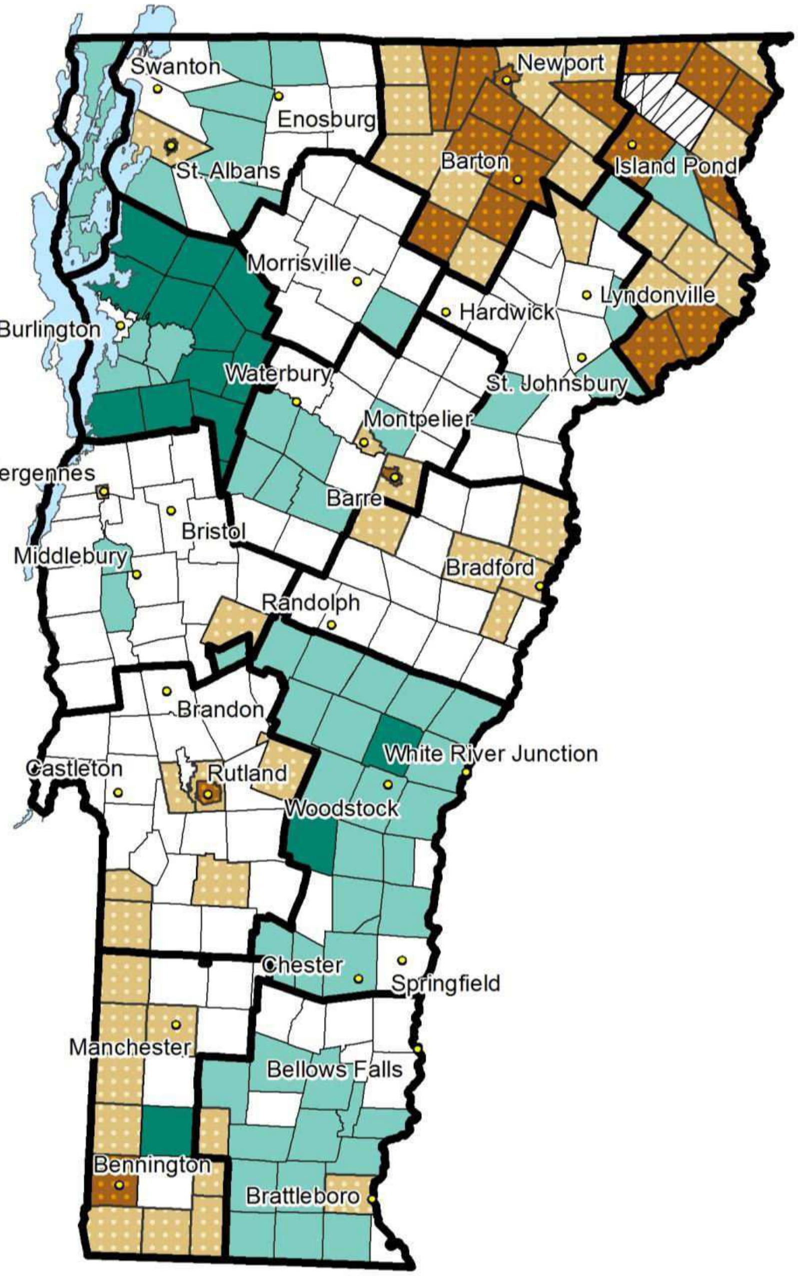


Heat Vulnerability in Vermont

Local Indicators of Heat Illness Risk

VERMONT
DEPARTMENT OF HEALTH

May 2016

Introduction

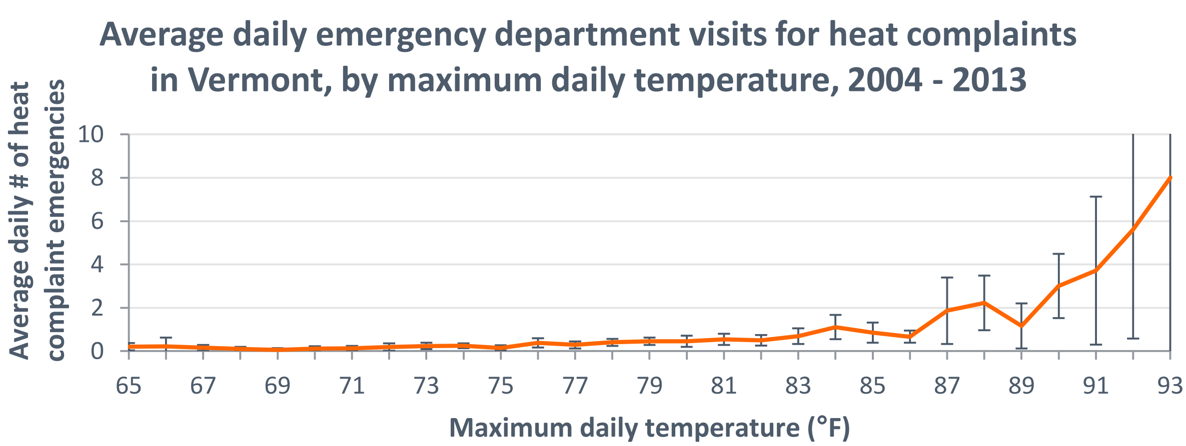
Vermonters are at greater risk for serious heat-related illnesses, and even death, when the statewide average temperature reaches 87°F or hotter. To better understand the geographic variability of heat-illness risk within Vermont, the Health Department has developed a heat vulnerability index. The heat vulnerability index uses state and federal data sources to quantify the risk for heat-related illness at the town/city level in Vermont. Indicators are mapped individually, combined into index indicators for six different categories of risk, and further combined to provide a composite heat vulnerability index. This report describes the indicators, the methods used to select these indicators and the results of this analysis.

The heat vulnerability maps included in this report are also available in an online format at: http://healthvermont.gov/enviro/climate/

Background

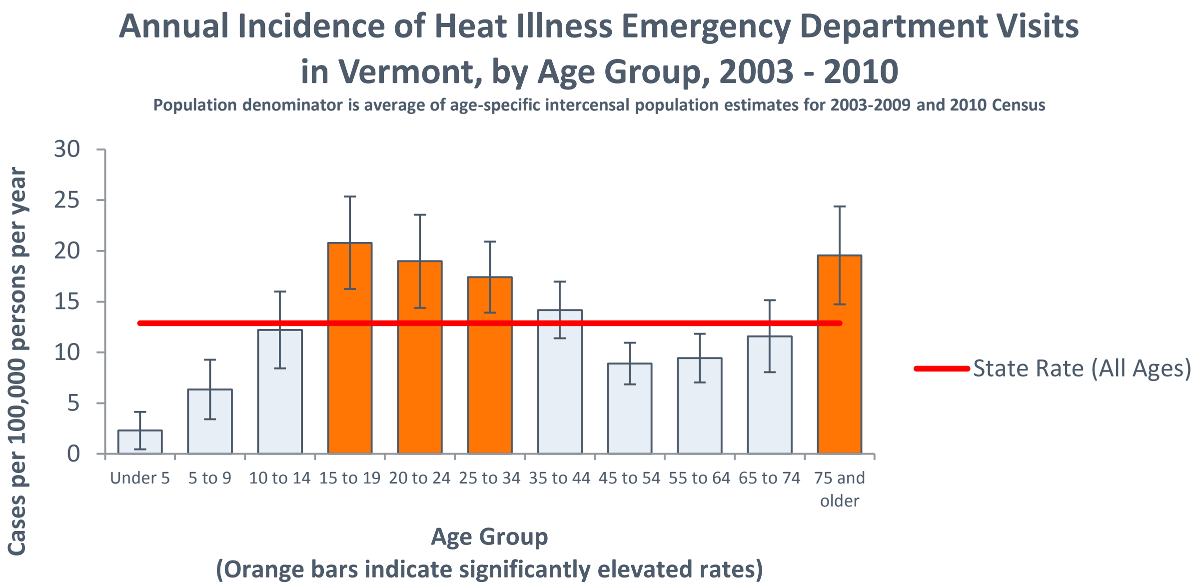
Since 2000, Vermont has had an average of seven hot days per year when the temperature reached 87°F or hotter. Climate models from the Vermont State Climate Office predict 15 to 20 hot days per year by mid-century and 20 to 34 hot days per year by the end of the century. In the absence of adaptation, as the climate warms and there are more hot days, more heat-related illnesses and deaths will occur.

Working with the Vermont State Climate Office, the Health Department analyzed 14 years of temperature and mortality data, and ten years of surveillance data for emergency department (ED) and urgent care visits. On days when the statewide average temperature reached at least 87°F, ED visits for heat-related illnesses, such as heat exhaustion and heat stroke, occurred eight times more frequently, and there was one additional death per day among individuals age 65 and older. Deaths due to heart disease, stroke, and neurological conditions were relatively more common on these days reaching at least 87°F as compared to cooler days. The statewide average temperature of 87°F corresponds to a range from about 85°F in cooler counties like Bennington and Essex to almost 89°F in warmer counties like Chittenden and Windham.



Data sources: temperature data – PRISM Climate Group, Oregon State University, in partnership with the Vermont State Climate Office and the National Oceanic and Atmospheric Administration's Postdocs Applying Climate Expertise Fellowship Program, University Corporation for Atmospheric Research; emergency department data - Early Aberration Reporting System (EARS).

Compared to those living in warmer climates, Vermonters may be especially sensitive to heat for two reasons: we are not accustomed to hot temperatures and many of our homes and businesses are not designed to deal with summer heat. This may help explain why some of the highest rates of heat-related illnesses occur in cooler counties in Vermont.



Data source: Vermont hospital discharge data

Vermont data indicate that adults 75 and older and people between the ages of 15 to 34 are affected most by heat-related illnesses. In addition to these at-risk age groups, national studies suggest that those who work or exercise outdoors, infants and children, people who are obese, have a long-term medical condition, and people living in more urbanized areas also tend to be at greater risk. Some people will have heat-related illnesses at temperatures even lower than the mid-80s.

Indicators

Indicators of heat-related illness were identified based upon their expected association with heat illness (as suggested by published evidence and/or Vermont data) and data availability. The selected indicators were categorized into six types of risk: population, socioeconomic, health, environmental, acclimation, and historic heat emergencies. The tables below list every indicator that was developed for each risk category, the data source, the geographic level that the data were available for, references or other notes providing evidence describing the relevance of each indicator, whether the indicator was included in the final heat vulnerability index, and the Pearson's correlation coefficient, between the indicator and the Vermont age-adjusted hospitalization rate for heat illness, per 100,000 persons, per year. Indicators that were not at least marginally associated with observed heat illness (p-value>0.1, corresponding to a correlation coefficient of about 0.1 or less) were not included in the final heat vulnerability index.

Population index

Certain population groups are at increased risk due to:

- Dependence on others for care (e.g. infants, older adults)
- Reduced thermoregulation ability (e.g. older adults)
- High occupational or lifestyle exposure (e.g. young adults, outdoor workers)

Indicator	Data source(s)	Geographic level	References/notes	Included in index?	Correlation coefficient
% of population < 5 years old	U.S. Census, American Community Survey (ACS), 2009-2013	Town	CDC 2013; Kovats and Hajat, 2008	Yes	0.11~
% of population 15-34 years old	ACS, 2009-2013	Town	Above average risk was identified for this age group using Vermont hospital discharge data	No	-0.06
% of population ≥65 years old	ACS, 2009-2013	Town	CDC 2013; Kovats and Hajat, 2008; Reid et al. 2009; Kenny et al. 2010	Yes	0.23***
% of adults working in outside occupations	ACS, 2009-2013	Town	Schulte and Chun, 2009	No	0.03

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, ~$p<0.1$

Socioeconomic index

Individuals with low socioeconomic status often lack the resources to adapt to extreme temperatures, while those living alone may lack access to needed care during a heat event.

Indicator	Data source(s)	Geographic level	References/notes	Included in index?	Correlation coefficient
% of population living below federal poverty line	ACS, 2009-2013	Town	CDC 2013; Reid et al. 2009; Kovats and Hajat, 2008;	Yes	0.19**
% of adults with no high school diploma	ACS, 2009-2013	Town	Reid et al. 2009;	Yes	0.30***
% of population with non-white race or Hispanic ethnicity	ACS, 2009-2013	Town	Reid et al. 2009;	No	-0.06
% of population >=65 years old living alone 6	ACS, 2009-2013	Town	CDC 2013; Reid et al. 2009;	Yes	0.11~
% of adults with no health insurance	ACS, 2009-2013	Town	Schmeltz et al. 2015	Yes	0.10~

*** $p<0.001$, ** $p<0.01$, * $p<0.05$, ~$p<0.1$

Health index

Those with certain pre-existing medical conditions or those taking certain medications may experience a reduced ability to thermoregulate.

Indicator	Data source(s)	Geographic level	References/notes	Included in index?	Correlation coefficient
% of adults that reported being diagnosed diabetes	Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013	County	Kovats and Hajat, 2008; Kenny et al. 2010	Yes	0.37***
% of adults with current asthma	BRFSS, 2012 - 2013	County	Kenny et al. 2010	Yes	0.14*
% of adults that reported being diagnosed with hypertension	BRFSS, 2012 - 2013	County	Kovats and Hajat, 2008; Kenny et al. 2010	Yes	0.39***
% of adults who are obese based on self-reported height and weight	BRFSS, 2012 - 2013	County	Kenny et al. 2010	Yes	0.26***
% of adults that reported being in fair or poor health	BRFSS, 2012 - 2013	County	This indicator is used as a more general proxy for other known medical risk factors	Yes	0.39***
Age-adjusted mortality rate (annual deaths per 100,000 population)	Vermont Vital Records, 1999-2012	Sub-county (89 towns or groups of towns)[a]	This indicator is used as a more general proxy for other known medical risk factors	Yes	0.32***

*** p<0.001, ** p<0.01, * p<0.05, ~p<0.1

[a] For further documentation, see: https://apps.health.vermont.gov/IAS/DynamicReports/CancerSIRsGeo107/DataNotes.html#_Toc397696306

Environmental index

Urban areas with extensive impervious surfaces (e.g. roads, rooftops) and limited vegetative cover may experience warmer temperatures than their more rural surroundings, especially for those living on upper floors of multi-story buildings.

Indicator	Data source(s)	Geographic level	References/notes	Included in index?	Correlation coefficient
Housing density (units / mile^2)	ACS, 2009-2013, as calculated from housing count and town area	Town	Kovats and Hajat, 2008;	Yes	0.19**
% of town area covered by impervious surface	National Land Cover Database, US Geological Survey (NLCD), 2011 Edition, (amended 2014)[a]	County	Reid et al. 2009; Kovats and Hajat, 2008	Yes	0.22***
% of town area covered by tree canopy	NLCD, 2011 Edition (amended 2014)[b]	County	Reid et al. 2009; Kovats and Hajat, 2008	Yes	0.22***

*** p<0.001, ** p<0.01, * p<0.05, ~p<0.1

[a] For more info: Xian G, Homer C, Dewitz J, Fry J, Hossain N, Wickham J. 2011. The change of impervious surface area between 2001 and 2006 in the conterminous United States. *Photogrammetric Engineering and Remote Sensing*, Vol. 77(8): 758-762.

[b] For more info: Homer CG, Dewitz JA, Yang L, Jin S, Danielson P, Xian G, Coulston J, Herold ND, Wickham JD, Megown K. 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354.

Acclimation index

Local climate conditions dictate the amount of heat exposure an area receives, the amount of physiological acclimation that takes place, and the design of homes, landscapes, and communities. When exposed to frequent, hot conditions, the body adjusts to better regulate sweating and cooling responses, and people tend to design buildings and landscapes to minimize heat impacts.

Indicator	Data source(s)	Geographic level	References/notes	Included in index?	Correlation coefficient
Average number of days per year >=87°F	PRISM, 1981-2010	County	Temperature threshold was established based on Vermont Department of Health analysis; acclimation: Hanna and Tait, 2015	Yes[a]	-0.34***

*** p<0.001, ** p<0.01, * p<0.05, ~p<0.1

[a] Vermont data indicated an inverse association between the county-level number of days per year when the temperature reached 87°F or warmer and observed heat illness. While this result is still being investigated, our hypothesis is that residents of cooler counties are less physiologically acclimated to high temperatures and less likely to have air conditioning or other means of mitigating heat impacts on health. Based on these findings, this indicator was included as a metric for acclimation, where fewer days per year with temperatures 87°F or warmer were associated with less acclimation and therefore higher risk for heat illness.

