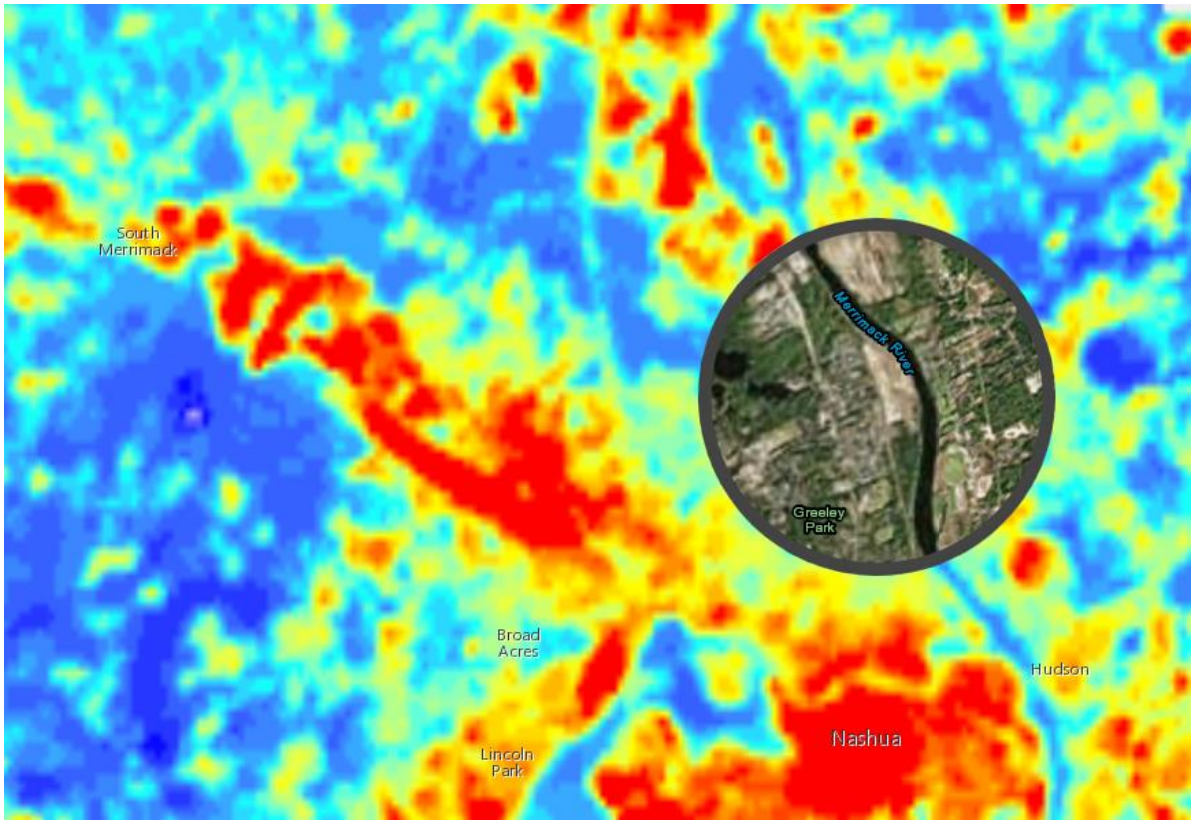
HOT TOPIC

A Climate and Health Adaptation Plan for the Greater Nashua Region



Prepared by: Nashua Regional Planning Commission

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Executive Summary

The Greater Nashua Region is a great place for people to work, live, and recreate in every season throughout the year. With a diverse population and landscape, thousands of people have made this region their home; they stroll around their neighborhoods, hike along trails, and play sports. However, changes in our region's climate may have a severe impact on the health and quality of life of many of the region's residents.

This project, designed to examine the impact climate has on health, was initiated by the Greater Nashua Regional Public Health Network; it is one portion of a multi-part effort to advance Public Health Initiatives funded by the Centers for Disease Control through a competitive grant program administered and supported by the NH Department of Health and Human Services Division of Public Health Services. The ultimate goal of the project is to create a region that is more aware of and resilient to the regional impacts of a changing climate. This Plan was modeled after similar projects done by the Upper Valley Lake Sunapee Regional Planning Commission and by the Lakes Region Partnership for Public Health (with assistance from the Lakes Region Planning Commission).

A robust review of available data sources, including local and regional hazard mitigation plans, climate reports, and social vulnerability studies were used to determine major weather hazards and the associated vulnerable populations. This information was then presented at work sessions with the Public Health Advisory Council (PHAC), emergency responders, health and welfare officers, and professional planners. Through their input, the severe weather risks, (including extreme temperature, air quality, extreme precipitation, and vector habitat) were prioritized based on where the most impact could be made.

Heat-related illness was identified as the primary health impact affecting the region, because of the anticipated increase of number of days with a heat index above 90˚F, particularly in the more urban areas of the region. This plan identifies and prioritizes opportunities to mitigate the effects of extreme heat. The anticipated outcome is a reduction in Emergency Department visits and associated cost savings and improved health.

The second phase of this grant-funded process is to begin implementation of the prioritized goals, objectives, and strategies. These actions are primarily short-term in length in order for them to be achievable within the constraints of available resources, as well as being able to measure their success. Medium and long term actions are also included in this plan, but will require further funding in order to complete.

Acknowledgements

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- Alice Ely, Public Health Council of the Upper Valley, Mascoma Vallley Health Initiative (MVHI)
- Sophia Japhet, Environmental Health Specialist at the City of Manchester Health Department

Partner Organizations assisting throughout the process include:

- Greater Nashua Public Health Advisory Council
- Nashua Local Emergency Planning Committee
- Planners in the Municipalities throughout the Nashua Region
- NH Climate and Health Working group
- Upper Valley Lake Sunapee Regional Planning Commission
- The Lakes Region Partnership for Public Health

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Introduction

Be it the rising temperatures, increased storm events or fewer snow-covered days, it is evident that the climate in New Hampshire is changing. The trend of warmer and wetter weather will impact the plants, animals, people, and landscape of the Granite State. With such wide-sweeping effects, there are health implications for many residents of the Nashua Region, putting additional stress on the finances and resources of health care providers and emergency responders.

To assess and reduce the public health effects from severe weather events resulting from a changing climate in the Nashua Region, the Nashua Regional Planning Commission (NRPC) partnered with the Greater Nashua Regional Public Health Network (GNRPHN). Using the CDC Building Resilience Against Climate Effects (BRACE) framework to create this Climate Change and Health Adaptation Plan allows health officials to develop strategies and programs to prepare for the health effects of climate change. By targeting vulnerable populations, this plan seeks to mitigate health impacts exacerbated by extreme weather events related to a changing climate.

The goals of the Plan are to:

- Identify weather hazards that will likely be exacerbated by climate change
- Evaluate various sources of data to project the impact that climate change will have on weather events and health
- List the priority climate and health impacts, and vulnerable populations related to weather and climate for the region
- Determine the highest priority climate and health topic area
- Identify any gaps in current preparedness resources within local, regional, and state plans
- Identify intervention strategies with baseline measures and targets to improve the resilience of vulnerable areas and populations
- Develop a tool kit for public health professionals to further promote the goals and strategies of this plan

Plan Process

The Building Resilience Against Climate Effects (BRACE) framework is a five-step process that allows health officials to develop strategies and programs to help communities prepare for the health effects of climate change. Part of this effort involves incorporating complex atmospheric data and both short and long range climate projections into public health planning and response activities. Combining atmospheric data and projections with epidemiologic analysis allows health officials to more effectively anticipate, prepare for, and respond to a range of climate sensitive health impacts:[i]

1. Anticipate Climate Impacts and Assess Vulnerabilities
2. Project the Disease Burden
3. Assess Public Health Interventions
4. Develop and Implement a Climate and Health Adaptation Plan
5. Evaluate Impact and Improve Quality of Activities

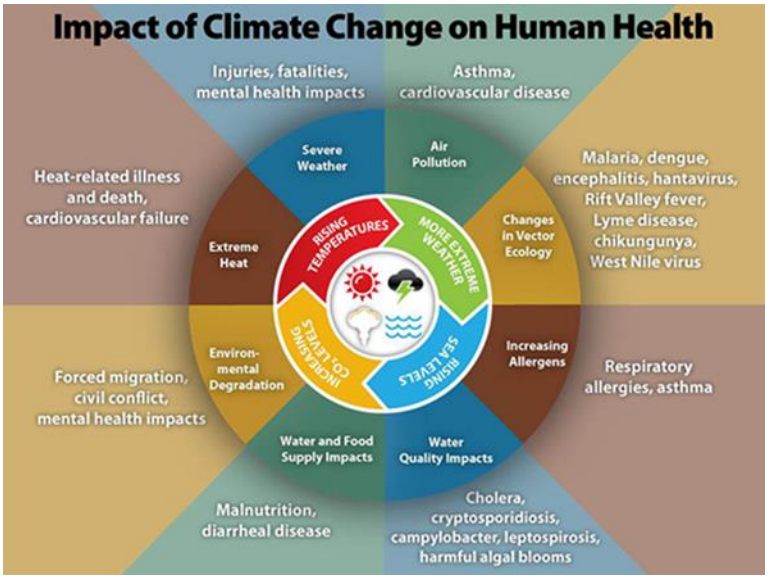


Figure 1: Climate change can impact human health in myriad ways. Source: U.S. Center for Disease Control and Prevention

NRPC applied the BRACE framework in order to complete this plan. The first step was to identify all potential relevant hazards due to severe weather and climate change by reviewing local hazard mitigation plans, emergency operation plans, the Regional Community Health Assessment and Improvement Plan, and the Regional Water Resiliency Planning effort. DHHS provided trainings to help staff plan, assess climate-related vulnerabilities, measure climate-related preparedness, and implement the BRACE framework. Through facilitated work sessions with the Public Health Advisory Council (PHAC), emergency responders, health and welfare officers, and professional planners, hazards were prioritized. By focusing on the most impactful extreme weather related exposure and related health outcomes, and the associated vulnerable populations, this Plan will help to implement one intervention strategy appropriate to the local communities and populations.

Regional Assessment

Geography

With over 200,000 residents, the Greater Nashua region comprises 13 communities in the southern half of Hillsborough County. Embodying both the second largest city in New Hampshire as well a number of rural communities, the Nashua Region is perhaps best characterized by the diversity of its landscapes. Situated among the foothills of the Merrimack River Valley, the geography of the region varies from higher elevation forestland in the west to low-lying riverbeds in the east.

Much of the Region's history has been defined by its industrial past, with many mills and the associated housing being constructed along the Merrimack, Nashua, and Souhegan Rivers. Housing development trends have left many of these historic homes intact, while leaving large swaths of forests preserved in outlying communities.

Based on 2010 U.S. Census, 61% of the region's housing stock is single-family, and there is at least some multi-family development across most of the region. However, in terms of overall numbers, Nashua has 72%, or almost three quarters, of the regions multi-family housing units. The greatest diversity of housing options or largest share of multifamily housing as a proportion of all housing choices are found in Nashua (38%), Milford (29%), Merrimack (11%), and Hudson and Wilton (9% each).

Like all other structures, housing units have a useful life. As a rule of thumb, housing units that are more than 60 years old are viewed as being those most likely to be in substandard condition. Due to these factors the proportion of housing units built prior to 1950 is an indicator of housing stock condition. A large percentage of older units are found in two types of situations within the region: rural communities with relatively slow growth rates and the older town and city centers that developed in the early years of the 20th century.

