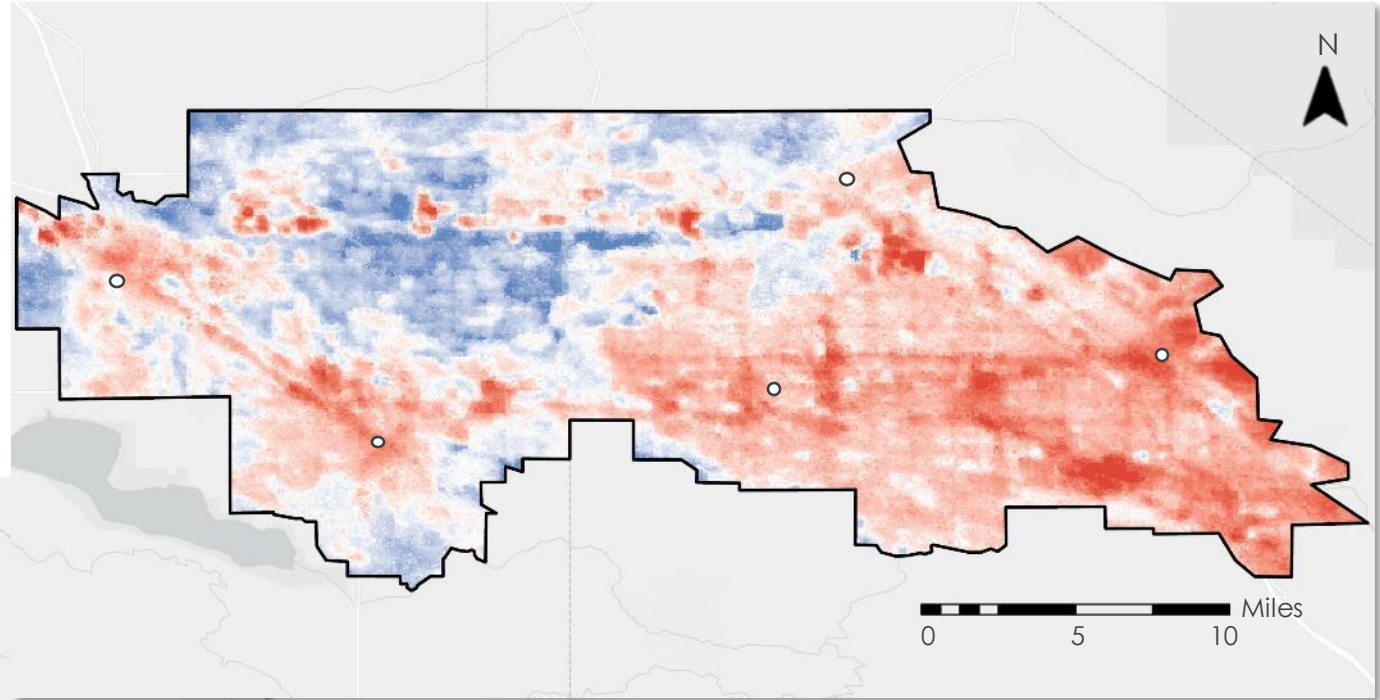
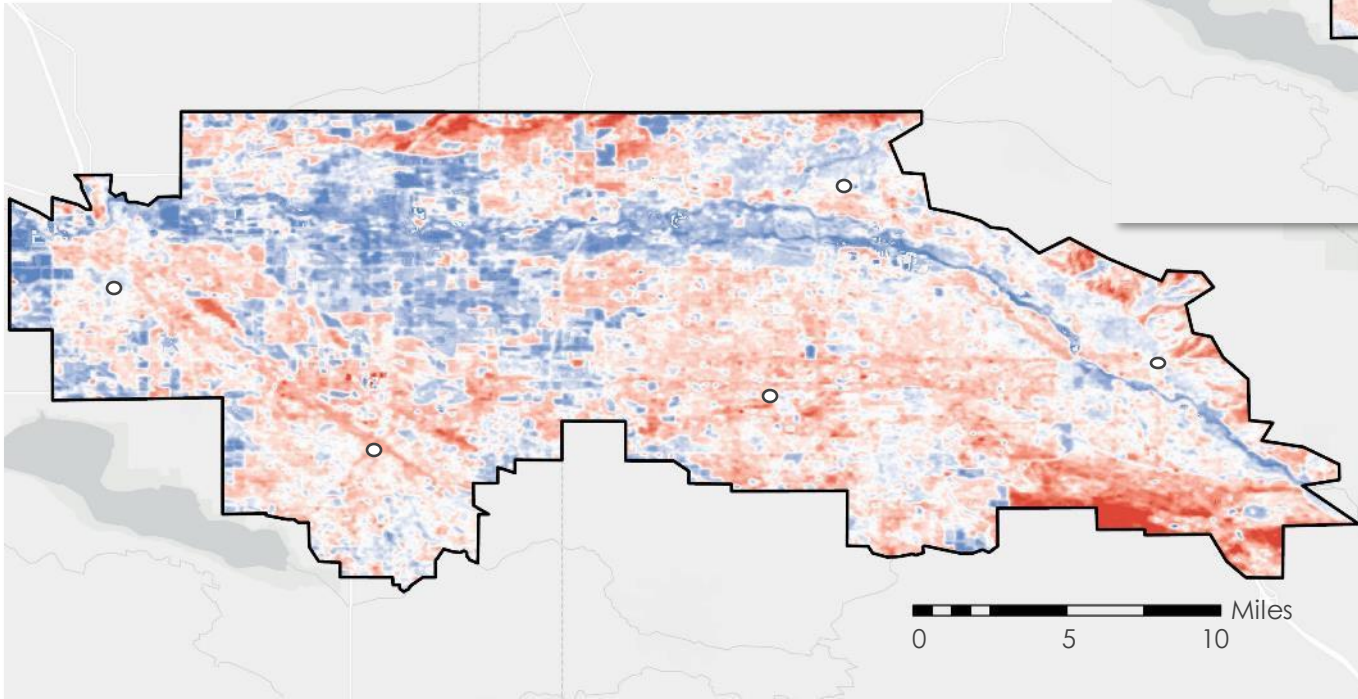
Night



Day & Night Median UHI 2024

Day

○ Major City



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

Night



Results

**Land Surface
Temperature
(LST) and
Urban Heat
Island (UHI)**

**Day-Night
LST
Difference**

Tree Canopy

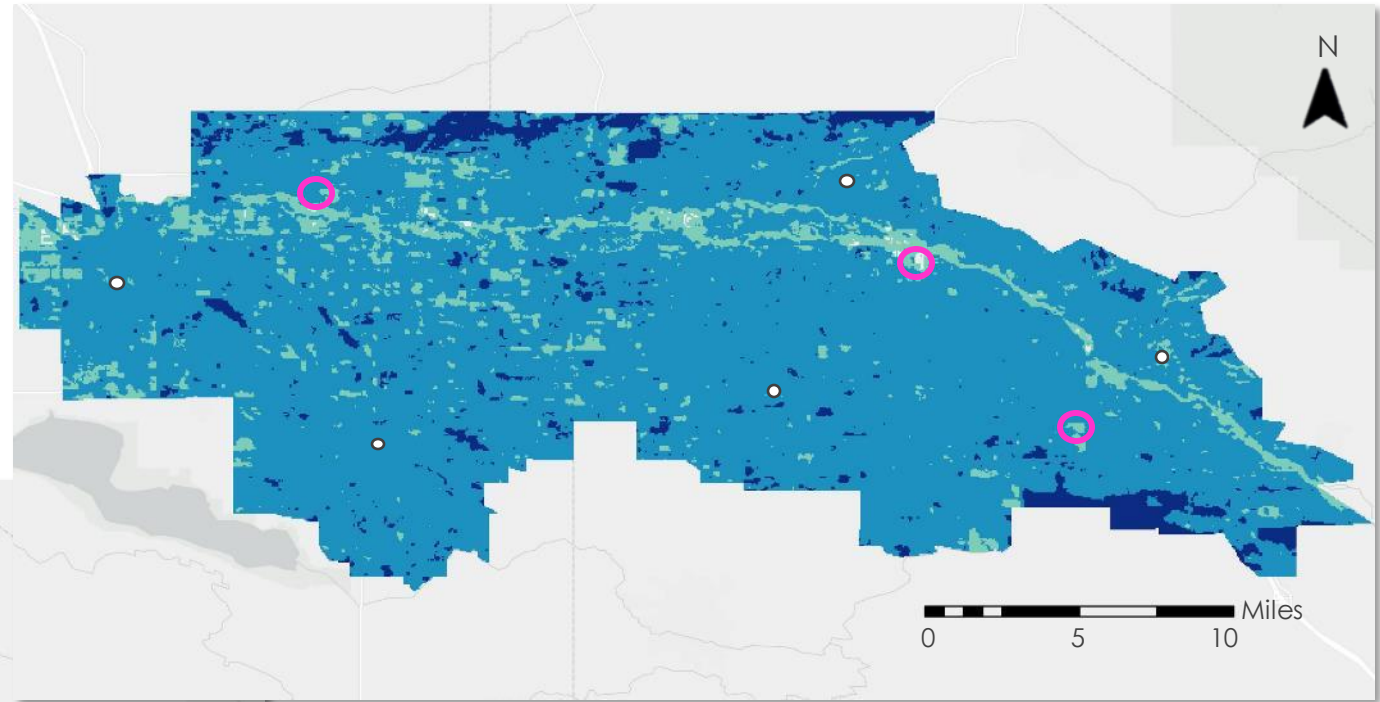
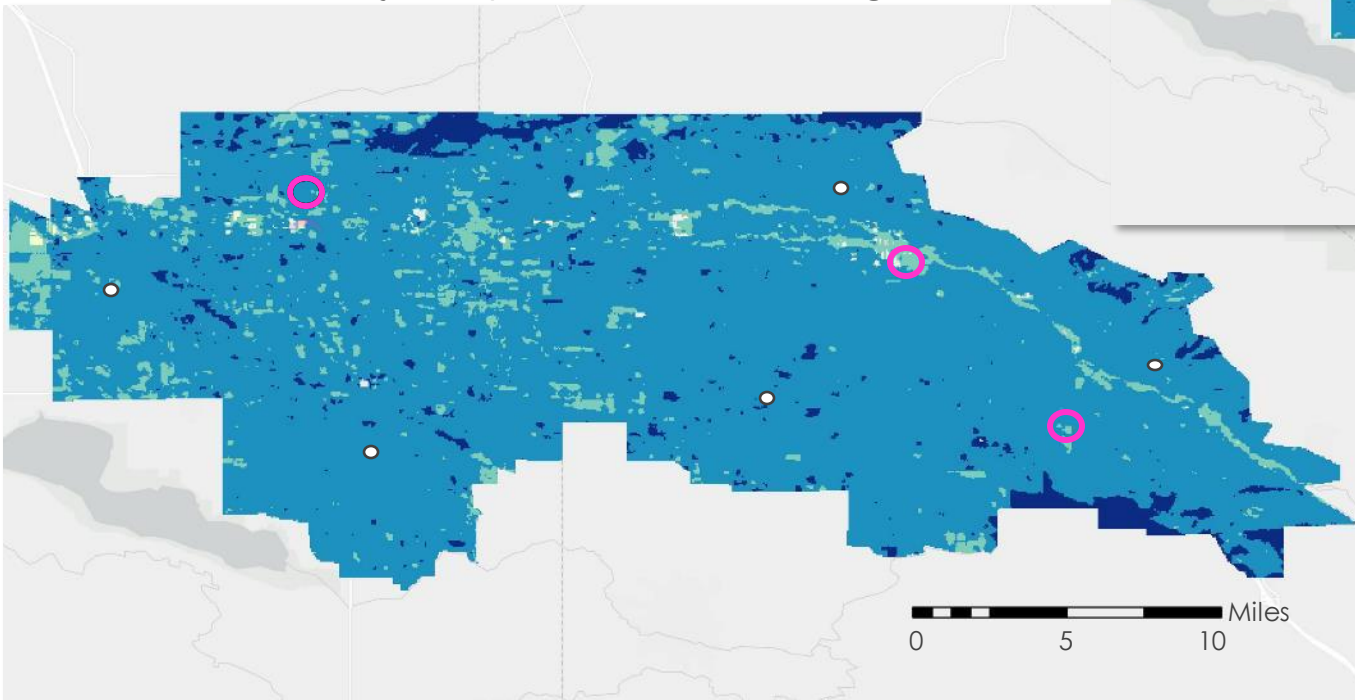
**Paired
Samples
Comparison**



