AUGUST 26, 2022

ASSESSING THE CARRYING CAPACITY OF THE BLUE HILL PENINSULA

Prepared for Blue Hill Heritage Trust by rbouvier consulting

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Executive Summary

This report, "Assessing the Carrying Capacity of the Blue Hill Peninsula," is a project of Blue Hill Heritage Trust (BHHT), a conservation organization looking to "conserve the farmland, forests, wetlands, and wildlife habitat needed to sustain ecological and community health in a changing climate" (Blue Hill Heritage Trust, 2022). BHHT is concerned about looking into the trends which, if left unchecked, could threaten the integrity of the region and challenge the ability of BHHT to achieve their mission. A study was conducted with the help of rbouvier consulting to identify risks on the peninsula associated with changes in the environment, population, and the local economy on land, infrastructure, and the communities in the region. This report contains:

- an account of the pandemic-related population trends of 2020 and beyond;
- a description of the climate-related migration that is already occurring and only expected to accelerate; and
- a portrayal of the physical, economic, and social carrying capacity of the Peninsula both in quantitative and qualitative terms, and visually in maps and in data.

BHHT contracted with rbouvier consulting to conduct the study. Their charge was to do the following:

- Assess the extent of COVID-19-related migration on the peninsula and its impacts.
- Investigate if climate migration is happening on the peninsula and what the future impacts may be.
- Assess the carrying capacity of the Blue Hill Peninsula and the region's ability to absorb an inflow of migration.

As part of the project, rbouvier consulting contracted with FB Environmental to conduct a GIS-based resource analysis of the study region. The data from this analysis were used in support of the carrying capacity analysis in this report. The maps and physical carrying capacity database created by FB Environmental are attached in this report as Appendix A and B.

To assess how the COVID-19 pandemic impacted domestic migration patterns on the peninsula, researchers used change-of-address request data to quantify estimated change in population due to COVID-19. They identified the origins of movers to the project area, from 2018 to 2021 and determined the origins of migrating households. The findings show a clear overall population growth trend on the peninsula due to COVID-19 (22%), with variable rates in each community, changing the trend from negative net population to positive. The group also looked at both school enrollment data and housing prices to learn more about the impacts on migration locally.

Findings include:

- Both temporary and permanent migration spiked in March 2020. Compared to March 2019, permanent change-of-address (COA) requests were up over 53%, while temporary COA requests were up by almost 264%.

- Incoming COVID-19-related migration patterns reveal people moving to the peninsula from outside of New England dominantly and from urban areas.
- The number of building permits increased as did real estate prices.
- Compared to pre-pandemic request levels, Brooksville, Castine, and Penobscot continue to have higher than normal COA requests in 2021. COA requests for Sedgwick levelled off, whereas those for Blue Hill continued to rise.

To assess the impact of climate migration on the Blue Hill Peninsula researchers were concerned with assessing a) if climate migration is occurring, and, if so, b) who is migrating and from where. To investigate these questions, researchers completed a literature review of climate migration studies, and inquired into national migration data published by the IRS. As part of their investigation, they compared migration trends with weather information for specific climate events and gleaned demographic information about climate migrants to the Blue Hill Peninsula. Further assessment was done to estimate the impact of this trend on housing, jobs, infrastructure and schools.

- Current climate migration to the study area is primarily voluntary.
- Households driving current climate migration trends have the financial wherewithal to move by choice to escape from perceived dangers (wildfires, flooding, hurricanes, or a pandemic).
- The households that migrated to Hancock County in 2020 had an average income that was 20% above the average household income for the county in 2019.

Researchers define carrying capacity in terms of regional sustainability. Looking at regional analysis and tourism impact studies, they determined three interconnected component systems that simplify regional systems: a) physical, b) economic and c) social. With these three focus areas, they developed candidate indicators and screened those indicators for data availability and accessibility. Initial data collection focused on establishing a threshold level for each. With these indicators and baselines set, researchers evaluated each indicator against the threshold and were able to categorize each indicator with a rating scale based on levels of constraint on the system. When we combine migration findings with carrying capacity analysis, the findings reveal present and future constraints on the carrying capacity of the region as follows:

- The impact of a wealthier, more urban population may affect the carrying capacity of the peninsula.
- The wastewater treatment facility in Blue Hill is not likely to be able to withstand a significant increase in population. Moreover, the facility is at risk from sea level rise.
- Roads and schools are likely to remain unconstrained for the foreseeable future.
- Land for development is already constrained, though it varies in each community.
- There appears to be enough land for farming, but to the extent it is being farmed is unknown. Preservation of farmland is already under conservation targets. Both cost of

living and housing affordability are likely to worsen, as is the economic inequality in the region.