Heat emergency index

Although many individuals do not seek medical treatment for heat illness, there are approximately 80 cases per year reported from Vermont hospitals.

Indicator	Data source(s)	Geographic level	References/notes	Included in index	Correlation Coefficient
Age-adjusted hospitalization rate for heat illness, per 100,000 persons, per year	Vermont Unified Hospital Discharge Data Set, 2003-2010	14 counties plus 5 urban areas	This indicator is a measure of historic, observed heat illness	Yes	n/a

One observed heat illness indicator was included in the **heat emergency index**.

Other potential indicators

Indicators could only be developed where data already existed at a sub-state geographic resolution. This excluded several relevant risk indicators that would be useful to include if and when data become available:

- Homeless population
- Air conditioning prevalence
- Availability of local cooling center

Methods

Several preliminary steps were required to appropriately combine indicators into an overall heat vulnerability index and map the results at the town level. To minimize the influence of outliers (data points falling far outside of the bulk of the distribution) and skewed data distributions (where most of the data are bunched at one extreme end of the distribution), transformations were applied to most of the indicators to better represent the data on a normal (Gaussian) distribution, where a perfectly normal distribution contains an equal number of data points distributed symmetrically above and below the mean. Using normal distributions was important for the calculation of z-scores, which were used to rank geographic areas in each indicator, and for identifying the cut points between mapping categories.

Histograms were used to visually review the distribution of each indicator and test the impact of standard transformations. In the example below, the distribution for impervious surface is extremely right skewed, with most of the values concentrated in the very low (left) end of the distribution and relatively few scattered throughout the high (right) end of the distribution. After applying a logarithmic transformation, the distribution better approximates a normal distribution. For right-skewed distributions, root or logarithmic transformations are commonly used to approximate normality. For left-skewed distributions, power transformations are commonly used to approximate normality.

Figure 1a. Percent Impervious surface coverage in Vermont Towns - Untransformed

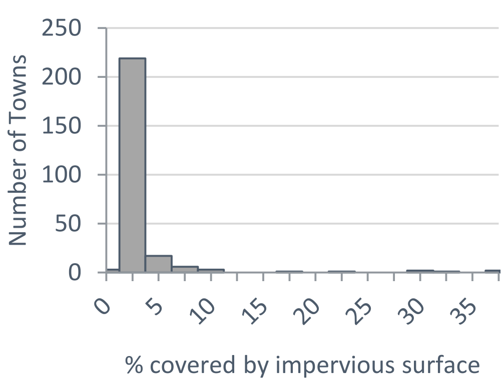
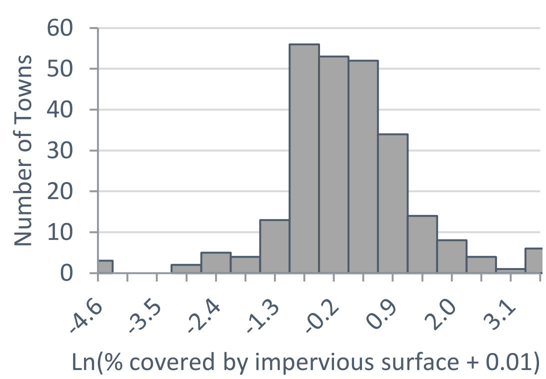


Figure 1b. Percent Impervious surface coverage in Vermont Towns - Log-Transformed



A list of the indicators and transformations is provided below:

Indicator	Skew	Transformation
% of population < 5 years old	minimal	none
% of population >= 65 years old	right (strong)	$x^{0.5}$
% in poverty	right (weak)	$x^{0.75}$
% with no high school diploma	right (strong)	$x^{0.5}$
% of adults >=65 living alone	right (weak)	$x^{0.75}$
% with no health insurance	right (weak)	$x^{0.75}$
% of adults who have ever been told they have diabetes	minimal	none
% of adults with current asthma	right (strong)	natural log(x)
% of adults with hypertension	minimal	none
% of adults who are obese	minimal	none
% of adults in fair or poor health	right (strong)	natural log(x)
Age adjusted mortality rate	minimal	none
Housing density	right (extreme)	natural log(x + 1)
% impervious surface	right (extreme)	natural log(x + 0.01)
% forest cover	left (extreme)	x^2
Number of days per year >=87°F	right (strong)	natural log(x)
Age-adjusted hospitalization rate for heat illness	right (strong)	natural log(x)

Following transformation, each indicator was converted to a z-score by applying the following formula:

$$z\ score = \frac{(indicator\ value - average\ of\ all\ indicator\ values)}{Std.deviation\ of\ all\ \ indicator\ values}$$

Z-scores were used to normalize the values of every indicator onto a consistent scale, allowing for the aggregation of indicators into index variables. Z-scored values for each indicator were centered on a mean of zero, with the z-score indicating the number of standard deviations (SDs) above or below the mean for each indicator value. SDs indicate the extent of the spread of a data distribution. For a normal distribution, 68% of the data fall within one SD of the mean, 95% of the data fall within two SDs, and 5% of the data are further than two SDs from the mean.

An index indicator was then developed at the town-level for each of the six categories by summing the z-scored indicator values within each category and dividing by the number of indicators in the index, thus taking the average score of the indicators in the index. The count of indicators in each index and the correlation between each composite indicator and observed heat illness were as follows:

Index name	Number of indicators included	Correlation coefficient
Population index	2	0.25***
Socioeconomic index	4	0.25***
Environmental index	3	0.16*
Health index	6	0.45***
Acclimation index	1	0.35***
Heat emergency index	1	n/a

*** p<0.001, ** p<0.01, * p<0.05, ~p<0.1

Each indicator was weighted equally within its index. For indicators that were not available at the town level, town values were assumed to be the same as those for the smallest available geographic level for which data were available. For example, if only county-level data were available for an indicator, all towns within that county were assumed to have the same county value for the indicator.

An overall heat vulnerability index was then developed by summing the values for the six composite indicators at the town level. Each composite indicator was weighted equally in the heat vulnerability index. The overall index had a correlation of 0.72 ($p<0.001$) with observed heat illness.

Mapping

Individual indicators were mapped using the geographic level of the original data source. For individual indicators, a 4-category scale was used. Threshold values dividing each category were identified using the transformed distribution of values for each indicator. The choice of cut points depended on the extent of skewness of the original distribution. The cut points for indicators, in standard deviations, were as follows:

Category	Extreme left skewed	Minimal, weak, or strongly skewed	Extreme right skewed
Lowest vulnerability	< -2	< -1	< 0
Low – average	-2 to -1	-1 to 0	0 to 1
Average – high	-1 to 0	0 to 1	1 to 2
Highest vulnerability	> 0	> 1	> 2

After identifying the cut point values using the transformed distribution, the cut point values were un-transformed back to the original scale for mapping.

All index values were mapped at the town-level. For index values, a 5-category scale was used. Cut points were identified using the distribution of town-level values for each index variable. The cut points for index values, in standard deviations, were as follows:

Category	All indices
Lowest vulnerability	< -1.5
Low – average	-1.5 to -0.5
Average vulnerability	-0.5 to 0.5
Average – high	0.5 to 1.5
Highest vulnerability	> 1.5

Results

All indicator and index maps are provided at the end of this report.

The heat vulnerability index indicated that the highest risk areas for heat illness were located in the northeastern counties of Orleans and Essex, along with the urbanized areas of Bennington, Montpelier, Rutland, St. Albans, and Vergennes. The high risk in both northeastern counties was most strongly related to high historic incidence of heat illness and lack of heat acclimation. In Orleans County only, pre-existing medical conditions were also a major determinant of risk. Low socioeconomic status, lack of health insurance, and a high percentage of older adults contributed to a lesser extent to the increased risk in both Orleans and Essex County. In the urbanized areas, the most common contributors to the high risk were high historic incidence of heat illness and an urbanized environment, which includes a high percentage of land area covered with pavement or rooftops with limited tree canopy cover.

In contrast, the areas with lowest risk for heat illness were predominantly located in Chittenden, Windsor, and Windham counties. All three counties rated high on heat acclimation. Having relatively few pre-existing medical conditions contributed to lower risk in Chittenden and Windsor counties. Chittenden's risk was also lowered by having high socioeconomic status.

Conclusions

The heat vulnerability indicator and index maps provide a basic understanding of heat illness risk at the local level in Vermont. Every individual in every town is at some risk for heat illness, though the indicators in this report should help to identify towns and cities where the risks are relatively higher than others, and why.

The indicators in this report offer a first, broad-brush assessment of localized risk. Within a specific town or city, risk will further vary by environmental and individual characteristics. Local knowledge is critical for understanding the people, places, jobs, or activities within the town or city where risk may be especially high. The maps and indicators in this report could be used at the local level by town officials, health officers, emergency responders, community aid organizations, and others to conduct a more localized vulnerability assessment to help identify the locations of the highest risk groups or individuals within the town or city.

Having identified local vulnerabilities, the next step is to ensure plans are in place for providing information and assistance to groups and individuals most at risk. On a hot day, the Health Department recommends that people:

- Stay in a cool location—either in the shade outdoors or in a cool room inside such as a basement or air conditioned room
- Draw shades while inside to keep out the sun
- Limit exercise and outdoor activity during the hottest midday hours
- Wear lightweight, light-colored, and loose-fitting clothing
- Take a cool shower or bath, or go swimming in a safe location

- Drink more water than usual—don't wait until you're thirsty to drink
- Avoid alcohol, caffeine, and drinks containing high amounts of sugar
- Rest if you feel faint or sick
- Check in on loved ones and neighbors
- Follow local weather and news reports
- Sign up to receive alerts at vtalert.gov
- Never leave children, pets, or adults with disabilities in a parked vehicle

Additionally, the Health Department encourages all Vermonters to learn how to recognize and respond to heat-related illness. Heat cramps may be the first sign; other signs may include weakness, heavy sweating, nausea, vomiting, dizziness, fainting, and confusion.

More information on heat-related illness—how to prevent it, signs to look for, and what to do—is available on the Vermont Department of Health website at: healthvermont.gov/emerg/extremeheat.aspx. Additional resources from the National Weather Service can be found here: www.nws.noaa.gov/om/heat/index.shtml.

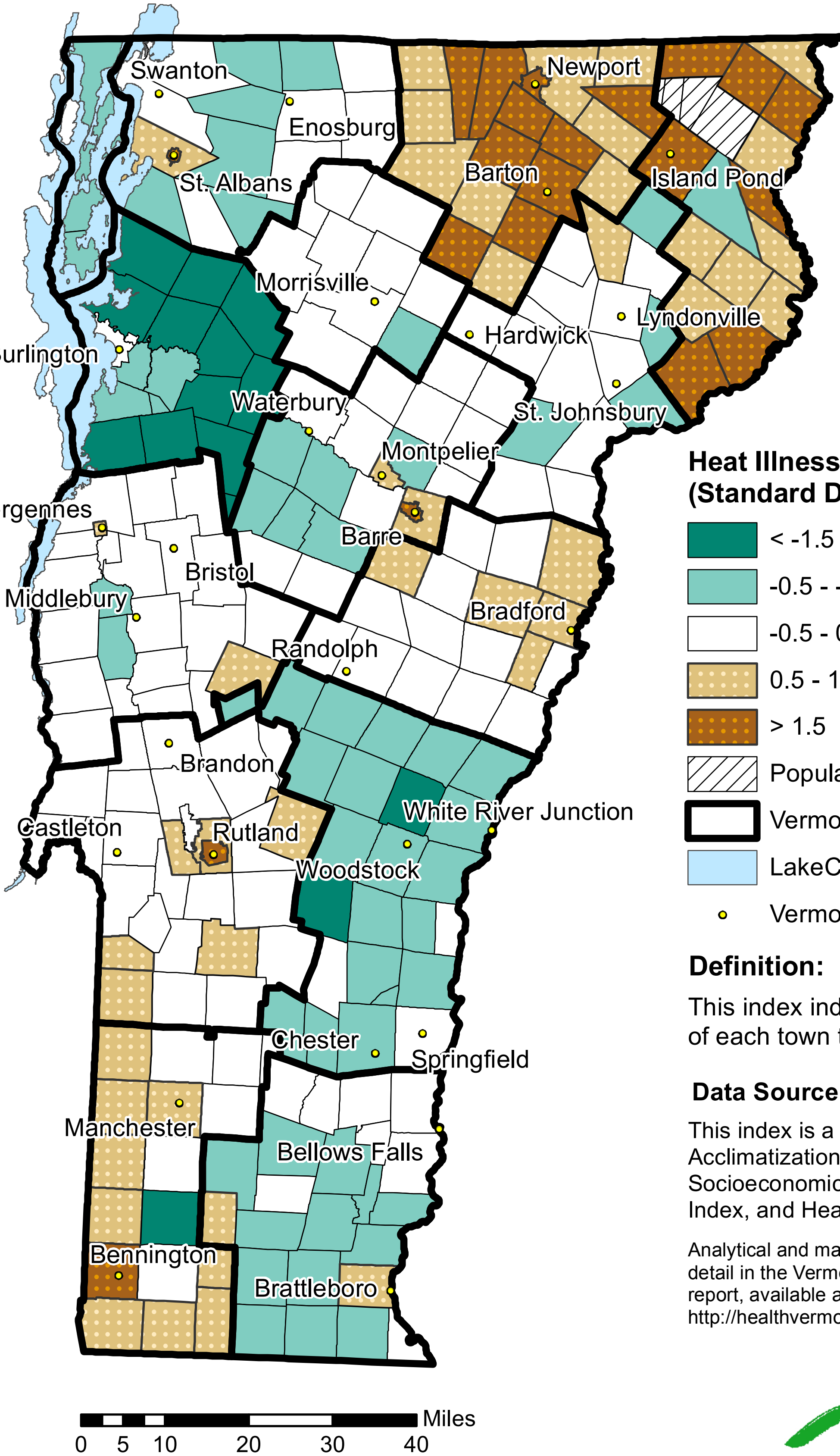
Especially since there will likely be more hot days in the future because of climate change, it is important for people, communities, and state agencies to take proactive steps to reduce heat-related health risks. Some steps that can be taken to better prepare for and lessen the effects of extreme heat events include:

- **Individuals and business owners** can:
  - Modify buildings to increase fresh air flow during summer heat, improve energy efficiency, and plant trees around buildings for more shade
  - Put in air conditioners, heat pumps, or similar cooling devices
- **Communities** and community groups can:
  - Create a community response plan for extreme heat events
  - Set up local cooling centers
  - Use local aid networks to find, check-in on, and assist at-risk people
  - Create cancellation policies for workers, students, and activities on hot days
  - Plant trees and shrubs, and reduce paved surfaces in urbanized areas
  - Use energy-efficient building design, including use of cool roofs and pavements
- The **Health Department** and its partner agencies can:
  - Make people aware of the dangers of extreme heat events
  - Offer education on how to reduce the risk of heat-related illness
  - Create a public health response plan for extreme heat events
  - Identify the appropriate temperature for issuing extreme heat warnings
  - Offer extreme heat information to the public through the Vermont 2-1-1 phone line

In addition to reducing health effects related to extreme heat, many of the steps listed above help in other ways such as reducing energy usage and costs, reducing greenhouse gas emissions, reducing air pollution, improving water quality, and increasing property values.

Heat Vulnerability Index

Heat Illness Vulnerability Index



Heat Illness Vulnerability (Standard Deviations)

- < -1.5
- -0.5 - -1.5
- -0.5 - 0.5
- 0.5 - 1.5
- > 1.5
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the overall vulnerability of each town to heat related illness.