Day-Night LST Difference





2019

○ Major City ○ Areas of Change



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

2024

-  Minimum/no difference
-  Slightly different
-  Moderately different
-  Substantially different

Day-Night LST Difference Change in °F 2019 - 2024

Zone	Min	Max	Range
Study Area	-34.47	43.41	77.88
Reference Area	-28.38	39.28	67.65

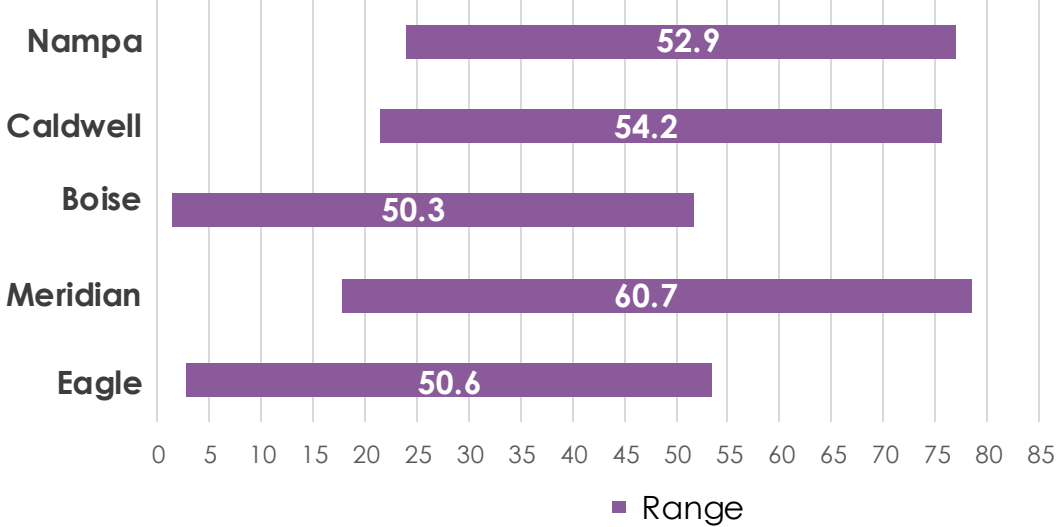
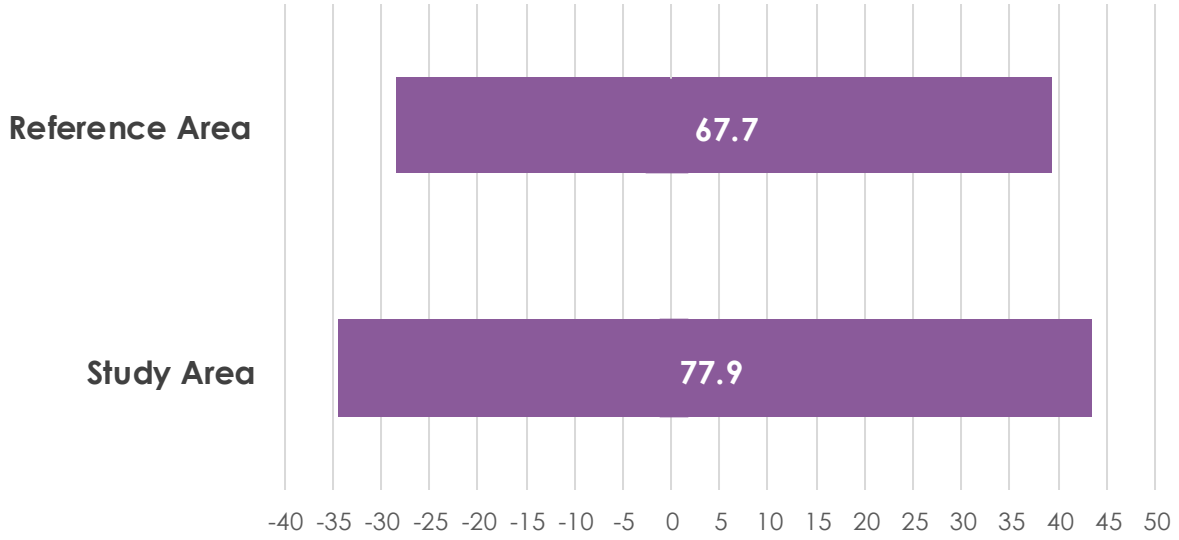


Image Credit: Treasure Valley Canopy Network



Results

**Land Surface
Temperature
(LST) and
Urban Heat
Island (UHI)**

**Day-Night
LST
Difference**

Tree Canopy

**Paired
Samples
Comparison**

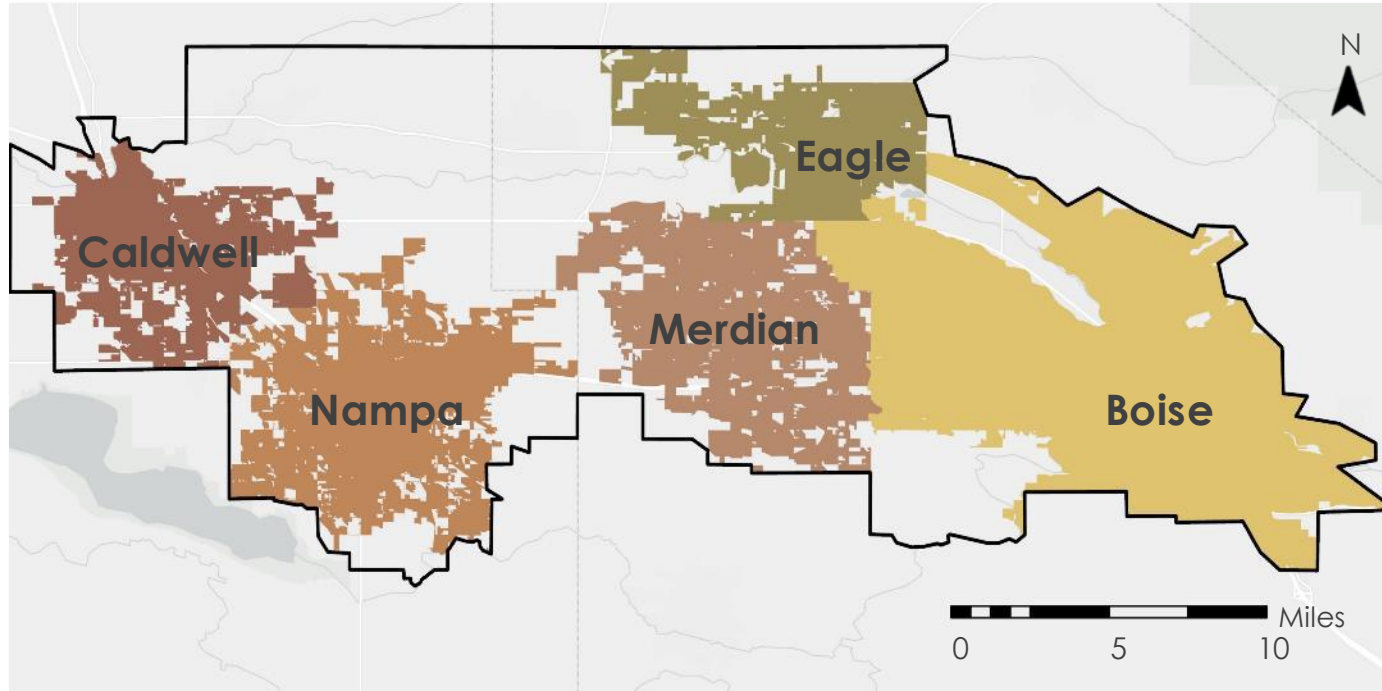


Tree Canopy & Impervious Surface Change

Study Area	Tree Canopy	Impervious Surfaces
2019	4.6 %	31.6 %
2023	7.5 %	37.4 %
Change	9.5 sq mi	18.7 sq mi

