Climate Change Adaptation Report:
Georgetown, Maine

Reid State Park, October 29, 2012, Hurricane Sandy landfall

Georgetown Conservation Commission 2015

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Foreword

We take great pride in our Georgetown Island community. We feel privileged to live in one of the most beautiful places on earth, where green spruce meet the blue ocean in a stunning contrast in color. We appreciate that many of our island residents depend on the sea for their livelihoods. We enjoy the privacy of our island, even though it can be a long hard trek to town in a snowy winter. We are also happy to share our island, especially the spectacular Reid State Park, with others.

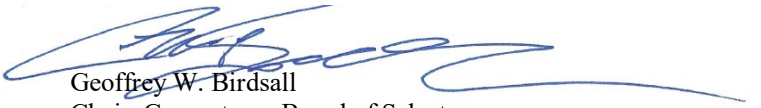
Our seaside location makes us especially vulnerable to a changing climate. Scientists now understand that the greenhouse gases from burning fossil fuels (oil, coal, natural gas) are warming up the earth. Although the exact degree of warming cannot be predicted due to the complexity of the earth's climate system, scientists understand the basic physics of adding carbon dioxide (CO_2), methane (CH_4), and other greenhouse gases to the atmosphere. New England's climate is becoming warmer and wetter, a trend that shows up clearly in historical weather data.

Perhaps of greatest climate change concern to Georgetown is higher sea level, in part because of melting ice sheets in other parts of the globe, but also because warmer ocean water actually expands. By the year 2100, the ocean is predicted to be 3 feet higher than today. Sea-level rise to that height would prevent Georgetown residents from getting to the mainland during high tide on most days. The situation would be far worse with a storm surge on top of sea-level rise.

Private properties will become at greater risk of flooding as sea levels increase. As a result, homeowner's insurance will become quite costly, and some may not even be able to get insurance. When insurance rates go up, a property's value declines, and that could have huge implications for Georgetown's future tax revenues.

The good news is that these changes are not going to happen overnight. We have time to think about what we can do to make our community resilient to the changes we know are likely to unfold in this century. And that is what this report is about, prepared for us by our own Conservation Commission. The report's purpose is to introduce us to the issue of climate change, and how it is already beginning to affect the things we value about our community. It lays out an array of "no regrets" recommendations that our citizens could begin to implement. They are "no regrets" because most of them make good sense, irrespective of climate change impacts.

As citizens and stewards of this beautiful island, it's our responsibility to be well-informed, and I encourage you to read this report. I commend our Conservation Commission for starting the conversation for us all. As a Selectman, I look forward to helping in every way I can to implement these recommendations. We have a responsibility to use our knowledge today to leave this island in great shape for the generations that follow.



Geoffrey W. Birdsall
Chair, Georgetown Board of Selectmen
May 31, 2015

1. Introduction

Chapter Author: John Hagan

The earth's climate has always changed. Just 12,000 years ago, what is now Georgetown was buried under a thousand feet of ice. It was not possible for any human to live in "Georgetown." Virtually our entire human civilization has been built in the last 4,000 years, during one of the most stable climate periods in the history of the earth. But we know the climate does not stay the same, and will not stay the same. In fact, over a century of temperature records show the climate is now changing very rapidly.

Climate is different from weather. Weather refers to day-to-day changes in our atmosphere—"will we need a jacket or umbrella if we go out today?" That's weather. Climate refers to change in the atmosphere over many years or decades, and prompts different questions such as "should I install central air conditioning in my house?" You often hear people in Georgetown say that it doesn't snow nearly as much as it did when they were a kid (despite the 2015 winter), or that winters are not as cold as they used to be. These trends are changes in the climate—changes over the decades scale. We could have the worst blizzard in a century on any given winter day (that's weather), but the long-term climate trend could still be warmer, less-snowy winters.

Figure 1.1. Five Islands wharf, enjoyed by both residents and visitors, is one of the most scenic spots on the Maine coast. It is also vulnerable to intensifying storms and sea-level rise. The livelihoods of many Georgetown fishermen (and their descendants) will change as marine species change with warming Gulf of Maine waters.

Climate change is difficult to comprehend because it happens so slowly relative to our busy lives. But the earth's climate is now changing quite fast relative to the last 1,000 years, or even the last 100 years. Still, it is far too slow for us to perceive as we go about our day-to-day activities. Every now and then we might have an extreme weather event in Georgetown that temporarily floods our roads or causes a power outage. We might experience a rare microburst, like we did in 2010. We might wonder briefly whether these events are signs of a long-term climate trend. But mostly, climate change is invisible in our daily lives. We operate on a different "clock" than the climate.

But it's the climate's "invisibility" that is all the more reason to pay close attention to it. If we don't consciously work at it, we may miss these changes altogether, and find ourselves "a day late and a dollar short"— unprepared for changes that are sneaking up on us.

Until recently, climate change has been thought of as an environmentalist's issue. That has changed. Climate change is now recognized as a major economic issue, a human health issue, and a national security issue. Ninety-seven percent of scientists agree that the climate is changing and that humans are causing it. This level of agreement is quite rare among scientists. Thoughtful people of all political persuasions are taking climate change very seriously. If we do not work to curb global fossil fuel emissions (mitigation), and if we do not prepare for the changes we know are going to take place (adaptation), the U.S. economy—the global economy—is going to be hit hard in the latter half of the 21st century. We can reduce this impact substantially by planning ahead. Climate change is a math problem, not a philosophical or scientific debate.

The climate is changing fast. Now is the time to start thinking and preparing.

Figure 1.2. Some of Georgetown's most cherished landmarks may not survive the projected 3 foot sea-level rise by 2100.

The purpose of this report is to begin an ongoing conversation about adapting to a changing climate in our place—Georgetown, Maine. Like all coastal communities worldwide, Georgetown is especially vulnerable to sea-level rise and strong coastal storms, both of which are increasing in intensity with climate change. Our fishing economy is vulnerable to warming ocean temperatures and increasing ocean acidification, both a result of burning fossil fuels. Our infrastructure is vulnerable, and there is only one way off the island by land, with many low-lying sections of road between the Georgetown Country Store and Bath. Indian Point and Kennebec Point are especially vulnerable.

It makes good common sense to start thinking about the climate change issue now, and to start making our island community resilient to what is already unfolding. There are many steps we can take that are low-cost, no-cost, and "no regrets." That is, they would just make good sense even if the climate were not changing.

Indeed, many readers may think the worst climate effects will come long after they are gone. But given that we can see the future today, does it not make ethical and economic sense for us to start now making it easier for the generations that follow us in Georgetown? What will the generations that follow say about us? Let's hope they say "they knew what was happening, and they were smart enough to plan ahead for us."

This report is all about starting the conversation about climate preparedness in Georgetown. It will take participation by the community and its leaders to take actions that begin to make Georgetown smart and resilient to the changing climate. ❖

2. 'Climate Science 101'

Chapter Author: John Hagan

Fortunately, the earth's atmosphere is partly made up of so-called "greenhouse gases." If the atmosphere did not contain greenhouse gases the earth would be a lifeless and uninhabitable frozen snowball.

Here is how greenhouse gases work. Short-wave (ultraviolet) solar radiation from the sun readily passes through the atmosphere (Figure 2.1). Some of this energy bounces off the earth's surface as long-wave (infrared) radiation. Greenhouse gases allow incoming short-wave radiation to pass, but block outgoing long-wave radiation. The result is that solar energy is retained in the atmosphere, and the earth warms up. That is a very good thing. Up to a point.

Carbon dioxide (CO_2) is the major greenhouse gas. It occurs naturally. It is exhaled by humans and other animals as a part of respiration. Methane (CH_4) is another greenhouse gas that occurs naturally. Even water vapor (H_2O) functions as a greenhouse gas.

Because these naturally occurring gases function to warm the planet, adding more of these gases to the atmosphere warms the planet even more. CO_2 makes up only a tiny 0.4% of the atmosphere, but it plays a huge role in keeping the planet warm (and not totally frozen).

Fossil fuels (oil, coal, natural gas) contain a lot of carbon that has been locked up underground for millions of years. When we burn fossil fuels the carbon ends up in the atmosphere as CO_2. Humans have added a lot of CO_2 to the atmosphere in the last 150 years, especially since the dawn of the industrial age and the discovery of all the amazing things you can do with fossil fuels, like heat your home and power your car. We have also added a lot of CO_2 to the atmosphere through deforestation (conversion of forestland to agriculture land; trees contain a lot of locked up carbon).

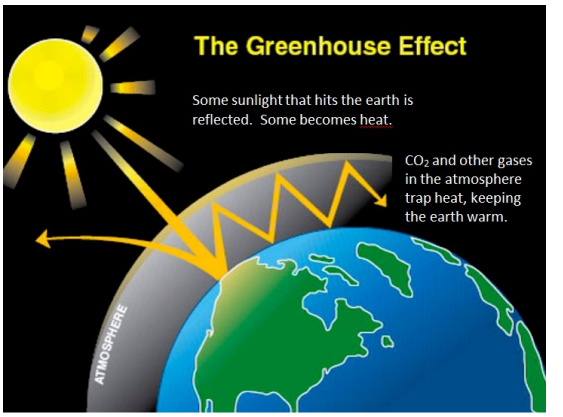


Figure 2.1. Energy from the sun passes through the atmosphere mostly as short-wave radiation. Some of that energy is reflected off the earth as long-wave radiation. Long-wave radiation is blocked by greenhouse gases such as carbon dioxide (CO_2) and methane (CH_4), thus heating the earth.

From gas bubbles trapped in Antarctic ice cores we know that the concentration of CO_2 in the earth's atmosphere has not exceeded a concentration of about 280 ppm (parts per million) in the last 640,000 years. Yet in the last 150 years, with deforestation throughout the globe and fossil fuel use, the concentration is now at 404 ppm, or a 69% increase in CO_2 since about 1890. Basic physics predicts how much we can expect the earth to heat up as a result of increasing the concentration of CO_2 in the atmosphere.

If it weren't for greenhouse gases, the earth would be a frozen "snowball." But too much of a good thing is not good.

In fact, in 1896, the Swedish physicist, Svante Arrhenius, calculated that a doubling of CO_2 in the atmosphere would result in about a 2ºC (3.7 ºF) increase in the average global temperature. He came to this conclusion based on what was known about the physics of the atmosphere at the time. Nowadays we have a far more sophisticated understanding of the atmosphere. We have extremely powerful computers to model the effects of adding greenhouse gases to the atmosphere, including complicated feedback loops, some of which accelerate warming and others that increase cooling. All said and done, the modern models predict a doubling of CO_2 in the atmosphere will result in about 2 ºC of warming, exactly the same result as Arrhenius obtained over 100 years ago. The point is, the basic scientific underpinning of climate change, or global warming, is not new. We've known this for a long time.