- Social conflicts are likely to accelerate between long-term residents and new arrivals.

1 Background and Introduction

Large scale migration is not unheard of in the United States. Between 1935 and 1940, during the Dust Bowl, over 250,000 people migrated from the states of Oklahoma, Texas, Arkansas, Kansas, and Missouri to California (Gregory, 2015). Hurricane Katrina in 2005 caused nearly one million people to leave their homes; not everyone was able to return and nearly 70,000 households had to migrate permanently. In March and April of 2020, during the early months of the COVID-19 pandemic, some estimates show about 650,000 additional households moving compared to the same period in 2019 (Frost, 2022).

During the early months of the pandemic there were news stories of a mass exodus from urban to rural regions. Maine was no exception. The Blue Hill Peninsula, comprised of the towns of Blue Hill, Brooklin, Brooksville, Castine, Deer Isle-Stonington, Penobscot, Sedgwick, and Surry, was among the regions in Maine that experienced pandemic-related migration and its impacts.

Another phenomenon is on the horizon, one that could dramatically alter the physical, economic, and social landscape of the Blue Hill Peninsula: climate change. Aside from physical changes such as sea level rise, changing precipitation patterns, and warmer temperatures, other changes are occurring, less tangible but still substantial. Climate-related migration, or migration from an area where the environment has been damaged by climate change, is on the rise both globally and regionally. Maine, and specifically amenity-rich regions like the Blue Hill Peninsula, is poised to become a magnet for families and households that are able to escape climate-related disasters such as heat waves, wildfires, and drought.

As the Blue Hill Peninsula attracts more and (perhaps more urban and wealthier) households, how will this influx affect the capacity of the Peninsula to sustain itself? How will the coming changes affect the mission of the Blue Hill Heritage Trust (BHHT): “to lead in conserving land, water, and wildlife habitat on the greater Blue Hill Peninsula; to teach and practice a stewardship ethic; to promote ecological, economic, and community health for this and future generations” (Blue Hill Heritage Trust, 2022)?

A note on terminology: Throughout this report the terms Blue Hill Peninsula, Blue Hill region, and study area are used to refer collectively to the towns of Blue Hill, Brooklin, Brooksville, Castine, Deer Isle-Stonington, Penobscot, Sedgwick, and Surry.

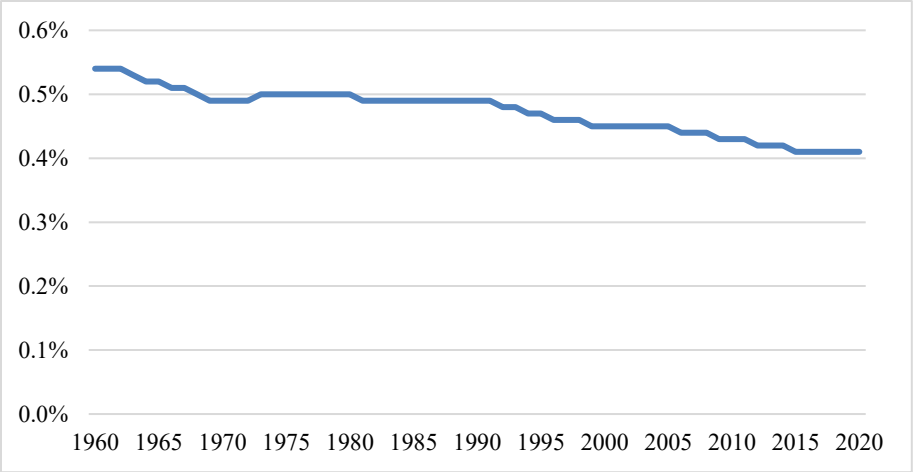
2 Current Growth Trends and COVID-19-Related Migration

2.1 Current Growth Trends in Maine and the Blue Hill Peninsula

Population growth in Maine has historically lagged behind national growth trend. While the national population grew 9.7% from 2000 to 2010, Maine’s population only grew by 4.2% (US

Census Bureau, 2022e). Figure 1 shows Maine's population as a percentage of the national population.

Figure 1 - Maine Population as a Percentage of the United States Total, 1960-2020



Source: (US REA Project, 2022)

The decline in Maine's population relative to the nation is due to two factors related to the State's negative natural population change. The first is that Maine has an aging population, and the second is that the State has the third-lowest birth rate in the county (Office of the State Economist & Maine Department of Administrative and Financial Services, 2021; Osterman et al., 2019). Any increase in the state's population has been a result of in-migration.