Within the region, communities that have experienced relatively less growth have the greatest percentage of older homes built before 1950, including, Wilton (42%), Lyndeborough (28%), Nashua (24%), and Mont Vernon (23%). The typical pattern is that the older stock is more often available for rent. Center of Nashua has the highest percentage of units built prior to 1950 as well as those built during the 1950s. In Census Tract 105 within Downtown Nashua, 80% of the housing stock was built before 1950.The newer, formerly rapidly developing suburbs of Litchfield and Hudson had some of the lowest percentages of older units, with median year built after 1985. The Town of Brookline had the most recent year for median age of 1989 for owner occupied units. Furthermore, while slightly more than a quarter of the region's housing stock is rental units, the majority of those are located within the City of Nashua, the center of Milford, and along Route 3 in Merrimack.

Demographics

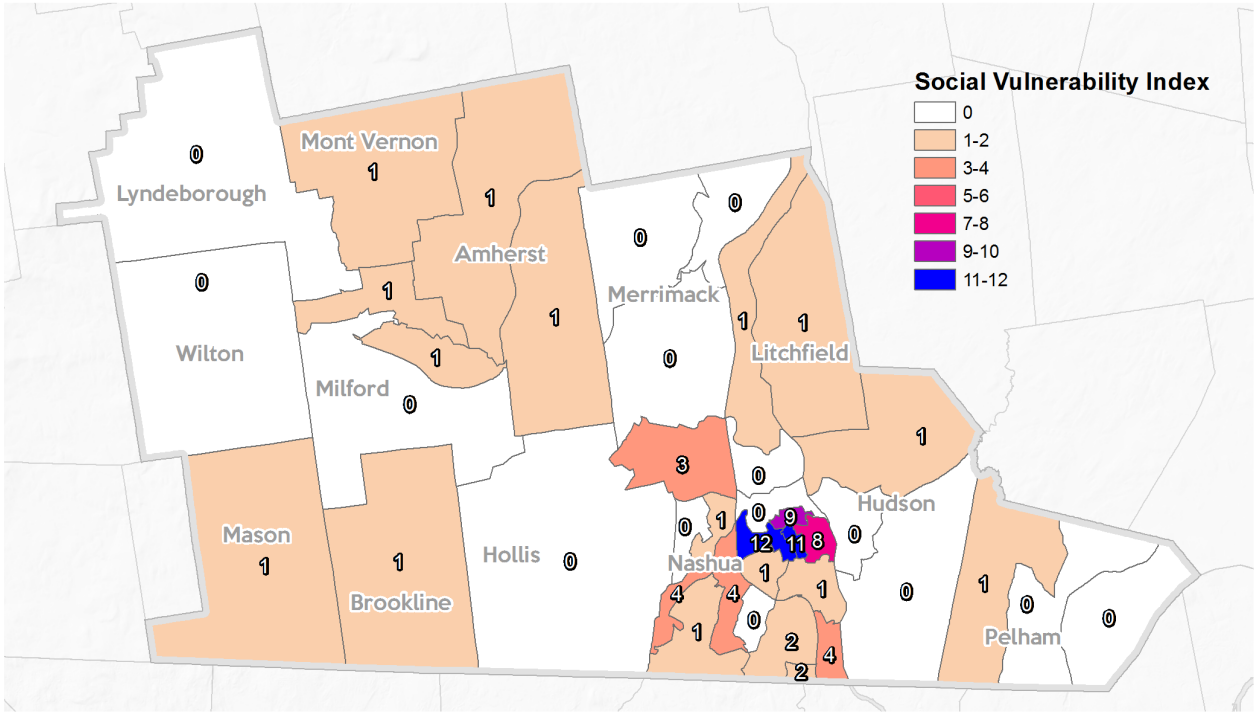


Figure 2: Map of the Nashua Region showing areas with the most vulnerable populations to external stressors Map source: NRPC. Data source New Hampshire Health and Human Services (NHHS) SVI (http://nhvieww.maps.arcgis.com/apps/PublicGallery/index.html?appid=38764e6f2a894165a60dd5c983543221) based on 2010-2014 American Community Survey estimates.

The people that make up the Nashua Region are just as diverse as its landscape. Figure 2 is a map that depicts the NH social vulnerability index within the Region. By compiling 16 factors at the Census Tract level related to socioeconomic status, household profiles, disabilities, minority, and non-English speaking populations, and limited transportation options, this map shows areas of communities most vulnerable to external stressors such as floods, forest fires, power outages and winter storms. While the majority of the communities within the region have low vulnerabilities, Nashua, especially within the downtown area shown in blue, has high scores of vulnerability factors.

Although the region is predominantly Caucasian, Nashua specifically has a high percentage of minorities relative to the rest of the region, including significant populations of people who identify as African-American, Indian-American or Latino. According to the 2006-2010 American Community Survey, the three communities in the Nashua region with the highest percentages of families living below the poverty level are Mason (7.2%, or 28 out of 387 families), Nashua (5.3%, or 1,165 out of 21,965 families) and Lyndeborough (5%, or 21 out of 417 families).

Regionally, 1.8% of the population does not speak English at all or cannot speak it well. Residents 65 and older have the highest rates of individuals with limited English proficiency at 2.4%. About 2% of those aged

18-64 have limited proficiency, and just over 1% of 5-17 year olds are limited. The majority of those who are not proficient in English speak Spanish as their native language; European languages are the next most common.

Across the Nashua region, 6.2% of residents live below the poverty level, 6.9% of all families with children and 5.9% of all elderly are living in poverty. The portion of residents who are Black or African American living below the poverty line is 18.4%, second to Hispanics or Latinos who rank highest in the region at 22.6%.

An important issue facing the region is the significant increase of those 65 and older as a percent of total population. Population projections (Figure 3) indicate that the age 65 and over cohort, which is currently about 12 percent of the region's population, will double by 2040 to about 25% or an increase of approximately 31,100 vulnerable people in the region.

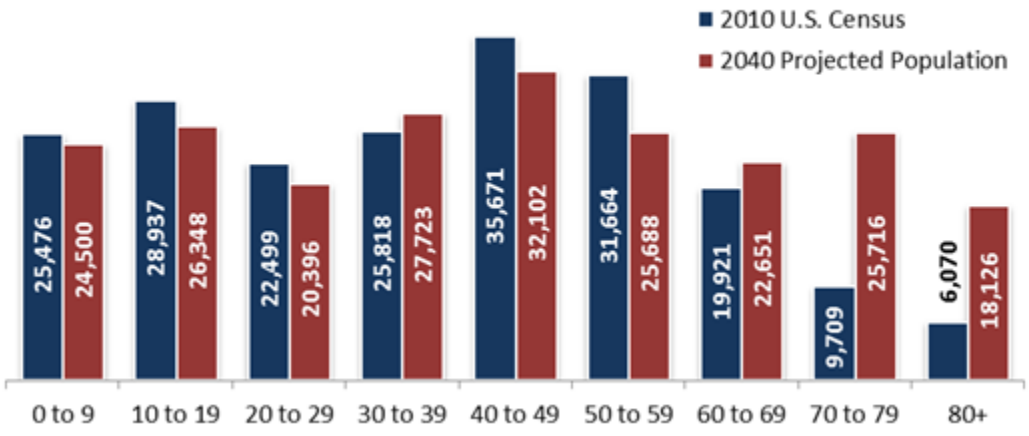


Figure 3: Population by Age – 2010-2040 Comparison. Image Source: NRPC. Data source: 2010 U.S. Census.

Weather Hazards and Climate Risk

Current and projected effects of climate change are well documented, and are described in the section below. While the scope of the studies have ranged from the United States to New England and even areas within New Hampshire, the consensus is that southern New Hampshire is getting warmer and wetter. These impacts are being felt by municipal workers, healthcare employees, and most importantly, the residents in the region.

Based upon an analysis of climate change-focused reports, community health assessments, and hazard mitigation plans within the region, this plan will assess four weather-related health impacts of climate change:

Extreme Heat

One of the consequences of the greenhouse effect (i.e. emitting carbon dioxide & other gases into the atmosphere) is the global rise in temperatures. In southern New Hampshire, overall temperatures have been steadily rising, with a marked increase since the 1970s.

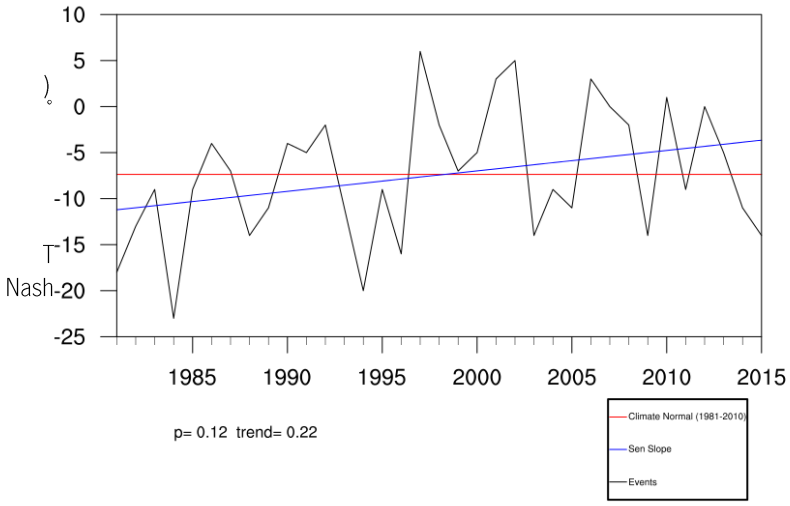
Taken from Cameron Wake's *Climate Change in Southern New Hampshire*, Table 1 details historical and projected temperature data from the Global Historical Climatology Network-Daily (GHCN-Daily) meteorological station in North Nashua. The data clearly demonstrate there is a projected increase in the number of days that are above 90˚F and 95˚F. Historically, through 2009, Nashua usually experiences about 9 days that are above 90˚F. In 2016 Nashua experienced 19 days with temperatures above 90˚F. Summers similar to 2016 could become the norm according to modeled predictions. For example under low carbon emission scenarios in the long-term through 2070 modeled predictions suggest 19 days above 90˚F will be normal.[ii]

Nashua (2), New Hampshire

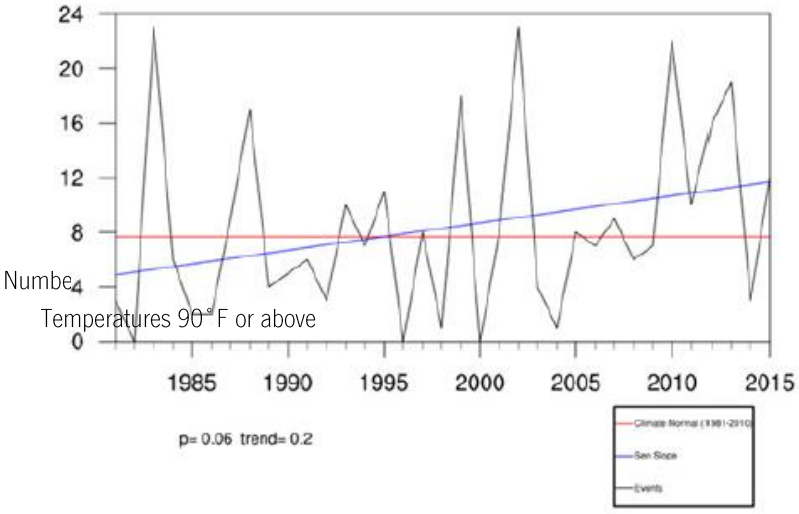
Indicators	Historical* 1980–2009	Change from historical (+ or -)					
		Short Term 2010–2039		Medium Term 2040–2069		Long Term 2070–2099	
		Low Emissions	High Emissions	Low Emissions	High Emissions	Low Emissions	High Emissions
Minimum Temperature (°F)							
Annual TMIN	36.2	1.7	1.9	2.8	5.0	3.6	8.6
Winter TMIN	15.3	2.1	2.3	3.4	5.1	4.6	8.5
Spring TMIN	33.8	2.8	1.5	4.4	4.1	5.6	7.2
Summer TMIN	56.5	1.6	2.1	2.8	5.7	3.5	10.4
Fall TMIN	38.7	0.3	1.7	0.6	5.1	1.0	8.5
Maximum Temperature (°F)							
Annual TMAX	59.0	1.7	1.7	3.0	4.8	4.0	8.2
Winter TMAX	36.0	1.7	1.5	2.5	3.5	3.6	6.1
Spring TMAX	57.1	2.6	1.6	5.0	4.8	6.7	8.8
Summer TMAX	80.8	1.7	2.1	3.3	5.8	4.2	9.6
Fall TMAX	61.6	0.9	1.6	1.3	5.3	1.5	8.5
Temperature Extreme (days per year)							
<32°F	157	-10	-11	-16	-25	-19	-43
<0°F	10	-4	-4	-6	-7	-7	-10
>90°F	9	5	7	14	26	19	54
>95°F	1	1	2	4	10	7	29
TMAX on hottest day of year	94.2	1.7	1.3	2.8	4.3	4.4	7.9
TMIN on coldest day of year	-11.9	3.8	4.3	6.1	9.7	7.7	16.4

Table 1: Climate projections for heat-related indicators analyzed from historical trends in North Nashua. Source: Climate Change in Southern New Hampshire, 2014.