Caldwell	Tree Canopy	Impervious Surfaces
2019	4.4 %	38.2 %
2023	5.0 %	48.9 %
Change	0.1 sq mi	2.5 sq mi

Nampa	Tree Canopy	Impervious Surfaces
2019	3.0 %	33 %
2023	4.3 %	52.5 %
Change	0.4 sq mi	6.8 sq mi



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

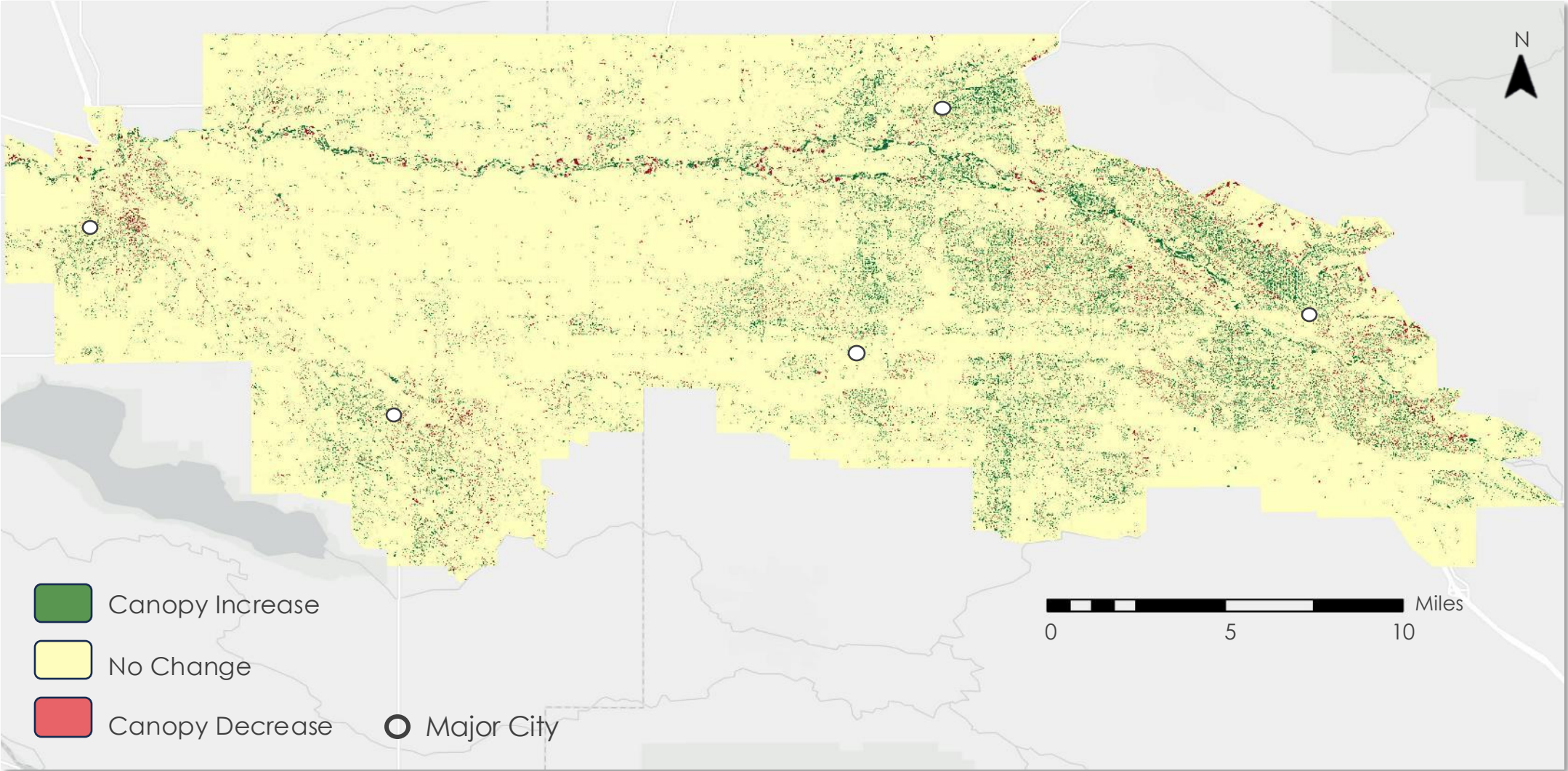
Eagle	Tree Canopy	Impervious Surfaces
2019	5.4 %	28.1 %
2023	11.9 %	26.8 %
Change	1.3 sq mi	-0.3 sq mi

Boise	Tree Canopy	Impervious Surfaces
2019	7.8 %	35 %
2023	13.2 %	39 %
Change	4.1 sq mi	3 sq mi

Meridian	Tree Canopy	Impervious Surfaces
2019	2.1 %	44.8 %
2023	5.2 %	55.2 %
Change	1.1 sq mi	3.5 sq mi

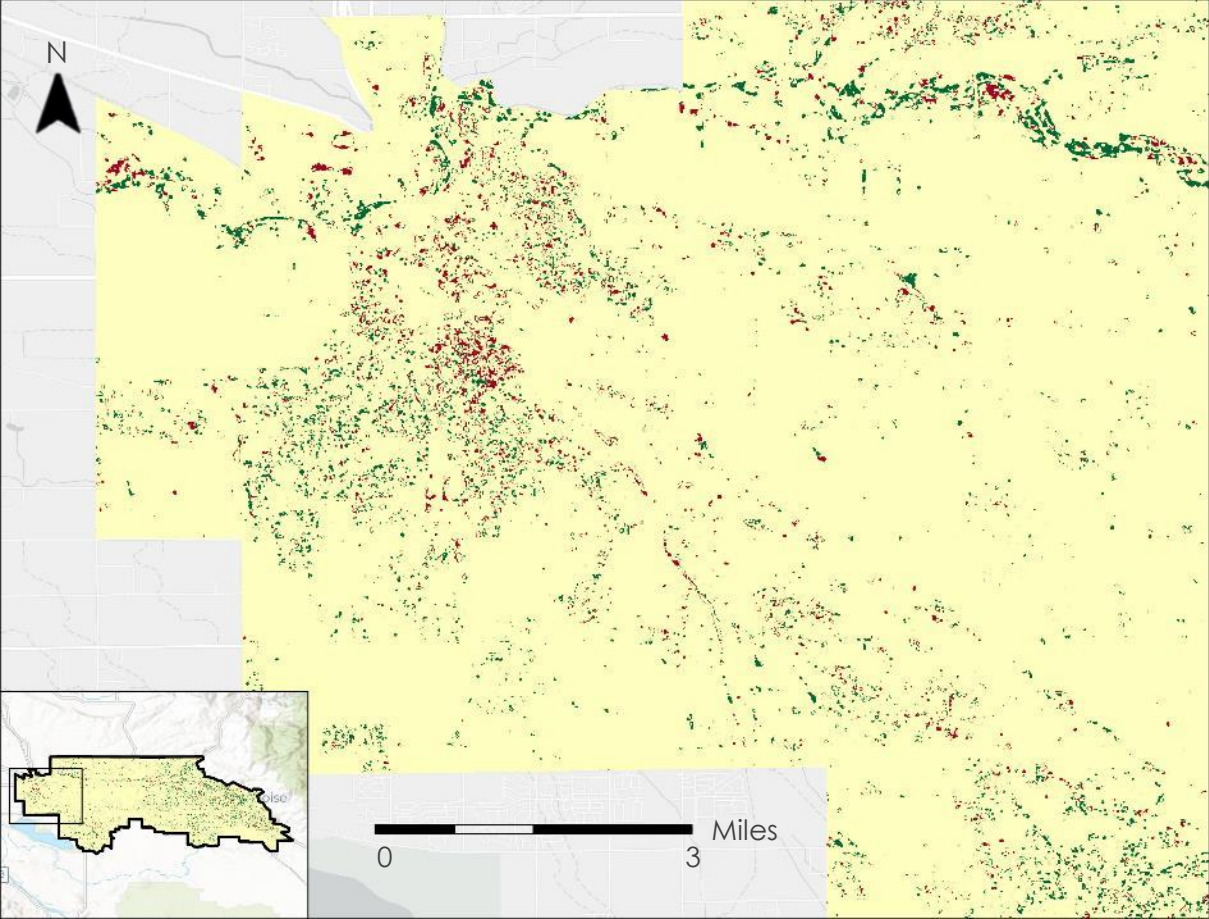
Ref Area	Tree Canopy	Impervious Surfaces
2019	0.02 %	22.4 %
2023	0.1 %	26.4 %
Change	0.2 sq mi	10.2 sq mi