Data Source:

This index is a composite of the following indices: Acclimatization Index, Population Index, Socioeconomic Index, Health Index, Environmental Index, and Heat Emergency Index.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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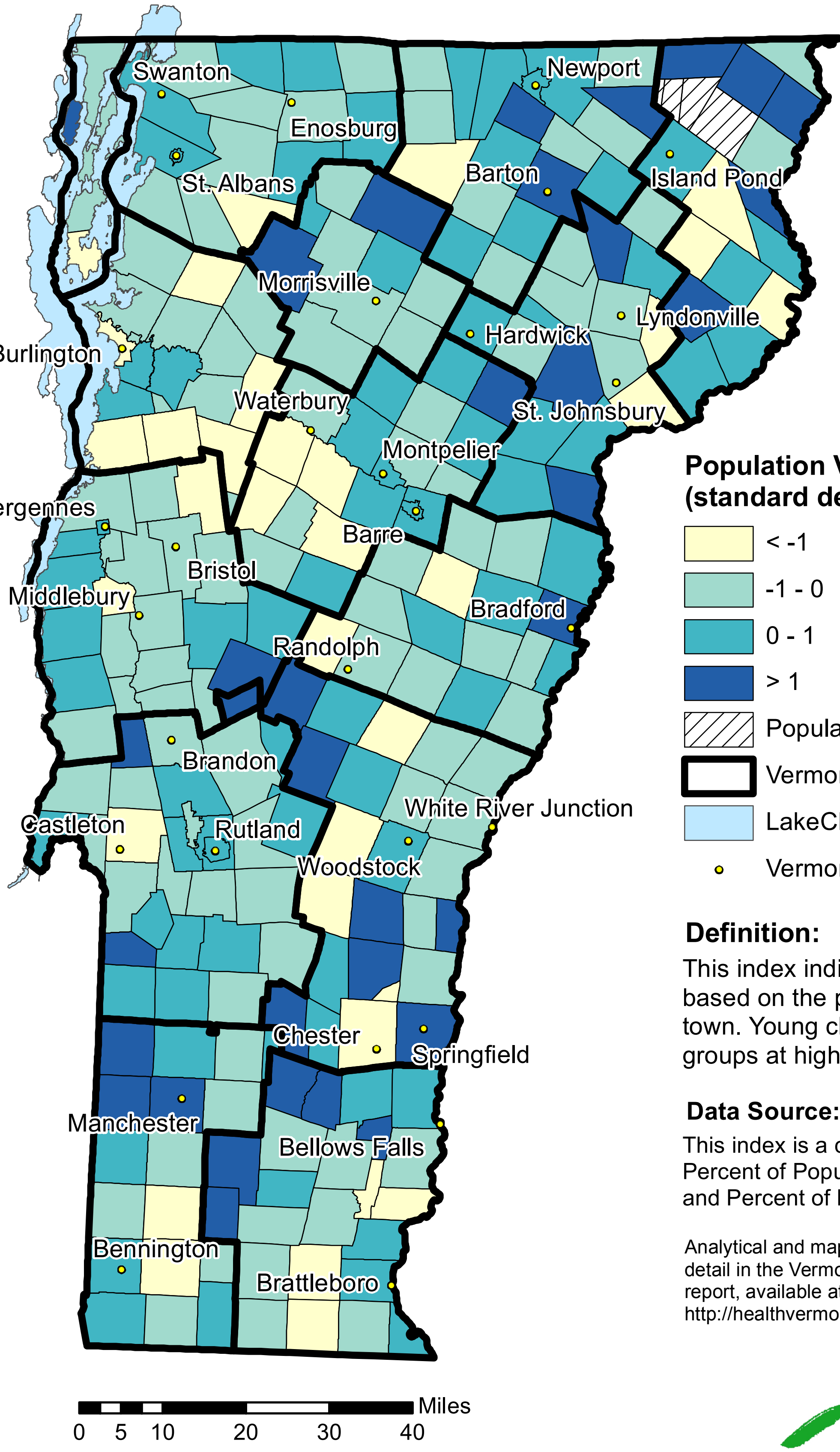
Population index

Indicators: Less than 5 years old
65 years old and older

Population Index



Population Vulnerability (standard deviations)

- < -1
- -1 - 0
- 0 - 1
- > 1
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the vulnerability of towns based on the population composition of the town. Young children and older adults are age groups at higher risk for heat-related illnesses.

Data Source:

This index is a composite of the following indicators: Percent of Population Less than Five Years Old, and Percent of Population 65 Years Old or Older.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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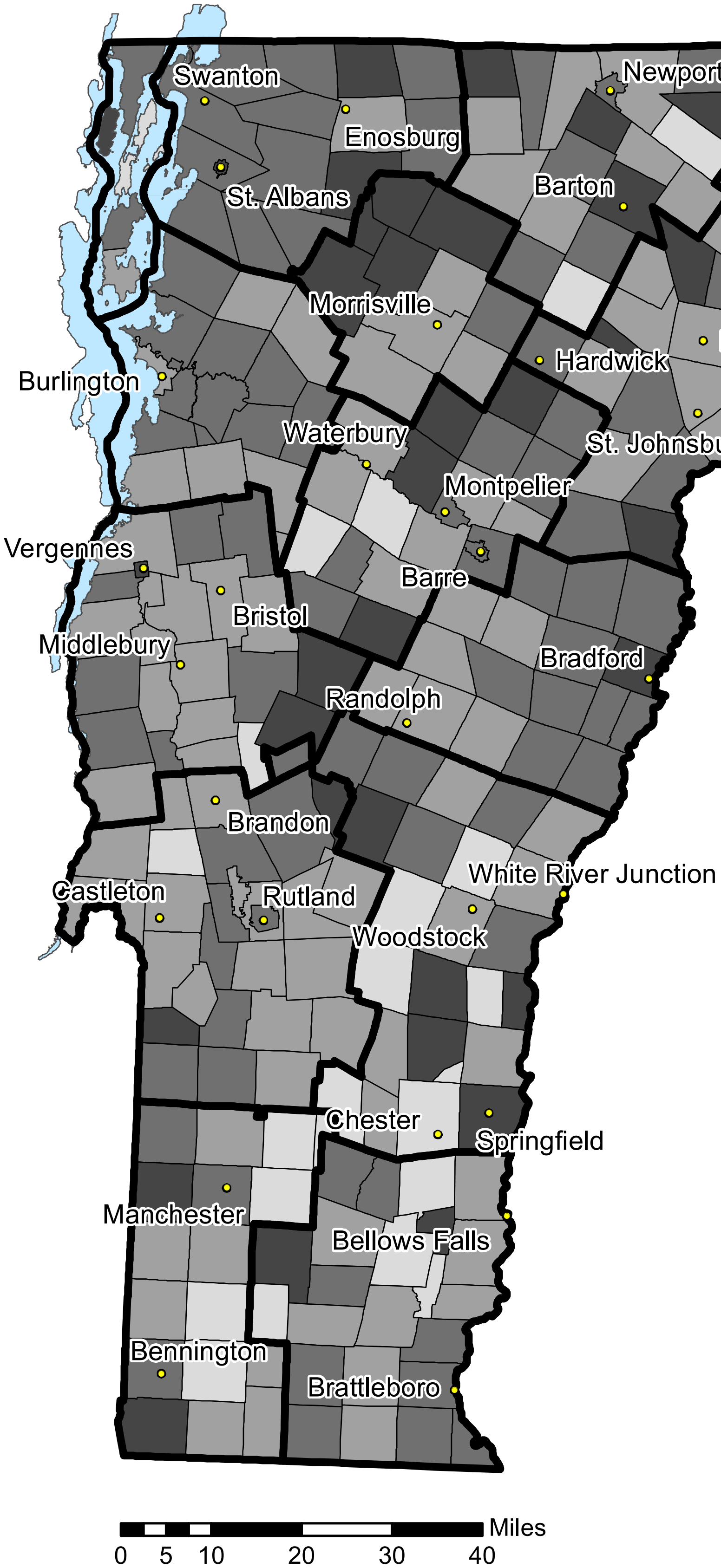
Children Less Than 5 Years Old



N

Vermont Average - 5.0%

National Average - 6.4%

Percent of Population Less Than 5 Years Old

- 0.0% - 2.3%
- 2.4% - 4.6%
- 4.7% - 6.9%
- 7.0% - 15.8%
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of the population that is less than five years old in Vermont towns

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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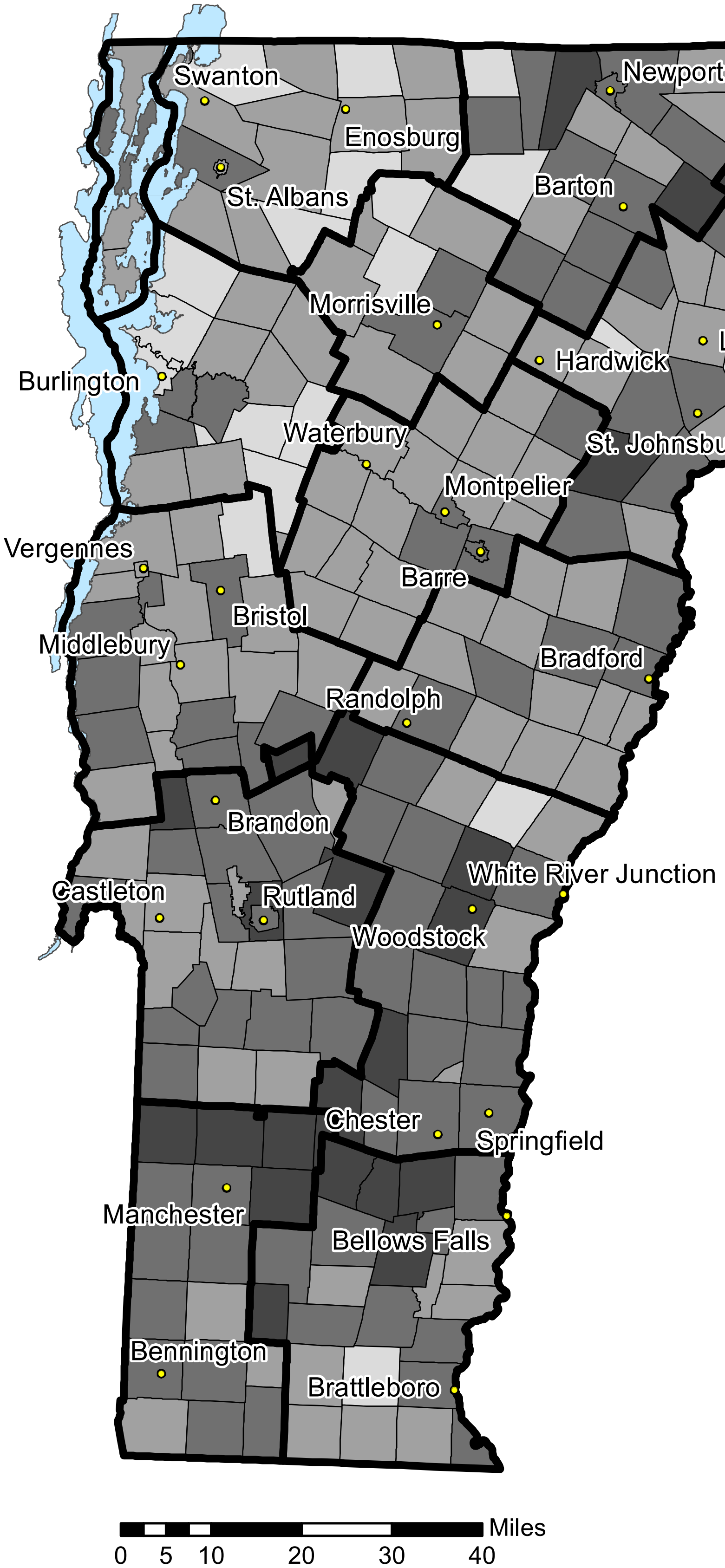
Adults Age 65 and Older



N

Vermont Average - 15.2%

National Average - 13.4%

Percent of Population 65 Years Old or Older

- 6.8% - 10.2% — *Less Vulnerable*
- 10.3% - 16.1%
- **State Median**
- 16.2% - 23.2%
- 23.3% - 100.0% — *More Vulnerable*
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Definition:

This is the percent of the population that is 65 years old or older in Vermont towns.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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Socioeconomic index

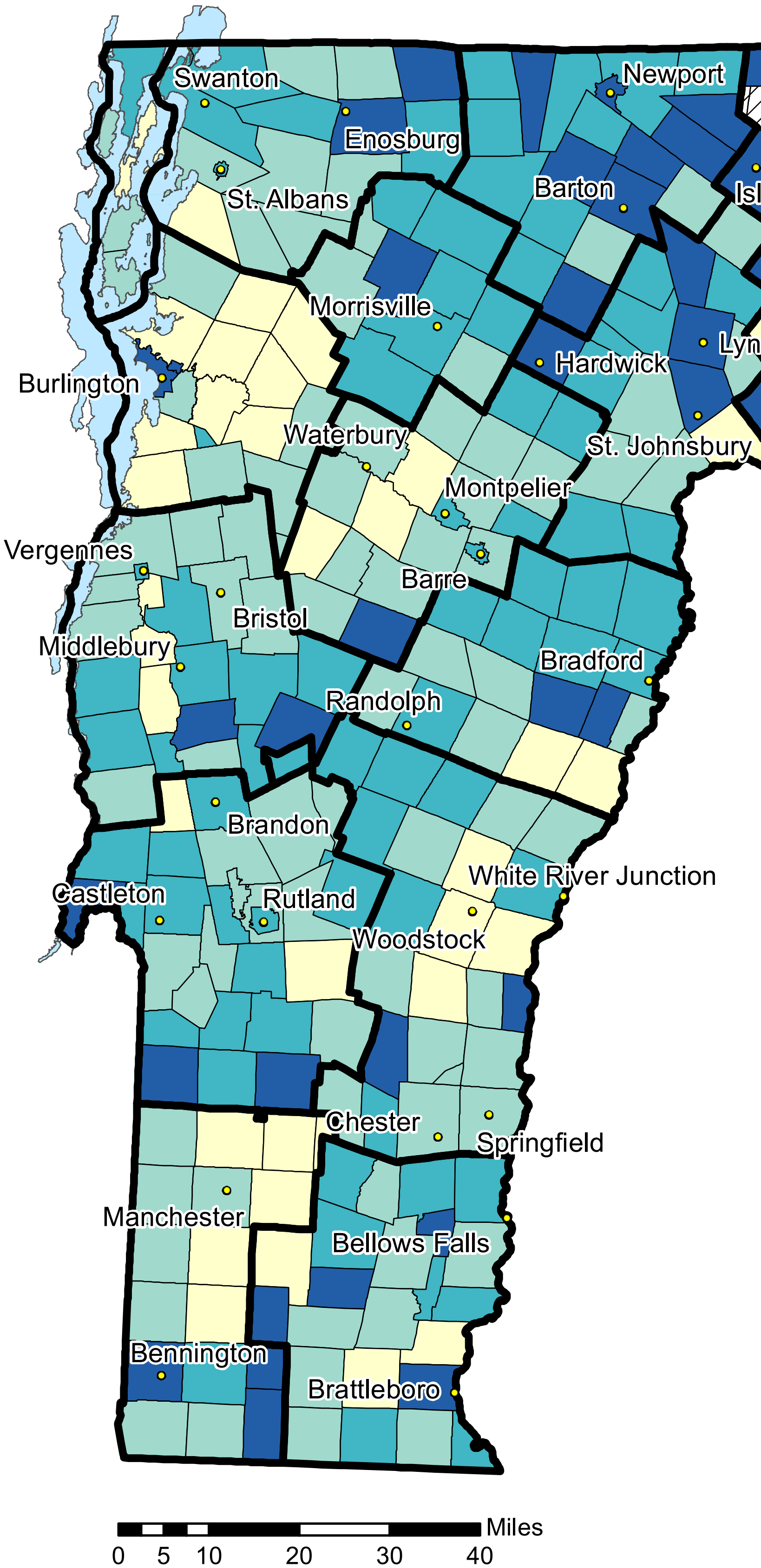
Indicators: Poverty

Education

Older adults living alone

Health insurance

Socioeconomic Index



N

Socioeconomic Vulnerability (standard deviations)

- < -1
- -1 - 0
- 0 - 1
- > 1
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the vulnerability of towns based on social and economic resources available to town residents. Older adults living alone, those with less education, and those with fewer economic resources are often less able to find relief during summer heat events.