Another important way to see how climate change is changing exposure to extreme heat is by looking at the maximum temperature recorded during each season. In an analysis conducted by Plymouth State graduate student Kelly Neugent (publication of final report forthcoming),[iii] climate trends are normalized from 1981 to 2010, to show that there is an overall increase in the number of days each year where the temperature reaches 90˚F or above in the Nashua area. A similar analysis was also done of temperature minimums trends in the same timeframe, which indicates that there is also a slight increase in the annual minimum temperature since 1980 (Figure 4).



Temperature Minimums: In the chart on the left, the red line shows the climate normal from 1981-2010, overlaid with the annual temperature minimums in black. The blue Sen Slope shows a positive trend, demonstrating an increase in minimum temperature in Nashua.



Number of Days with Temperatures 90˚F or above: In the chart on the left, the red line shows the average number of days 90˚F or above from 1981-2010, overlaid with the annual count of days 90˚F or above. The blue Sen Slope shows a positive trend, demonstrating an increase in the number of extreme heat days in Nashua.

Figure 4: In a study conducted using data in Nashua, climatological trends suggest the minimum temperature and the number of days 90F or above are both increasing. Source: Presentation by Kelly Neugent, 2016. Source: Neugent, 2016.

Geographic variations also play an important role in the effect of heat on human health. Urban areas tend to have warmer temperatures than their rural counterparts due to greater levels of impervious surface and less tree cover. This phenomenon is called the heat island effect, and is more likely to be found in Nashua and more developed parts of the region rather than towns like Mason or Lyndeborough.

Figure 5 is a geographic analysis of the Nashua Region's heat islands. This remote sensing map shows land surface temperature as detected by the LandSat8 OLI_TIRS sensor on August 30, 2016 at approximately 10:30 am. Thermal bands 10 and 11 wavelengths were averaged, converted to satellite temperatures, and then adjusted according to land surface emissivity as estimated from proportion of vegetated land cover. An interactive version of this map can be found at: http://arcg.is/2eFGq7m.

From this map, it is clear that the heat islands exist within central and south Nashua and extend northward into Merrimack along the F.E. Everett Turnpike Corridor and westward into Merrimack, Amherst, Milford, and Wilton along the NH101A Corridor. Small pockets also exist in Hudson, Pelham, and Litchfield.

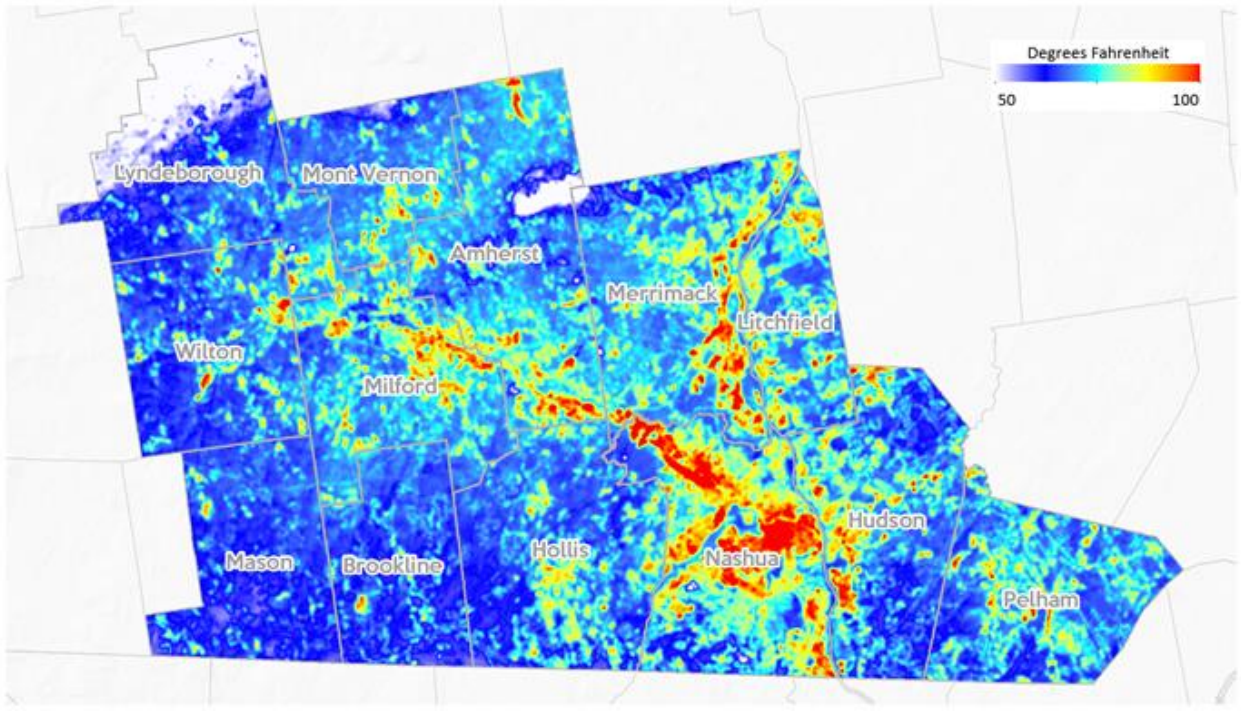


Figure 5: Urban heat islands, NRPC Region. Map Source: NPRC. Data source: LandSat8.

Air Quality

The air quality of southern New Hampshire may also be affected by climate change. As evidenced in Table 2, growing seasons are expected to be extended. This phenomenon may be due to overall temperature increases. In the short-term scenario, there is expected to be 14 additional days added to the historic 168 day growing season. In the long term, this could extend from 21 to 48 days, depending on the level of carbon emissions emitted over the next 50 years. The extended growing season means that greater amounts of pollen will be released into the air over longer periods of time[iv].

Nashua (2), New Hampshire

Indicators	Historical* 1980–2009	Change from historical (+ or -)					
		Short Term 2010–2039		Medium Term 2040–2069		Long Term 2070–2099	
		Low Emissions	High Emissions	Low Emissions	High Emissions	Low Emissions	High Emissions
Growing Season (days)	168	14	14	18	29	21	48

Table 2: Climate projections for air quality indicators analyzed from historical trends in North Nashua. Source: Climate Change in Southern New Hampshire, 2014.

Another potential by-product of a warmer climate is reduced air quality due to ground level ozone. Ground level ozone formation occurs when nitrogen oxides (NOx), carbon monoxide (CO) and volatile organic compounds (VOCs), react in the atmosphere in the presence of sunlight. Higher temperatures enhance the ozone formation chemistry and increase the evaporative emissions of volatile organic compounds. With more days expected to exceed 90˚F, increases in the number of days where ground level ozone exceeds EPA standards are probable. In addition to the local formation of ground level ozone, ozone that forms in neighboring metropolitan areas can be transported into the Nashua region under certain atmospheric conditions. In Nashua, temperatures in excess of 90˚F occur most often when a ridge of high pressure builds off the east coast resulting in a light southwesterly wind. This wind direction generally results in warm humid conditions and transport ozone formed in the large metropolitan areas to the south and west.

Table 3: Ozone and Particulate Matter in Hillsborough County

Year	Number of 8-Hour Ozone Exceedance Days in Hillsborough County	Number of 24-Hour PM2.5 Exceedance Days in Hillsborough County
2000	2	
2001	13	
2002	16	2
2003	8	2
2004	5	1
2005	10	1
2006	5	1
2007	14	1
2008	5	
2009		
2010	4	
2011	1	
2012	3	
2013		

Note: Blank cells may indicate either zero exceedances or lack of monitoring data from that county.

Source New Hampshire Department Of Environmental Services

Table 4 compares Hillsborough County ozone and particulate matter to the rest of the state from 2000-2013. Hillsborough County is consistent with the number of state wide exceedance days. There were 16 exceedance days in 2002, the highest of the 13 year data period. The statewide average and Hillsborough County was the highest from 2001-2007 and has declined since. The decrease is largely due to improved motor vehicle technology and reduced tailpipe emissions combined with a number of cooler summers.

Extreme Precipitation

The Nashua region is not unfamiliar with major storm events hitting its region with subsequent flooding and infrastructure damage. The Federal Emergency Management Agency (FEMA) has declared disasters in Hillsborough County during Hurricane Bob (1991) and Hurricane Irene (2011) due to intense flooding. One of the most significant floods in recent memory was the Mother's Day Flood (2006), where portions of the Merrimack River were 10 feet above the flood stage.[v]

Figure 6: Evidence of drought in Purgatory Brook in Lyndeborough in Fall 2016. Source: NRPC

One possible reason for the increase in precipitation events is that the atmosphere can hold more water as it warms, which in turn results in heavier rain events. There are two measures of extreme precipitation: when 1" of rain falls in 24 hours or when 2" falls in 48 hours. Historically, Nashua has had approximately 12 events where 1" of rain fell in 24 hours, and 5 of the more severe 2" in 48 hours. Projections suggest that these events will increase by 1.5 events within the short– and medium-term (Table 4). By 2100, the number of extreme precipitation events in the summertime could increase by more than 200% across New Hampshire, according to a study by Prein et al. The study also found that the intensity of summertime extreme rainfall events could increase up to 70% in the Northeast.[vi]

Nashua (2), New Hampshire

Indicators	Historical* 1980–2009	Change from historical (+ or -)					
		Short Term 2010–2039		Medium Term 2040–2069		Long Term 2070–2099	
		Low Emissions	High Emissions	Low Emissions	High Emissions	Low Emissions	High Emissions
Precipitation (inches)							
Annual mean	46.3	4.3	3.3	4.3	4.9	6.9	7.3
Winter mean	10.8	1.3	0.9	1.6	1.2	2.2	2.8
Spring mean	12.2	0.6	1.1	0.4	1.3	1.2	1.9
Summer mean	11.2	1.8	1.1	1.2	2.1	2.0	2.1
Fall mean	12.2	0.5	0.2	1.1	0.2	1.3	0.4
Extreme Precipitation (events per year)							
1" in 24 hrs	12.3	1.5	1.5	1.5	2.3	2.4	3.4
2" in 48 hours	5.4	1.5	0.9	1.5	1.7	2.7	3.6
Extreme Precipitation (events per decade)							
4" in 48 hours	5.3	1.6	-0.1	4.5	3.0	6.0	6.4
Snow-Covered Days	77	-14	-15	-19	-34	-27	-45

Table 4: Climate projections for extreme precipitation indicators analyzed from historical trends in North Nashua. Source: Climate Change in Southern New Hampshire, 2014.