Tree Canopy Change 2019 - 2024

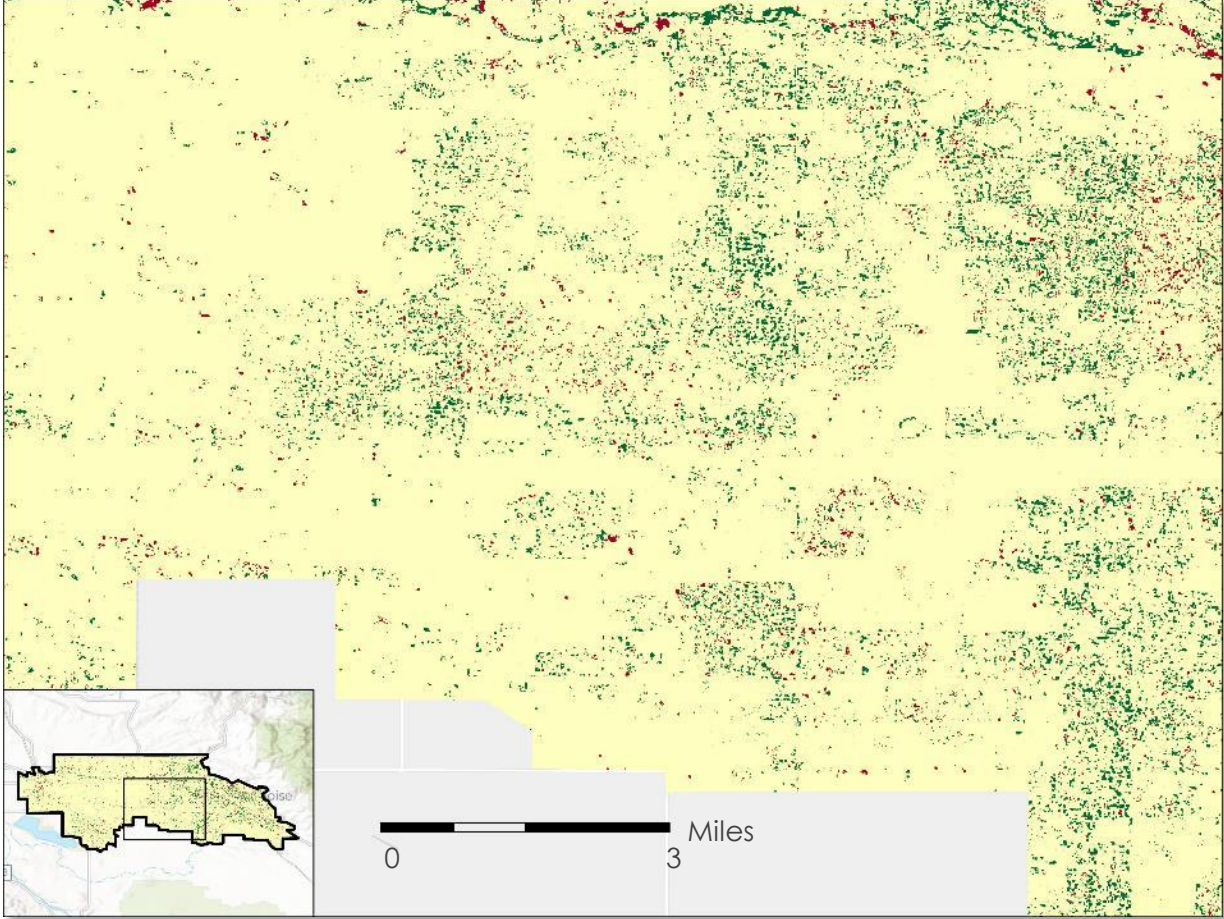


Tree Canopy Change 2019 - 2024

Caldwell



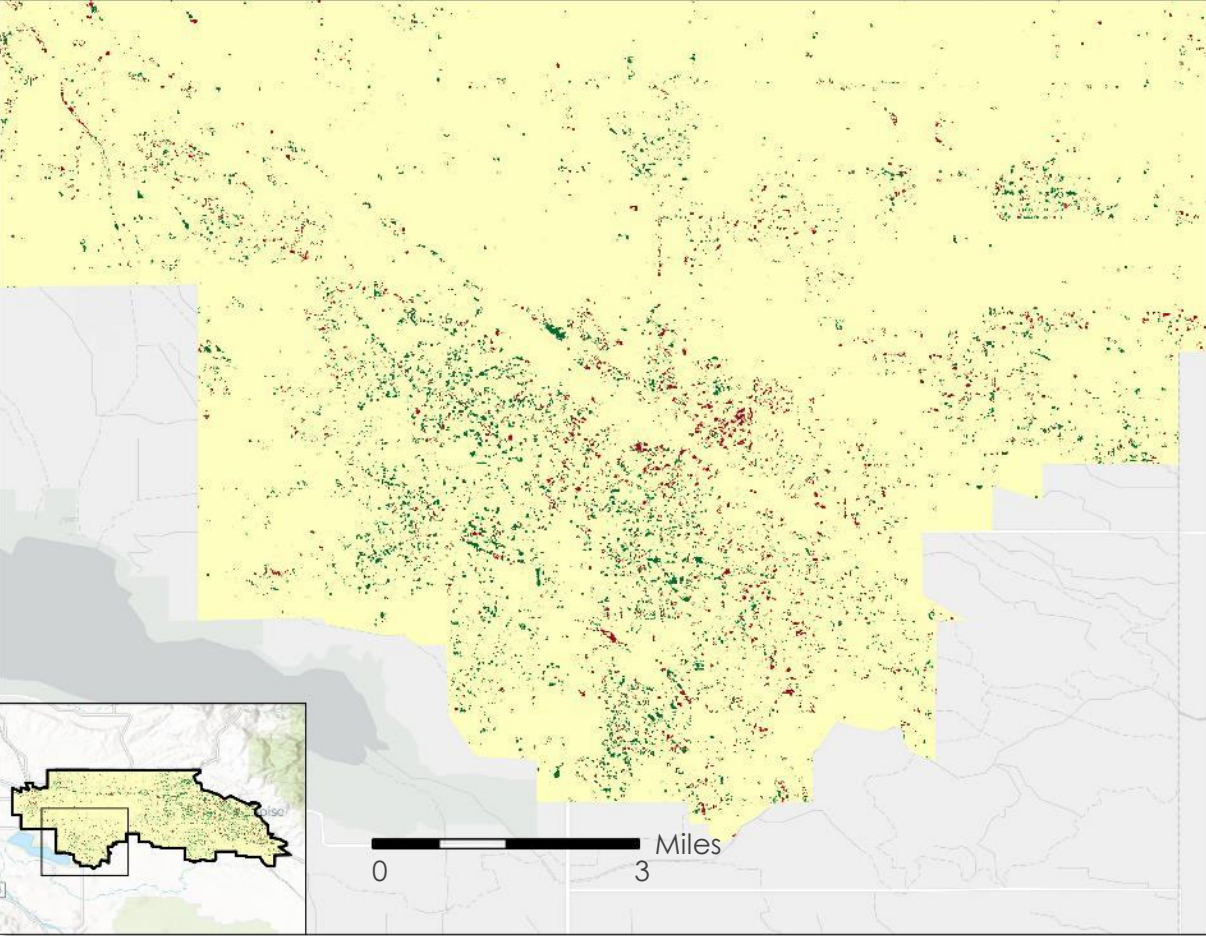
Meridian



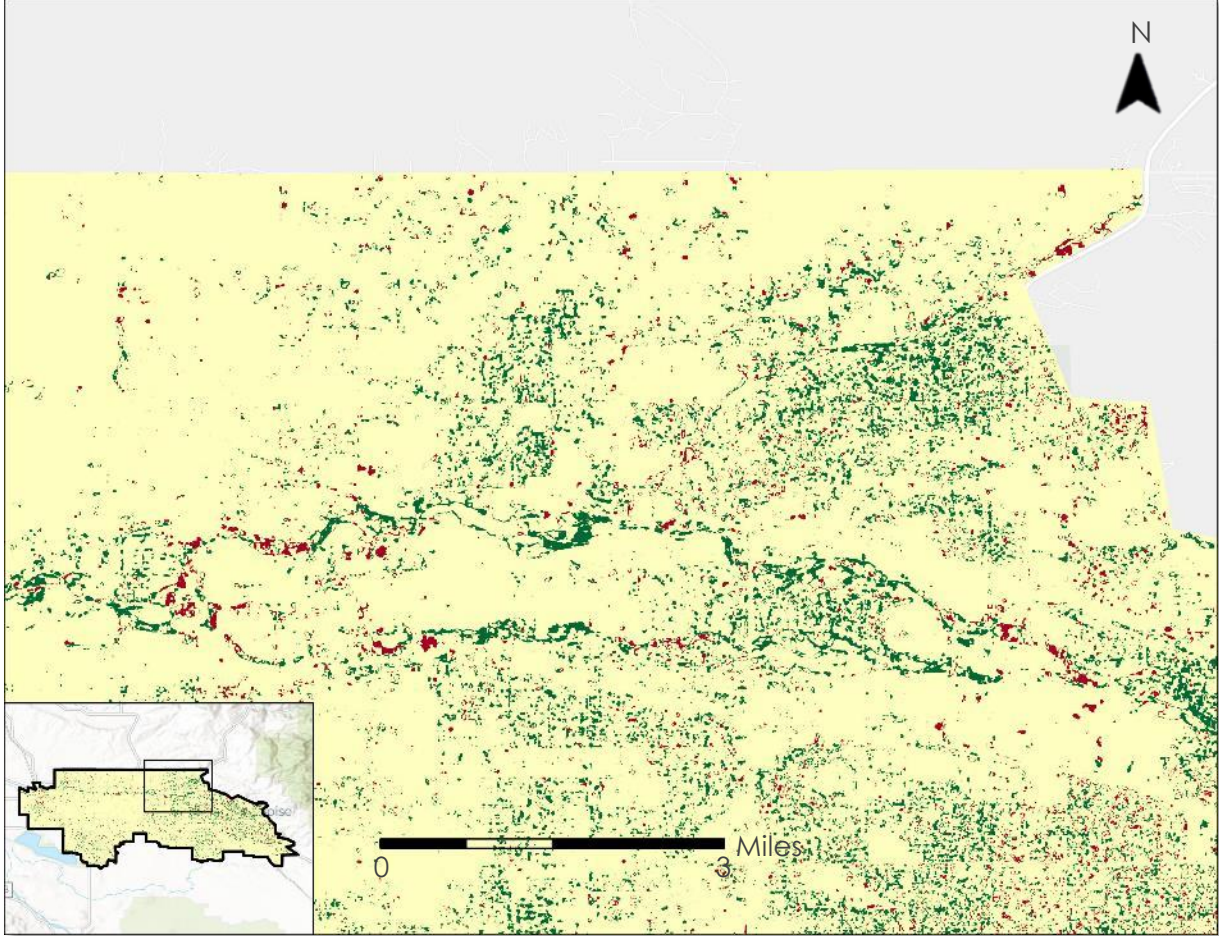
Canopy Increase No Change Canopy Decrease