Data Source:

This index is a composite of the following indicators: Percent of Older Adults Living Alone, Percent of Population Living in Poverty, Adult Population with no High School Diploma, and Percent of Adult Population with No Health Insurance.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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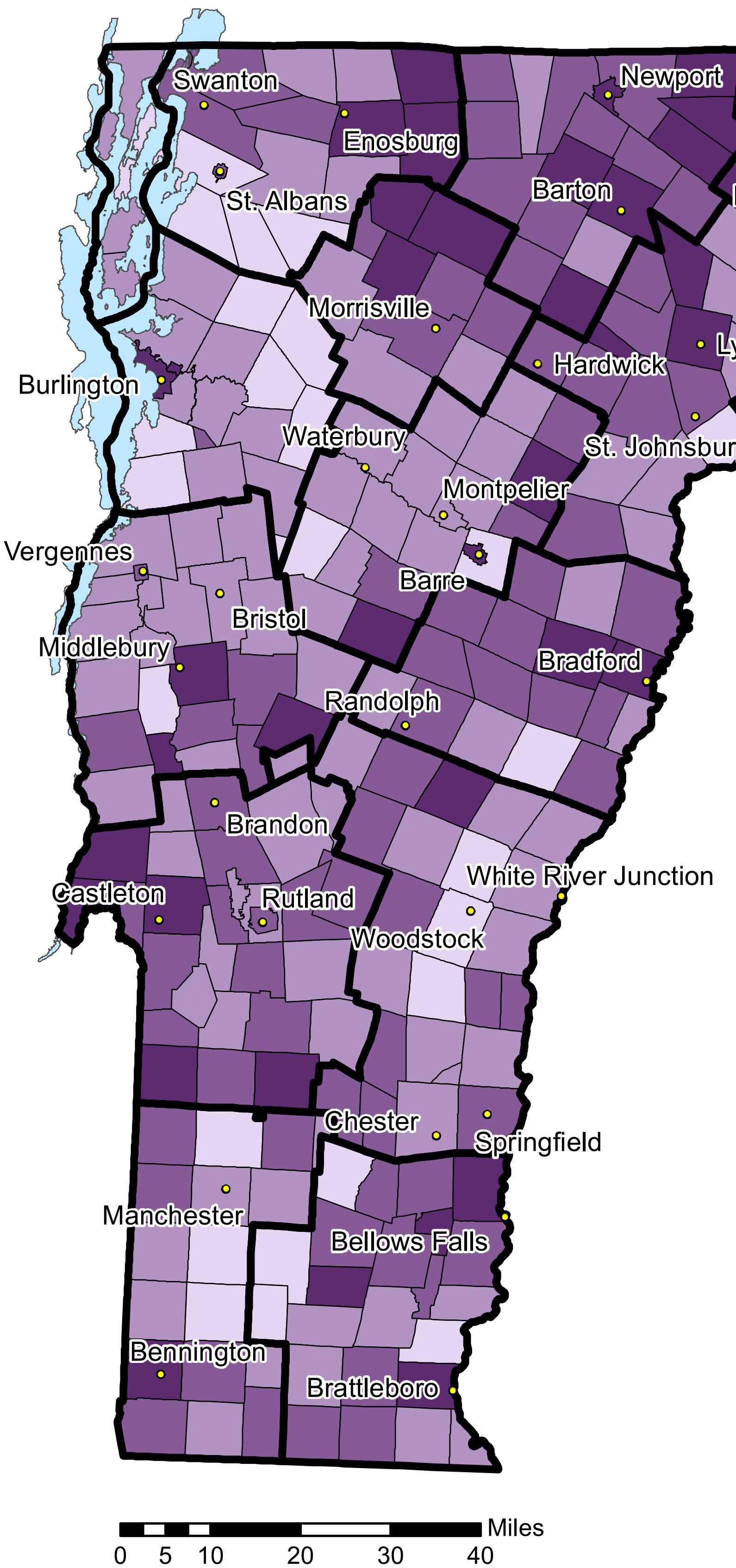
Poverty



Vermont Average - 11.8%

National Average - 15.4%

Percent Population Living Below the Federal Poverty Line

- 0.0% - 5.1%
- 5.2% - 10.2%
- 10.3% - 16.1%
- 16.2% - 30.9%
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of the population living below the federal poverty line. Families or individuals living below the federal poverty line are considered to be lacking the necessary resources to meet the basic needs for healthy living.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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VERMONT

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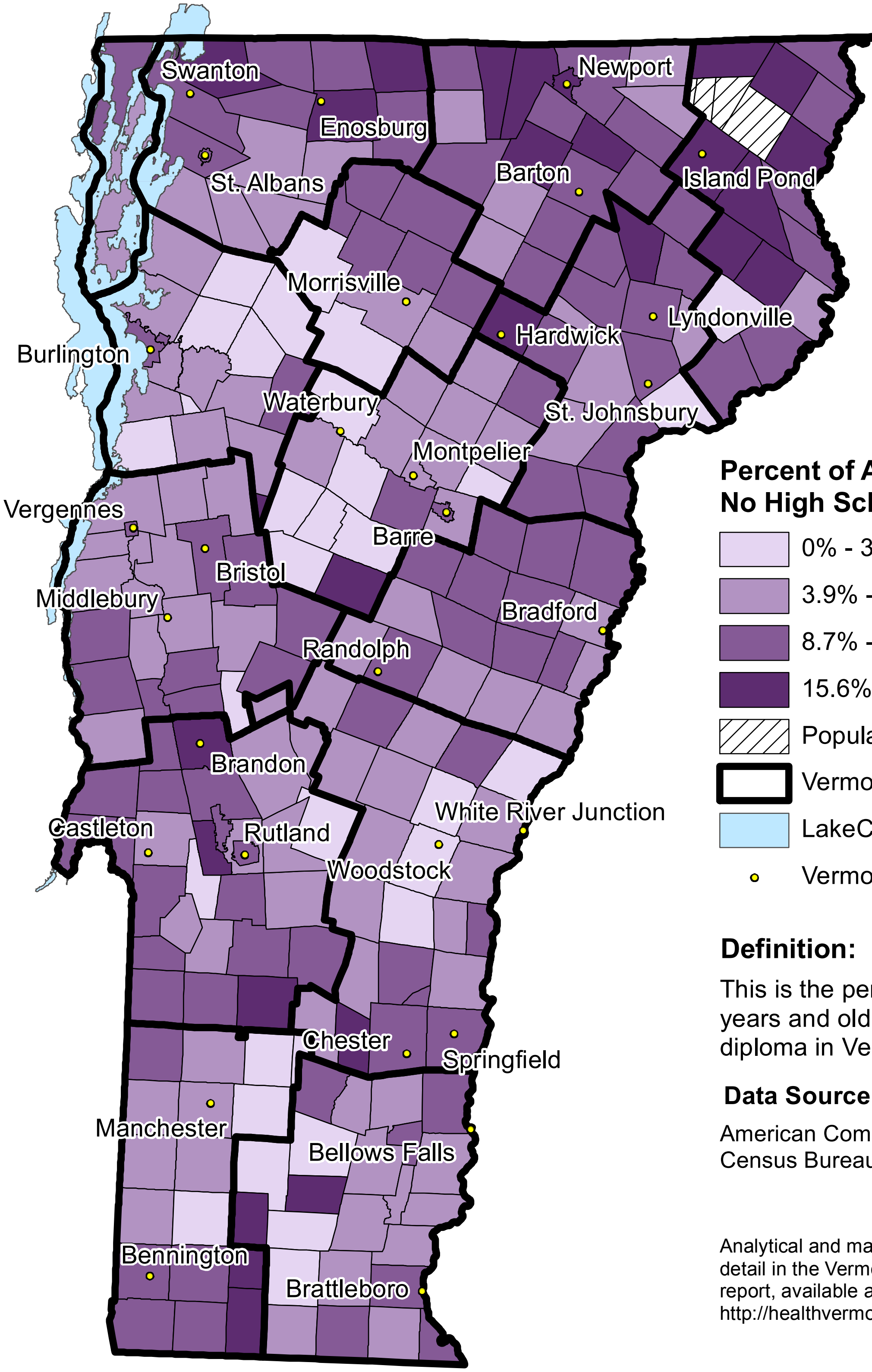
Less Than High School Education



N

Vermont Average - 7.5%

National Average - 12.2%

Percent of Adult Population with No High School Diploma

0% - 3.8% — *Less Vulnerable*

3.9% - 8.6%

State Median

8.7% - 15.5%

15.6% - 100% — *More Vulnerable*

Population is less than 6 persons

Vermont Counties

LakeChamplain

Vermont Major Towns & Cities

Definition:

This is the percent of the population twenty-five years and older that does not have a high school diploma in Vermont towns.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

Miles
0 5 10 20 30 40

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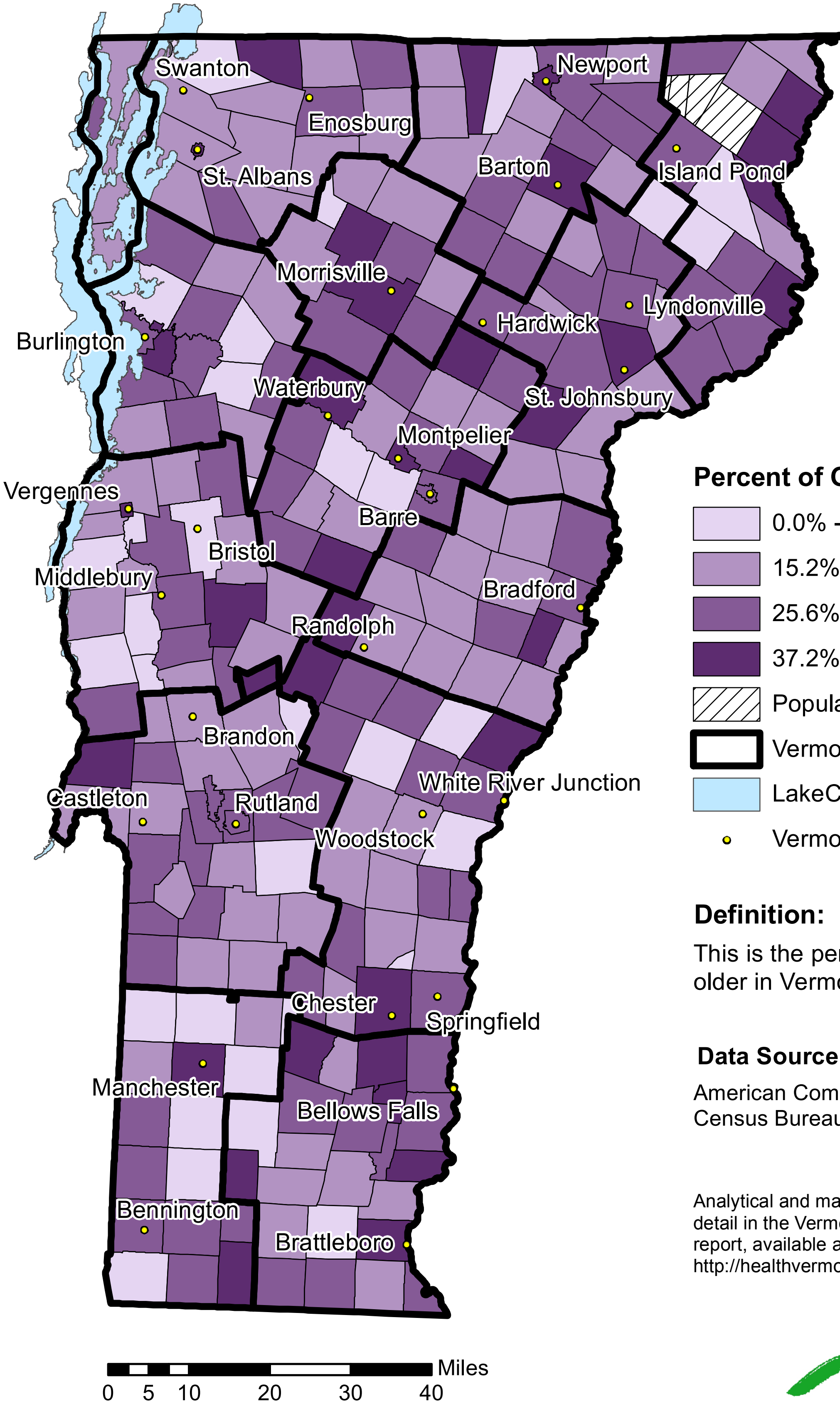
Older Adults Living Alone



N

Vermont Average - 28.8%

National Average - 27.0%

Percent of Older Adults Living Alone

0.0% - 15.1%	*Less Vulnerable*	
15.2% - 25.5%		
	State Median	
25.6% - 37.1%		
37.2% - 100.0%	*More Vulnerable*	

Population is less than 6 persons

Vermont Counties

LakeChamplain

Vermont Major Towns & Cities

Definition:

This is the percent of adults age 65 and older in Vermont towns who are living alone.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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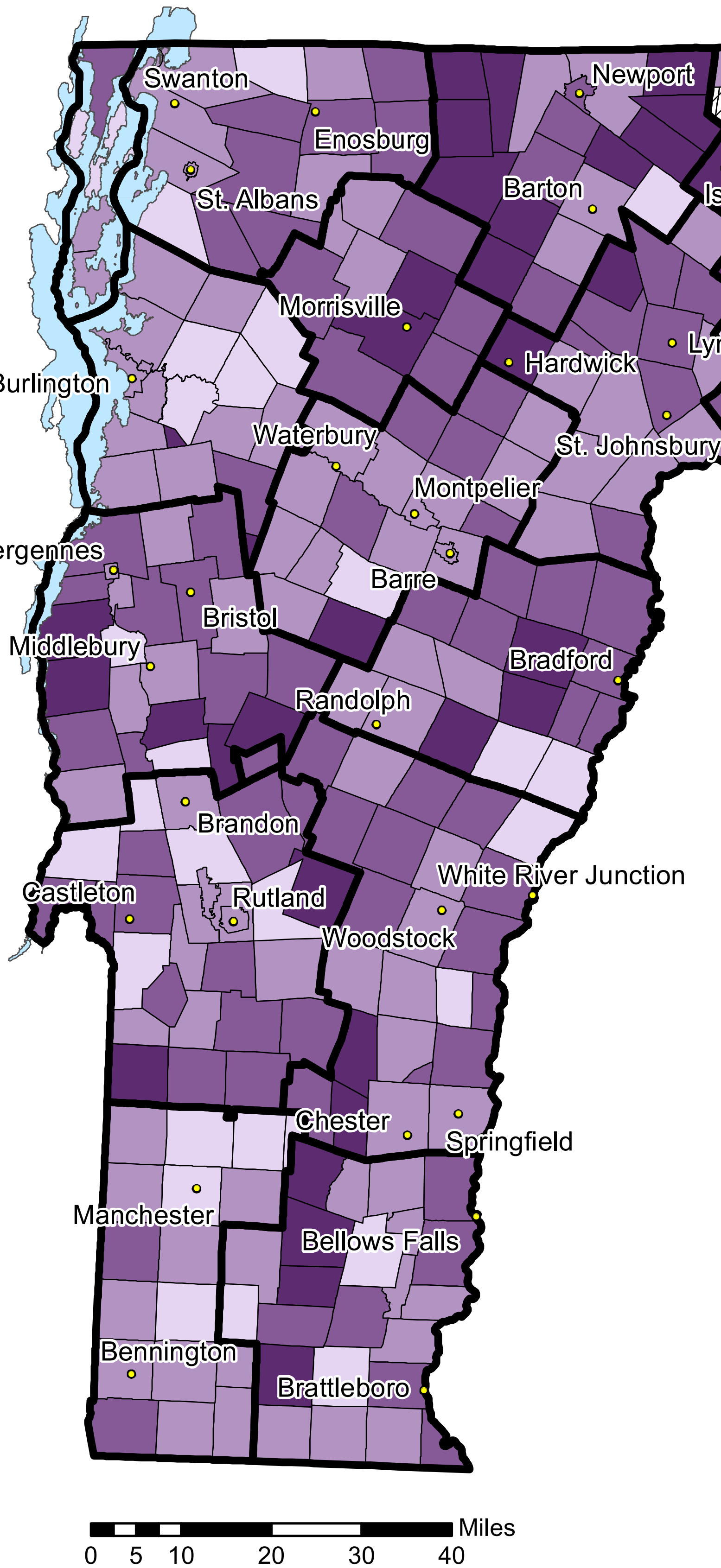
No Health Insurance



N

Vermont Average - 7.3%

National Average - 13.0%

Percent of Adult Population with No Health Insurance

0.0% - 4.4%

4.5% - 7.8%

7.9% - 11.5%

11.6% - 20.0%

Less Vulnerable

State Median

More Vulnerable

Population is less than 6 persons

Vermont Counties

LakeChamplain

Vermont Major Towns & Cities

Definition:

This is the percent of adults twenty-five years and older in Vermont towns that have no health insurance.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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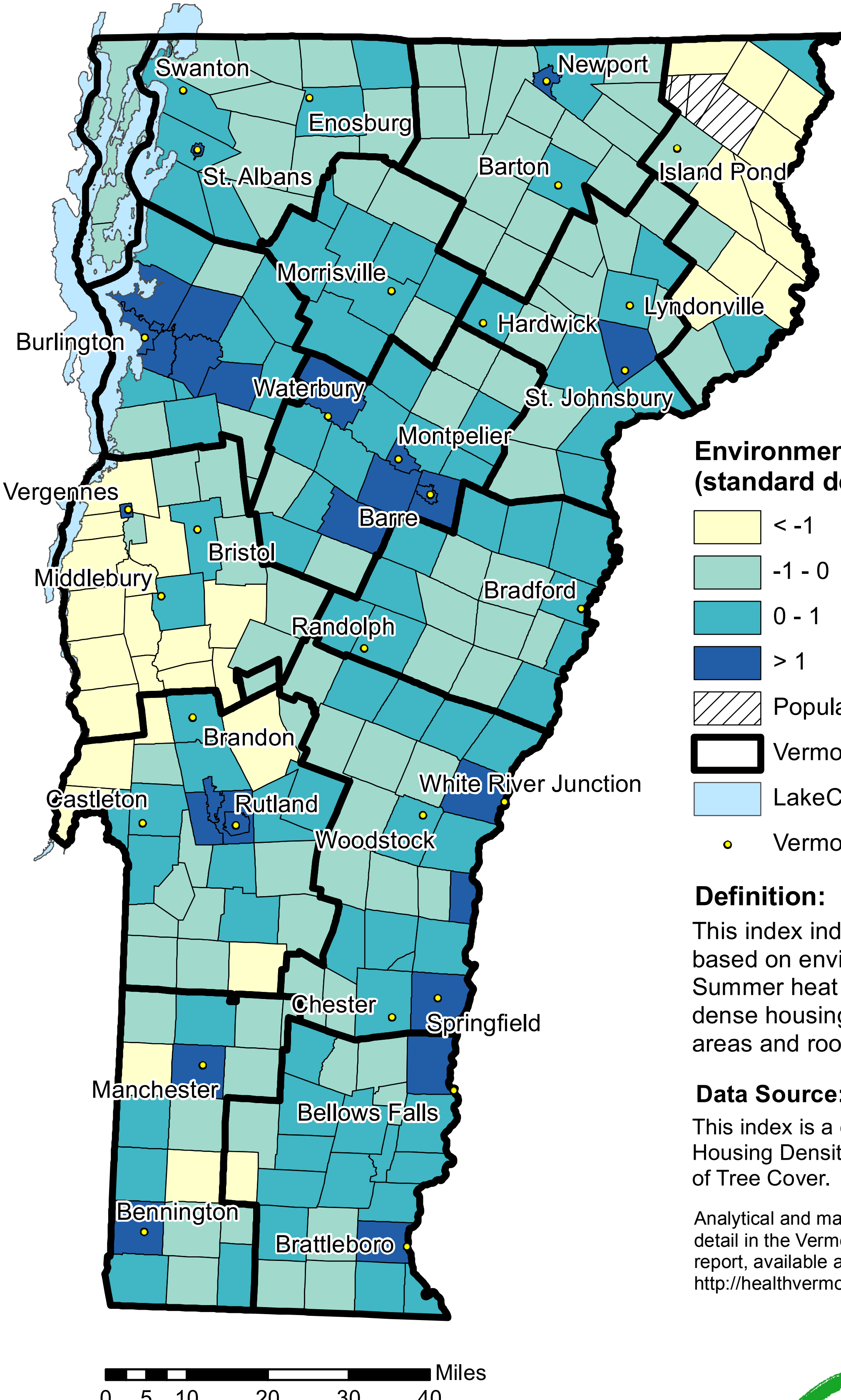
Environmental index

Indicators: Housing density
Impervious surface
Forest cover

Environmental Index



Environmental Vulnerability (standard deviations)

- < -1
- -1 - 0
- 0 - 1
- > 1
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the vulnerability of towns based on environmental characteristics. Summer heat is exacerbated in locations with dense housing, a high proportion of paved areas and rooftops, and a lack of tree cover.

Data Source:

This index is a composite of the following indicators: Housing Density, Impervious Surface, and Percent of Tree Cover.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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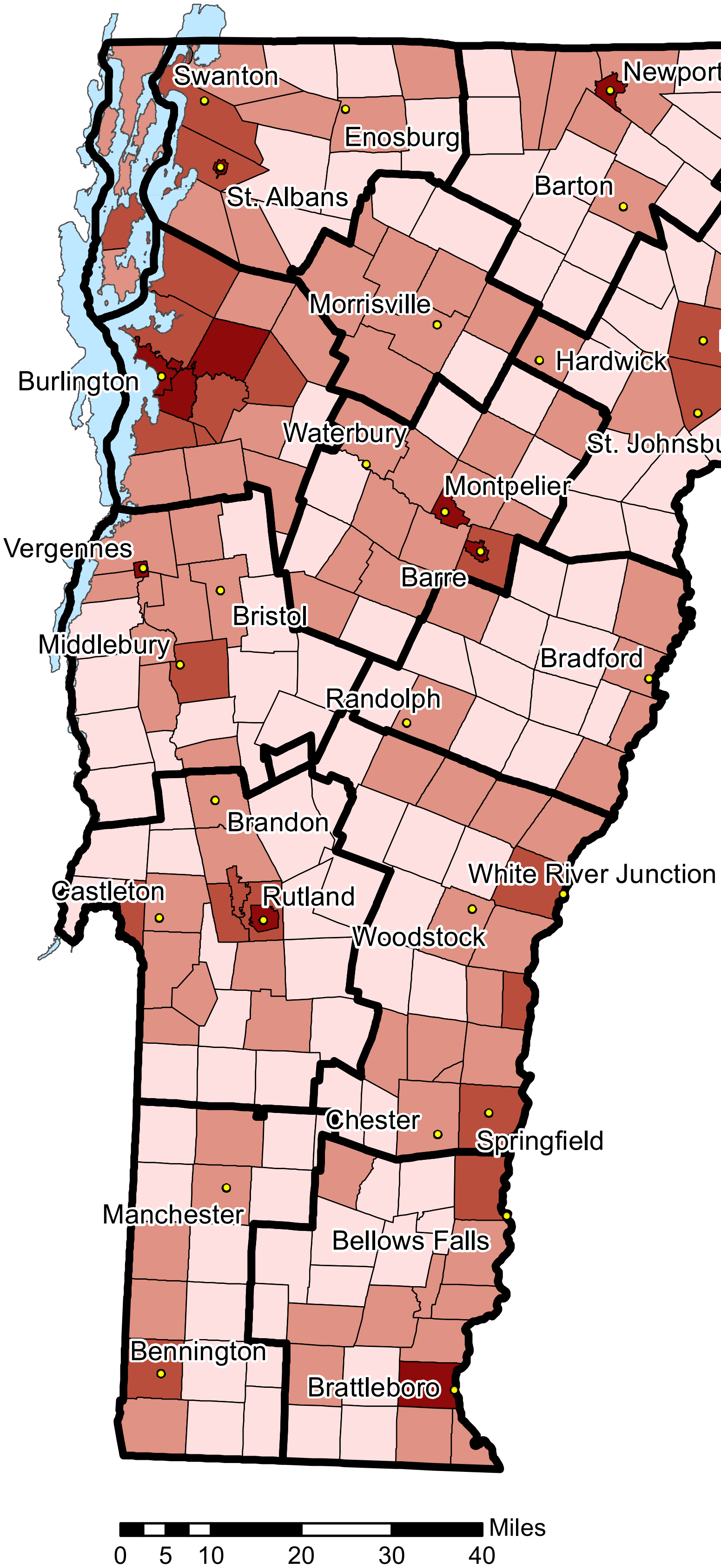
Housing Density



Housing Units Per Square Mile

0 - 15		*Less Vulnerable*
16 - 52	**State Median**	
53 - 168		
169 - 2272		*More Vulnerable*

Population is less than 6 persons

Vermont Counties

LakeChamplain

Vermont Major Towns & Cities

Definition:

This is the number of housing units per square-mile in Vermont towns.

Data Source:

American Community Survey, United States Census Bureau (2013, 5-year Estimates)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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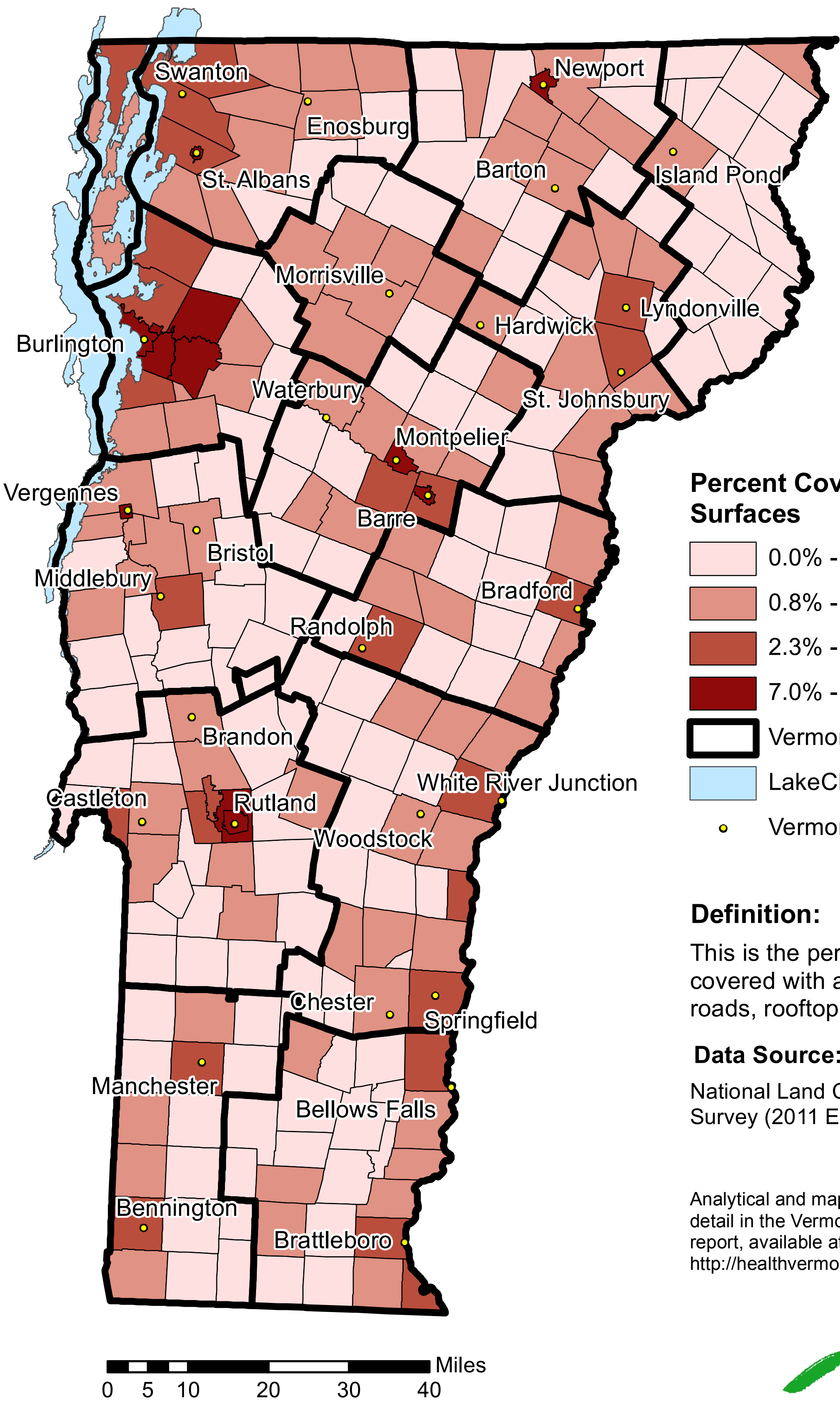
Impervious Surface Coverage



Percent Covered with Impervious Surfaces

- 0.0% - 0.7%
- 0.8% - 2.2%
- 2.3% - 6.9%
- 7.0% - 38.0%
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of land area in each town covered with an impervious surface, such as roads, rooftops, parking lots, and sidewalks.

Data Source:

National Land Cover Database, U.S. Geological Survey (2011 Edition, amended 2014)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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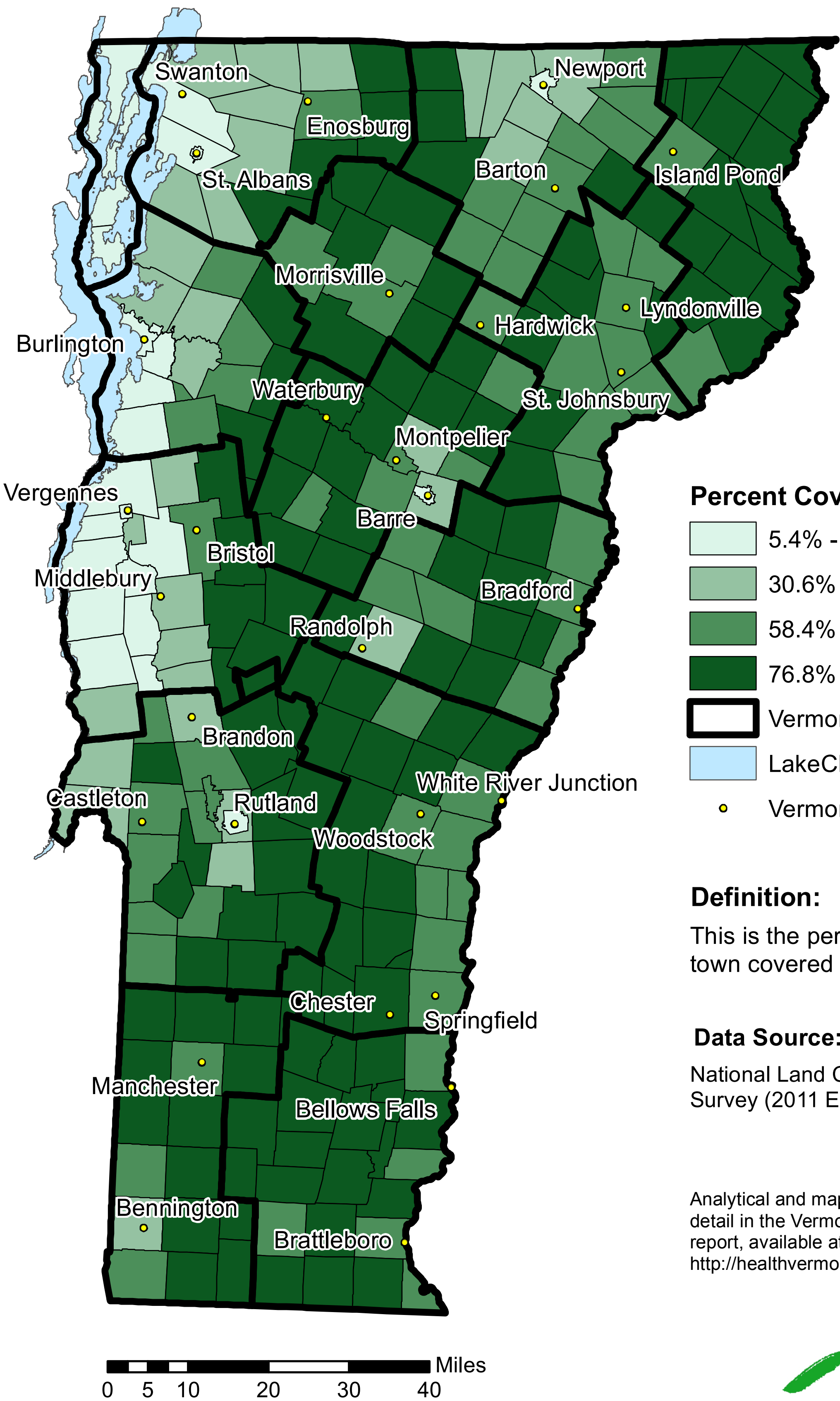
Tree Coverage



Percent Covered by Tree Canopy

- 5.4% - 30.5%
- 30.6% - 58.3%
- 58.4% - 76.7%
- 76.8% - 98.2%
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

More Vulnerable

State Median

Less Vulnerable

Definition:

This is the percent of land area in each town covered by tree canopy.