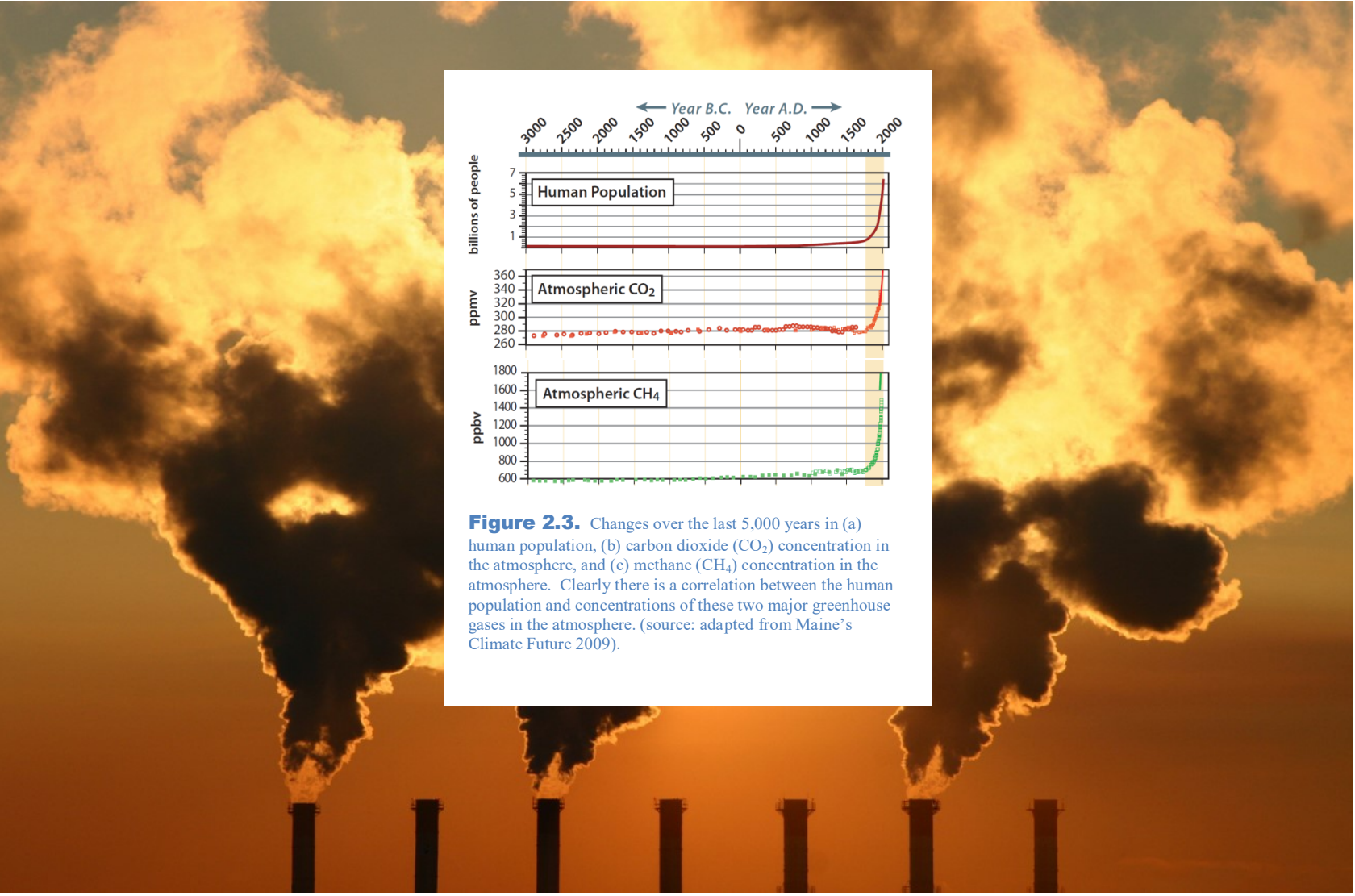


Figure 2.3. Changes over the last 5,000 years in (a) human population, (b) carbon dioxide (CO_2) concentration in the atmosphere, and (c) methane (CH_4) concentration in the atmosphere. Clearly there is a correlation between the human population and concentrations of these two major greenhouse gases in the atmosphere. (source: adapted from Maine's Climate Future 2009).

Two degrees centigrade doesn't sound like much. The air temperature changes that much and more from the time you wake up each day until lunchtime. But 2 ºC, spread over the whole globe (on average) represents a lot more energy in the earth's atmosphere. That additional energy is manifested as a change in climate.

Global policy makers and scientists have concluded that warming more than about 2 ºC greater than the pre-industrial (1850) temperature would be very dangerous for human civilization. We've already warmed up about 0.8 ºC since 1880. In fact, because of the time-lag effect and persistence of CO_2 emissions in the atmosphere for the long term, we will very likely reach 2 ºC by 2050.

What's worse, there are enough known reserves of fossil fuel still in the ground to warm the planet 6 ºC, if we burned them all. That's three times the warming considered "safe" by most scientists. Right now it's not clear what policies would be needed for us to leave those resources in the ground. So, we are on a trajectory to warm up 6 ºC or even more by 2100. The economic damages of that much warming would be profound. Hundreds of millions of people—whole cities, such as Boston, New York, and Miami – would cease to exist as a result of sea-level rise.

We need to begin thinking and planning now. The purpose of this report is to help the residents of Georgetown, Maine, in the year 2015, to start to think and plan. ❖

Further Reading

Emanuel, K. 2012. What We Know About Climate Change. Massachusetts Institute of Technology. The MIT Press, Cambridge, MA. 96 pp.

Hansen J, P. Kharecha, M. Sato, V. Masson-Delmotte, F. Ackerman, et al. 2013. Assessing ''Dangerous Climate Change'': Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. PLoS ONE 8(12): e81648. doi:10.1371/journal.pone.0081648.

IPCC. 2014. Climate Change 2014: Synthesis Report: Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.
Online: https://www.ipcc.ch/report/ar5/)

Jacobson, G., I.J. Fernandez, P.A. Mayewski, and C.V. Schmitt (editors). 2009. Maine's Climate Future: An Initial Assessment. Orono, ME: University of Maine.
Online: http://www.climatechange.umaine.edu/mainesclimatefuture/

Melillo, J.M., T.C. Richmond, and G.W. Yohe (Editors). 2014. Climate Change Impacts in the United States: The Third National Climate Assessment . U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2. Online: http://nca2014.globalchange.gov/

3. A Framework for Understanding Climate Impacts

Chapter Author: John Hagan

Coming to grips with a changing climate, and what we might do about it in Georgetown may seem overwhelming at first glance. We're all very busy just getting through each day. The impacts of climate change, even if severe, seem far in the future. To take any practical action today we need a way to frame up the problem so that it doesn't seem so overwhelming. We have to feel like we can make a difference; otherwise, why bother?

That's one purpose of this report—to make meaningful action seem possible. First, we thought carefully about the basic categories of interests that nearly all residents care about in Georgetown and that could be affected by climate change (Table 3.1, left column). Then, we thought about the ways in which a changing climate might affect those interests (Table 3.1, right column). Some of our concerns, like the spread of Lyme disease, might be enhanced by warmer air temperatures. Other interests, such as our lobster fishery, might be affected by warmer water temperature. Still others might be affected by rising sea level, like coastal properties (and, in turn, the town's tax revenues). We wanted to frame up the scope of climate change factors without becoming overwhelmed by the scale and complexity of the problem.

This report is structured so that each chapter focuses on one of the ten interests listed in Table 3.1. Each of these chapters first lays out the general nature of the problem. Then, we tried to frame the problem through the lens of Georgetown. Where possible, we pulled data from the town to help articulate our specific vulnerabilities to climate change.

Table 3.1. Our framework for understanding the climate change challenge for Georgetown. On the left are major interests of Georgetown residents. On the right are climate factors that might affect these interests. By structuring our thinking this way, the climate change challenge becomes more manageable. It gives us a way to see the whole "landscape" of what we might be dealing with.

Our common interests	Climate factors that affect the things we care about
Roads & Infrastructure	Warming water
Water Supply	Increasing wind
Fisheries Economy	Rising sea-level
Private Property	Coastal storm surge
Public Property	Extreme rainfall
Ecology	Extreme wind events
Recreation	Drought and fire
Emergency Preparedness	Ocean acidification
Cultural and Historical Assets	Invasive species
Human Health	

Each chapter ends with a short list of "low-hanging fruit" recommendations for the town that could either reduce our vulnerability to climate change or allow us to learn more so that we can make more specific recommendations in the future.

The Conservation Commission plans to use this report to encourage citizens to take meaningful, practical steps to prepare for climate change in Georgetown. Again, many of the recommendations in this report are "no regrets." That is, they are just good practical ideas for preparing for any kind of change, climate or otherwise.

Our goal was to keep each chapter as short as possible, while still being informational and useful to general citizens, the Board of Selectmen, and the various town committees. ❖

4. Infrastructure: Roads

Chapter Author: John Hagan

Background

State and regional transportation agencies across the country are facing extreme weather events that damage roads and bridges and cost large sums to repair, not to mention the cost to the economy from disrupted travel. Extreme weather—including heat waves, drought, tropical storms, high winds, storm surges and heavy downpours—are becoming more frequent and severe as the climate changes.

With the changing climate we can expect the following:

- More frequent/severe flooding of low lying roads due to more intense precipitation, sea-level rise, and storm surge.
- Increased numbers and magnitude of storm surges, which will shorten road lifespan.
- Increased thermal expansion of bridge joints and paved surfaces, which will accelerate degradation.
- Higher maintenance/construction costs for roads and bridges, due to increased temperatures, or exposure to storm surge.
- Culvert and drainage infrastructure damage resulting from increased precipitation intensity, or snow melt timing.
- Increased risk of vehicle crashes due to road degradation.

Implications for Georgetown

There is only one way to get to and from Georgetown by land—Route 127. Route 127 crosses several low-lying areas in Arrowsic, which, even today, could cut off access to the entire island of Georgetown with a storm surge at highest annual tide. During the course of a year, high tide can range from 6.9 feet to 10.4 feet in Georgetown. So, the degree of storm surge *along with* the timing of the surge in relation to the tide cycle influences whether (and how much) roads are flooded.

With rising sea level and the increasing frequency of severe rainfall events in New England, we can anticipate not only being cut off from the mainland, but that many of Georgetown's residents could be cut off from access to Route 127 within Georgetown. Road sections that are vulnerable to sea-level rise are listed in Table 4.1, and a map of "choke points" in Georgetown is provided in Figure 4.1.

Figure 4.1. Culverts should be sized to handle the predicted increase in precipitation. Preemptive replacement can save the town money over the long term.

Irrespective of sea-level rise, severe rainfall events can and do exceed the capacity of our culvert drainage infrastructure in Georgetown. Annual rainfall in New England has increased by 20% over the last century. These trends are predicted to continue.

Under normal weather conditions, being cut off from the mainland for a day is not a life-threatening situation. But if a severe storm or hurricane causes the flooding, Georgetown residents may need emergency medical services. Air transportation is expensive, even if available during such an emergency. Georgetown should consider how it will maintain essential services if cut off from the mainland for several days, and without power (see Emergency Preparedness, Chapter 11). Fortunately, the twice-daily *low* tide cycle should make roads passable (unless washed out), if only for a brief time during a 24-hour period. ❖

Recommendations

4.1 Inventory our road culvert system for volume capacity (diameter). Systematically, over time, replace any undersized culverts pre-emptively with larger-diameter culverts. When a culvert needs replacing, upgrade the diameter if warranted by the size of the upstream drainage area.

4.2 Develop an evacuation plan for residents beyond "choke points" (low lying road sections) shown in Table 4.1 and Figure 4.1. Residents beyond choke points should be made aware of the risk.

4.3 Collaborate with Arrowsic on evacuation planning and emergency access. If Arrowsic is cut off, so is Georgetown.

4.4 Develop a plan to address the low lying areas indicated in Figure 4.1.

4.5 Increase the town budget for pre-emptive road maintenance, especially for sizing culverts. It is far cheaper to take pre-emptive action than to repair washouts. Pre-emptive action will save the town money in the long run.

4.6 Develop a neighbor assistance program (or "buddy" program) so that elderly residents or vulnerable residents have someone to check on them in the case of a severe storm event. The plan should include a contingency if power is lost and phone lines are down. This program could be modeled on the Georgetown Working League existing program.