Tree Canopy Change 2019 - 2024

Nampa

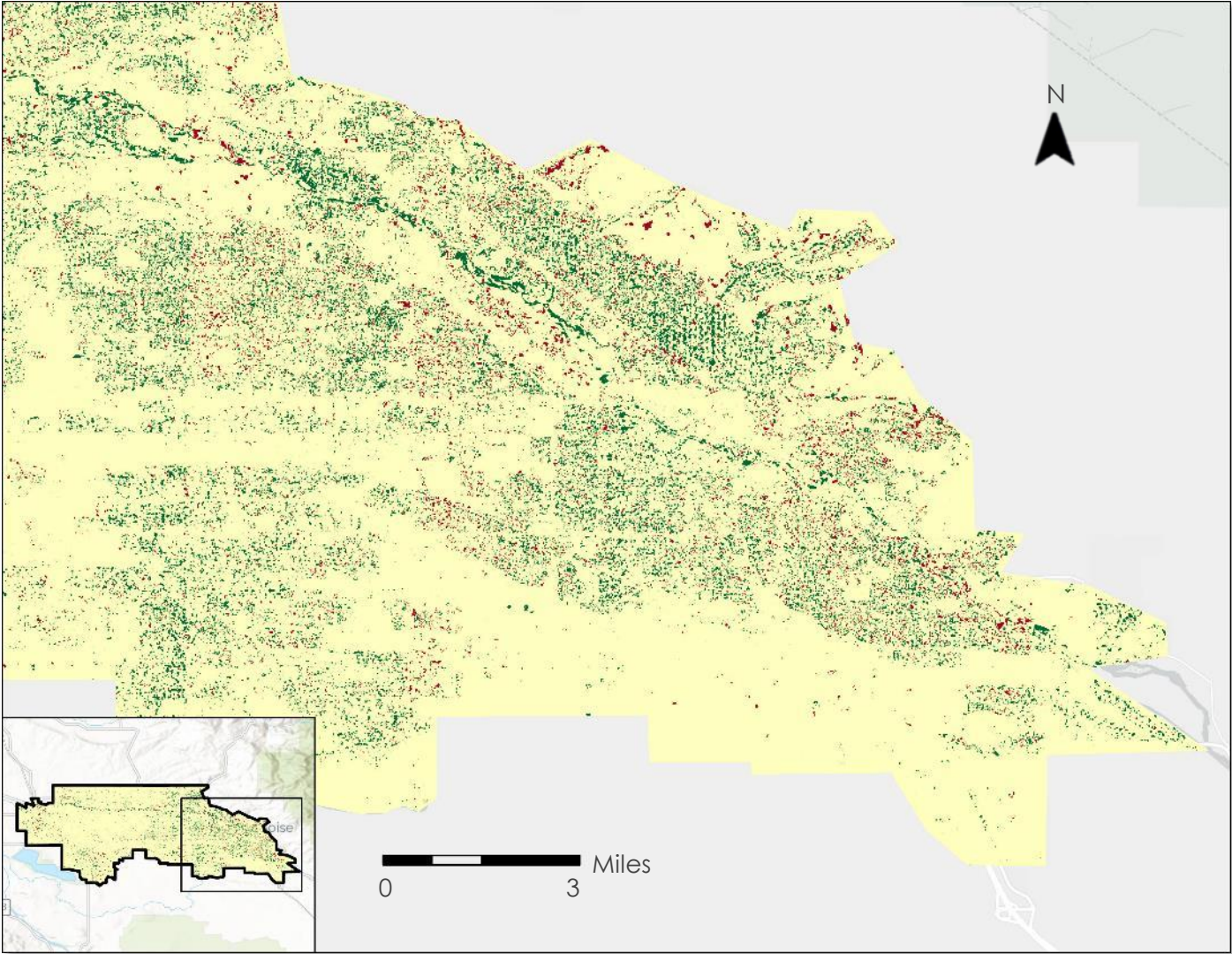


Eagle



 Canopy Increase  No Change  Canopy Decrease

Tree Canopy Change 2019- 2024



- Boise**
- Canopy Increase
 - No Change
 - Canopy Decrease

Results

**Land Surface
Temperature
(LST) and
Urban Heat
Island (UHI)**

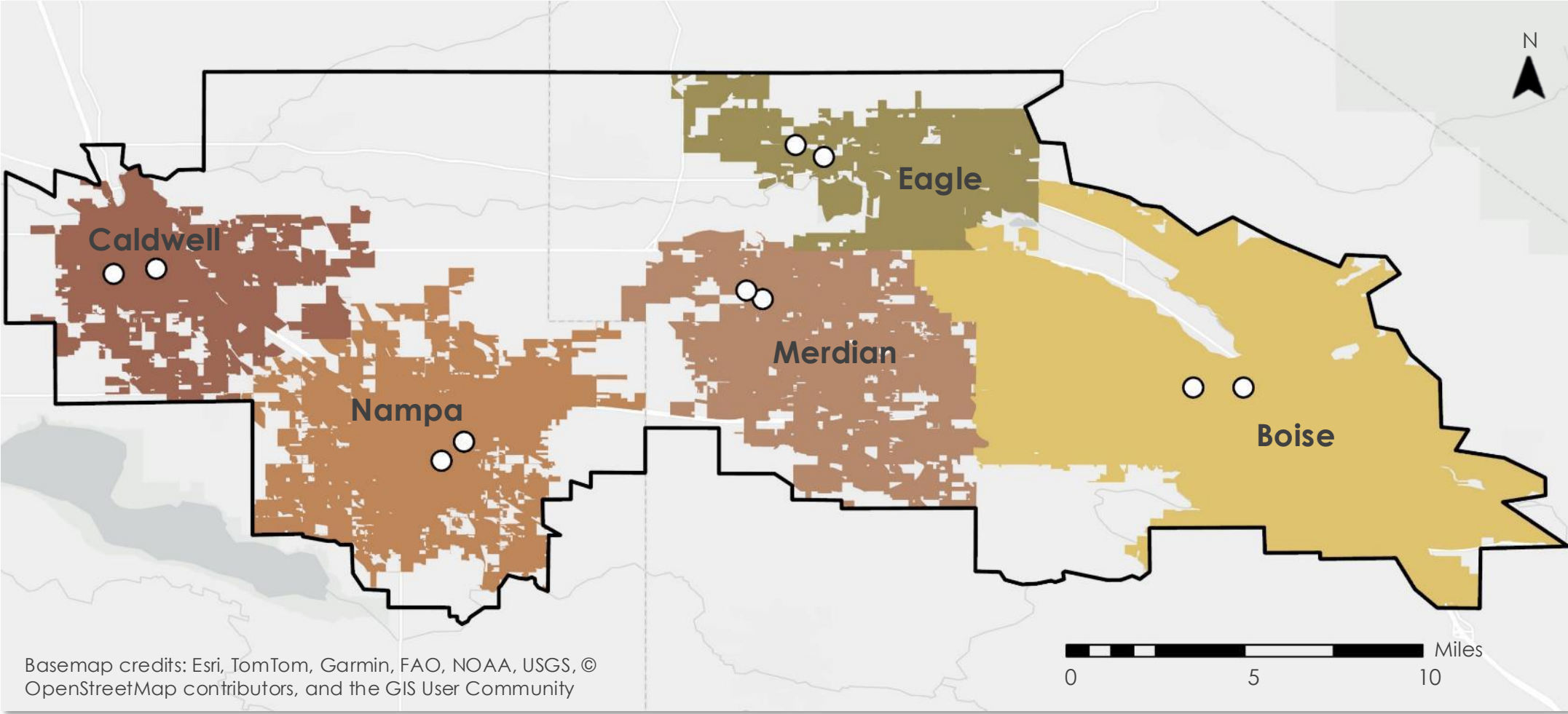
**Day-Night
LST
Difference**

Tree Canopy

**Paired
Samples
Comparison**

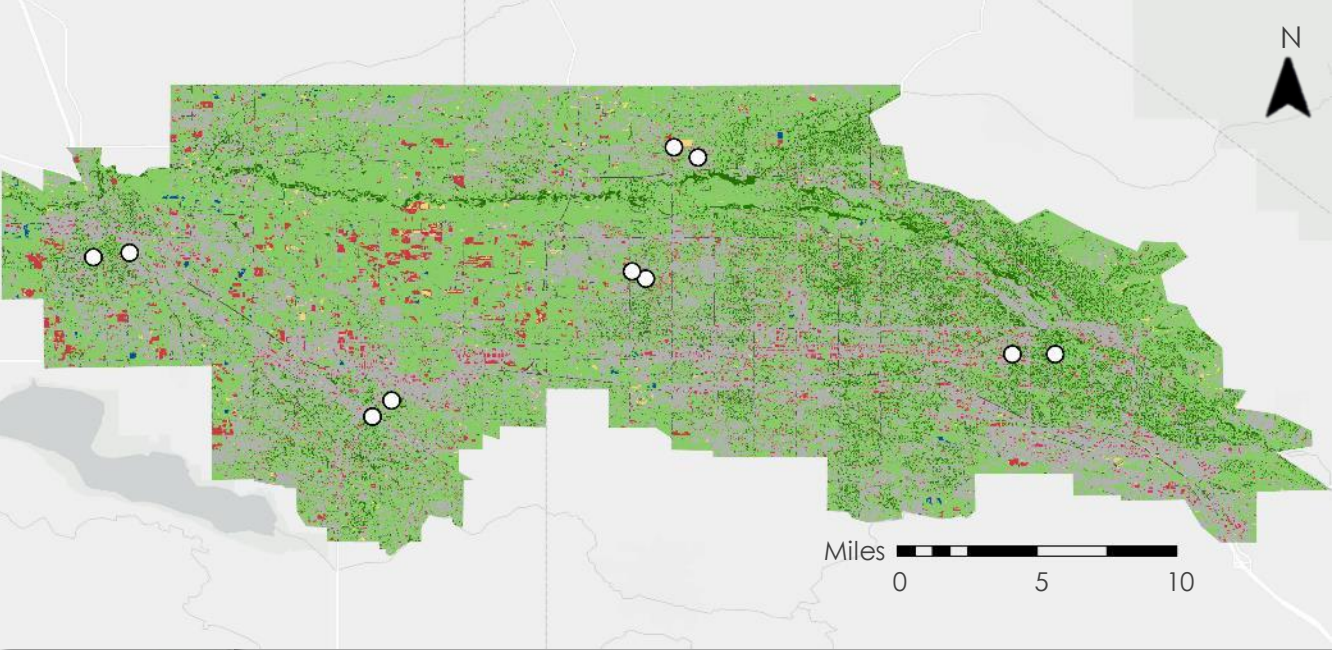