Data Source:

National Land Cover Database, U.S. Geological Survey (2011 Edition, amended 2014)

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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Health index

Indicators: Diabetes

Asthma

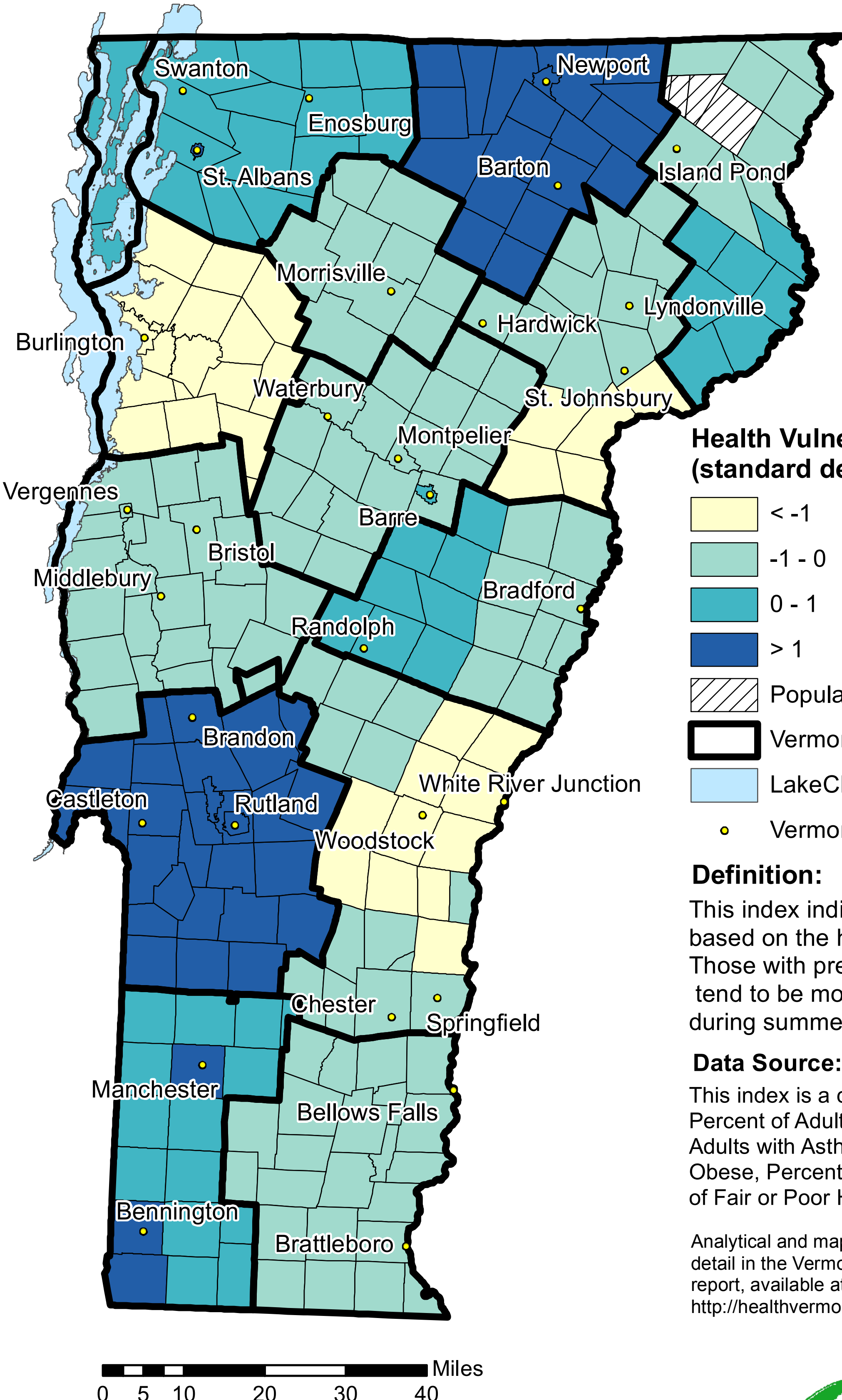
Hypertension

Obesity

General health status

Mortality rate

Health Index



N

Health Vulnerability (standard deviations)

- < -1
- -1 - 0
- 0 - 1
- > 1
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the vulnerability of towns based on the health status of town residents. Those with pre-existing medical conditions tend to be more likely to suffer health impacts during summer heat events.

Data Source:

This index is a composite of the following indicators: Percent of Adults with Hypertension, Percent of Adults with Asthma, Percent of Adults who are Obese, Percent of Adults with Diabetes, Adults of Fair or Poor Health, and All-Cause Mortality Rate.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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VERMONT
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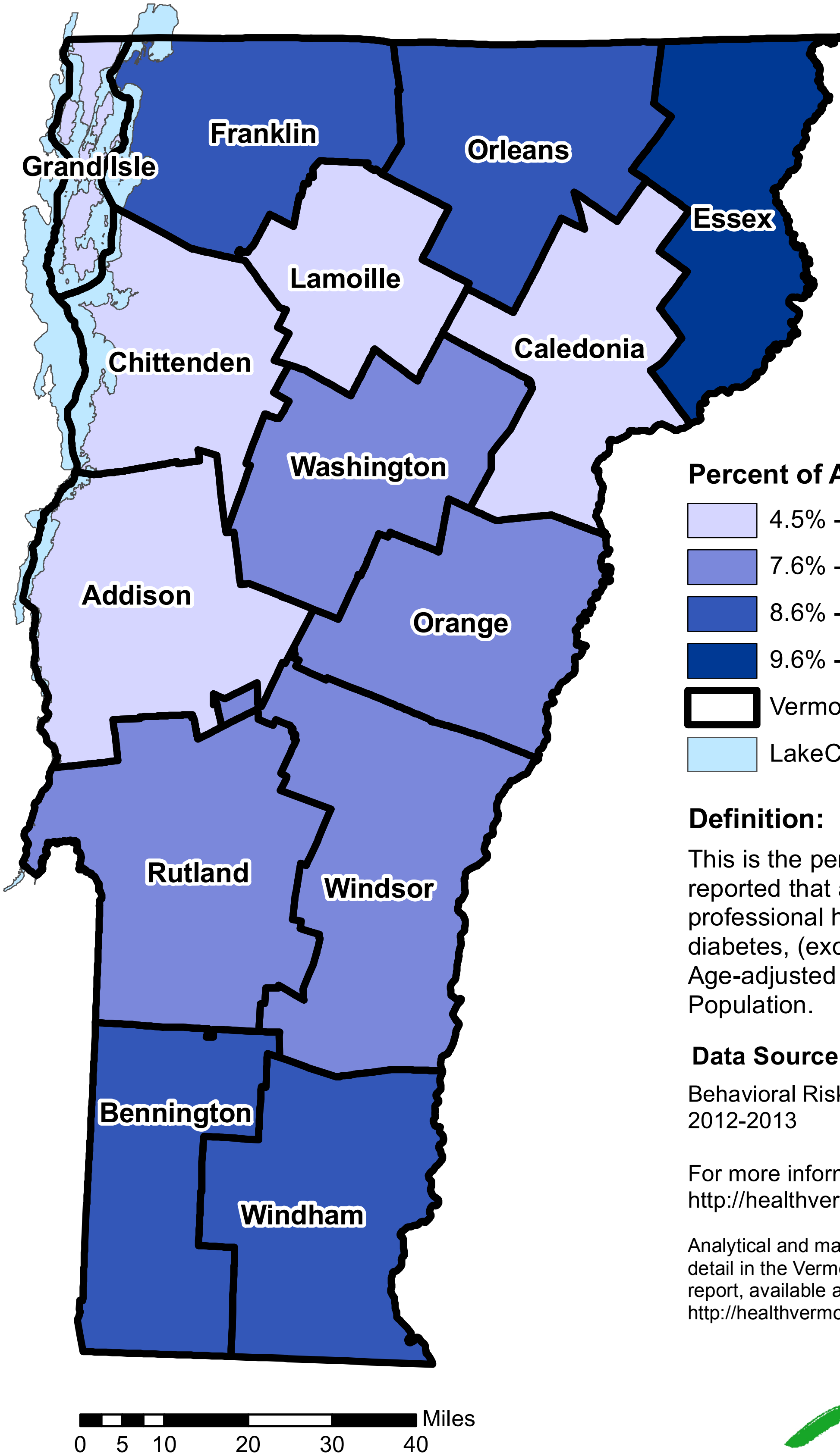
Diabetes Prevalence in Vermont Adults



N

Vermont Average - 8.0%

National Average - 10.0%

Percent of Adults with Diabetes

- 4.5% - 7.5%
- 7.6% - 8.5%
- 8.6% - 9.5%
- 9.6% - 10.5%
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of adults in each county who reported that a doctor, nurse, or other health professional had ever told them that they have diabetes, (excluding gestational diabetes). Age-adjusted to the year 2000 U.S. Standard Population.

Data Source:

Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013

For more information on the BRFSS, visit: http://healthvermont.gov/research/brfss/IA.aspx

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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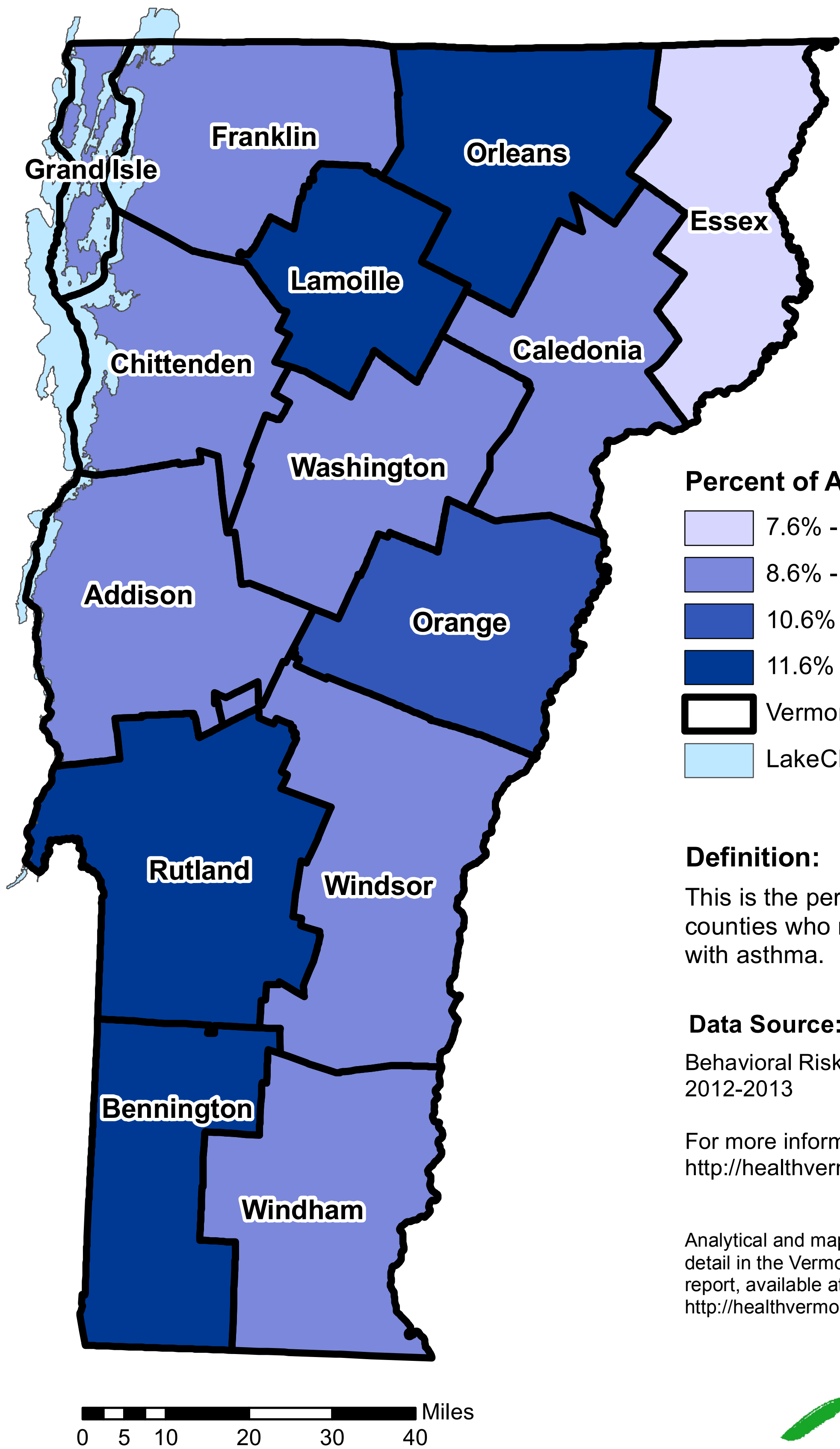
Asthma Prevalence in Vermont Adults



Vermont Average - 11.0%

National Average - 9.0%

Percent of Adults with Athsma

- 7.6% - 8.5%
- 8.6% - 10.5%
- 10.6% - 11.5%
- 11.6% - 15.5%
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of adults in Vermont counties who reported being diagnosed with asthma.

Data Source:

Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013

For more information on the BRFSS, visit: http://healthvermont.gov/research/brfss/IA.aspx

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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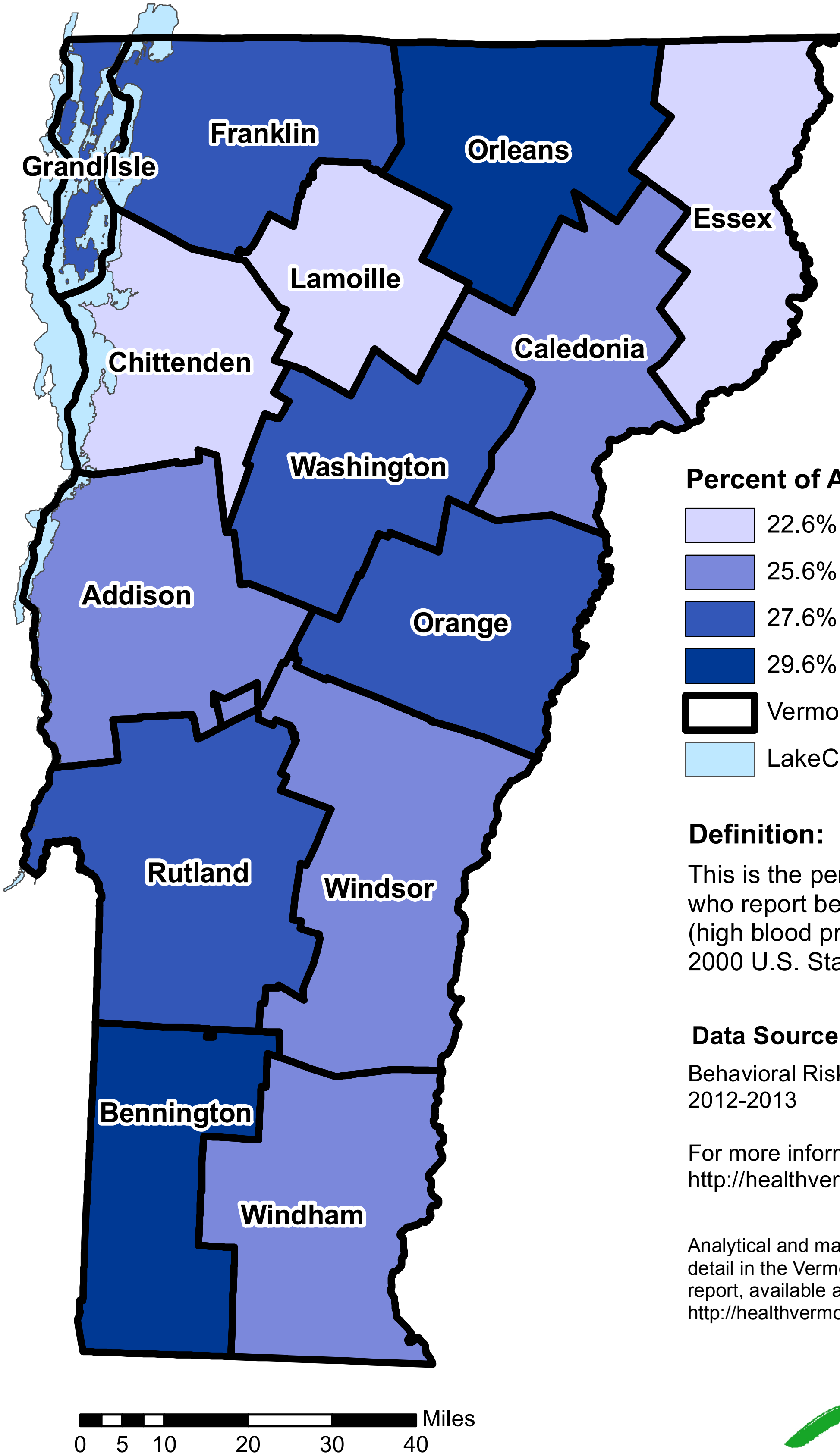
Prevalence of High Blood Pressure in Vermont Adults



Vermont Average - 27.0%

National Average - 30.0%

Percent of Adults with Hypertension

- 22.6% - 25.5%
- 25.6% - 27.5%
- 27.6% - 29.5%
- 29.6% - 33.5%
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of adults in Vermont counties who report being diagnosed with hypertension (high blood pressure), age-adjusted to the year 2000 U.S. Standard Population.