Further Reading

National Research Council of the National Academies. 2008. Potential Impacts of Climate Change on U.S. Transportation. Transportation Research Board Special Report 290, Transportation Research Board, Washington, D.C., 2008 www.trb.org

State of Maine Department of Transportation. http://www.maine.gov/mdot/

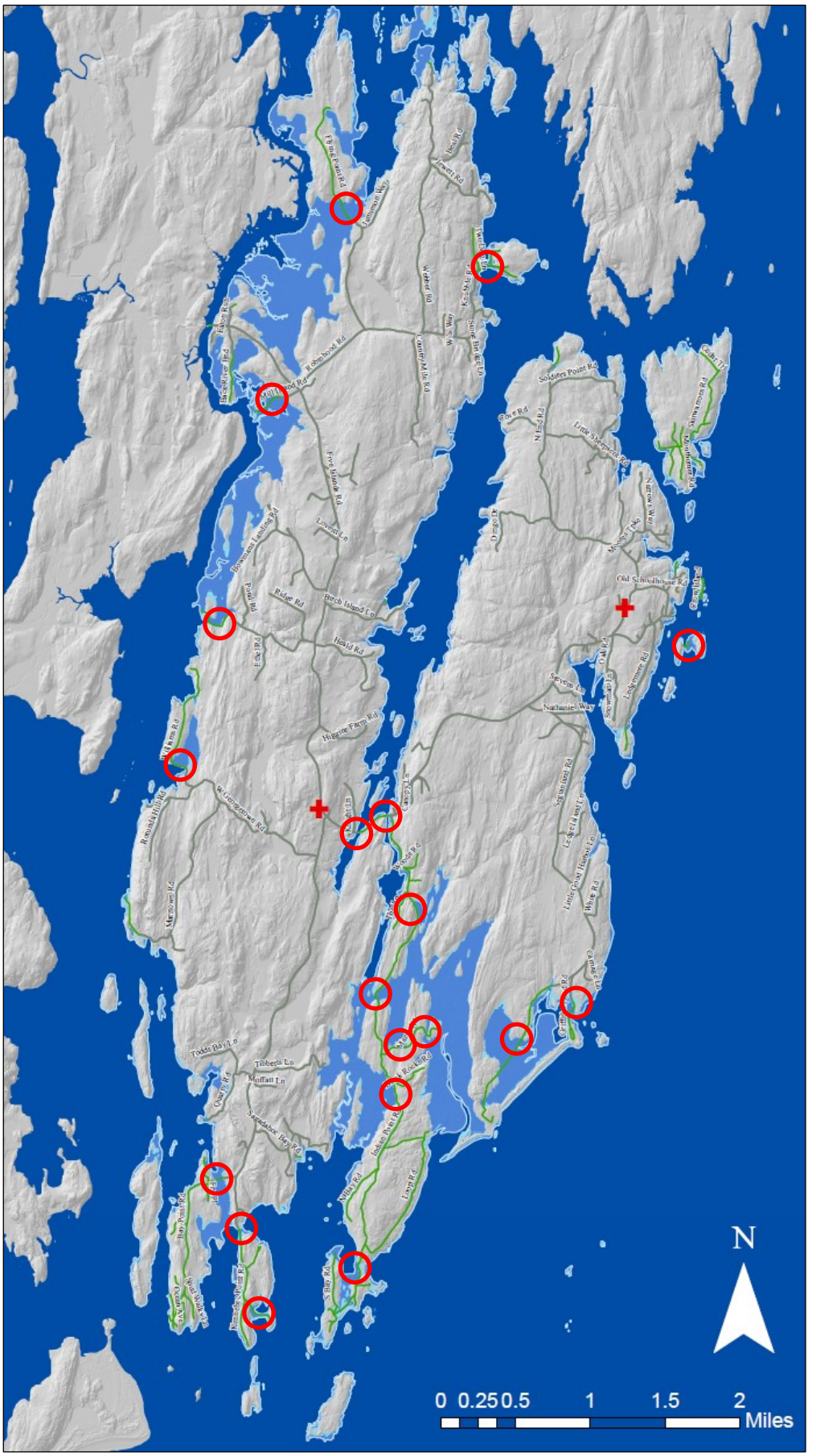


Figure 4.1.
Location of "choke points" in the Georgetown road system that could be inundated during high tide plus storm surge.

Table 4.1. Road name, tax map location, and length of road segment (in linear feet) in Georgetown that would be inundated under different high-water scenarios. See Figures 4.1 for precise locations of vulnerable road sections.

		Scenarios …			
Road Name	Tax Map #	Highest Annual Tide (ft)	Highest Annual Tide + 1 ft SLR[1] (ft)	Highest Annual Tide + 100 year Storm (ft)	Highest Annual Tide + 1 ft SLR[1] + 100 year Storm (ft)
Route 127	U-3, U-4	150	150	150	150
Route 127	U-4	100	100	100	100
South Bay Rd (Private)	U-8	-	260	470	470
Indian Pt Rd (Private)	U-8	-	-	320	320
Indian Pt Rd	U-9	-	-	600	600
Promontory Way	U-8	-	-	-	-
Malden St	U-12	240	250	820	900
Webber Rd	R-1	10	20	90	100
Flying Pt Rd	R-2	720	730	800	800
Mill Island Rd	R-2	710	720	800	1000
Birch Island	R-3	75	100	100	100
Five Island Rd	R-2	-	10	10	10
Misty Lane	U-14	-	-	75	100
Knubble Rd	R-2	-	-	250	250
Back River Rd	R-2	-	-	50	70
Beaver Valley Rd	R-3	-	-	50	100
Williams Road	R-4	35	285	667	660
Beaver Valley Rd	R-4	-	-	115	200
Marrtown Road	R-5	-	-	2	33
Bay Point Road	R-6	-	-	80	150
Kennebec Point Road	R-6	-	-	30	325
Quarry Lane	R-6	-	-	-	-
Molly Point Lane	R-6	-	-	-	-
Little Harbor Head Lane	R-7	80	700	750	790
Seguinland Road	R-8	-	1400	1480	1562
Griffiths Head Road	R-8	30	40	130	320
Indian Point Road	R-8	-	70	150	470
Indian Point Road	R-9	-	-	20	90
Ledgemere Road	R-10	-	-	50	100
North End Road	R-11	-	-	-	-
Total	-	2150	4835	8159	9770

[1] Sea-level Rise

5. Water Supply

Chapter Author: Nancy Kinner

Background

Thirty percent of the Earth's freshwater is located underground in aquifers that consist of fractures in bedrock or spaces between the soil grains where water can be stored. In the U.S., 14% of the population uses groundwater as its source of drinking water (USGS, 2010).[1] Ninety-eight percent of those who use groundwater live in homes or very small communities (fewer than 25 individuals) served by private wells. In Sagadahoc County, 50% of the population is served by individual wells that tap groundwater. In Georgetown, the residents get their water almost exclusively from the ground using wells located on their property. Some collect rainwater in cisterns.

Islands along the coast of Maine suffer from multiple issues concerning drinking water, including inadequate quality, quantity and accessibility. The quantity of groundwater is limited by the fact that bedrock fractures, the aquifer material in Georgetown and most Maine islands, hold much less water than soil. The sole source of freshwater to the four independent aquifers underlying Georgetown is precipitation, but only 10 to 15% of the precipitation that falls on the ground's surface actually recharges them (Mabee, 1992)[2]. Groundwater quality is generally good, though some of the wells require pretreatment for iron or salt. The latter can come from road salt used in the winter, but is primarily linked to seawater intrusion and typically affects wells very near the shoreline. Occasionally, wells are contaminated with coliform bacteria from vegetation, birds, or nearby septic systems. Radon, a naturally-occurring radioactive gas, is found in some Georgetown wells in levels above the recommended Maine Advisory (4,000 pCi/L), but is generally not the main contributor to indoor air radon levels in most homes.

Figure 5.1. Georgetown's ponds, such as Morse's Pond between Seguinland Rd. and Indian Point Rd., provide critical recharge reservoirs for feeding fractured bedrock aquifers.

Currently, Georgetown's 1,100 year-round residents and the two to three times as many people who are here in the summer, have an adequate potable water supply because an annual average of 45 inches of precipitation recharges the island's aquifers, which supplies recharge 10 to 20 times greater than the demand. The main problem with the supply occurs when the immediate demand to an individual well exceeds the rate at which the groundwater can flow through the tiny bedrock fractures.

Wastewater Treatment

There is no municipal, central wastewater treatment facility in Georgetown. Residences, public buildings, and businesses have individual septic systems (septic tank and leachfield). There are currently 60 overboard discharge permits in Georgetown. Siting septic systems can be challenging on Georgetown because of the limited amount of topsoil on the island, so artificial mounding is often required.

Climate Change Effects

The main way that climate change affects water supply and wastewater treatment is sea-level rise, especially for residences near the shoreline. Higher seawater elevations increase seawater intrusion into drinking water wells and flooding of septic systems, causing their failure. In addition, extreme precipitation events can lead to contamination of groundwater wells with coliform bacteria from intense runoff or high groundwater tables linking septic system leachate with aquifers. Conversely, if drought becomes a problem in the Northeast, then the aquifers may not be recharged sufficiently to replace water removed by residential wells.

Implications for Georgetown

Georgetown's population is entirely dependent on the groundwater in its four bedrock aquifers to supply potable water. Any threat to the quantity or quality of the potable well supply will decrease the standard of living of the community's

[1] Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014, Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p., http://dx.doi.org/10.3133/cir1405.

[2] Mabee, S.B. 1992. Lineaments: Their Value in Assessing Groundwater Availability and Quality in Bedrock Aquifers of Glaciated Metamorphic Terrains: A Case Study. Ph.D. Dissertation, University of Massachusetts, Amherst, MA.

year-round and seasonal residents and businesses, as well as present potential problems for its tourism industry. Any situation that compromises the integrity of the septic systems from an increased water table or storm surge will not be easily accommodated because of the limited availability of land at higher elevations for siting new systems. While packaged drinking water and wastewater treatment systems exist for individual residences, they are very expensive and require a higher level of maintenance than conventional systems. Georgetown's low population density makes centralized water and wastewater systems very expensive and ineffective choices. ❖

Recommendations

5.1 Encourage homeowners and businesses to identify water wells and septic systems at risk from flooding (contamination) and seawater intrusion (sea-level rise).

5.2 Provide information to homeowners and businesses on options for protecting drinking water quantity and quality and maintaining on-site wastewater treatment.

5.3 Provide information to the community on water-saving measures during periods of drought.

6. Fisheries Economy

Chapter Author: John Hagan

Background

Global annual revenues from marine fisheries are about $85 billion (US).[3] Fisheries support the well-being of 144 nations with coastlines through direct employment of fishermen and fisheries processing. Eight percent of the world's population is connected directly or indirectly to the fishing economy. Fish (and shellfish) provide an estimated 3 billion people around the world with at least 15% of their animal protein. Fishing matters globally, and fishing matters in Georgetown. The changing climate has already affected Georgetown's fishing economy.

There are two main ways climate change affects the oceans, and hence fisheries. First, much of the heat trapped by greenhouse gases in the atmosphere ends up in the oceans, resulting in warmer ocean water. Most commercial fish species, such as lobster (*Homarus americanus*) and cod (*Gadus morhua*), prefer a certain temperature range, so if Gulf of Maine waters begin to warm, we can expect the geographic range of lobster to move north. Maine has seen an increase in lobsters in the last 20 years, but Massachusetts and Rhode Island lobster landings have dropped significantly.

Lobster boat docked at Five Islands wharf in Georgetown.