Paradoxically, the National Center for Atmospheric Research (NCAR) study also found that extreme precipitation events are also associated with drought events. This is because, as extreme precipitation events are expected to increase in frequency and intensity, summertime light to moderate rainfall events are projected to drastically decrease. As a result, it will be possible to have below normal rainfall despite an increase in extreme flooding events. In other words, when it rains, it pours.

Since 2013 New Hampshire has experienced drier than normal conditions and entered into a period of severe to extreme drought. Previously, the most recent drought for New Hampshire was in 2002. Southern New Hampshire has been classified as being in a state of extreme drought from June to November 2016. The region has a deficit of 13.86 inches of rainfall since April, equivalent to 58% of the normal amount.[vii]

Vector Habitat

The combination of the rising temperatures and increased moisture will have a dramatic effect on the landscape, impacting many different types of environments. Habitat change can be one of the main drivers of insect population patterns, who are transmitters of vector borne illness like Lyme, Eastern equine encephalitis (EEE), and West Nile virus. Two of the most prominent vectors in the region are ticks and mosquitos.

As described in Table 5, the number of snow-covered days is estimated to be reduced by 14 days in the short term (by 2039) and further reduced to between 27 and 45 days by 2099, which will also contribute to the pervasiveness of insects. Since, ticks are active any time the temperature is above 40˚F and there is not dense snow cover,[viii] the reduction in number of days with snow cover will increase the period when these

vectors are active. Later frost and freeze dates can also extend the mosquito season. All of this results in increased exposure to these insects and vector-borne illness.

Furthermore, mice are one of the major hosts for ticks. Mice populations tend to thrive in fragmented forests, which have fewer natural predators, such as foxes. Due to a climb in mice populations in the summer of 2016, experts predict that the number of Lyme disease cases will increase in 2017.[ix]

Nashua (2), New Hampshire

Indicators	Historical* 1980–2009	Change from historical (+ or -)					
		Short Term 2010–2039		Medium Term 2040–2069		Long Term 2070–2099	
		Low Emissions	High Emissions	Low Emissions	High Emissions	Low Emissions	High Emissions
Growing Season (days)	168	14	14	18	29	21	48
Snow-Covered Days	77	-14	-15	-19	-34	-27	-45

Table 5: Climate projections for habitat change indicators analyzed from historical trends in North Nashua. Source: Climate Change in Southern New Hampshire, 2014.

Regional Health Risks and Vulnerable Populations

It is evident that climate change will have wide-reaching effects on the weather and vector habitats. But it is also important to consider how these effects will impact human health. While the following health risks are related to the weather hazards described above, impacts on mental health (i.e. stress, anxiety) cross-cut all of these health risks.

Heat-related Illness

Prolonged exposure to high temperatures can impact people's health in a variety of ways. The health impacts of heat illness ranges from mild (e.g., heat rash, cramps, and fatigue) to moderate (e.g., heat syncope and heat exhaustion) to life-threatening (e.g., heat stroke).[x] Further, heat illness can also exacerbate pre-existing medical conditions. People living with diabetes may have damaged blood vessels or nerves, which can affect sweat glands, thus diminishing the body's capacity to cool.[xi] Recurrent physical activity in high temperature situations coupled with poor hydration can also lead to kidney damage.

A study in California[xii] found that for every 10˚F increase above the mean ambient temperature, there was a 393% increase in hospitalization for heat exposure, a 3% increase in ischemic stroke hospitalizations, and a 15% increase in acute renal failure hospitalizations. This finding is supported by a national study that also found a strong correlation between an increase in emergency room visit rates and temperature anomalies.[xiii]

It is important to note that the maximum temperature during the day has a major impact on health, but it is also vital to consider the minimum temperature of that day. If the temperature does not fall below the upper 70s and 80s˚F during the night, people (who may not live in well insulated homes or lack air conditioning) may not be able to cool down and may succumb to the stresses of heat. The most extreme example of this phenomenon was a five day period in Chicago in 1995 where the temperature did not fall below 76˚F at night and rose up to 106˚F during the day, resulting in the death of over 700 people.[xiv]

Another example closer to home is the Heatwave of 1911. In early July, temperatures topped 100˚F, with overnight highs in the 80s. The historic date of July 4, 1911 is considered one of the hottest days in New England, with Nashua holding the state record at 106˚F (Figure 7). Over 1,000 people died throughout New England and New York City during this event.

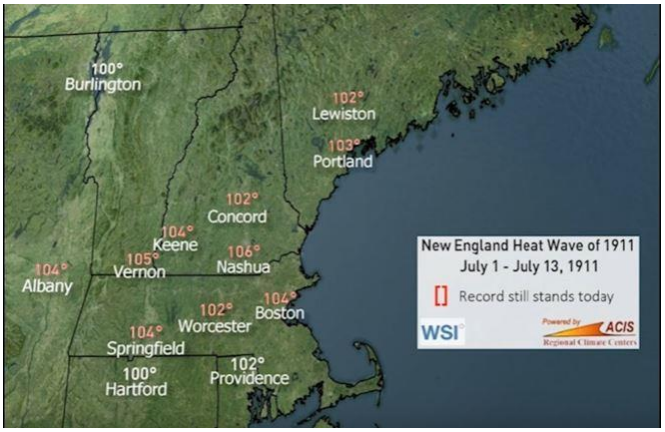


Figure 7: Temperature maximums during the Heatwave of 1911.Source: Weather Services International, NOAA Regional Climate Centers.

Furthermore, heat's effect on health is not confined solely to the day with high temperatures. Preliminary findings from research conducted by Kathleen Bush at DHHS found that on a day when the maximum heat index (the combination of temperature and humidity) was 95˚F (compared to 75˚F) all-cause emergency department (ED) visits increased by 7.5% over the following 7 days, heat-related ED visits increased by ~200% over the following 7 days, and deaths increased by 5.1% over the following 7 days. This study is due to be published in Spring 2017, and findings are available via NH DHHS.

There is evidence to support a correlation between the intensity of the heat index and emergency department visits. Table 6 shows that Nashua has approximately 334 heat-related emergency room visits annually at a heat index of 90˚F. However, National Weather Service (NWS) heat advisories only go out when the Heat Index is between 100˚F and 104˚F for a two hour period, at which point it is estimated that hundreds of people have already suffered a heat-related illness at 90˚F and 95˚F and go to the emergency department. A new NWS policy will issue an Excessive Heat Advisory when the Heat Index is 95˚F and above for two or more days or greater than 99˚F for one or more days.

	Annual ED Visits by Heat Index Category (2001-2010)			
Study Area	*90˚ F*	*95 ˚ F*	*100 ˚ F*	*Total*
Concord	121	50	13	121
Keene	45	14	4	45
Laconia	69	25	7	69
Lebanon	29	11	3	29
Manchester	251	95	27	251
*Nashua	334	167	68	334
Portsmouth	146	70	20	146
Total	994	432	143	994

Table 6: Estimated Annual Emergency Department Impacts at HI > 90˚F. Note that the emergency room visits at 95 ˚F and 100 ˚F represent a portion of the totals represented in the previous column. Source: Bush, NH DHHS, Environmental Public Health Tracking Program & Cahillane, NH DHHS, Climate and Health Program, 2016

Heat-related illnesses are not only a cost to human health, but also a financial cost. One study[xv] found that the adjusted mean cost of heat-related illnesses was $5,539 per hospitalization. However, the study also concluded that costs for heat-related hospitalizations were higher for minority populations, low-income populations and the elderly. Human health is not the only cost associated with heat-related illnesses.

Vulnerable Populations

The elderly and very young are usually considered the most at risk for heat-related illnesses. Also, there is evidence to support that people in the Northeast are not conditioned to experience such high temperatures, unlike people in warmer climates, therefore residents of southern New Hampshire are less likely to alter their behavior to cope, or know the symptoms of when they should seek a cooling center or medical care.

Furthermore, as Figure 5 showed the Nashua region also has many urban heat islands in parts of Nashua (especially the Tree Streets and French Hill neighborhoods), Merrimack, Milford, and downtown Wilton that contain an older, denser housing stock. These areas typically have fewer green spaces and more blacktop resulting in the “heat island effect”. Income level is also an issue to be considered within these regions because the populations within these heat islands may not be able to afford upgrades to their house, an air conditioner, or the expense to run the air conditioner.

NRPC created a simplified heat-specific vulnerability index (Figure 8) to describe areas in the region that maybe contain populations susceptible to the effects of heat stress. The approach is based on a modification of a publicized study that concluded on the national level, heat vulnerability is most strongly influenced by

educational attainment, poverty, race, proximity to green space, social isolation, availability of air conditioning, and elderly/diabetes status.[xvi]

The modified NRPC Heat Vulnerability Index considered the following block-group level variables obtained from the American Community Survey 5-year estimates (2011-2015):

- Population living below poverty level
- Age 25+ without a high school diploma
- Black or African American race
- Age 65+ living alone
- Pre-1970 housing as a proxy for lack of central Air Conditioning

Black or African American populations were included as the only racial variable in this heat index because several heatwave studies in the United States have shown that they are particularly vulnerable compared to other racial and ethnic demographics.[xvii]

Additionally, the amount of impervious surface was captured from the 2011 National Land Cover database and aggregated by the same block-group geography.

The range of values in the NRPC region for each of these six measures was then divided up into five classes based on Natural Breaks (Jenks) classification. Block groups were then assigned sub-scores between 1 and 5 for each of these six measures, and then a cumulative Heat Vulnerability Index score from the summation of each of the 6 sub-scores. That is to say, no one measure was weighted more heavily than the others in this analysis.

The NRPC Heat Vulnerability Index ranged from between 6 and 27 inclusive. Mapping of the values shows that the most vulnerable populations exist in central Nashua, with medium at risk populations in eastern Merrimack and Milford Center.

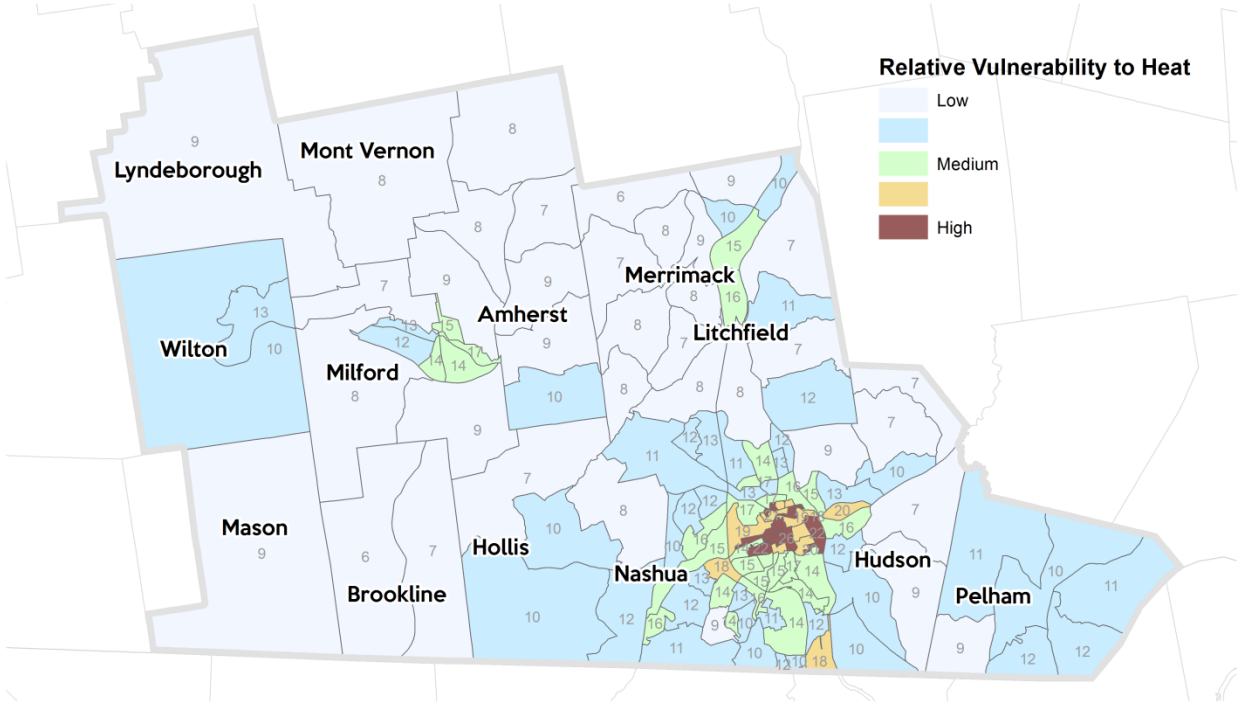


Figure 8: NRPC Heat Vulnerability Index by census block group. Labels represent overall composite score that ranged in value between 6 and 27. Map Source: NRPC.