Data Source:

Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013

For more information on the BRFSS, visit:
http://healthvermont.gov/research/brfss/IA.aspxx

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at:
http://healthvermont.gov/emerg/extremeheat.aspx#more

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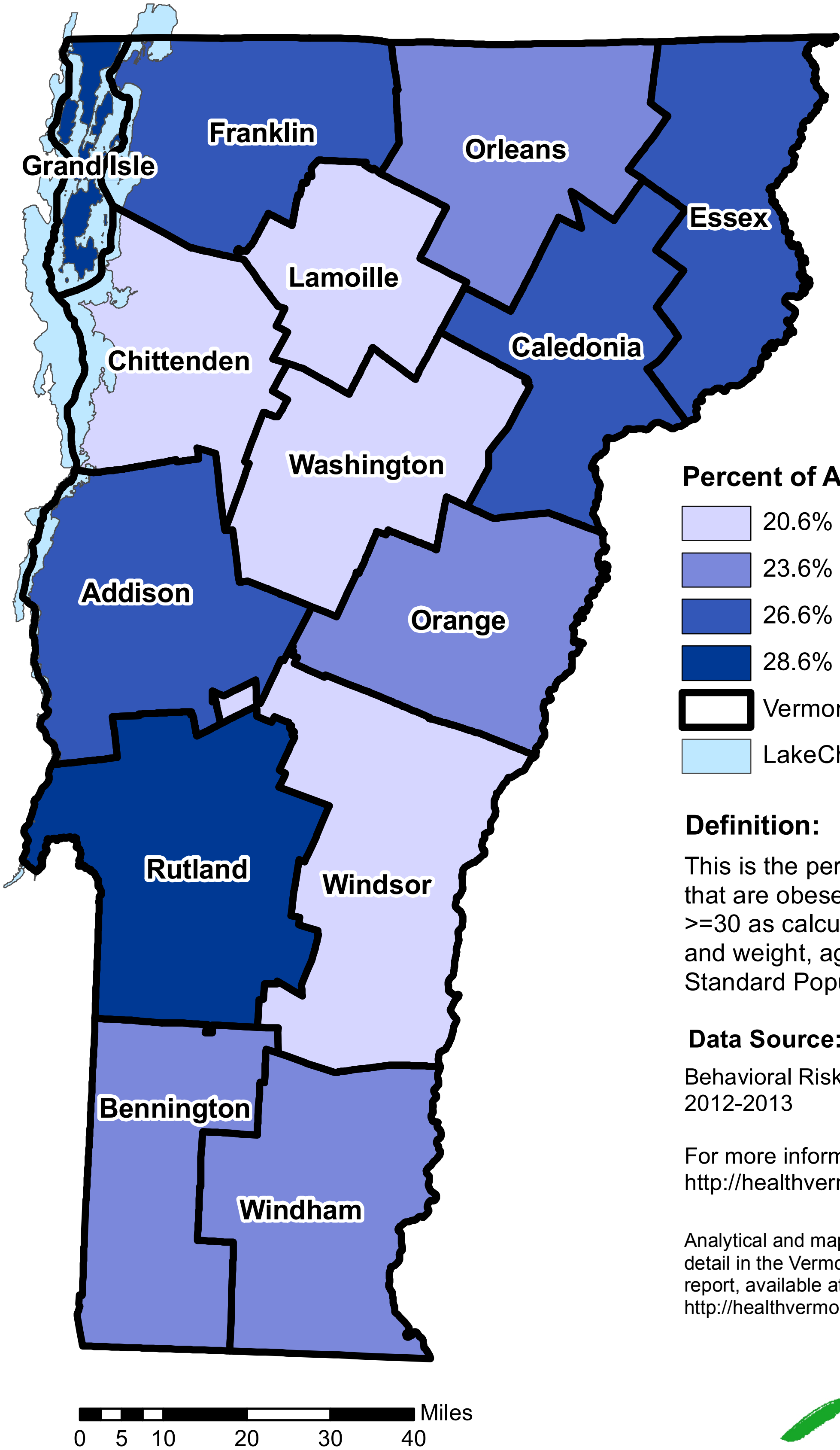
Prevalence of Obesity in Vermont Adults



N

Vermont Average - 25.0%

National Average - 29.0%

Percent of Adults Who Are Obese

- 20.6% - 23.5%
- 23.6% - 26.5%
- 26.6% - 28.5%
- 28.6% - 32.5%
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of adults in Vermont Counties that are obese, based on a body mass index >=30 as calculated from self-reported height and weight, age-adjusted to the year 2000 U.S. Standard Population.

Data Source:

Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013

For more information on the BRFSS, visit:
http://healthvermont.gov/research/brfss/IA.aspx

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at:
http://healthvermont.gov/emerg/extremeheat.aspx#more

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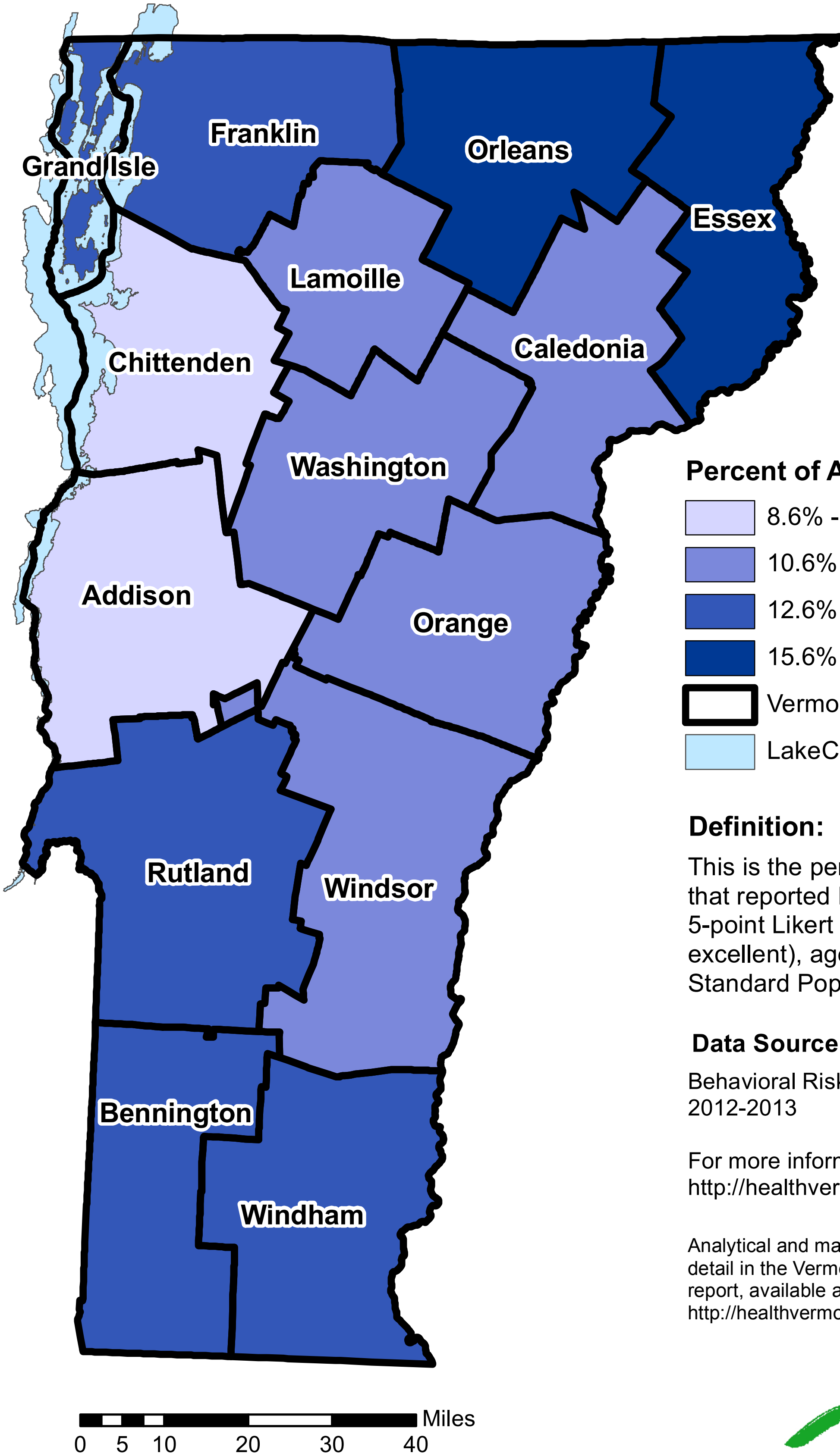
Fair or Poor Health



Vermont Average - 12.0%

National Average - 18.0%

Percent of Adults in Fair or Poor Health

- 8.6% - 10.5%
- 10.6% - 12.5%
- 12.6% - 15.5%
- 15.6% - 22.5%
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the percent of adults in Vermont counties that reported being in fair or poor health (from a 5-point Likert scale ranging from poor to excellent), age-adjusted to the year 2000 U.S. Standard Population.

Data Source:

Behavioral Risk Factor Surveillance Survey (BRFSS), 2012-2013

For more information on the BRFSS, visit:
http://healthvermont.gov/research/brfss/IA.aspx

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at:
http://healthvermont.gov/emerg/extremeheat.aspx#more

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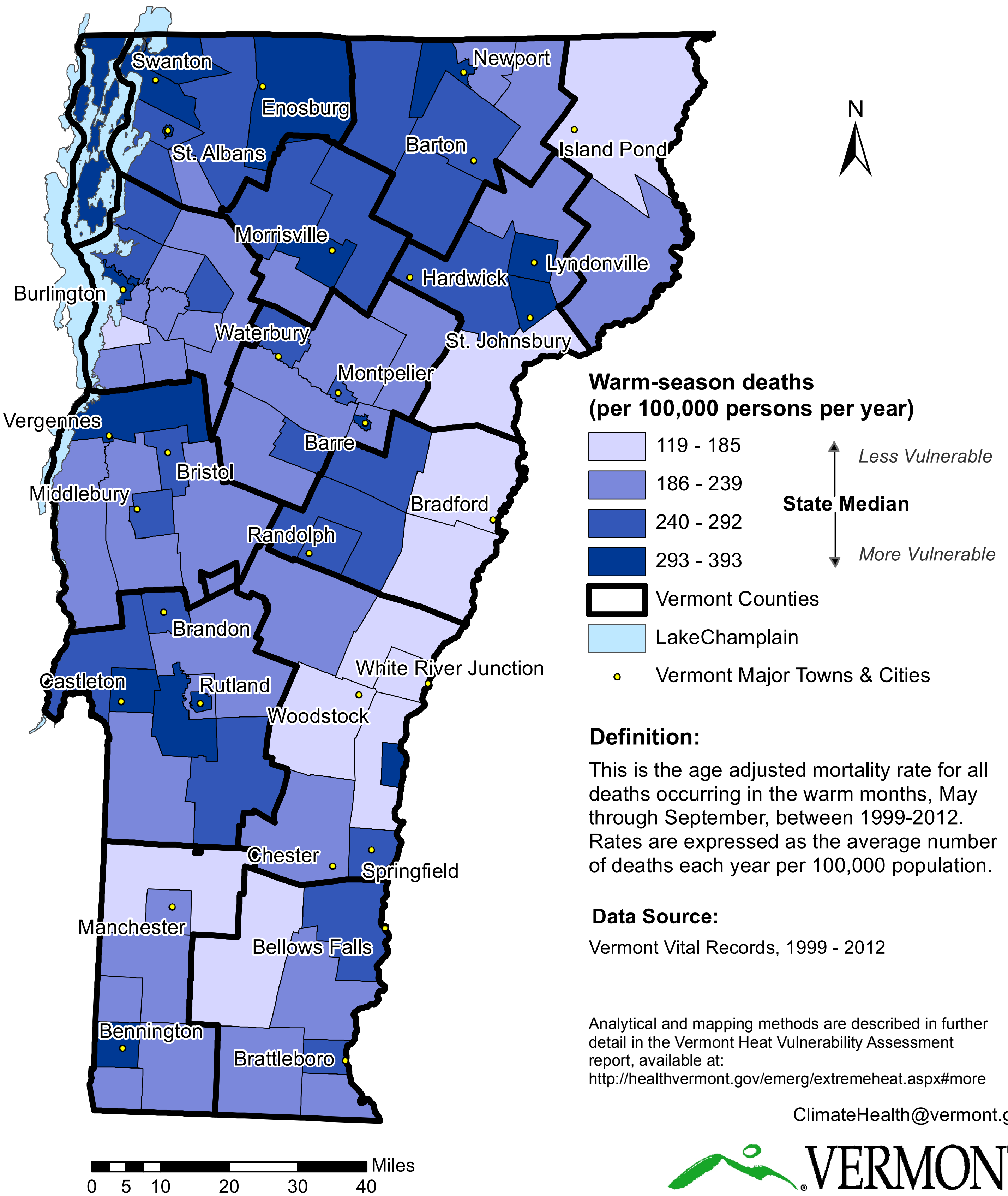
All-Cause Mortality



Definition:

This is the age adjusted mortality rate for all deaths occurring in the warm months, May through September, between 1999-2012. Rates are expressed as the average number of deaths each year per 100,000 population.