With warming waters we can expect more southern species, such as black sea bass, to move into the region and possibly become important commercial species in the future. Gulf of Maine waters are warming faster than 99.8% of the world's oceans—5.5ºF in just the last decade (Figure 6.1). In 2012, a massive oceanic heat wave hit the Gulf of Maine that dramatically altered the shedding period for lobsters and caused prices to plummet. [4] [5]

Warmer water also allows predators to move northward. In recent years there has been a huge increase in the invasive European green crab (*Carcinus maenus*) in Maine. Green crabs have likely decimated some softshell clam flats in Georgetown. As ocean waters continue to warm, green crab populations will grow and further decrease the softshell clam industry in Georgetown. One Georgetown harvester is pioneering a cost-effective clam farm model in Heal Eddy using netting exclosures for protecting clams from green crabs. To date, the results of this technique look promising.

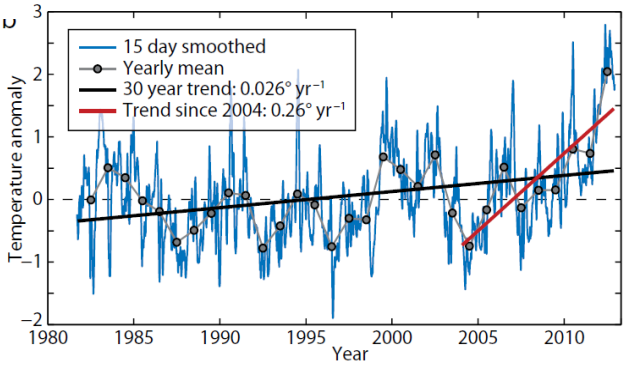


Figure 6.1. Water temperature in the Gulf of Maine over the past 23 years. Water temperature is expressed as "Temperature anomaly," (deviation from 1980-2013 average). Water temperature increased 10 times faster in the last decade (red line). (Source: Mills et al.; see footnote 4).

[3] Sumaila, U.R., W.W.L. Cheung, V.W.Y. Lam, D. Pauly, and S. Herrick. 2011. Climate change impacts on the biophysics and economics of world fisheries. Nature Climate Change 1:449-456.

[4] Mills, K.E., A.J. Pershing, C.J. Brown, Y. Chen, F.-S. Chiang, D.S. Holland, S. Lehuta, J.A. Nye, J.C. Sun, A.C. Thomas, and R.A. Wahle. 2013. Fisheries management in a changing climate: Lessons from the 2012 ocean heat wave in the Northwest Atlantic. Oceanography 26(2):191–195, http://dx.doi.org/10.5670/oceanog.2013.27.

[5] Bangor Daily News, July 5, 2012; Maine lobstermen reeling from low prices, seeking cooperation from dealers.

Table 6.1. Landings (lbs.) and value of major fisheries in Georgetown for 2012. Source: Maine Department of Marine Resources.

Species	Total Pounds*	Total Value*	Active Harvesters
Soft-shell Clams	180,274	$269,524	19
American Lobster	445,273	$1,281,338	25
Other Species *	34,670	$29,271	50

* includes surf clam, seaweeds, elvers, periwinkles, worms, urchins and shrimp

The second effect of climate change is ocean acidification. CO_2, the primary greenhouse gas resulting from burning fossil fuels, is absorbed by the ocean and changes its chemistry, making the water more acidic. The greater the acidity (a *lower* pH), the more difficult it is for shellfish, like softshell clams and lobster, to form their shells. Over the last 100 years, the world's oceans have become about 26% more acidic. If humans continue on a business-as-usual emissions trajectory, the oceans will be 156% more acidic by the year 2100. Softshell clams therefore face two climate related threats—predation by the green crab in the near term, and ocean acidification in the longer term. Researchers are working hard to understand how different shellfish species will respond to increasing ocean acidification.

Implications for Georgetown

Commercial fisheries are an important source of income for the residents of Georgetown. Fisheries support Georgetown's economy and many households within the town. Approximately 12.3% of males and 6.3% of all residents of Georgetown are employed in fishing, hunting, or forestry/logging (City-Data, 2013). The Maine Department of Marine Resources (ME DMR) reported that in 2012 there were a total of 89 licensed fishery harvesters in Georgetown.

Georgetown's fishing economy is overwhelmingly dependent on just two species—the American lobster and the softshell clam. Softshell clam populations in Georgetown are already being affected by green crabs and it is very likely the impact will continue to grow with warming ocean temperatures. The lobster industry has largely benefited from greater productivity and warmer waters to date, but if waters continue to warm, the catch will begin to decline, as it already has in Massachusetts and Rhode Island. ❖

Recommendations

6.1 Encourage diversification of Georgetown's fisheries, so that if one species collapses (due to climate change or some other stressor), other species can fill in the economic gap.

6.2 Host a workshop with the fishing community on changes in Maine's fisheries. Discuss both emerging opportunities and risks for fishermen.

6.3 Support efforts to remove overboard discharges. Discharges place additional stress on an already stressed marine system.

6.4 Encourage softshell clam farming using clam seeding in combination with protective netting to reduce or eliminate green crab predation.

7. Private Property

Chapter Author: Kate MacKay

Background

Worldwide, more than a billion people live in low-lying and coastal regions.[6] In the United States, counties directly on the shoreline constitute less than 10 percent of the total land area (not including Alaska), but account for 39 percent of the total population.[7] Coastal areas are substantially more crowded than the U.S. as a whole, and population density in coastal areas is expected to increase in the future. In fact, the population density of coastal shoreline counties is over six times greater than the corresponding inland counties.[8]

Within the next 15 years, higher sea levels combined with storm surge are predicted to increase the average annual cost of coastal storms along the Eastern Seaboard and the Gulf of Mexico by $2-3.5 billion. Adding in potential changes in hurricane activity, the likely increase in average annual losses grows to $7.3 billion, bringing the total annual cost for hurricanes and other coastal storms to $35 billion.

If we continue on our current path of greenhouse gas emissions, by 2050, $66 to $106 billion worth of existing coastal property will likely be below sea level nationwide, with $238 billion to $507 billion worth of property below sea level by 2100.[9]

Millions of U.S. property owners in flood zones receive discounted flood insurance from the federal government at taxpayer cost. The Federal Emergency Management Agency (FEMA) provides food, shelter, and whatever is needed after a disaster, but they also help before the disaster with flood insurance. The Federal Insurance and Mitigation Administration (FIMA) is a division within FEMA that manages the National Flood Insurance Program (NFIP).[10] Essentially, the government subsidizes the loss of homeowners in flood zones. However, this program is likely to change because risk is going up.

"We are $24 billion in debt," says Craig Fugate, who directs FEMA.[11] Part of the problem is that people rebuild in flood zones. In 2012, Congress passed the Biggert-Waters Insurance Reform Act, which instructed FEMA to charge more accurate insurance rates, and removed subsidized rates for some classes of structures.[12]

In 2013, FEMA began phasing in higher premiums for people in flood zones — mostly for second homes and for properties that have changed hands since then. In some cases, premiums went up by thousands of dollars. Congress was surprised by the high cost (to property owners) of its own legislation, so it passed a number of bills that delayed implementation of flood insurance rate increases that were part of Biggert-Waters.[13]

The intensity of Atlantic hurricanes is likely to increase as the ocean warms. Climate models project that for each 1.8°F increase in tropical sea surface temperatures the rainfall rates of hurricanes could increase by 6-18% and the wind speeds of the strongest hurricanes could increase by about 1-8%.[14] Insurance companies are taking these projections into consideration because they cannot afford to miscalculate risk. Projected damage costs will be factored in to new homeowner insurance rates.

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[6] http://worldoceanreview.com/en/wor-1/coasts/living-in-coastal-areas/
[7] Hinrichsen, Don. 1998. Coastal Waters of the World: Trends, Threats, and Strategies. Washington D.C. Island Press,
[8] http://oceanservice.noaa.gov/facts/population.html
[9] http://riskybusiness.org/reports/national-report/executive-summary
[10] http://www.fema.gov/what-mitigation/federal-insurance-mitigation-administration#0
[11] http://www.npr.org/2014/01/01/258706269/federal-flood-insurance-program-drowning-in-debt-who-will-pay
[12] http://www.floodplain.ar.gov/2012_NFIP_Reform_Act_ASummary_of_Contents.pdfFPM_S
[13] http://www.georgetownclimate.org/bills-attempting-to-roll-back-biggert-waters-national-flood-insurance-program-reforms
[14] http://www.epa.gov/climatechange/science/future.html#ref1

John R. Nolon, a professor of Law and Counsel to the Land Use Law Center at Pace Law School reports that property values are declining along the East Coast because of increased flooding and continued threats of storm surges, as well as sustained high temperatures, increased risk of wildfire, and lack of water, among other things. An array of reports support this trend at the national and international level.[15]

In the U.S., property taxes constitute the largest source of local governments' revenue in 2010, totaling $430 billion, or 30 percent of general revenues. Property taxes in Maine generate $2.0 billion a year for local government services, or 41 % of general revenue.[16] In Georgetown, 86% of town revenue comes from property taxes (according to the 2013-14 year end audit). Consequently, a decrease in property value as a result of revised flooding vulnerability could have a serious effect on town tax revenue and on personal wealth.

There are five ways that climate change is affecting private property value. The first three, sea-level rise, storm surge, and high wind events have been mentioned above. The fourth is by extreme precipitation events. Between 1958 and 2012 there has been a 71% increase in precipitation falling in the most severe storms in the Northeast.[17] The fifth way climate change can affect private property is by drought. Ironically, climate change will bring both greater precipitation and greater likelihood of drought. That is, weather will be more variable than it is today. In 1934, 16 dwellings and a large portion of Five Islands were burned in a forest fire during a drought. While disasters like this can be expected in the absence of human-caused climate change, we can expect more in the future.

Implications for Georgetown

Georgetown has about 83 miles of coastline and is about 65 square miles of area.[18] There are slightly over 900 houses, a little less than half of which are occupied year round.[19] About 3.2% of these homes are at risk today as a result of Highest Annual Tide (Table 7.1). About 10% of these homes will be at risk under Highest Annual Tide + a 3.3 ft. increase in sea level and a 100-year storm event. All the homes on the island are vulnerable to extreme wind events, rain events, and drought. ❖

Table 7.1. Number of properties at risk in Georgetown under different storm/sea-level rise scenarios.

Scenario	# of Properties At risk
Highest Annual Tide	29
Highest Annual Tide + 1 ft. sea-level rise	39
Highest Annual Tide + 3.3 ft. sea-level rise	53
Highest Annual Tide + 100-year storm	57
Highest Annual Tide + 1 ft. sea-level rise + 100-year storm	61
Highest Annual Tide + 3.3 ft. sea-level rise + 100-year storm	95

Recommendations

7.1 Know your property. Is it vulnerable to flooding? Consider cutting any branches that might damage your house or power lines in a storm.

7.2 Know your house. Is the roof tied to the walls? Are the walls tied to the foundation? Strengthen your house. If you need to replace your roof, take the opportunity to strengthen it if necessary.

7.3 Consult more in-depth guides to better prepare for coastal hazards: such as (a) Massachusetts Homeowners Handbook to Prepare for Coastal Hazards[20], (b) National Association of Realtors Guide "Things Every Homeowner Should Know About Protecting Against Extreme Weather"[21], and (c) University of Maine's SeaGrant Coastal Hazards Guide[22]

[15] http://digitalcommons.pace.edu/cgi/viewcontent.cgi?article=1954&context=lawfaculty
[16] http://www.memun.org/TrainingResources/LocalGovernment/GuidetoPropertyTax.aspx
[17] http://thinkprogress.org/climate/2015/01/26/3615330/blizzards-climate-scientists/
[18] https://www.google.com/maps/place/Georgetown,+ME/@43.7964745,-69.7405401,12z/data=!3m1!4b1!4m2!3m1!1s0x4cad9e77a46769ab:0xa7eaccfd9258e1e9
[19] http://www.city-data.com/housing/houses-Georgetown-Maine.html
[20] http://www.mass.gov/eopss/docs/mema/ma-homeowners-handbook-to-prepare-for-coastal-hazards.pdf
[21] http://www.houselogic.com/home-advice/protect-your-home/extreme-weather-climate-change/#
[22] http://www.seagrant.umaine.edu/coastal-hazards-guide

7.4 When renovating, move to more energy efficient systems to reduce greenhouse gas emissions and save money. Get an energy audit done of your home.[23] [24]

7.5 When renovating or adding on, consider raising your "freeboard" (freeboard is elevating a building's lowest floor to above predicted flood elevations by a small additional height, generally 1-3 feet above National Flood Insurance Program [NFIP] minimum height requirements).