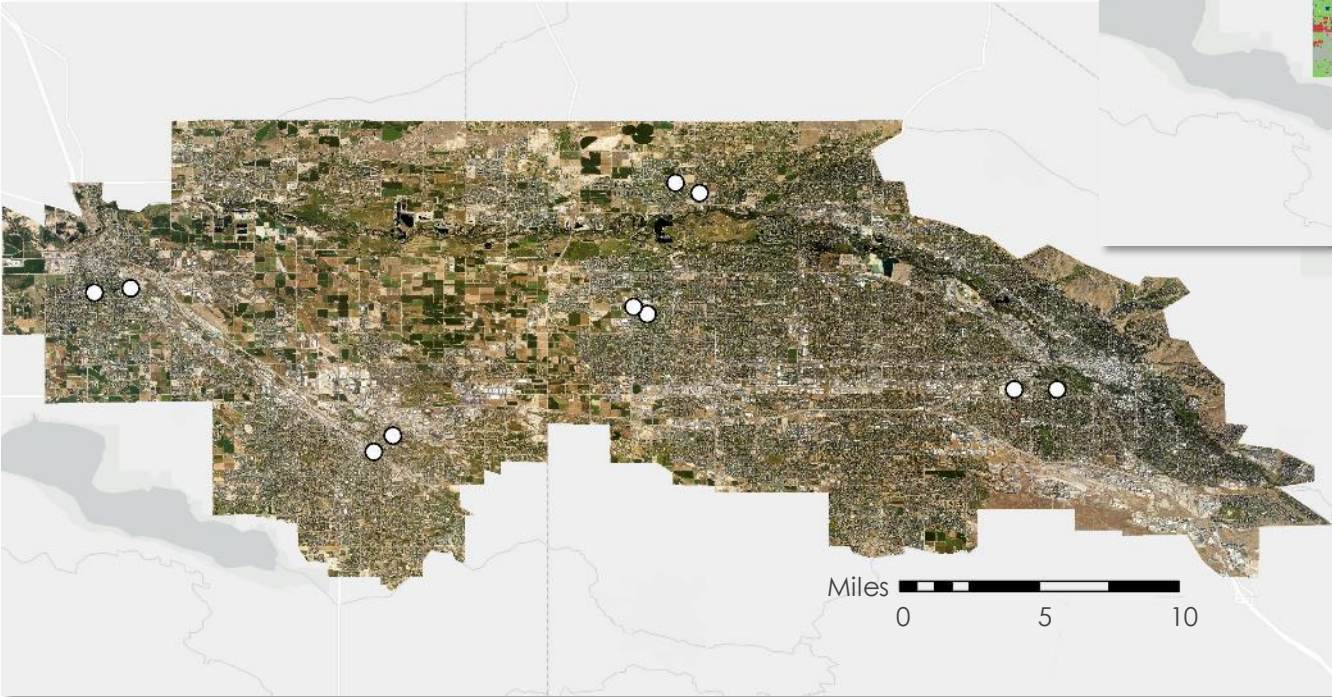


Paired Samples Comparison

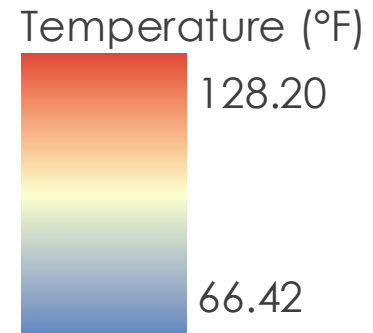


Paired Samples Comparison

Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community

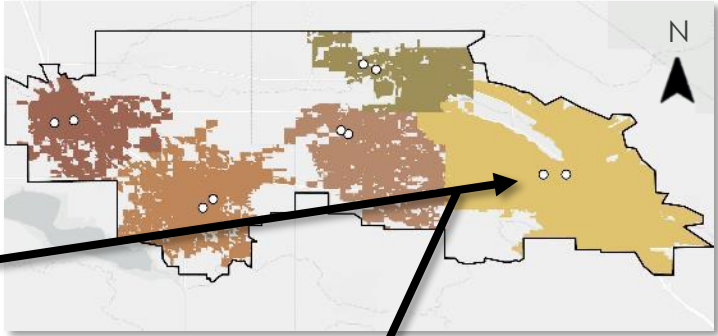


- Tree Canopy
- Grass/Shrubs
- Bare Soil
- Water
- Buildings
- Roads/Railroads
- Other Paved Surfaces
- Tall Shrubs

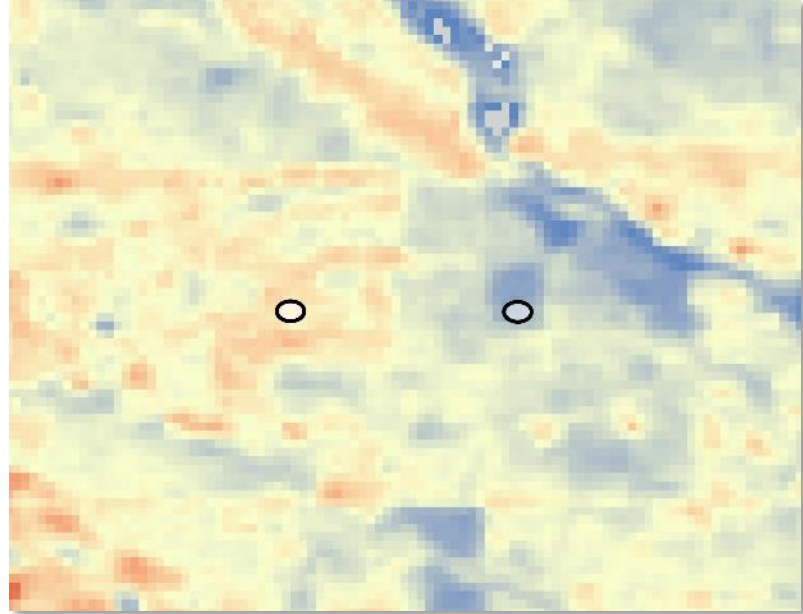
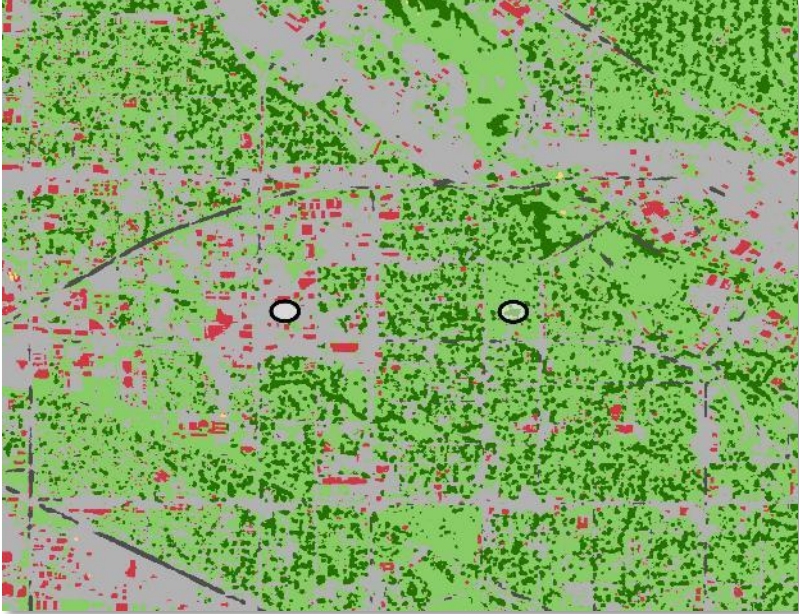