As shown in Figure 2 below, the State began to see an uptick in population growth in 2016, primarily driven by a shift to positive net domestic migration (Office of the State Economist & Maine Department of Administrative and Financial Services, 2021).

Figure 2 - Components of Population Change, Maine

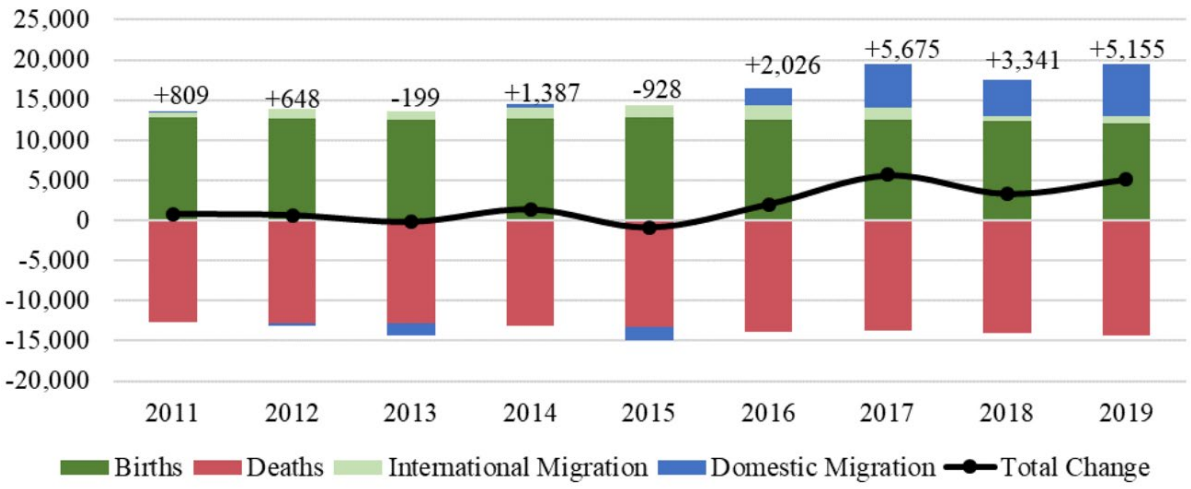


Image Source: (Office of the State Economist & Maine Department of Administrative and Financial Services, 2021)

The Blue Hill Peninsula has generally followed state growth. Table 1 shows the Peninsula populations and growth rates, compared to the county, state, and nation. The only Peninsula towns that have seen an increased growth rate over the past ten years compared with the previous decade are Brooklin, Deer Isle, Stonington, and Surry. Blue Hill, Deer Isle, and Surry grew at a faster rate than both county and state. Castine and Penobscot saw a decline in population in the last decade.

Table 1 - Population Growth, 2000-2020

	2000	2010	2020	% Change, 2000-2010	% Change, 2010-2020
Blue Hill	2,390	2,686	2,792	12.4%	3.9%
Brooklin	841	824	827	-2.0%	0.4%
Brooksville	911	934	935	2.5%	0.1%
Castine	1,343	1,366	1,320	1.7%	-3.4%
Deer Isle	1,876	1,975	2,194	5.3%	11.1%
Penobscot	1,344	1,263	1,136	-6.0%	-10.1%
Sedgwick	1,102	1,196	1,202	8.5%	0.5%
Stonington	1,152	1,043	1,056	-9.5%	1.2%
Surry	1,361	1,466	1,632	7.7%	11.3%
Blue Hill Peninsula	**12,320**	**12,753**	**13,094**	**3.5%**	**2.7%**
Hancock County	51,791	54,418	55,478	5.1%	1.9%
Maine	1,274,923	1,328,361	1,362,359	4.2%	2.6%
United States	281,421,906	308,745,538	331,449,281	9.7%	7.4%

Source: (US Census Bureau, 2022c, 2022a, p. 1, 2022a, p. 1)

Table 2 displays the same information for households rather than individuals. The distinction is important because throughout this report migration patterns are assessed in terms of households as opposed to individuals due to data availability. Therefore, Table 2 gives a baseline for understanding how migration patterns have shifted.