Data Source:

Vermont Vital Records, 1999 - 2012

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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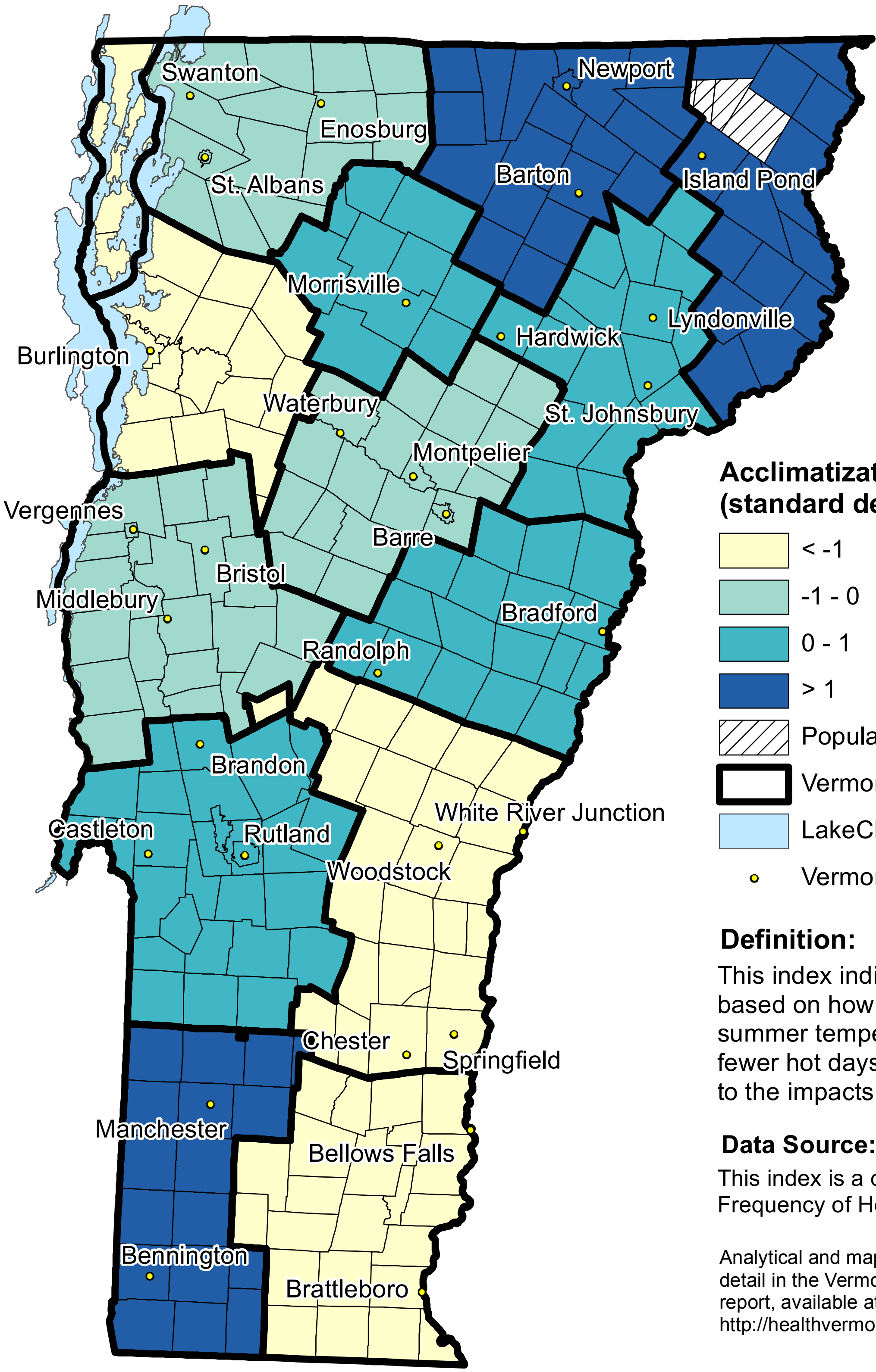
Acclimation index

Indicators: Number of days per year >=87°F

Acclimatization Index



Acclimatization Vulnerability (standard deviations)

< -1	Less Vulnerable	
-1 - 0	State Mean	
0 - 1		
> 1	More Vulnerable	

Population is less than 6 persons

Vermont Counties

LakeChamplain

Vermont Major Towns & Cities

Definition:

This index indicates the vulnerability of towns based on how acclimated residents are to hot summer temperatures. Those experiencing fewer hot days per year tend to be less adapted to the impacts of summer heat.

Data Source:

This index is a composite of the following indicators: Frequency of Hot Days.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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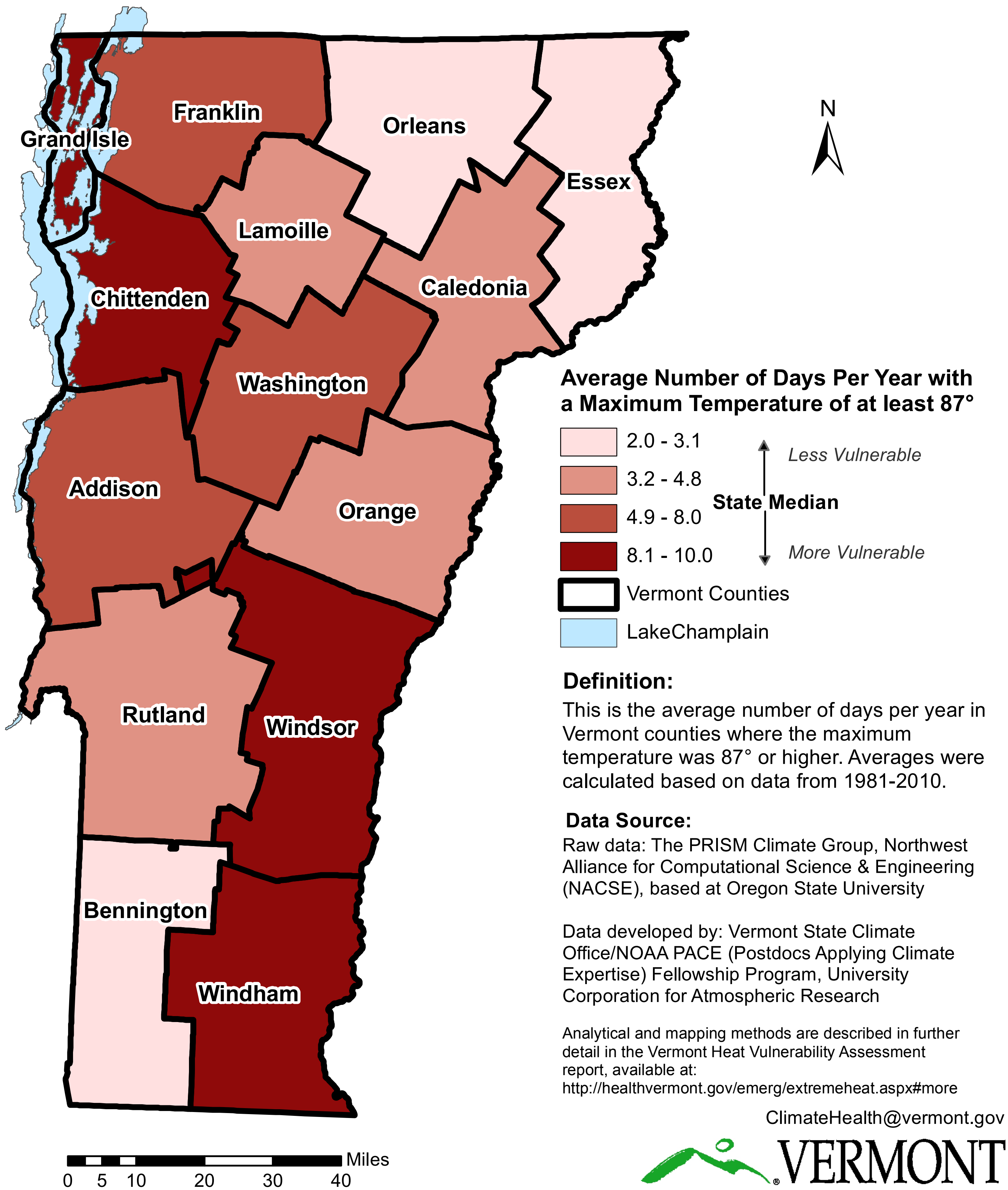
Frequency of Hot Days



Definition:

This is the average number of days per year in Vermont counties where the maximum temperature was 87° or higher. Averages were calculated based on data from 1981-2010.

Data Source:

Raw data: The PRISM Climate Group, Northwest Alliance for Computational Science & Engineering (NACSE), based at Oregon State University

Data developed by: Vermont State Climate Office/NOAA PACE (Postdocs Applying Climate Expertise) Fellowship Program, University Corporation for Atmospheric Research

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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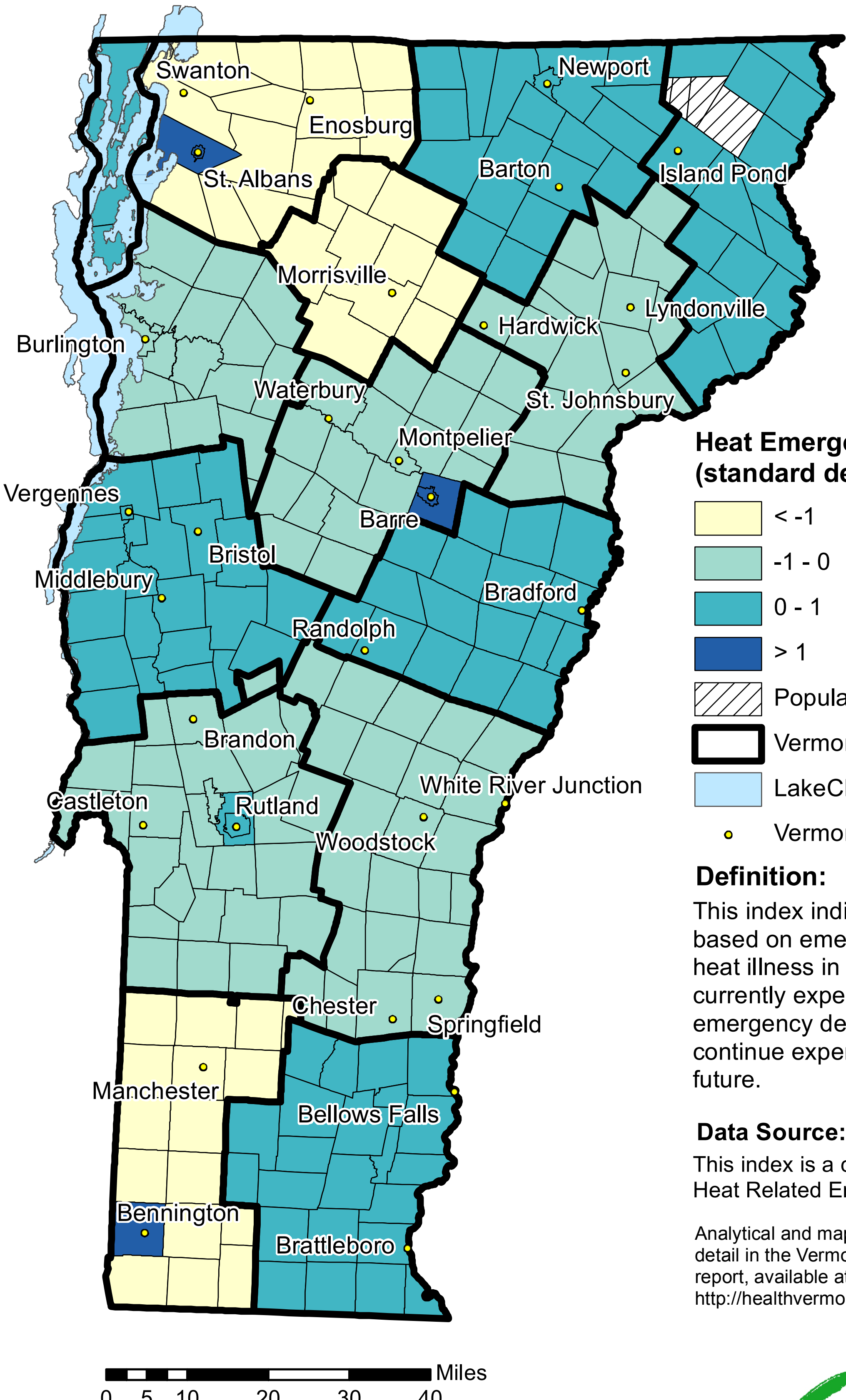
Heat emergency index

Indicators: Heat illness hospitalization rate

Heat Emergency Index



Heat Emergency Vulnerability (standard deviations)

- < -1
- -1 - 0
- 0 - 1
- > 1
- Population is less than 6 persons
- Vermont Counties
- LakeChamplain
- Vermont Major Towns & Cities

Less Vulnerable

State Mean

More Vulnerable

Definition:

This index indicates the vulnerability of towns based on emergency department visits for heat illness in recent years. Towns that currently experience a high rate of heat-related emergency department visits are expected to continue experiencing a high rate in the near future.

Data Source:

This index is a composite of the following indicators: Heat Related Emergency Department Visits.

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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VERMONT

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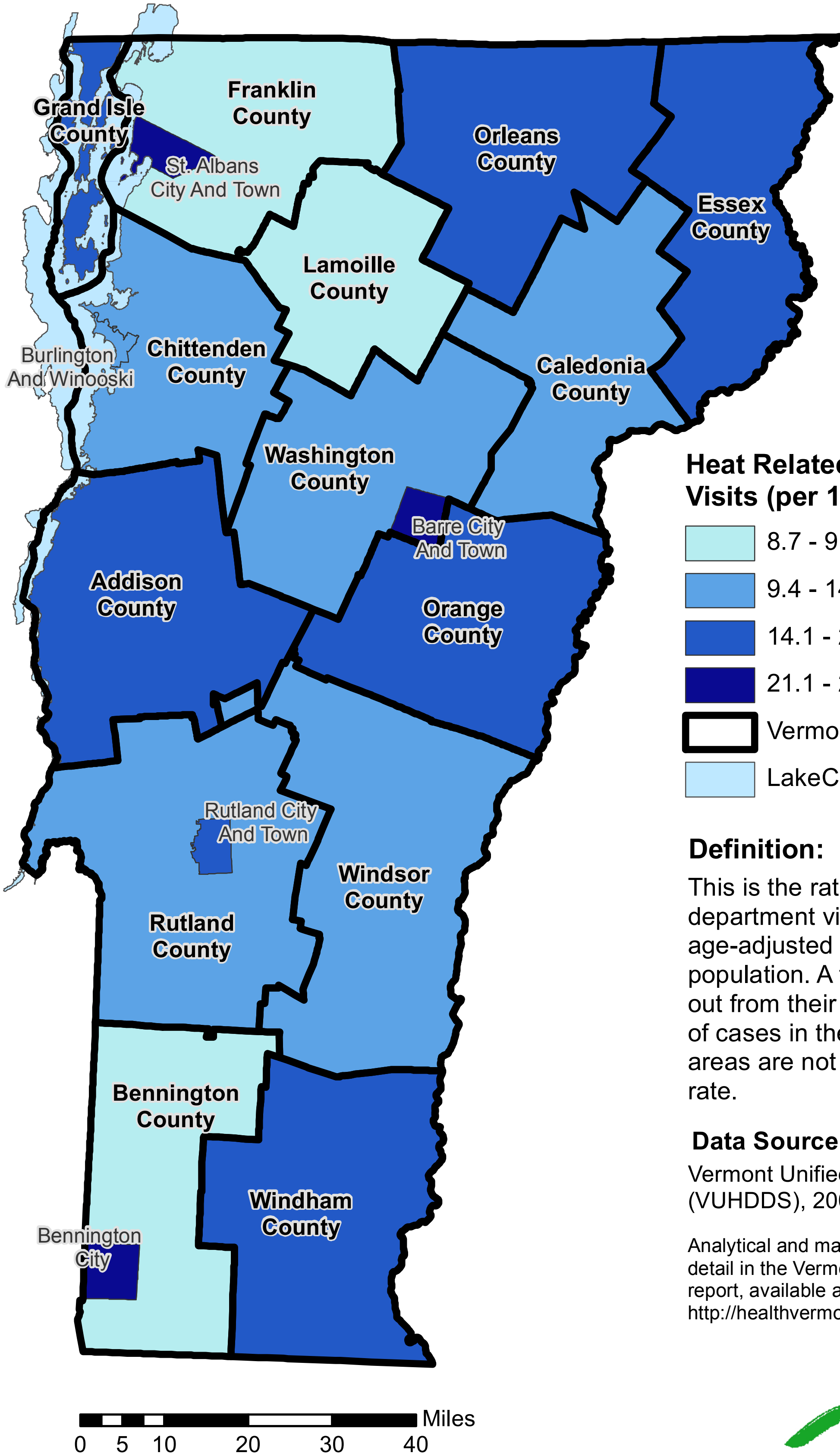
Heat-Related Emergency Department Visits



Heat Related Emergency Department Visits (per 100,000 persons, per year)

- 8.7 - 9.3
- 9.4 - 14.0
- 14.1 - 21.0
- 21.1 - 28.0
- Vermont Counties
- LakeChamplain

Less Vulnerable

State Median

More Vulnerable

Definition:

This is the rate of heat-related emergency department visits by area of residence, age-adjusted to the 2010 Vermont state population. A few cities and towns are broken out from their counties due to the high number of cases in these locations. Visits from these areas are not included in the surrounding county rate.

Data Source:

Vermont Unified Hospital Discharge Dataset (VUHDDS), 2003-2010

Analytical and mapping methods are described in further detail in the Vermont Heat Vulnerability Assessment report, available at: http://healthvermont.gov/emerg/extremeheat.aspx#more

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