7.6 Assess your house and property for fire hazard. Create defensible space around your home.[25]

7.7 Work with your local planning board to discuss modifications to Shoreland Zoning and Floodplain Management Ordinances to adapt to sea-level rise . Climate-intelligent zoning forms the backbone of all long-term comprehensive coastal planning.

Further Reading

Richard Lou, et al. 2012 . Municipal Climate Adaptation and the Insurance Industry, Emmett Environmental Law & Policy Clinic, Harvard Law School, Cambridge, MA. 26 pp.

Moser, S. C., M. A. Davidson, P. Kirshen, P. Mulvaney, J. F. Murley, J. E. Neumann, L. Petes, and D. Reed. 2014. Chapter 25: Coastal Zone Development and Ecosystems. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, , 579-618. doi:10.7930/J0MS3QNW.
Online: http://nca2014.globalchange.gov/report/regions/coasts

Risky Business Project. 2014. Risky Business: The Economic Risks of Climate Change in the United States. June 2014.
Online: http://riskybusiness.org/uploads/files/RiskyBusiness_Report_WEB_09_08_14.pdf

Rhodium Group. 2014. American Climate Prospectus: Economic Risks in the United States. The Rhodium Group. 206 pp.
Online: http://rhg.com/wp-content/uploads/2014/10/AmericanClimateProspectus_v1.2.pdf

[23] http://www.efficiencymaine.com/at-home/energy-audit/
[24] http://coldclimatehome.com/
[25] http://www.troikadrafts.com/defspace.html

8. Public Property

Chapter Author: Kate MacKay

Background

In the next century, the majority of America's publicly-owned tidal shorelines could be replaced by a wall to protect communities from sea-level rise of two to three feet. Throughout the United States developments are being built just inland of the marshes, swamps, muddy shores, and sandy beaches that collectively comprise the "public trust tidelands." Because sea level is rising and most shores are eroding, the water will eventually reach these developments unless they are moved or the sea is held back. Increased coastal flooding will cause local governments to abandon some previously populated areas and create "retreat policies" due to a rising sea.

Beaches are the prominent parts of our coastline. However, farther inland the "hidden coast" comprises 80 percent of our tidal shorelines. Part sand, part mud, and part vegetated wetland, these shores have diverse uses. Few policy makers have addressed the loss of natural shores along the hidden coast. Ironically, land use planning has provided state and local governments with a process for ensuring that some of the privately owned farms and forests remain as open space, but coastal states generally have no process for deciding how much of the publicly owned shore should remain in its natural condition, or even in public hands.[26]

In 2013, the U.S. Government Accountability Office (GAO) added "high risk areas" in its report to Congress. The GAO felt that it was important to limit the federal government's exposure to climate change risk. The GAO stated that "the federal government is not well positioned to address the fiscal exposure presented by climate change, and needs a government-wide strategic approach with strong leadership to manage related risks." [27]

Since August, 2005, the value of federal contracts awarded as a result of Hurricane Katrina has totaled $19.6 billion. Since August, 2011, the value of contracts awarded as a result of Hurricane Irene is $179 million, and since October 2012, contracts related to Hurricane Sandy have a value of $181 million. Katrina, along with Hurricane Rita less than a month later, destroyed or damaged 215,000 homes, compared with 305,000 in New York from Sandy. In New York, 265,000 businesses were damaged or destroyed by Sandy, compared with 18,500 by Rita and Katrina.[28] Natural disasters can be very expensive. Costs are ultimately born by taxpayers. With climate change, disasters are becoming more severe and therefore more expensive.

But we can act now to keep costs down in the future. The Maine Department of Environmental Protection's (DEP) 2010 report, "People and Nature. Adapting to a Changing Climate. Charting Maine's Course" alerts our agencies, businesses, and communities that early planning and adaptive actions are likely to be cost effective.[29] Now, through the creation of the Environmental & Energy Resources Working Group, DEP is consolidating a summary of the state's activities for cross agency partnerships, information sharing, efficiencies, and streamlining for climate change adaptation.[30]

The University of Maine "Maine's Climate Future 2015" updated its 2010 report. The update provides recent examples of how Maine people are experiencing these changes.[31]

[26] http://papers.risingsea.net/takings.html
[27] http://www.gao.gov/assets/660/652133.pdf
[28] http://www.washingtonpost.com/business/economy/hurricane-sandys-180-million-federal-tab-tops-cost-of-irene/2012/12/02/940f7fb4-39a6-11e2-8a97-363b0f9a0ab3_story.html
[29] http://umaine.edu/maineclimatenews/files/2011/06/NAT_003_Booklet_6_forWeb_Single.pdf
[30] http://www.maine.gov/dep/sustainability/climate/Working%20Group%20maine%20prepares.pdf
[31] http://cci.siteturbine.com/uploaded_files/climatechange.umaine.edu/files/Maines _Climate_Future _2015_UpdateFinal-1.pdf

Implications for Georgetown

In Georgetown, the State of Maine owns almost $9 million of property, more than half of which is Reid State Park. Most of the remaining state land is owned by Inland Fisheries and Wildlife, and is mostly marshes, wetlands and forests. All of these wetlands are vulnerable to sea-level rise and storm surge.

The Town itself owns slightly more than $4 million of property. The most valuable is the town dock, valued at more than $1 million. Collectively, the Fire Department has about $400,000, including "water access points" and two fire stations. The two town-owned forests, Ipcar and Round the Cove, are valued at over $300,000. The School and the land around it is valued at close to $800,000. The library is valued at close to $400,000. The church, across the road from the Town Office, and the Community Center in Five Islands together are valued at a bit over $300,000. The remaining properties are the historic Stone School House on Bay Point Rd ($77,000), cemeteries and the ball field in Five Islands, ($331,000), a parcel on Robinhood Cove ($91,000), and the piece of land at the corner of #127 and Seguinland Rd., which has the rock painted with the U.S. flag ($98,200). Of all the town-owned assets, the most vulnerable property to climate change is the town dock.

Coastal adaptation is not a one-size-fits-all model. What works best depends on numerous local factors such as geography, soil types, erosion, subsidence rates, and the community's values and priorities. Preferences for how to balance these often competing priorities differ from place to place, but there are an increasing number of options available to protect shorelines and coastal communities.[32] ❖

Recommendations

8.1 Revise our comprehensive plan to consider sea-level rise and climate change. The new reality of sea-level rise due to climate change requires new considerations in managing areas to protect resources and reduce risk to humans. Funding opportunities which may arise will require an up-to-date comprehensive plan.[33]

8.2 Assess and catalogue pier, harbor, and waterway infrastructure likely to need elevation or improvement using current data that is specific to our geographical location.

8.3 Conduct an energy audit on all town owned buildings.[34] [35]

8.4 Work with other municipalities to share resources and to acquire capital funding for necessary mitigation or adaptive efforts.

8.5 Work with other towns in cooperative land use planning initiatives, to make natural resources and development decisions on a regional level, rather than having each town work independently.

[32] http://www.americanbar.org/publications/probate_property_magazine_2012/2013/november_december_2013/2013_aba_rpte_pp_v27_6_article_negro_preparing_adapting_and_rebuilding.html
[33] http://www.maine.gov/dacf/municipalplanning/technical/climate.shtml
[34] http://www.newgloucester.com/index.asp?Type=B_BASIC&SEC={8D3ADCE1-7C47-46E4-B891-FE717090DDAE}
[35] http://www.waldoboromaine.org/docs/MaineEnergyHandbook.pdf

9. Ecology

Chapter Author: John Hagan

Background

Climate change is rearranging species across the globe, and New England is no exception. Warming temperatures are causing many species to move northward out of New England. Other species are moving in from the south. Some are pest species we would rather not have in our community, such as the deer tick (an arachnid that carries Lyme disease) and the hemlock wooly adelgid, which attacks and kills hemlock trees. Globally, if we stay on our present fossil fuel emissions pathway, climate change this century is predicted to lead to the extinction of some 30% of earth's species. This would represent the sixth great extinction on earth in the last 600 million years.

Forest habitats will also move northward in New England. Tree species such as pines and oaks will fare better in the 21st century climate, while spruce, fir, sugar maple, and hemlock will decline in Maine (see Figure 9.1).

Implications for Georgetown

At present Georgetown is a lightly-populated and heavily-forested town. It is known for its natural beauty, with abundant privately-owned conservation land, as well as the spectacular Reid State Park.

Georgetown's forest types will likely shift more heavily to oak, red maple, and white pine. Mature spruce stands on thin soils, such as in Ipcar Preserve, will give way to white pine. Our most popular Christmas tree species, balsam fir, will also become less abundant in Georgetown in this century.

The deer population is likely to continue to grow with warmer winters. Unusually severe winters with heavy snow pack, such as 2014-2015, may reduce the population, but only temporarily, given the warming climate trend in New England. With increasing deer populations comes an increase in the occurrence of Lyme disease. Lyme disease has greatly increased by 500% between 2004 and 2013 in Maine (see "Human Health" Chapter 13).

Our salt marshes, habitat for many wetland species will diminish with the estimated two to three foot sea-level rise by 2100. The hardened (rocky) coast of Georgetown is not conducive to the inland migration of our existing marshes. (See "Fisheries Economy" Chapter 6, for implications to the fishing economy of Georgetown).

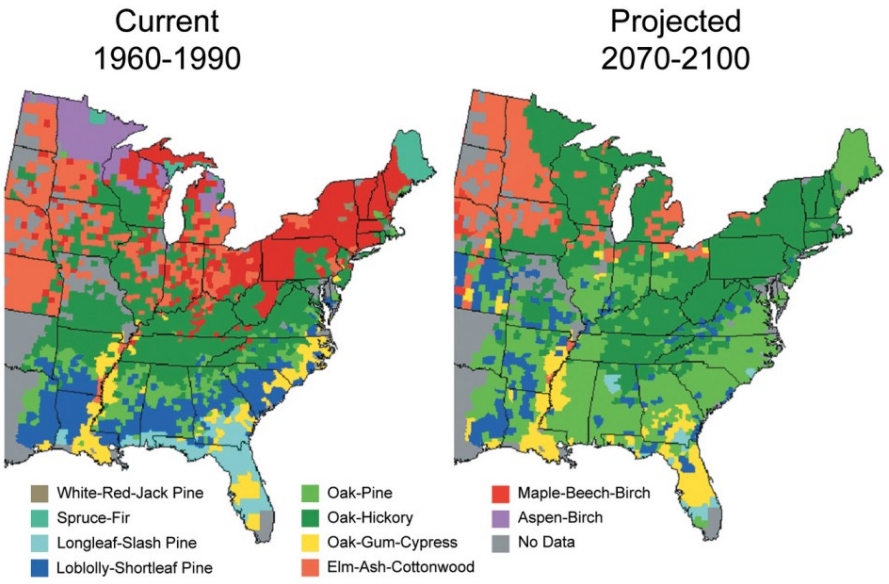


Figure 9.1. Maps show current (left) and projected (right) forest types in the eastern U.S. under a mid-range warming scenario by 2100. In the Northeast U.S. the current dominant maple-beech-birch forest is projected to be completely displaced by other oak-hickory and oak-pine forest. (Source: Karl et al. 2009.)