Table 2 - Households, 2000-2020

Town	2000	2010	2020	% Change, 2000-2010	% Change, 2010-2020
Blue Hill	1,074	1,279	1,320	19.1%	3.2%
Brooklin	375	397	396	5.9%	-0.3%
Brooksville	412	437	460	6.1%	5.3%
Castine	372	380	347	2.2%	-8.7%
Deer Isle	779	929	970	19.3%	4.4%
Penobscot	533	593	562	11.3%	-5.2%
Sedgwick	466	529	532	13.5%	0.6%
Stonington	504	515	520	2.2%	1.0%
Surry	551	673	715	22.1%	6.2%
Peninsula	5,066	5,732	5,822	13.1%	1.6%
Hancock County	21,864	24,221	24,948	10.8%	3.0%
Maine	518,200	557,219	582,437	7.5%	4.5%

Source: (US Census Bureau, 2022a, p. 1, 2022b, 2022e)

2.1 Impacts of the COVID-19 Pandemic on Migration Patterns and Growth Trends

The COVID-19 pandemic brought an unprecedented change in migration across the country, as well as birth and death rates. Fears of the virus prompted many to move away from urban centers, to less densely populated areas due to higher transmission rates (Chiumenti, 2021; Office of the State Economist & Maine Department of Administrative and Financial Services, 2021). School closings and shifts to online learning sent university students across the country back home (Chiumenti, 2021). The sudden transition to remote work for those with the capacity to do so allowed workers the ability to relocate to other areas (Chiumenti, 2021). The pandemic spurred an out-migration from densely populated areas. In recent years, migration has begun to shift away from large urban areas and toward other regions; however, the pandemic has accelerated this trend (Whitaker, 2021). New York and San Francisco, which are densely populated areas with a high share of jobs that can be done remotely, saw unprecedented out-migrations (Kolko et al., 2021). Migration from high-cost, large metro areas to midsized metro areas increased by over 10% at the start of the pandemic, and migration toward small metro areas, towns, and rural areas increased by over 9% (Whitaker, 2021).

As a primarily rural state, Maine witnessed a drastic shift in net migration (Chiumenti, 2021; Fields et al., 2016). Table 3 shows net household migration to Maine from 2017 to 2020 as measured by the total number change-of-address (COA) requests to the state. Individuals and families can file COA requests with the United States Postal Service (USPS) when they move. A request can be for either a temporary or permanent move. Before 2020, the State was experiencing out-migration (Chiumenti, 2021).

Table 3 - Net Migration by Request Type, 2017-2020

Request Type	2017	2018	2019	2020
All	-5,348	-9,907	-7,122	4,545
Permanent	-6,969	-8,889	-6,365	888
Temporary	1,559	-784	-344	3,218

Source: (Chiumenti, 2021)

Perhaps the most wide-reaching consequence of the pandemic on migration patterns was the widespread implementation of remote work for those in occupations where it was possible. As fears of the virus subside and schools begin to reopen, many have speculated that remote work is here to stay. An estimated 37% to 39% of jobs in the country are remote work amenable (Wallace, 2020). Between 36% and 40% of firms in the United States believe that 40% or more of their workers that switched to remote work at the start of the pandemic will continue after it ends (Wallace, 2020).

Remote work has significant implications for migration decisions as workers are not geographically bound to the area in which they are employed. These workers can move to a new location while maintaining access to the same opportunities for their skill set, allowing them to take advantage of wage differentials (Wallace, 2020). Remote workers can make locational decisions based on factors like recreational or other amenities, which are an "important predictor of where remote workers migrate to and concentrations of remote work in general" (Wallace, 2020). In Maine, before the pandemic, connection to place was the top factor driving migration decisions of remote workers relocating to the State. The overall quality of life and social connections were also considered very important factors in migration decisions (Wallace, 2020).

When compared to non-remote workers, remote workers typically have higher formal education, higher income levels, and are slightly older. These characteristics are likely a function of their occupations, which tend to be in science, technology, engineering, arts, and mathematics (STEAM) industries (Wallace, 2020). The rise of remote work has already had substantial implications for communities across the country and will likely continue to do so.

2.2 Assessing COVID-19-Related Migration: Methodology

The project team used USPS change of address (COA) requests to assess how the COVID-19 pandemic impacted domestic migration patterns in the project area. Data on COA requests were used in place of Census data as they provide a timelier record of population changes. These data were sourced through the USPS FOIA Library webpage and a private data company (USPS, 2022). At the time of this project's data collection period, COA request data were available and utilized from early 2018 to February 2022.