Respiratory Illness

Poor air quality can have many effects on health. Higher temperatures could increase air pollution in the state, creating more days when national air-quality standards cannot be met. Poor air quality resulting from increased ground level ozone will exacerbate the risk of respiratory, cardiovascular, and other ailments.

Allergy sufferers can expect rising temperatures, carbon dioxide levels and pollen levels across New Hampshire.[xviii] Due to a number of factors, New Hampshire has one of the highest asthma rates in the nation. Air quality indoors and outdoors may explain some of this excess asthma burden. Particulate Matter and ozone that forms in neighboring metropolitan areas can be transported into the Nashua region under certain atmospheric conditions. In Nashua temperatures in excess of 90˚F occur most often when a ridge of high pressure builds off the east coast resulting in a light southwesterly wind. This wind direction generally results in warm humid conditions and transport ozone formed in the large metropolitan areas to the south and west.

Ozone can cause the muscles in the airways to constrict, trapping air in the alveoli, which leads to wheezing and shortness of breath. Other short-term effects of ground level ozone are coughing, painful breathing, temporary loss of lung function, aggravating asthma, emphysema, and bronchitis. Long-term effects include lung inflammation, impairment of lungs, changes in lung structure, and premature aging of lungs.

Vulnerable Populations

Populations with asthma and other respiratory illnesses are most at risk from poor air quality. Approximately eight percent of children in Hillsborough County have asthma.[xix] As data collected by the Greater Nashua Public Health Region shows, asthma hospitalizations primarily are the elderly and children below the age of four (Figure 9). However, it is a common finding that males are hospitalized in greatest number at the lowest and highest age ranges, while female hospitalization (although skewed toward children and elderly), tend to be more evenly distributed across the age spectrum. Past studies indicate that testosterone may have a protective effect on the lungs and may explain these patterns.[xx]

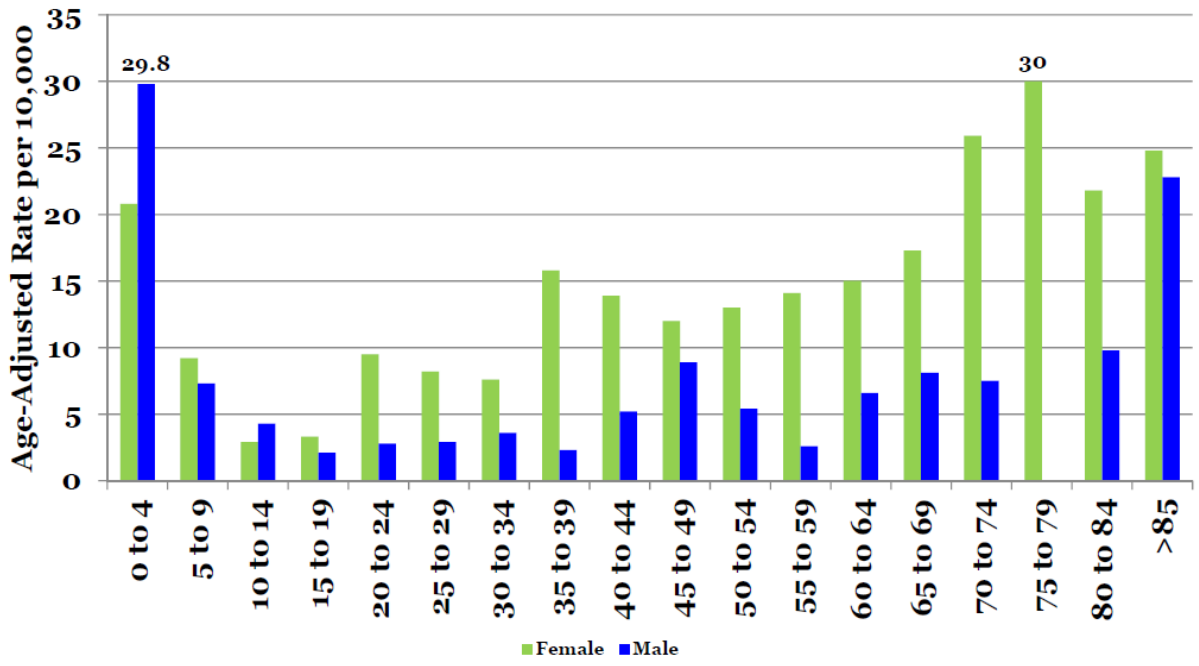


Figure 9: Rate of Asthma Hospitalizations by Age from 2005-2009. Source: Greater Nashua Regional Public Health Network.

Flood and Drought–related Health Outcomes

The health risks of extreme precipitation vary depending on whether there are drought or flood conditions.

There are many health risks due to flooding or storm events. One of the more extreme results is when storm events directly cause fatalities and when they damage infrastructure (roads, bridges, etc.) that cut people off from emergency responders and necessary resources. Figure 10: Summary of fatalities associated with different weather phenomena. Source: National Weather Service shows that flooding was the leading cause for weather fatalities for 2015. Also, when flooding occurs in buildings, there is an increased chance of mold growth, which can cause respiratory issues, and throat and eye irritation. Flooding can also contaminate wellheads with runoff and other chemicals. Destruction of public water systems and broken pipes can affect public water supplies. Floodwaters that top a wellhead or other piping system can contaminate groundwater

with chemical runoff, hazardous waste, fuel runoff and pathogens. Increased risk of gastrointestinal diseases caused by viruses, bacteria and protozoa in contaminated water is the most likely health impact.

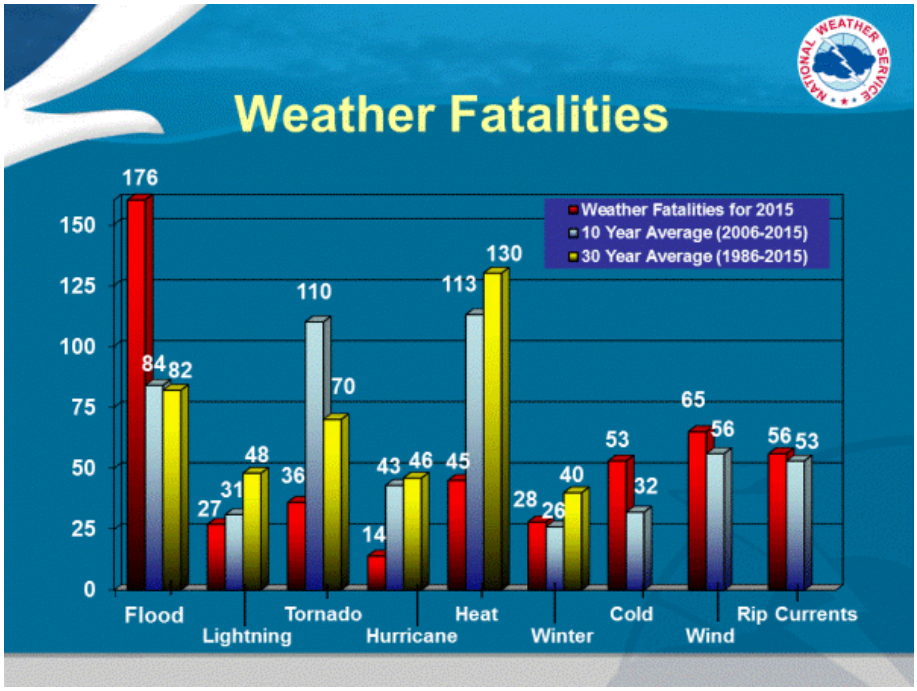


Figure 10: Summary of fatalities associated with different weather phenomena. Source: National Weather Service

In a drought scenario, threats to water and food supplies will usually lead to water restrictions or bans. There are hypotheses that these restrictions can affect hygiene as people are less likely to bathe regularly or wash their hands as frequently.[xxi] Worldwide, drought-related famine has major impacts on health, including nutritional deficiencies and dehydration. Within New Hampshire, droughts can lead to an increase in the cost of produce, forcing a greater number of people to rely on processed foods. Loss of well water also forces people out of their homes, increasing stress and anxiety. Future work should look at how drought conditions impact well water quality since over 37.2% of the Region relies on private well water.

Vulnerable Populations

For drought conditions, people on well water within aquifer regions are most at risk. Forty four percent (44%) of the Nashua Region relies on groundwater as a primary source of drinking water. Roughly 63% of the region's population uses public water; however, 8 of the 13 communities have 50% or more of their population served by household wells.[xxii]

Figure 11 below demonstrates the region's groundwater supplies. Stratified drift aquifers provide the majority of the water supplies. Additionally, dug wells, bed rock wells and surface waters support residential and commercial operations. The largest confluence of resources exists at the intersection of Amherst, Hollis and

Nashua along the Souhegan River corridor where the stratified drift aquifer exceeds 8,000 feet squared per day and gravel well analysis of 150 gallons per minute. A gravel well analysis is the minimum well yield required by the community water system. The Merrimack and Nashua River corridors provide lower level of gravel well analysis but significant water resources reside under the City of Nashua.

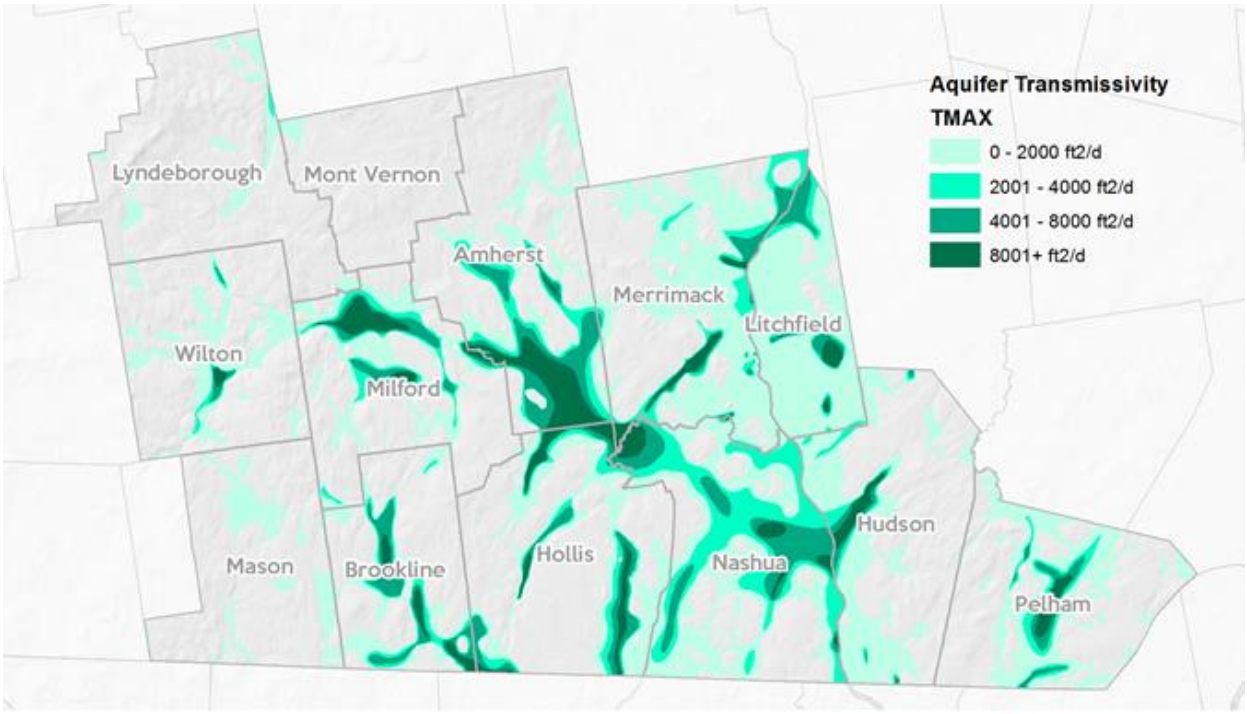


Figure 11: Drought-vulnerable groundwater areas. Map Source NRPC. Data source: Aquifer Transmissivity provided by NH GRANIT.