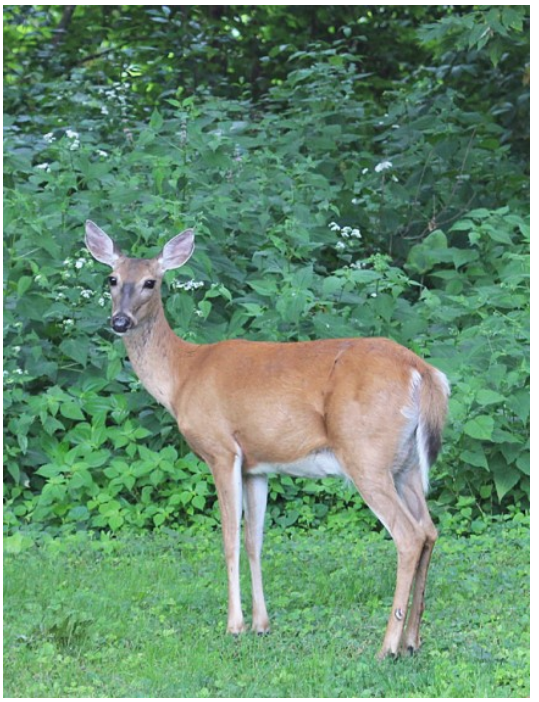


Figure 9.2. The white-tailed deer (left) will become more common in Georgetown under a warming climate. Deer impacts on gardens will increase. The occurrence of Lyme disease will grow. The Red-bellied Woodpecker (right) is a more southern species that has been expanding its range into New England in recent years. It has become a winter resident in Georgetown in recent years, and probably breeds here now.

Many birds, mammals, and amphibians will change abundance in Georgetown over the next century with climate change. A more detailed discussion of which species are vulnerable to climate change in Maine is available in the report "Climate Change and Biodiversity in Maine: Vulnerability of Habitats and Priority Species" (Whitman et al. 2013).

On the good news side, the growing season in Georgetown will lengthen. Vegetables will grow earlier in the spring and last longer into the fall. The coast of Maine has already changed in plant hardiness score, and will change again by 2050. Some vegetables, such as tomatoes, will grow better under the new climate. If the deer can be kept at bay, gardeners will enjoy the expanded growing season. ❖

Recommendations

9.1 Keep the deer population in check. Encourage the state to allow hunting at a level that decreases the deer population to the target goal established by the state (15 deer per square mile). Encourage more harvesting of does because does largely determine the population size.

9.2 Encourage local and regional land trusts to invest in and conserve properties that are likely to become the marshlands of the future.

9.3 Continue with seasonal "turtle crossing" signage to help grow awareness within the community.

9.4 Consider pre-emptive harvesting of mature spruce stands before they blow down as a result of severe storm events.

9.5. Educate kids on climate change through forest monitoring plots.

Further Reading

Karl, R.R., J.M. Melillo, and T.C. Peterson (eds.). 2009. Global Climate Change Impacts in the United States. United States Global Change Research Program. Cambridge University Press, New York, NY, USA.

Kolbert, E. 2014. The Sixth Extinction. Macmillan. Henry Holt and Company, LLD, New York, New York. 319 pp.

Maine Department of Inland Fisheries and Wildlife. 2007. White-tailed Deer Population Management System and Database. Wildlife Resource Assessment Section Mammal Group. 186 pp.

Mantyka-Pringle, C. S., Martin, T. G. & Rhodes, J. R. 2012. Interactions between climate and habitat loss effects on biodiversity: a systematic review and meta-analysis. *Global Change Biology* 18, 1239–1252.

Whitman, A., A. Cutko, P. deMaynadier, S. Walker, B. Vickery, S. Stockwell, and R. Houston. 2013. Climate Change and Biodiversity in Maine: Vulnerability of Habitats and Priority Species. Manomet Center for Conservation Sciences (in collaboration with Maine Beginning with Habitat Climate Change Working Group) Report SEI-2013-03. 96 pp. Brunswick, Maine.

r Forest Preserve is one area
blowdown because the spruce
n very thin soils.

10. Recreation

Chapter Author: Ruth Indrick

Background

Recreation is a central part of Maine's economy and quality of place. Maine's natural beauty and easy access to the outdoors are both important to Maine residents. The majority of people in Maine rank conserving places and access as high or higher in importance than private investment and jobs.[36] People seeking recreation opportunities come to Maine as tourists. In 2014, tourism supported 94,118 jobs and brought in $5.4 billion to the state.[37]

Georgetown's extensive coastline and large reserve of conserved land form the basis of many of Georgetown's recreation opportunities. These opportunities serve as an economic driver for the town and are some of the key reasons that it is a desirable place to live and visit. Some of Georgetown's recreational opportunities are:

Figure 10.1. Reid State Park on a busy summer day. A longer summer season with global warming could lead to increased tourism in Georgetown.

Boats – There is a multitude of popular boating recreation opportunities in Georgetown at private properties, public properties, and local businesses. Four town businesses and two town properties provide water access as well as more than 80 moorings and 155 slips.

Beaches – Reid State Park, with its 1.5 miles of beach, draws 120,000 to 150,000 visitors each year.[38] This is the oldest state-owned saltwater beach in Maine, donated in 1946. The state receives income from the site through park entrance fees, and the town annually receives money from the state through fee sharing of 7% of these entrance fees.[39]

Hiking and Nature –There are 11 sites with public access and systems of hiking trails that have a total of 17.4 miles of trails open to the public both summer and winter. These sites provide people with chances to visit and explore a combination of rich natural habitats, stunning views, and waterfront.

Hunting and Fishing – Deer and turkey are the most popular game animals in town. Recreational fishing opportunities include clamming, ice fishing, and other fin fishing.

Vacationing – Georgetown's recreation opportunities, and the thousands of visitors that they draw to the town, support three bed and breakfasts, one inn, one campground, and more than 50 vacation rentals. These visitors also frequent Georgetown's restaurants and stores.

Implications for Georgetown

Climate change impacts that affect recreation in Georgetown will include: more frequent intense storm events, warmer summers and milder winters, and rising sea levels.

[36] Market Decisions and The Commission on Maine's Future. (1989). The People of Maine: A study of values.
[37] Maine Office of Tourism. (2014). 2014 Maine Tourism Highlights. visitmaine.com/assets/downloads/ FactSheet2014.pdf
[38] Wilkinson, Samantha. (2014, March 20). Phone Interview.
[39] Office of the Revisor of Statutes. (2015). Maine Revised Statutes - Title 12: CONSERVATION Part 2: FORESTS, PARKS, LAKES AND RIVERS Chapter 220: BUREAU OF PARKS AND PUBLIC LANDS Subchapter 2: PARKS AND HISTORIC SITES. Retrieved from http://legislature.maine.gov/statutes/12/title12sec1820.html; June 7, 2015

Boats: More intense storm events increase the risk of storm damage to boats or boating infrastructure. Storms will also limit the number of days people can safely participate in boat recreation. The location of waterfront access and boating facilities at sea level puts the buildings and infrastructure at these sites at risk of flooding with higher water levels and storm surge events. On the other hand, warmer summers and milder winters will have a positive impact on boating use, increasing the demands for boating recreation and lengthening the boating season.

Beaches: Warmer summers may increase demand and use of beach recreation in Georgetown as visitors flock to Reid State Park. Other aspects of climate change put this beach area at risk. Waves and storm surge during intense weather events can reshape the beach, changing the amount of area that is available for recreation. The low-lying roads that lead to Todds Point and Griffith Head, two of the park's three parking areas, are at risk of flooding daily at high tide with only two feet of sea-level rise. Flooding will limit the number of visitors who access the park or cause portions of the park to be closed to the public.

Hiking and Nature: Blowdowns from significant storm events could make it difficult to access local trails and will increase demands for trail maintenance. The tree, plant, bird, and other wildlife species that are present in Georgetown's natural areas could shift to include more warm-weather-tolerant species and fewer cold-weather-tolerant species (see "Ecology" Chapter 9). A warmer climate is also expected to increase deer tick populations. This could lead to increased incidence of Lyme disease. Rising sea levels may flood some shoreline trails or make some properties, like Flying Point and portions of the Josephine Newman Sanctuary, difficult to access. Low-elevation forested areas that border wetlands may convert to wetlands.

Hunting and Fishing: For hunting, blowdowns from significant storm events could make it more difficult to move through the woods to access sites. Higher deer tick populations could mean a greater risk of Lyme disease for hunters. On the bright side, milder winters could increase deer populations and opportunities for deer hunting as more deer are able to survive and reproduce. For fishing, warm-water predators, like green crabs, pose a threat to Georgetown's clam populations and could decrease recreational clamming opportunities. Higher sea levels could make it difficult to access certain parts of local clam flats. Warmer winters could also mean thinner ice and a shorter ice-over season for the local ponds that provide venues for popular winter ice fishing.

Vacationing: Warmer, longer summers may increase the number of visitors who make their way to Georgetown for a visit or a vacation. However, intense storm events could cause people to postpone or cancel their visits to Georgetown's recreation sites. Flooding of roads could make it difficult for visitors to access the town of Georgetown (due to flooding in Arrowsic) and specific areas of Georgetown (due to flooding of roads in town). One area with many summer visitor residences that is particularly at risk of having limited access due to flooded roads is Indian Point.

Recreation-related goals from the 1993 Georgetown Comprehensive Plan that are at risk from climate change:

1. Recreation: Provide year-round activities for school children and for adults at minimum or no cost to the individual.
2. Natural Resources: Preserve and enhance the quality of Georgetown's natural resources.
3. Scenic Resources: Retain the scenic qualities of Georgetown that are integral to its quality of life, and the rural character of the community.
4. Marine Resources: Maintain the town's harbors and facilities for commercial fishing, transportation and recreation, and protect its marine related industries and harbors from incompatible development. Promote access to the shore for commercial fishermen and townspeople. ❖

Recommendations

10.1 Assess the vulnerability of boating facilities: determine which boat ramps and docks are at risk from impacts by storm surge or sea-level rise. Develop a plan for making these sites more resilient.

10.2 Plan and collaborate with the state: For example, work with the state to maintain public access to sites within Reid State Park under a sea-level rise scenario.

10.3 Be prepared to maintain trails: Encourage public and private landowners to continue trail maintenance or coordinate putting together a trail maintenance crew.

10.4 Raise tick and Lyme disease awareness: post signage around town at hiking kiosks and provide outreach about ticks and Lyme disease.

10.5 Adapt trail systems: identify and re-route trails that may be flooded during high water events.

10.6 Plan for flooded roads: provide outreach during the summer months for areas of Georgetown that are most at risk of losing access to roads due to flooding. (See suggestions in "Infrastructure: Roads" Chapter 4).