Paired Samples Comparison - Boise

Sample Site	% Tree Canopy	% Impervious	Mean LST (°F)
Tree-covered	38.66	0.03	91.75
No trees	0	99.93	107.75

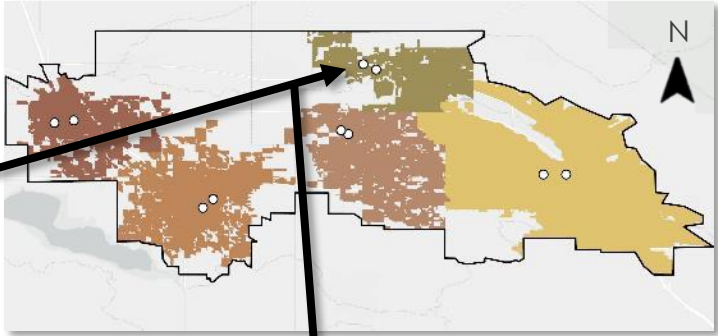


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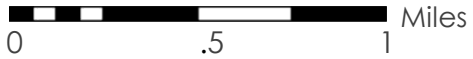
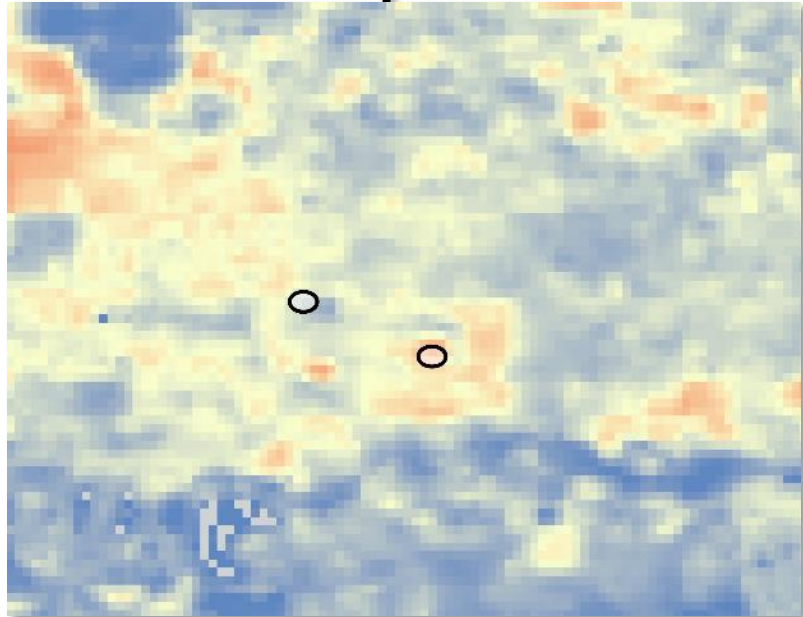
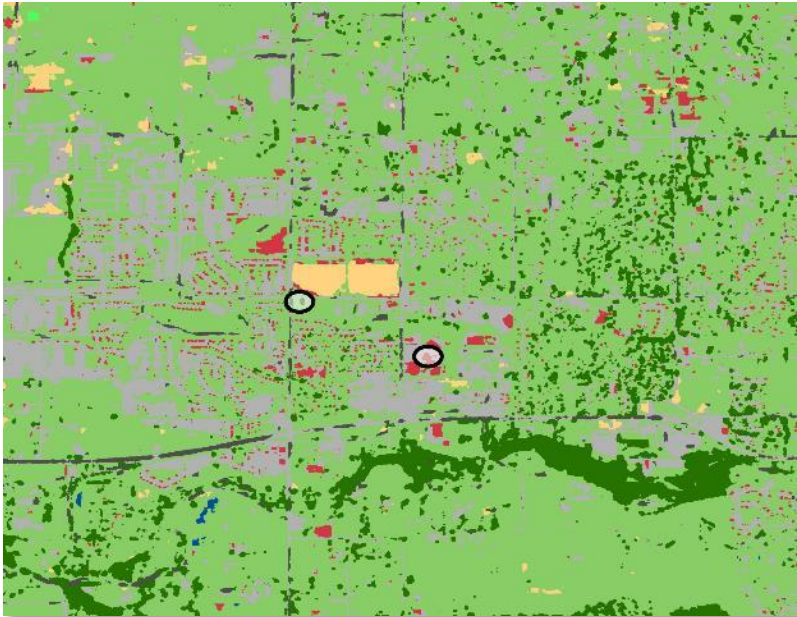


Paired Samples Comparison - Eagle

Sample Site	% Tree Canopy	% Impervious	Mean LST (°F)
Tree-covered	15.07	20.05	97.16
No trees	0	94.29	113.09



Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



Errors & Uncertainties

Data

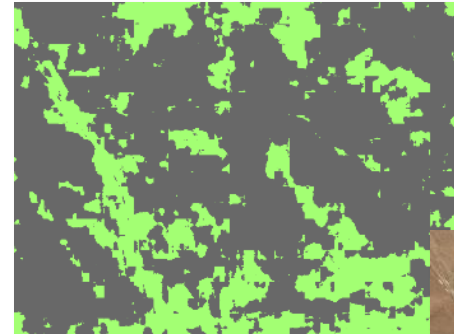
- Availability
- Quality
- Spatial resolution

Process

- Filtering
- Resampling
- Qualitative comparison
- Classification



Image Credit: Treasure Valley Canopy Network



Reference area misclassification



Partner Implementation

Identify and locate urban heat islands in Treasure Valley

Use maps to identify areas with lowest tree canopy cover to focus tree planting efforts

Community education/outreach



Image Credit: Treasure Valley Canopy Network



Conclusions



Image Credit: Treasure Valley Canopy Network

Areas in Treasure Valley saw an expansion and **intensification of UHI**

Areas in Treasure Valley with lower **tree canopy** + more **impervious surface** tend to exhibit **higher LST**



Areas in Treasure Valley, particularly dense urban cores, would **benefit from tree planting to mitigate UHI**

Acknowledgements

- **Treasure Valley Partners:** Emma Stammer (Program Director at TVCN) and Alex Brooks (Climate and Sustainability Coordinator for City of Boise)
- **DEVELOP Science Advisors:** Keith Weber (Idaho State University), Dr. Xia Cai (NASA Langley Research Center), Dr. Kenton Ross (NASA Langley Research Center)
- **Lead:** Isaac Goldings (Idaho – Pocatello)