For storm events, people living in floodplains or near waterbodies are most at risk (see Figure 12), especially those living on well water. The Nashua region contains 413.6 miles of rivers and streams and 3,296 acres of open water. In the Nashua Region, some 74% of the water bodies with documented water quality problems are related to the pollutants commonly found in stormwater. An additional 23 percent of water bodies have problems related to an intermingling of stormwater and other types of pollutants sources.[xxiii]

Floods can lead to Combined Sewer Overflows into local rivers, thereby depositing stormwater, and sewage directly into water bodies which contaminate water systems resulting in beach closures and infected areas. The Merrimack River receives raw sewage periodically from the City of Manchester and City of Nashua CSO's resulting in heavy contamination and infected waters. Additionally, the Merrimack and Nashua Rivers receive a number of industrial discharges from local manufacturing operations, as detailed in the Non-point Source Discharge Elimination Systems (NPDES) section.[xxiv]

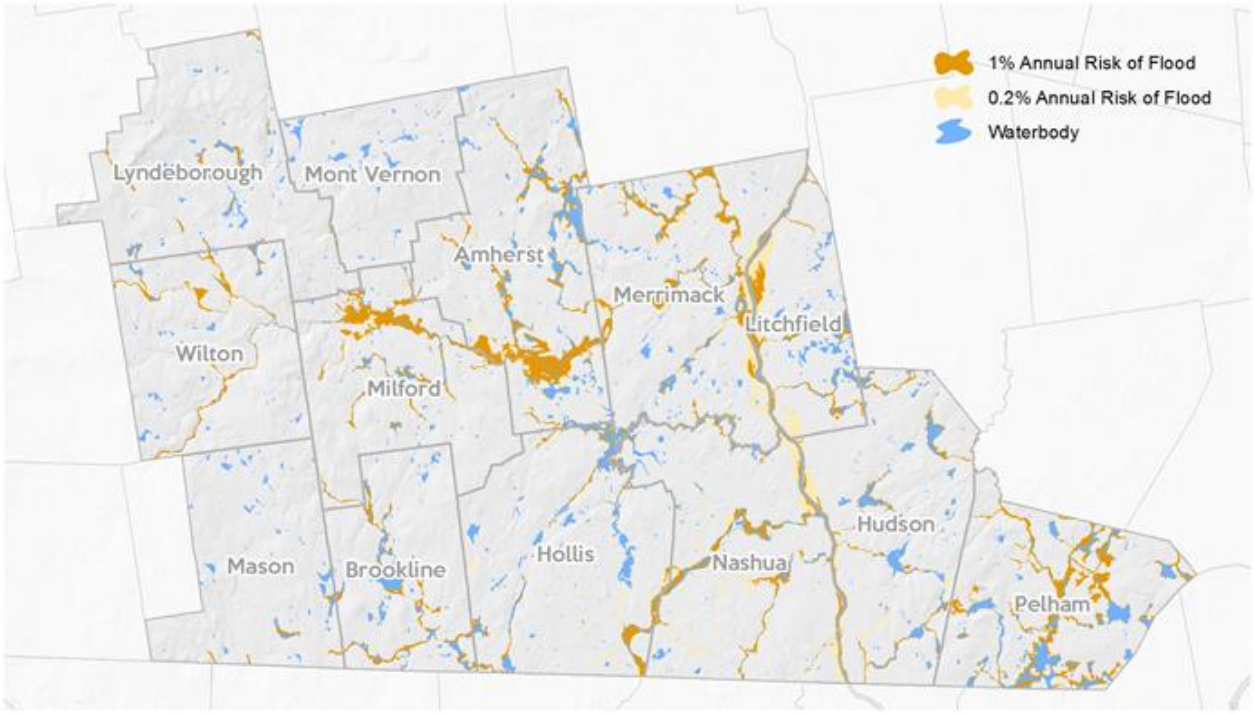


Figure 12: Flood-Prone Areas. Map Source: NRPC. Data source FEMA Digital Flood Insurance Maps obtained from NH GRANIT.

Vector-borne Illnesses

The reduction in snow-cover days, the extended growing season, and increasing temperature all contribute to mosquito and tick population growth. Deer ticks can act as the carriers of Lyme Disease, while mosquitos can be vectors for West Nile Virus and Eastern Equine Encephalitis (EEE).

As Figure 13 shows, Hillsborough County as a whole has a relatively lower rate of Lyme disease compared to Rockingham, Strafford, and Carroll Counties. However, the Greater Nashua Region's rate of Lyme (highlighted in green) is much higher compared to the rest of Hillsborough County, even exceeding the overall rate of New Hampshire.

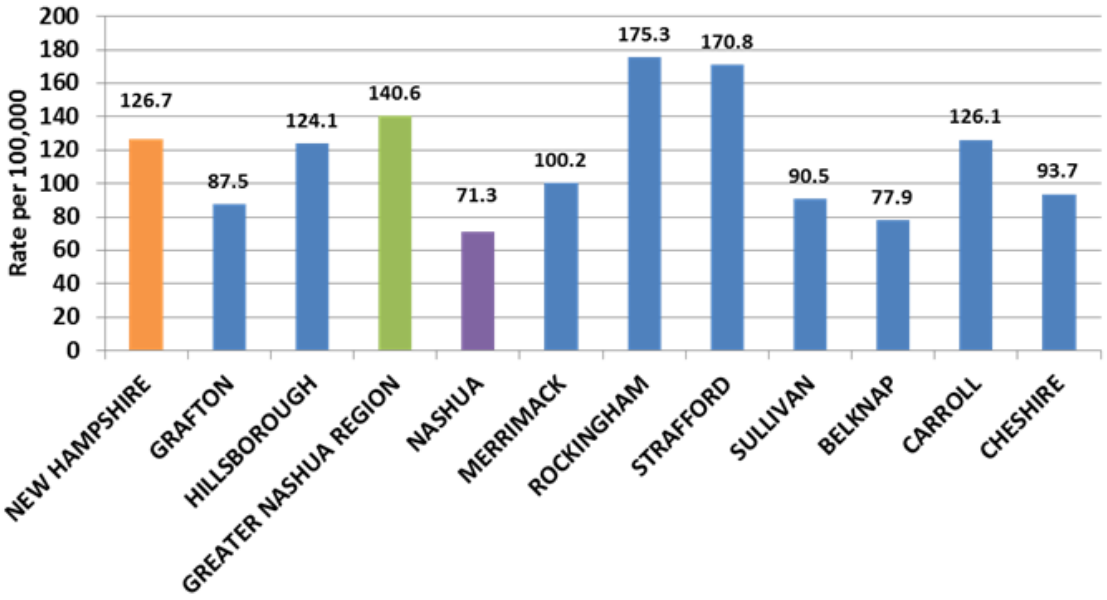


Figure 13: Incidence Rate of Lyme Disease Cases by Geography – 2013. Source: NH DHHS

West Nile Virus was first identified in mosquitos in New Hampshire in August 2000. In 2016, mosquitos in Nashua tested by the New Hampshire Public Health Lab were positive for West Nile Virus, although no mosquitos tested had EEE. In 2015, three mosquito batches tested positive for West Nile Virus in the state and there were two positive batches for EEE.[xxv]

Vulnerable Populations

In terms of vulnerable human populations, Lyme Disease is most common, is highest among the 5-14 year age group, but is high for all primary and secondary aged children in New Hampshire. The onset of symptoms is most commonly seen from June to August.[xxvi] Children are particularly vulnerable since they spend more time outside and are more likely to be exposed. They also usually have to rely on an adult to provide insect repellant and check for ticks.

Also, living in a rural area puts one at greater risk than living in an urban area; yet, this risk is not equal across all areas.[xxvii] Ticks live in moist and humid environments, particularly in or near wooded or grassy areas. Since deer and mice are two major hosts for ticks, tracking their habitats helps identify areas where people's exposure to tick population (and potentially Lyme Disease) is increased (see Figure 14 for these areas within the Nashua Region). Forest fragmentation is also an important factor in identifying areas that ticks inhabit. Although Figure 14 does not include fragmentation, the Wildlife Action Plan has recently developed the Index of Ecological Integrity (IEI) to measure this, which will be utilized for any future research into Lyme Disease by NRPC. This explains why the Greater Nashua Region has a high rate of Lyme Disease, but the City of Nashua has a much lower rate due to urban development. In addition to the people who live within these types of habitats, people who recreate and work in these environments are more at risk. There is

some evidence to show that general outdoor workers, forestry workers, gardeners, people with pets, and those who recreate, such as hikers, and runners are at a higher risk of exposure.[xxviii]

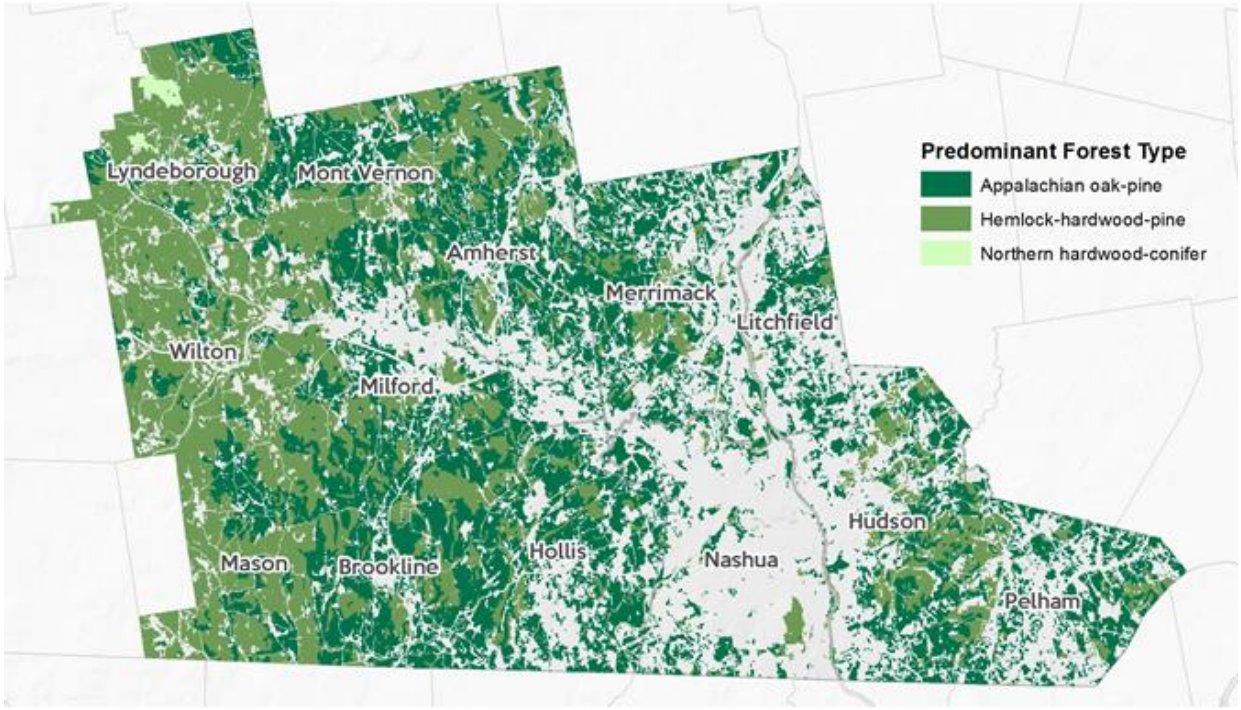


Figure 14: Potential Deer and Mouse Habitats in the Nashua Region. Map Source: NRPC. Data source 2015 Wildlife Action Plan provided by New Hampshire Department of Fish and Game.