Further Reading

Climate Change Indicators in the United States: Lyme Disease by the Environmental Protection Agency: http://www.epa.gov/climatechange/pdfs/print_lyme-2014.pdf

Lyme Disease and Other Tick Related Illness on Rise in Maine By Jackie Farwell of the Bangor Daily News: http://bangordailynews.com/2012/05/30/health/lyme-disease-and-other-tick-related-illnesses-on-the-rise-in-maine/

Sea-Level Rise Viewer from the National Oceanic and Atmospheric Administration's Office for Coastal Management's Digital Coast website. http://coast.noaa.gov/digitalcoast/tools/slr

Georgetown Trails Guide by the Georgetown Conservation Commission. http://gtownconservation.com/wp-content/uploads/2013/11/Gtown-Trails-Guide-v7-P12-combined.pdf

Climate Impacts on Hunting and Fishing from the National Wildlife Foundation: http://www.nwf.org/Sportsmen/Climate-Change.aspx

Maine's Climate Future Report: Tourism and Recreation (pages 50-52 of the report) by The University of Maine (Kathleen P. Bell, John Daigle, Harold Daniel, Todd Gabe, and Jessica Leahy)

11. Emergency Preparedness

Chapter Author: Nancy Kinner

Background

The United States has a well-established system of emergency management at the federal, state, and local levels. Maine's Emergency Management Agency (MEMA) was established in 1949 in response to the 200+ fires that occurred across the state in October 1947 during a period of drought and extreme winds. Poor preparation, training, coordination and communication during these fires resulted in 16 fatalities, ~10,000 injuries, as well as 1,182 homes and 1,473 other structures destroyed. Because emergency management is so important at the local level, each county has an emergency management director and a Local Emergency Planning Committee (LEPC) that supplies assistance and training, and access to resources for the local communities. Maine's state statutes require that every municipality must have a local emergency management director (LEMD) whose job it is to coordinate disaster mitigation, preparedness, response and recovery. The LEMD works with appropriate county and state agencies on behalf of the town. Unfortunately, most LEMDs have no paid staff. Because most towns have a very small or no budget for emergency management, LEMDs rely on resources available at the county, state and federal level to help them do their job. Maine, through a series of agreements, can also reach out to nearby states and the eastern Canadian provinces for response assistance (mema.gov).

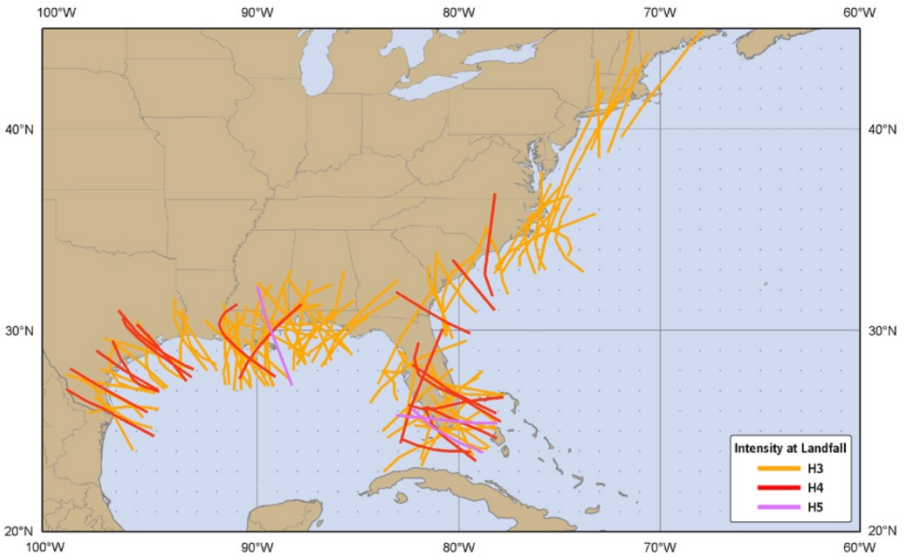


Figure 11.1. Major hurricane strikes (Category 3 or higher) between 1851 and 2010 in the eastern U.S. The probability of a major hurricane hitting New England is increasing with climate change because the ocean is warming and can provide more "fuel" for future hurricanes (source: Blake and Gibney 2011, NOAA Technical Memorandum NWS NHC-6.)

In order to be ready for climate-related emergencies, emergency management plans focus on mitigation, preparedness, response and recovery. Mitigation involves actions to reduce or eliminate long-term risks to people and their property from hazards and their effects (e.g., elevating structures above the predicted level of flooding). Preparedness includes all of the planning, training, practice, public information and education, facilities, and communication that develop resilience to emergencies, ensure effective response, and speed recovery. Response consists of the decisions and actions during the emergency to prevent loss of life and property, minimize injury and impacts, maintain order, and provide assistance. Recovery includes the short- and long-term activities to return a community to normal activity after the emergency.

Implications for Georgetown

The Town of Georgetown has an emergency management director (GEMD), appointed by the Selectmen, as well as a detailed Emergency Operations Plan (GEOP) which was most recently updated in March 2013. The hazards identified in the GEOP include: winter storms, wild fires, windstorms (e.g., hurricanes), floods, drought, earthquakes, national emergencies, hazardous and radiological material spills, aircraft crashes, and energy and food shortages. The roles of the GEMD, Selectmen, Fire Chief, Sheriff, and Road Commissioner are described in the plan. The Georgetown Central Fire Station will serve as the Emergency Operations Center (EOC). Designated shelters include the Georgetown Community Center, the Central School and the Historical Society.

Having an EOP is a major accomplishment for a small town, and Georgetown is in an excellent position to take the next important steps towards emergency preparedness with specific planning and preparations, especially for the most likely emergencies—flooding and extreme storm events. The next steps typically focus on specific preparedness, mitigation and response options for buildings and infrastructure, roads, coastal areas (e.g., beaches), and water supply. In addition, specific disaster response actions are usually planned to address: (1) evacuation of stranded residents in areas likely to be flooded or damaged, (2) transportation interruptions caused by flooded/impassable roads, (3) contamination of water supplies, and (4) failure of on-site wastewater treatment systems. It is also important to develop a set of objectives and goals for recovery to help prioritize rebuilding and restoration strategies after the emergency is over.

The other major component to emergency preparedness is to practice the actions that the GEOP describes and insure that members of the community are aware of what the plans are. The best EOP is not useful if it is never tested and no one knows what it says or what to do in case an emergency is declared. This is why annual drills are specified in the GEOP and communication/outreach to the community is emphasized. ❖

Recommendations

11.1 Conduct specific planning for climate change-related emergencies.

11.2 Focus on vulnerable communities within Georgetown and conduct outreach concerning the GEOP, including getting input on emergency preparedness.

11.3 Communicate about the annual GEOP with the public so it is aware of the importance of emergency preparedness.

12. Cultural and Historical Assets

Chapter Author: Kathy Gravino

Background

Climate change threatens cultural and historic landmarks all over the world. Coastal sites are particularly vulnerable to changing weather patterns, increased severity of storms, coastal erosion, and sea-level rise. In 2012, Superstorm Sandy flooded New York City's Battery Park and iconic subways, damaging and closing historic landmarks on Liberty and Ellis Islands in New York Harbor. A similar super storm, reaching Boston at high tide, could put the historic Boston neighborhoods of Faneuil Hall and the old North End under water.[40]

Figure 12.2. Remains of fish weirs in tidal flats, southw

Implications for Georgetown

With more than 80 miles of shoreline, proximity to productive Gulf of Maine fishing grounds and marine resources, acres of salt marsh and tidal flats, and access to navigable water on every side, Georgetown Island has a long history of human settlement and reliance upon surrounding waters. Many early settlement sites in Georgetown are undisturbed and undocumented. Most are on private land. Much remains to be learned.

Figure 12.1. Arrowheads from Georgetown (Mary Leonard Collection, Georgetown Historical Society).

Native Americans lived at the mouths of the Kennebec and Sheepscot Rivers long before Georgetown Island was acquired by English colonists from an Abenaki chief in 1650. European fishing stations existed in the region from the early 1600s onwards.[41] Georgetown's homesteads and villages grew along its shores as its inhabitants followed industries that depended upon easy access to marine resources and navigable waterways: fishing, logging, lobstering, shellfish harvesting, boat building, coastal and ocean trade, sheep farming, and quarrying. Travel was predominantly by water until well into the twentieth century. More recently, Georgetown has welcomed summer "rusticators," artists, writers, and others who enjoy the natural beauty of the island.

Many of Georgetown's cultural and historical assets are located near Georgetown's shorelines, reflecting the important historic relationship between its people and the waters around it. Assets in these categories include the following:

Prehistoric Archaeological sites in Georgetown. The Maine Historic Preservation Commission has identified 31 or 32 known prehistoric archaeological sites in Georgetown. Many of these are shell middens "on eroding coastline" (communication from Dr. A. Spiess, Maine Historic Preservation Commission, 2013). Additional prehistoric archaeological sites remain to be identified.

Historic Archaeological sites in Georgetown. The Maine Historic Preservation Commission has inventoried 27 historic archaeological sites in Georgetown, primarily along Georgetown's shorelines.[42] Georgetown's most recent Comprehensive Plan (1993) included a recommendation from the Maine Historic Preservation Commission that "fieldwork could focus on sites relating to the earliest European settlement of the town, beginning as early as the 1630s. Many such sites are known from primary documentary sources and should be located as a high priority."

Historic Buildings (National Register of Historic Places). The National Historic Register lists seven National Register properties in Georgetown. In addition, in 1998, the Maine Historic Preservation Commission determined that there is a National-Register-eligible linear district in Georgetown consisting of 13 buildings clustered along Route 127 on the east and west branches of Robin Hood Cove. Five additional properties elsewhere in Georgetown have been determined to

[40] Holtz et al, National Landmarks at Risk: How Rising Seas, Floods, and Wildfires are threatening the United States Most Cherished Historic Sites, 2014.
[41] McLane, Islands of the mid-Maine Coast, Vol. IV, 1994.
[42] communication from Dr. A. Spiess, Maine Historic Preservation Commission, 2013.

meet National Register eligibility criteria.[43] At least three of the historic National Register properties have been identified as likely to flood in some projection scenarios.[44]

Cemeteries. More than 50 small family cemeteries have been located on Georgetown Island.[45] Most are on private property, and contain unrecorded graves; many are near the shorelines where early settlers lived. Six of Georgetown's family cemeteries have been identified as likely to flood in some projection scenarios.[46]

Historic working waterfront sites. Fishing and landing "privileges" and grist and saw mills powered by tides and currents appear in Georgetown deeds from earliest times.[47] Today, the shores and tidal flats of Georgetown Island contain many remnants of old wharves, retaining walls, fish weirs, tidal mills and other relics of the island's long maritime history. Georgetown's 1993 Comprehensive Plan recommended preserving remains of the island's tidal mills, fish weirs, wharves, and buildings related to marine industries. These have not been inventoried.

Salt marsh "improvements." The salt marshes of Georgetown were a valuable economic commodity in earlier times. Salt hay had many uses and required no cultivation. In the 1771 Georgetown Valuations, Georgetown Island residents reported 346 acres of salt marsh as valuable property.[48] Salt marshes were "improved" with dikes, ditches, dams, and elevated roadbeds. Remains of such historic "improvements" can be found in most salt marshes surrounding Georgetown, are vulnerable to sea-level rise and intensifying storms, and have not been inventoried.

Little River marshes. Georgetown has an ecologically important salt marsh system that was not historically diked, ditched, or dammed. A rare example of a natural northern New England salt marsh, the upper reaches of the Little River salt marsh system are in conservation and vulnerable to intensifying storms, changing weather patterns, and sea-level rise. ❖

Recommendations

12.1. Work with the Maine Historic Preservation Commission and other regional and local groups to identify and inventory Georgetown's vulnerable historic and prehistoric sites.

12.2 Prioritize the significance and vulnerability of known sites based on site content, elevation above sea level, ongoing erosion, and sea-level rise models, and develop plans to protect, preserve, and/or record the most vulnerable sites.

12.3 Encourage community programs to raise awareness of and appreciation for Georgetown's vulnerable cultural and historic assets.

Further Reading

Holtz et al. 2014. National Landmarks at Risk: How Rising Seas, Floods, and Wildfires are Threatening the United States' Most Cherished Historic Sites. Union of Concerned Scientists. On-line at (www.ucsusa.org/landmarksatrisk).