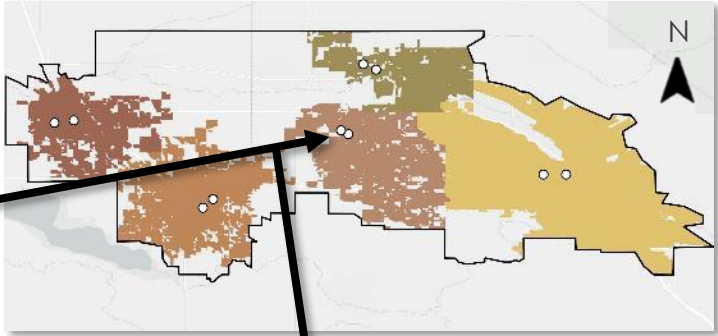
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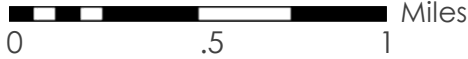
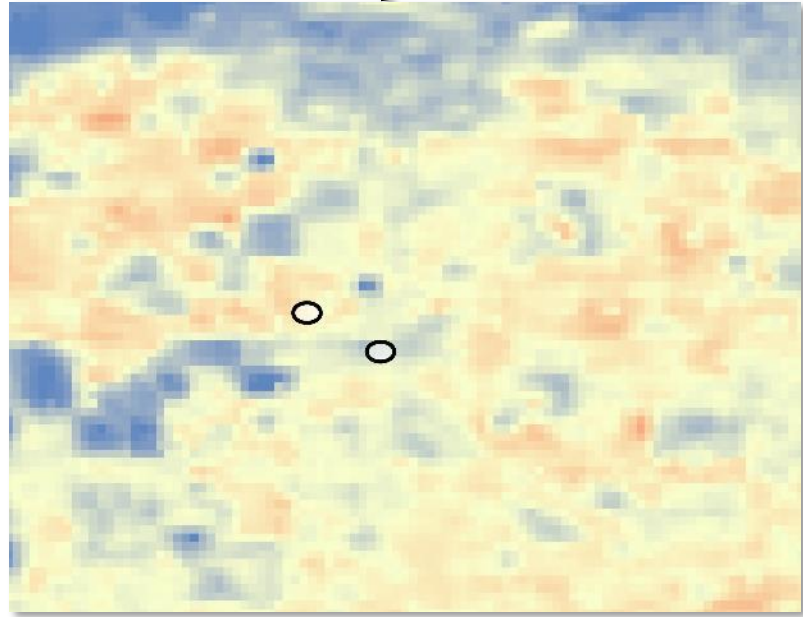
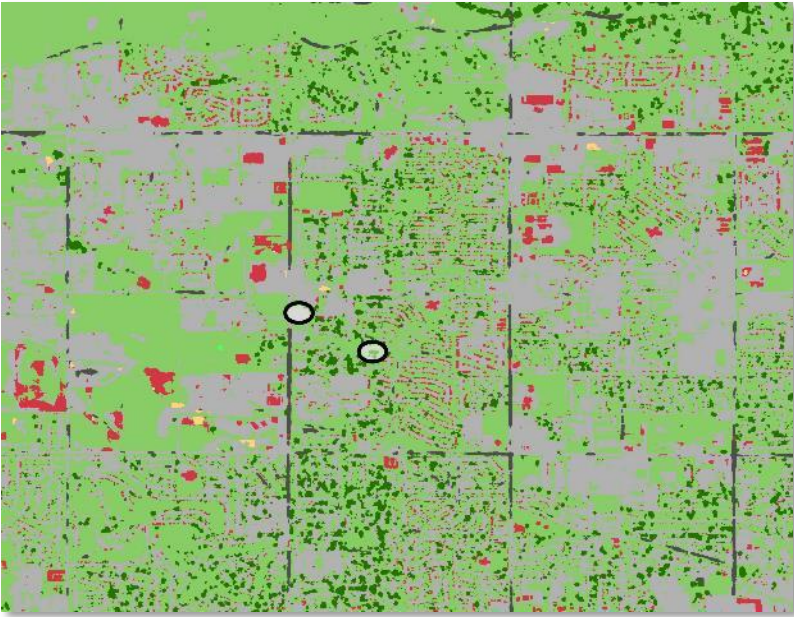
Additional Partner Information

Paired Samples Comparison - Meridian

Sample Site	% Tree Canopy	% Impervious	Mean LST (°F)
Tree-covered	19.77	25.16	99.21
No trees	4.29	76.11	107.16

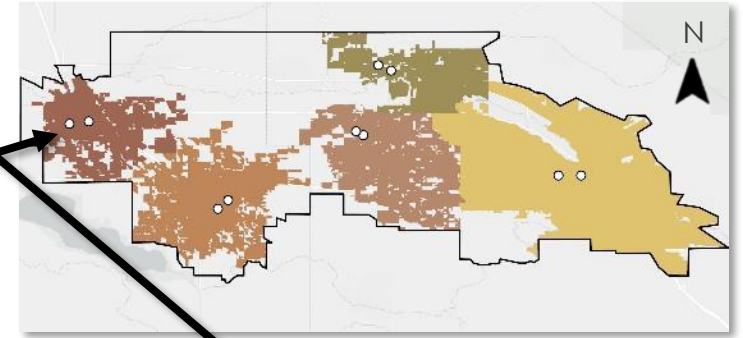


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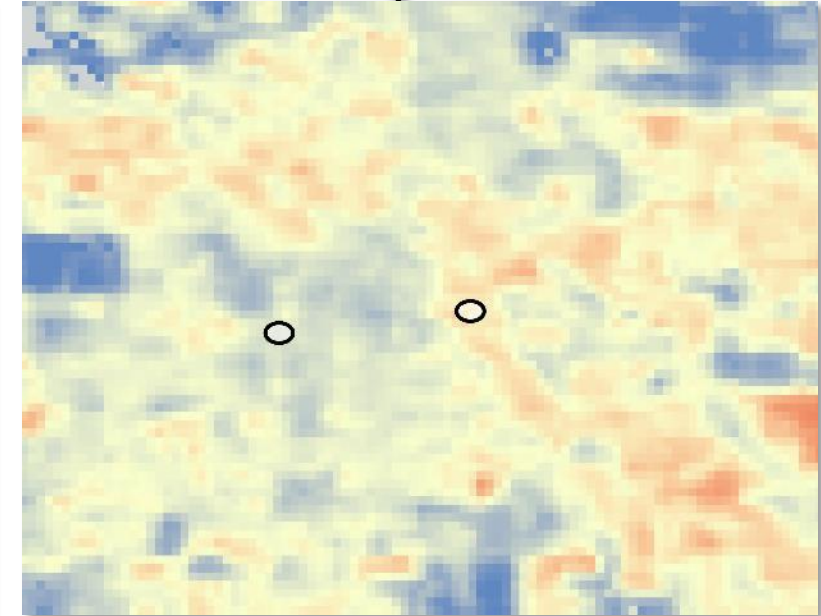
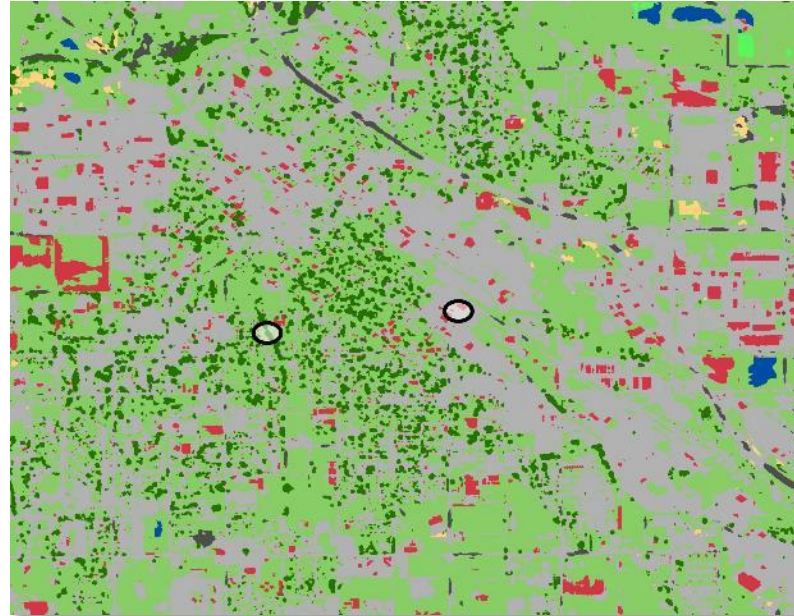
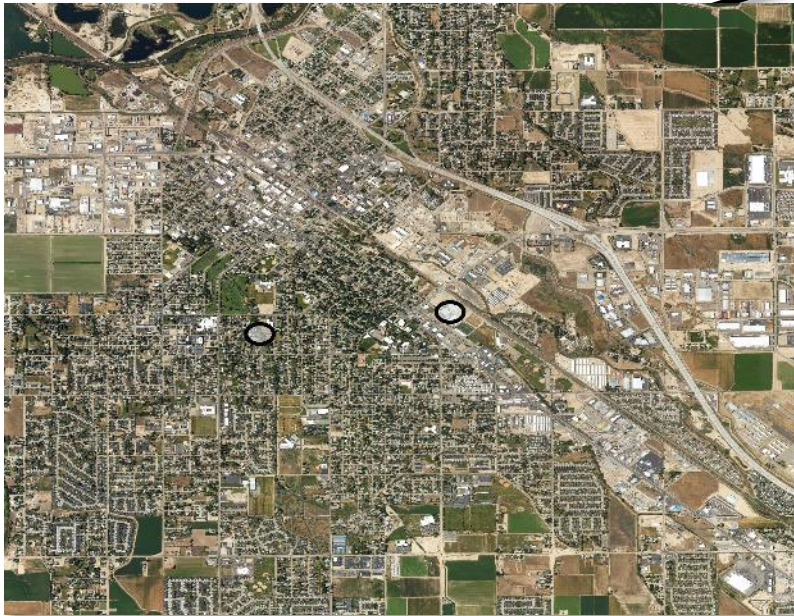


Paired Samples Comparison - Caldwell

Sample Site	% Tree Canopy	% Impervious	Mean LST (°F)
Tree-covered	26.24	15.19	99.66
No trees	0	96.49	108.03



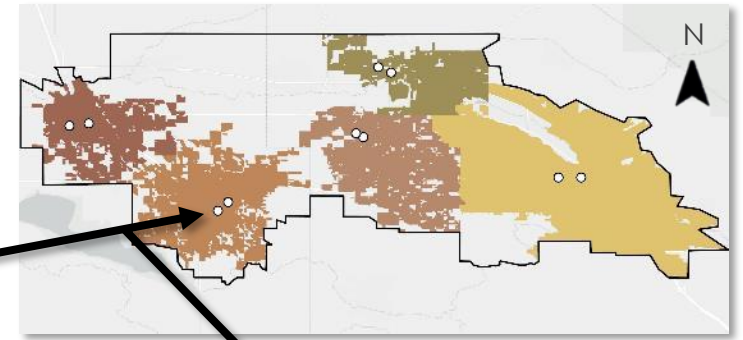
Basemap credits: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



0 .5 1 Miles

Paired Samples Comparison - Nampa

Sample Site	% Tree Canopy	% Impervious	Mean LST (°F)
Tree-covered	39.56	2.68	91.47
No trees	1.27	96.49	112.02



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