The vulnerable populations most susceptible to the effects mosquitos are pregnant women, children, people with compromised immune systems, and the elderly.[xxix] Diseases transmitted by mosquitos can severely affect children, especially EEE. In fact, these demographics are more likely to suffer fatalities, and more intense systems from the diseases carried by mosquitos.[xxx]

Geographically, since mosquitos prefer stagnant water within which to lay their eggs, vulnerable populations are those who live or recreate near infest ponds, marshes, swamps and other wetland habitats. Figure 15 shows that the Nashua Region has many impaired and unimpaired wetlands, which may affect people living nearby or people who actively recreate in the wilderness. Farmers are considered one of the occupations more susceptible to mosquito-transmitted diseases.[xxxi] Pelham and Amherst contain the most wetlands in the region at 12 and 13% each. Wilton has the least number of wetlands at just 3%.[xxxii]

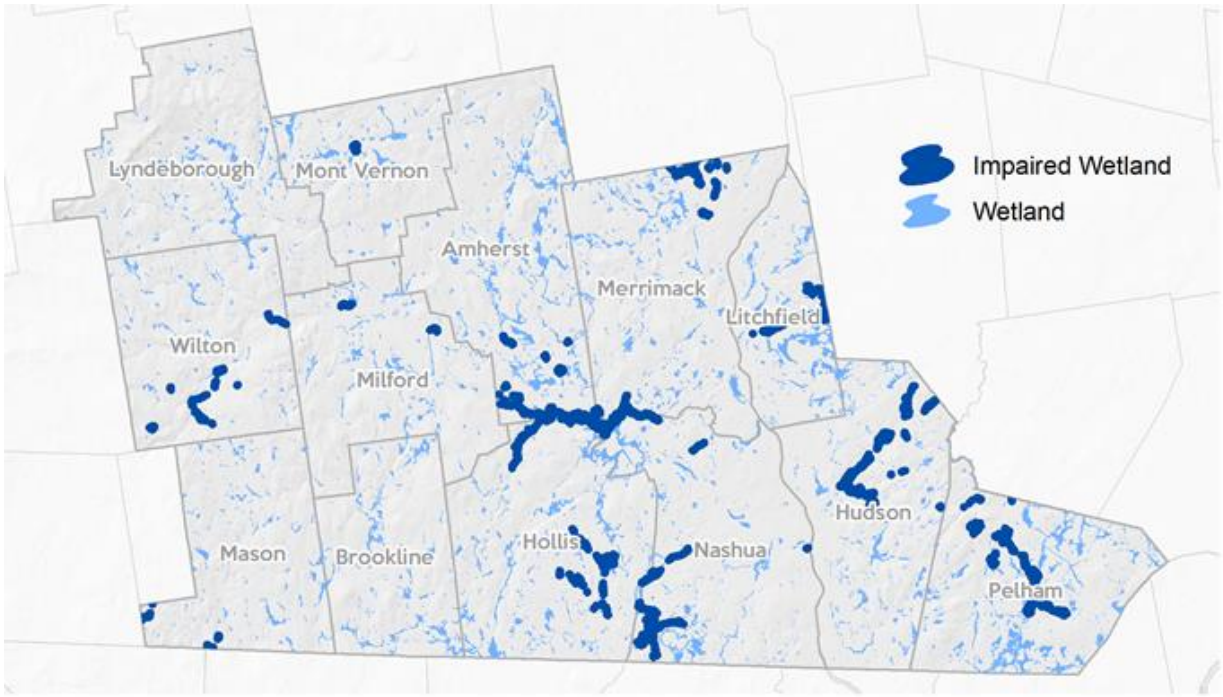


Figure 15: Potential Mosquito Breeding Areas. Map Source: NRPC. Data sources: New Hampshire Department of Environmental Services (NH DES) and National Wetlands Inventory provided by NH GRANIT.

Prioritization Process

In order to determine which singular intervention strategy would be most effective, the regional health risks and vulnerable populations identified above were analyzed to determine the focus of the remainder of this plan.

Table 7: Health Vulnerability Assessment is a detailed assessment of climate-related health burdens, or vulnerabilities. Project partners participated in this evaluation process and provided input and guidance. The prioritization process was based on a qualitative assessment process that considered likely impacts of the region considering characteristics in the regional overview.

Table 8: Vulnerable Populations analyzes the populations most vulnerable to the weather hazards exacerbated by climate change. This assessment relied on geographic and demographic information, obtained from a variety of federal, state, regional, and local sources.

Climate Exposure or Vulnerability	Pathways: Direct & Indirect	Health Effects & Impacts	Evidence for Relevance to the Nashua Region	Data Source	Priority for the Nashua Region
Increase in extreme heat events (days over 90˚F)	Increase in outdoor and indoor temperature. People without adequate cooling or outdoor workers suffer heat stress. Increased heat and humidity traps more ground level ozone, thus reducing air quality.	Heat stroke, heat exhaustion, cramps and dehydration, and potentially death. Exasperation of chronic respiratory, renal and cardiovascular illnesses	Climate models forecast that the number of days 90˚F or above may double or triple by 2040 depending on emission scenarios. 2016 already exceeded short-term estimates for number of extreme heat events.	Climate Change in Southern New Hampshire (2014), National Weather Service	**High:** Health impacts likely for the overall population and severe health risks for vulnerable populations.
Longer Growing Season	Increase in the number of days over 32˚F, allergic plants bloom earlier and later, which increases people's exposure to pollen.	Increase in respiratory diseases, increased asthma rates and severity.	Climate models indicate that the growing season will extend 11-17% by 2040. By 2100, the growing season will be expected to be 13-29% longer.	Climate Change in Southern New Hampshire (2014)	**Low:** Health risk is high, yet the state asthma program is strong. Many different factors contribute to asthma, hard to make focus of plan.
Increase in extreme precipitation events	Increase in the number of days with heavy rain or snowfall. This could result in flooding, power outages, infrastructure damage, contaminated water supplies by bacteria or hazardous materials	Injury, drowning, death, water– and food-borne infectious diseases, respiratory illnesses from mold, exposure to hazardous materials, cut out from emergency services or needed resources.	There has been an increased frequency of storm events in New Hampshire. New England's weather, overall, is projected to get wetter.	Climate Change in Southern New Hampshire, 2014	**Medium:** Can have major short-term and long-term effects. Floodplain regulations and FEMA response is strong.
Increase in drought events	Warmer temperatures increase water demands and evaporation. Arid soils also lead to more particulate matter in the air.	Increase in dehydration, overheating, and respiratory diseases. Also increased risk of Dry Well and decreased hygiene.	The Greater Nashua Region had record drought conditions during the summer and fall of 2016.	New Hampshire DES, 2016; NOAA, 2016; National Weather Service Climate Prediction Center	**Low:** 2016 is an anomaly to projected weather for the New England region.
Fewer snow-covered days	Snow and cold weather acted as population check for disease vectors (e.g., ticks and mosquitos) so vector season extends	Increase exposure to and incidence of vector-borne diseases.	Greater Nashua Region has one of the highest rates of Lyme Disease in the state.	Climate Change in Southern New Hampshire, 2014; GNRPHN, 2014	**Medium** for Lyme Disease, **Low** for other vector diseases.

Table 7: Health Vulnerability Assessment

Climate Exposure or Vulnerability	Pathways: Direct & Indirect	Health Effects & Impacts	Vulnerable Populations & Places	Evidence of Risk for Focus Populations	Locations of Populations at Risk
Increase in extreme heat events (days over 90 F)	Increase in outdoor and indoor heat. People without adequate cooling or outdoor workers suffer heat stress.	Heat stroke, heat exhaustion, cramps and dehydration, and potentially death. Exasperation of chronic respiratory, renal and cardiovascular illnesses.	People with lower incomes, elderly, those living alone or isolated without air conditioning. People with chronic illnesses. FOCUS POPULATIONS: Lower income population.	Social Vulnerability Index (SVI), NH WISDOM	Nashua (Tree Streets and French Hill neighborhoods); Merrimack, Milford, and downtown Wilton.
Longer Growing Season	Increase in the number of days over 32 F, allergic plants bloom earlier and later, which increases people's exposure to pollen. Increased heat and humidity traps more ground level ozone, thus reducing air quality.	Increase in respiratory diseases, increased asthma rates and severity.	The elderly and children aged four and below. People with asthma and other respiratory illnesses.	Asthma Burden in New Hampshire, 2014; SVI	Lyndeborough, Wilton, Mason, Mont Vernon, Brookline, Milford, Hollis, Amherst, Merrimack
Increase in extreme precipitation events	Increase in the number of days with heavy rain or snowfall. This could result in flooding, power outages, infrastructure damage, contaminated water supplies by bacteria or hazardous materials.	Injury, drowning, death, water– and food-borne infectious diseases, respiratory illnesses from mold, exposure to hazardous materials, cut out from emergency services or needed resources.	People living within the floodplain. Elderly people. Those with limited transportation options (no vehicle). People with low incomes.	SVI, local Hazard Mitigation Plans & National Flood Insurance Program	Milford, Amherst, Merrimack, Litchfield, Nashua, Pelham
Increase in drought events	Warmer temperatures increase water demands and evaporation. Arid soils also lead to more particulate matter in the air.	Increase in dehydration, overheating, and respiratory diseases.	People on well water living in aquifer areas. Low income populations.	Local Hazard Mitigation Plans, recent events	Brookline, Milford, Amherst, Merrimack, Nashua, Litchfield, Pelham
Fewer snow-covered days	Snow and cold weather acted as population check for disease vectors (e.g., ticks and mosquitos) so vector season extends.	Increase in incidence of vector-borne diseases.	Children aged five to nine. People who live, work and recreate in rural areas.	State of New Hampshire Tick-borne Disease Prevention Plan, 2015; SVI	Lyndeborough, Wilton, Mason, Mont Vernon, Brookline, Milford, Hollis, Amherst, Merrimack

Table 8: Vulnerable Populations

Interventions and Outcomes

The next step is to develop a plan of action to implement the findings of the early BRACE hazard assessment process and disease burden estimates. This assessment and review process identified a number of intersecting hazards that prioritized rising temperatures, heat stress, and vulnerable people in the Nashua area. Since extreme heat events are related to air quality, habitat change, and certain extreme precipitation events (i.e., drought), the partners of this plan directed the focus of this plan toward **heat stress**. The target populations for this implementation strategy are the elderly and low income people. To begin the process of implementation, we also worked with the DHHS on an exposure pathway (Figure 16) that highlights some of the key points where we may be able to break the cycle that leads to heat stress.