McLane, C.B. 1994. Islands of the mid-Maine Coast, Vol. IV. Island Institute and Tillbury House. 300 pp.

[43] communication from K. Mahoney, Maine Historic Preservation Commission, 2013.
[44] University of New Hampshire, Georgetown, Maine Climate Change Vulnerability Study, 2014.
[45] Brown, The Family Cemeteries of Georgetown, Maine, 1977.
[46] University of New Hampshire, Georgetown, Maine Climate Change Vulnerability Study, 2014.
[47] Sagadahoc and Lincoln County Registries of Deeds.
[48] McLane, Islands of the mid-Maine Coast, Vol. IV, 1994.

13. Human Health

Chapter Author: Nananda Col, M.D.

Background

Human health is intricately connected to our physical environment. Environmental degradation, including climate change, air pollution, and increases in the amount of harmful UV radiation, can have direct and indirect effects on our health. People living in more polluted areas die sooner than those living in cleaner communities. While most people readily adapt to usual temperatures, older people and those with chronic health conditions do not adapt well to unusual or sudden temperature increases in the summer. Extreme weather events can cause psychological stress and accidents, and can disrupt access to medical care. Climate change is predicted to lead to more heavy rainfall events and rising water levels, which can contaminate drinking water. Yet perhaps the most immediate and significant effect of climate change on health has already materialized—substantial changes in the disease-carrying parasites and microorganisms that live both on land and in water.

The health risks associated with climate change are not equally distributed. They depend on the extent of the environmental changes, people's health-related behaviors, and their individual susceptibility to disease. Susceptibility, in turn, is determined by age, health status, occupation, lifestyle choices, past medical history, and socio-economic status. The poor are more vulnerable to the harmful health effects because they tend to have more exposure to harmful environmental conditions in their homes and at work, fewer resources to manage those risks, and less access to medical care.

Implications for Georgetown

With a median age of 49.6 years (in 2010), Georgetown permanent residents are 6.6 years older than the average for Maine. The risks of having one or more chronic conditions (such as diabetes, stroke, and cancer) increase markedly with age. It is therefore probable that many Georgetown residents are managing multiple chronic health conditions. Climate change will disproportionately affect the elderly. Yet there are no health care services available on the island, and residents must cross three to five bridges to get to Bath. Interruptions in power and communication are common. Many residents live here only part of the year. There is no public water supply or public sewage system on the island—most have septic systems or holding tanks and private wells. Many homes have wood-burning stoves. Many residents work outdoors (fishermen) or are engaged in outdoor recreational activities (boating, hiking). Seafood, which may become contaminated as a result of impacts of climate change, is very popular and is the mainstay of many local eateries.

Milder winters and more vector-borne diseases: Milder winters have both increased the deer population and have helped deer ticks survive the winters. Deer ticks carry Lyme disease, Anaplasmosis, Babesiosis, and Powassan virus. More deer lead to more deer ticks which leads to higher risks of contracting Lyme and other tick-borne diseases. Lyme disease was first reported in Maine in 1985 but is now present throughout Maine. The number of tick-borne diseases has increased exponentially over the past decade (Figure 13.1). Most deer ticks in coastal Maine carry Lyme disease; half of them also carry one or more other serious diseases. Deer ticks' two-year lifecycle depends on the presence of small rodents (primarily the white-footed mouse) and the white-tailed deer. Deer ticks acquire and transmit diseases as they transform from larvae to nymph to adult ticks. Anyone who spends time outdoors is at risk.

The impact of climate change on mosquito-borne diseases such as West Nile Virus and Eastern Equine Encephalitis is more uncertain but the duration of the mosquito season is expected to last longer.

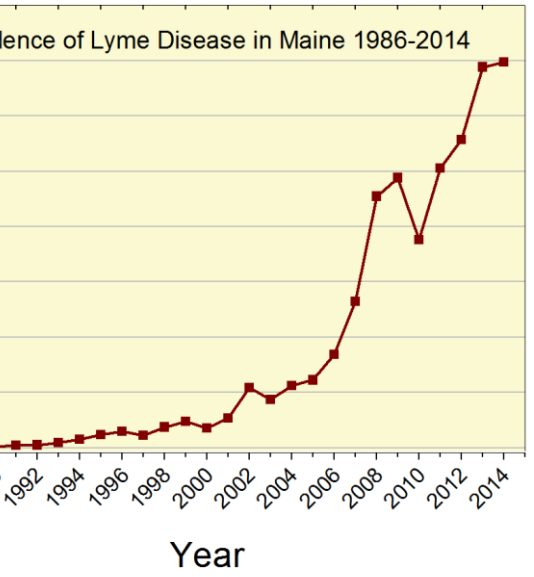
Rising water levels and contamination: Heavy rainfall and rising water levels can waterlog soil, saturate septic system drainage fields, and cause them to malfunction. This may result in contaminants from partially treated wastewater entering ground and surface water. Additionally, when the water cannot flow out of the septic tank due to flooded conditions, sewage water can back up into houses. Dangerous pathogens (norovirus, hepatitis A, E. Coli, Cryptosporidium) can enter drinking water supplies or homes, resulting in diarrheal diseases and other intestinal diseases.

The harmful marine bacteria *Vibrio vulnificus* (related to Cholera) thrives in warm, low-saline sea water and is greatly concentrated by filter-feeding organisms such as shellfish. It can cause lethal skin infections among fishermen and boaters and is responsible for the vast majority of seafood-related deaths (most from consuming raw oysters). A 10ºF increase in the water temperature triples its *Vibrio* population. Though still few in number, *Vibrio* cases have been rising in Maine and outbreaks will likely increase if the trend towards warmer water and lower salinity continues. Over 85% of outbreaks occur between May and October. Those with compromised immune systems, chronic liver disease, or diabetes are at highest risk.

Harmful algal blooms, commonly known as red tide, produce toxins that are concentrated by shellfish and cause paralytic shellfish poisoning. Areas affected by harmful algal blooms are expected to increase in size and duration along the coast, contaminating a variety of shellfish with a potentially lethal toxin. These toxins do not affect the taste of food and are heat stable, so cooking does not reduce their toxicity.

Air pollution and lung disease: Higher predicted levels of smog, which includes unhealthy ozone and CO_2, can significantly worsen common lung diseases such as asthma and emphysema (COPD). Increased reliance on wood fuel and pellet stoves can worsen health impacts and may exacerbate air pollution because wood smoke generates 50 times more particulates than conventional oil furnaces and more toxic substances (polycyclic organic compounds and naphthalene). The predicted rise in CO_2 levels may result in more plants that produce higher levels of allergic pollens, such as ragweed, which will aggravate seasonal allergies, asthma, and COPD. People with lung conditions and smokers are at higher risk for complications.

UV radiation: Dangerous ultraviolet radiation from the sun is expected to become stronger in the coming years. This UV radiation increases the risks of a variety of common skin cancers (including melanoma, basal cell, and squamous cell) and increases the risk of cataracts and Pterygium, both of which can compromise vision. Fishermen and others who have higher exposure to sunlight are at greater risk, as are those with a personal or family history of melanoma. Routine use of sunscreen and other forms of sun protection (hats, sunglasses) can lower the risk.



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Severe weather events: Heat waves increase death rates, especially among the elderly and those with chronic disease. Storms and excessive snowfall increase the risk of falls, back injuries, and fractures, causing substantial morbidity and mortality. Hip fractures among the elderly can be devastating, often resulting in prolonged disability, loss of independence, or even death. Snow shoveling after heavy snow fall increases the risk of painful and often debilitating back injuries, fractures, head injuries, and heart problems.

Access to Health Care: Disruptions in communication, transportation, and power can restrict access to healthcare and medical treatments, with deleterious health consequences. For those facing an emergency medical situation, even a short delay can be catastrophic. For those with chronic diseases (e.g., diabetes, heart disease), treatment adherence is especially important to maintaining health. Those who rely on daily medications or routine monitoring need to be able to refill medications when they run out and/or undergo appropriate monitoring to adjust dosing. For those who rely on home medical equipment (e.g., CPAP for sleep apnea), who require infusions, or who require visiting nurses or other health personnel, even short disruptions in power, transportation, or communication can have serious health consequences. ❖

Recommendations

13.1 Tick-borne diseases: Convene a town hall meeting with experts in this area to explore community options for reducing tick-borne diseases, for monitoring new cases, and for educating about ways individuals can minimize exposure to tick-borne diseases.[49]

13.2 Monitor red tide and *Vibrio* levels, especially in areas where shellfish are harvested.

13.3 Septic systems: (1) Revise the definition of at-risk areas for flooding to prevent placement of leech fields in future water-logged areas, (2) develop strategy for managing existing septic systems in high-water areas, and (3) educate citizens on how to minimize the risk of septic system failure during periods of high water.

[49] As an island, we have a unique opportunity to control tick-borne diseases. Eradication of tick-borne diseases has been accomplished on two Maine islands—Monhegan and Isleboro—by managing the deer population. Reducing deer densities to eight deer per square mile or less should interrupt the transmission of Lyme and other tick-borne disease. Other approaches, such as application of topical acaricides to deer to kill ticks, should also be effective.

13.4 Health Buddy system: Develop a strategy for dealing with disruptions in power, transportation, and communication by understanding the medical needs of residents through a voluntary reporting system and health buddy system for those at greatest risk.

13.5 Host educational programs and conduct outreach about the variety of protective measures and behavior changes that individuals can undertake to mitigate these risks.

13.6 At a town meeting, prioritize health concerns because of the number of health threats posed and the older age of Georgetown's population.

Table 13.1. Climate-related risk factors for disease.

Effect of Climate Change	Downstream Effect	Health Risk
Milder winters, more snowfall	More disease-carrying deer ticks	Lyme disease, Anaplasmosis, Babesiosis, Pow virus
Warmer coastal water, lower salinity	More harmful algal blooms (red tide) and marine bacteria	Paralytic shellfish poisoning, gastrointestinal disease from eating seafood, *V* Vulnificus wound infections
More air pollution, CO_2 and reliance on wood fuel/ pellets	Toxic substances from wood smoke; more pollen-producing plants.	Lung diseases (asthma, emphysema, COPD, l cancer), pollen allergies
Depleting ozone layer	More UV radiation	Skin cancers, cataracts, Pterygium (eye condit can impair vision)
Extreme weather conditions and more storms	Hot temperatures increase death rates, slippery surfaces, disruptions in access to health care	Heat stroke; falls/bone fractures, car crashes; r health disorders (depression, anxiety), delayed emergency medical services and medical treat
Rising water levels	Septic system malfunction and overflow	Diarrheal diseases and other pathogens enteri supplies and homes

Conclusions

Georgetown's climate is changing. It will impose costs on our community. By thinking ahead we can reduce those costs. The purpose of this report is to begin a conversation about climate change in Georgetown. We thought about the varied interests of our community, and we thought about what could be done to secure those values in the face of climate change. We have made many recommendations that, if implemented, would help make our people, our culture, and our economy resilient. Most of the recommendations are "no-regrets"—they make good sense regardless of climate change.

We realize that it is far easier to make a recommendation than it is to carry one out. But carefully thinking through what can be done is an important start. The Conservation Commission plans to act on as many of the recommendations as possible, but it will be critical for citizens and town leaders to take initiative as well. Many of the recommendations can be taken by private property owners.

We hope you read this report and think about what you can do to lead implementation of one or more of the recommendations. We are a small community, and therefore it is often quite easy to get something truly meaningful done. We invite you to get involved. Take leadership. Or, just get in touch with the Conservation Commission to figure out how you might help Georgetown prepare for the climate of the 21st century.

PHOTO: John Hagan