Since the pathway shows that knowledge is very important to reducing the effects of heat stress, this plan emphasizes education as part of its intervention and action strategies. In order to most effectively target the populations of concern, this plan recommends educating service providers and emergency managers, as it has been an effective strategy in other locations, such as Philadelphia. The following section elaborates on the details of the action plan.

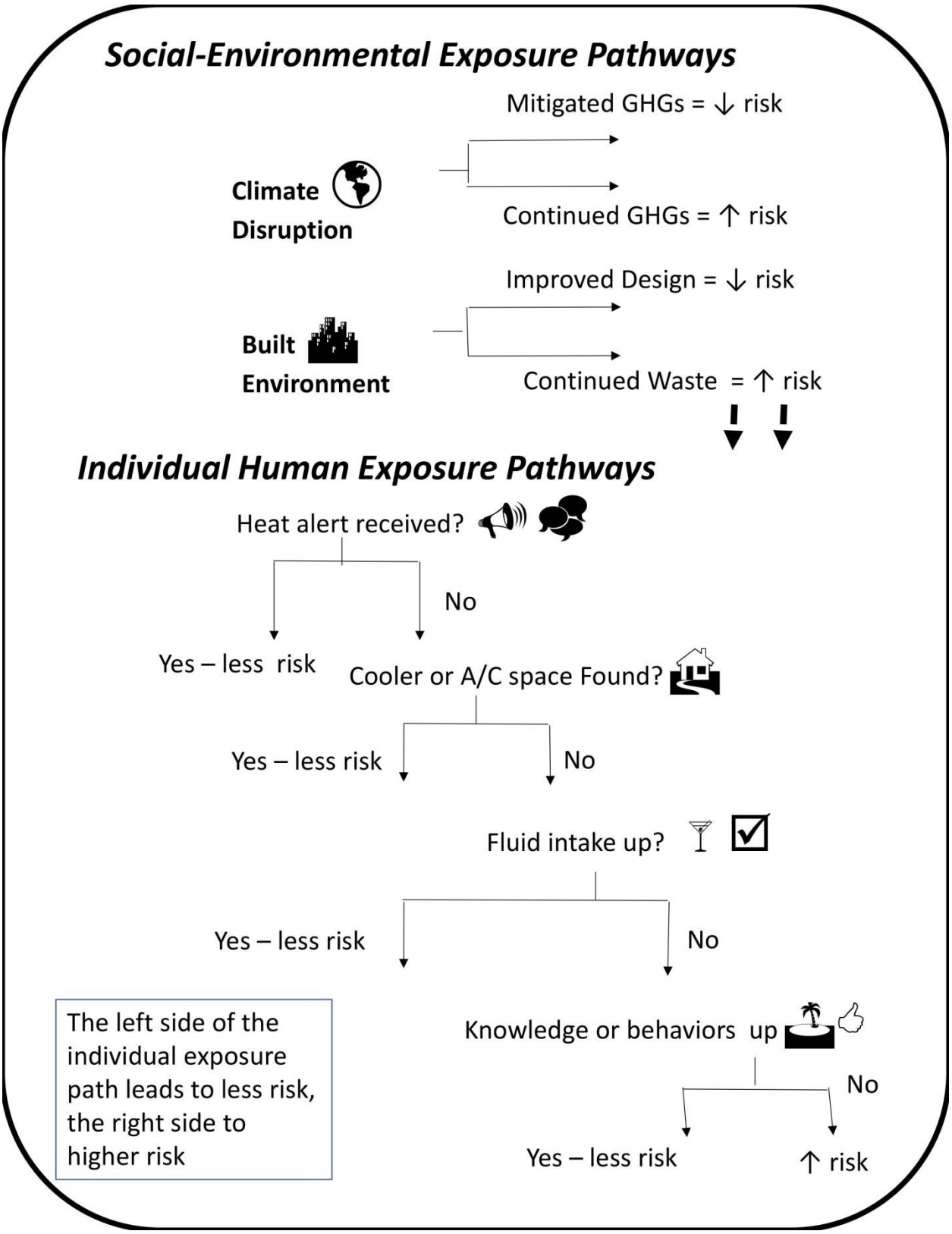


Figure 16: Exposure Pathway Diagram for Heat Stress that shows intervention points to break the cycle of heat stress. Source: DHHS

Action Plan

To create a feasible and effective implementation strategy considering the available resources, the following goal with associated objectives and strategies was established:

Goal	Increase community and individual resilience to the impacts of heat-related illness (among vulnerable populations) in the Greater Nashua region
Objective 1	The Nashua PHN partners will use an outreach or education intervention to reach regional emergency managers and work to ensure that at least 75% have a proficient understanding of policy changes and tips that better prevent or mitigate heat-related and heat stress risk factors by 6/30/17.
Strategy 1	Work with regional emergency managers and first responders to develop alert system for forthcoming revised NWS heat advisory and for events when there are high overnight temperatures. Ensure notification uses a variety of media platforms to target at-risk populations.
Strategy 2	Conduct further research on similar policies in other areas to determine which thresholds (temperature at night, duration of nights, etc.) would be most effective considering Nashua Region's environment and emergency management resources.
Strategy 3	Coordinate with NH DHHS, emergency managers, health officers, and GNPH Media Advisory Group to develop educational materials to clarify roles and responsibilities of cooling centers and shelters.
Strategy 4	Coordinate with emergency managers and health officers to identify facilities designated as cooling centers within the region and ensure they understand the responsibility and requirements associated with being designated a cooling center.
Strategy 5	Coordinate with key stakeholders to communicate new NWS heat advisory policies and list of cooling centers.
Objective 2	The Nashua PHN partners will use a single educational intervention (a 30-60 minute training session) to reach service providers to low income households, and ensure that at least 75% have a proficient understanding of the risk factors or protective actions to prevent heat stress by 6/30/17.
Strategy 1	Identify partner organizations that work with target populations (e.g. Meals on Wheels, Outreach Programs, Nashua Housing Authority, Home Health & Hospice, Faith-Based Organizations, SHARE Outreach, Property Owners Association, etc.).
Strategy 2	Gauge the extent of current practices, heat stress mitigation programs in comparable locations, and other public health intervention programs (e.g. asthma programs).
Strategy 3	Work with DHHS, GNRPHN, and NH DPHS High Heat group to develop educational program about extreme heat, heat-related illnesses, and protective actions for people who work with target population.
Strategy 4	Work with DHHS, GNRPHN, and NH DPHS High Heat group to create outreach materials as part of extreme heat educational program (e.g., magnets with thermometer, tumblers with messaging, brochures).
Strategy 5	Distribute educational materials with other material that reaches targeted populations (e.g. prescriptions for illnesses with symptoms exacerbated by heat, municipal tax bill, Eversource bills).
Strategy 6	Present information to those who work with target populations ("train the trainers").
Strategy 7	Conduct pre- and post- assessment of heat-related illness knowledge on those who attend training session.
Objective 3	Within 18 months, expand tracking health impacts of heat-related illness tracking data
Strategy 1	Add to Community Health Assessment Questionnaire questions about whether homes have air conditioners, whether people have enough money to power air conditioners, and if people know their options during extreme heat events.
Strategy 2	Work with DHHS to identify appropriate resources and methodology to expand upon state initiatives.

Appendix

I. Preparedness Resources

The following represents a list of current preparedness resources for weather hazards in the Nashua Region:

Extreme Heat

1. A number of adaptation strategies are described in the *New Hampshire's Excessive Heat Plan* http://www.dhhs.nh.gov/dphs/climate/documents/nh-excessive-heat-plan.pdf.
2. Hospitals and health centers that treat heat stress
3. Hospitals – Southern New Hampshire Medical Center and St. Joseph's Hospital in Nashua
4. Municipal Cooling Centers
5. Local Programs
   - 5.1. City beaches and pools
   - 5.2. School Athletic Programs
6. Parks & Recreation Department Directors
7. Hazard Mitigation Plans that directly address heat
   - 7.1. Nashua HMP, 2013
   - 7.2. Amherst HMP 2015
   - 7.3. Litchfield HMP, 2013
   - 7.4. Merrimack HMP, 2015
   - 7.5. Milford HMP, 2014
   - 7.6. Mont Vernon HMP, 2015
8. Publications
   - 8.1. New Hampshire, the Resilient Granite State
   - 8.2. Greater Nashua Community Health Assessment, 2014: http://www.nashuanh.gov/DocumentCenter/View/2478
   - 8.3. Article Summary "Heat-related morbidity and mortality in New England: Evidence for local policy" https://tinymce.nhwis.net/plugins/moxiemanager/data/files/docs/Meetings/heat-article-summary.pdf
   - 8.4. Staying Safe During Extreme Heat by Greater Nashua Public Health http://nashuanh.gov/DocumentCenter/View/8770
   - 8.5. Extreme Heat Precautions by City of Nashua Division of Public Health & Community Services: http://milfordnh.info/milford/HeatWavePrecautionsNashua.pdf
   - 8.6. Heat and Health: Understanding Community Risk by NH DHHS: https://www.nh.gov/epht/highlights/documents/heat-health.pdf

Air Quality

1. Asthma Burden Report Update New Hampshire, 2014
2. *State Asthma Plan 2015-2019:* https://www.dhhs.nh.gov/dphs/cdpc/asthma/documents/state-plan.pdf

Extreme Precipitation

Consensus from advisory committees was that local hazard mitigation plans (HMP) are the best tool for addressing concerns related to flooding and drought conditions. Most communities in the Nashua Region do have up-to-date HMPs (Table 9); to remain valid, plans are updated every five years. NRPC is currently working with Mason, Brookline, and Pelham on updating their plans. Local information about participation in the National Flood Insurance Program (NFIP) and efforts to mitigate flooding in floodplains are required elements of the hazard mitigation plan.

Municipality	FEMA Formal Approval Date	Plan Expiration Date	NFIP Participant
Amherst	June 8, 2015	June 8, 2020	Y
Brookline	August 21, 2012	August 21, 2017	Y
Hollis	November 28, 2012	November 28, 2017	Y
Hudson	July 16, 2012	July 16, 2017	Y
Litchfield	August 22, 2013	August 22, 2018	Y
Lyndeborough	April 1, 2015	April 1, 2020	Y
Mason	September 1, 2011	September 1, 2016	Y
Merrimack	August 6, 2015	August 6, 2020	Y
Milford	June 9, 2015	June 9, 2020	Y
Mont Vernon	June 3, 2015	June 3, 2020	Y
Nashua	December 19, 2013	December 19, 2018	Y
Pelham	June 18, 2012	June 18, 2017	Y
Wilton	June 12, 2015	June 12, 2020	Y

Table 9: List of municipalities within the Nashua Region and the status of their Hazard Mitigation Plans

Vector Habitat

1. Local recreation plans
2. Hospitals and health centers may be a resource to educate the population about risk reduction strategies, identify ticks, and treat exposures

3. Outdoor clubs may be a resource for at-risk populations
4. The Cornell Integrated Pest Management program is a resource for reducing ticks through landscape management practices: http://nysipm.cornell.edu/%5C/whats_bugging_you/ticks/default.asp
5. The New Hampshire Tickborne Disease Prevention Plan (2015) is a resource for understanding tickborne disease, changes in risk factors, prevention and control, educational outreach, and surveillance http://www.dhhs.state.nh.us/dphs/cdcs/lyme/documents/tbdpreventionplan.pdf
6. City of Nashua Lyme Disease Toolkit: http://www.nashuanh.gov/DocumentCenter/View/2707
7. VT webpage http://lymediseaseguide.org/

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