COA requests to and from a 5-digit zip code are broken out by month. The totals to and from each zip code include families, individuals, and businesses. As COA requests can be made by either individuals or families, it is not possible to discern the number of people that move, therefore, COA requests are best thought of as number of households (Chiumenti, 2021). As previously mentioned, COA requests can be made for either a temporary or permanent move.

For the purposes of protecting their customers' privacy, the USPS does not disclose "COA volumes where the count is less than 11." In other words, if there are fewer than 11 COA requests in a particular category, it is displayed as a zero (USPS National Customer Support Center Addressing & Geospatial Technology, 2021). In order to avoid undercounting, COA requests, the project team input "5" for months when the COA requests for a zip code showed as zero.

Additionally, it is important to note that not all movers file COA requests, particularly young adults moving to college and households moving abroad (Kolko et al., 2021). Therefore, these numbers should be regarded as a low-end estimate.

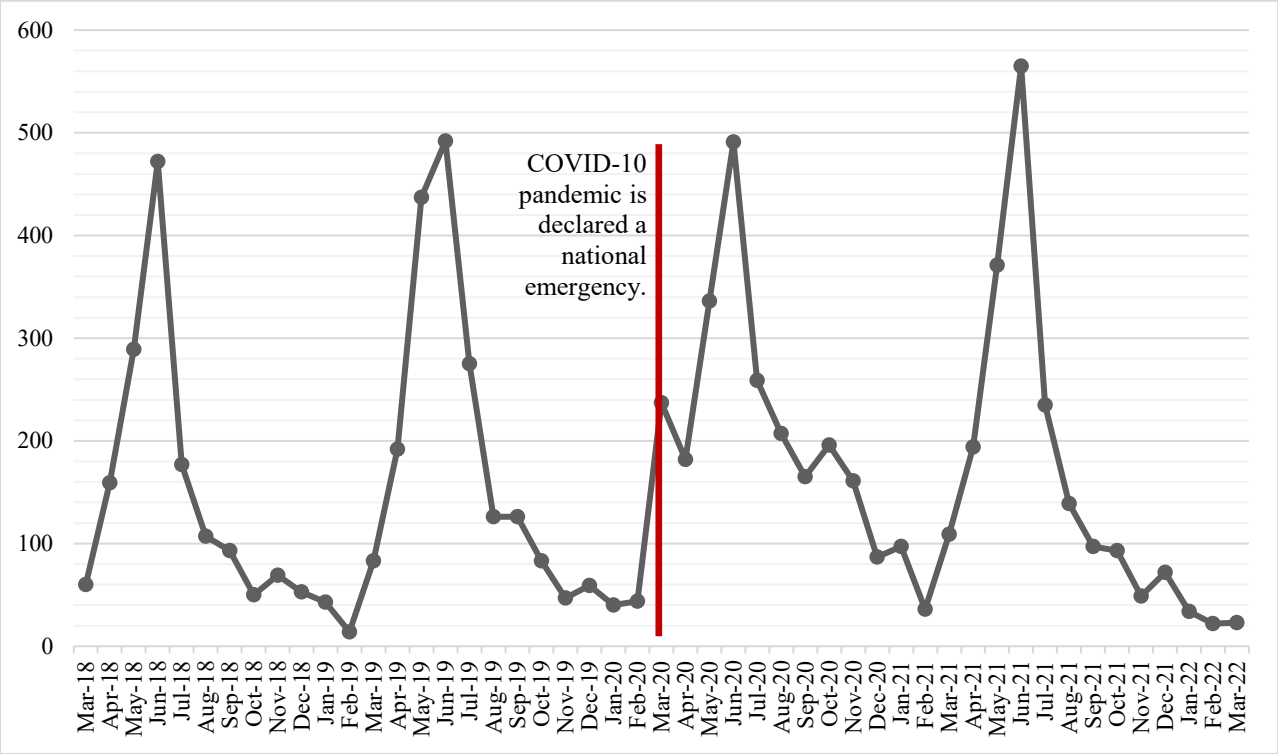
To assess the origins of movers to the project area, the project team contracted with Peachtree Data. Peachtree obtained data on the zip codes of movers to the project area from 2018 to 2021 through sources such as commercial change-of-address reports (Peachtree Data, personal communication, July 2022). The available data represents approximately 30% of the total project area COA requests during the defined time period.

To determine whether movers to the zip codes within the project area are from urban or rural areas, the project team utilized the 2010 Rural-Urban Commuting Area (RUCA) Codes from the USDA. RUCA codes use data from the 2010 decennial census and the 2006-10 American Community Survey (ACS) to classify zip codes in different urban and rural classifications. RUCA codes are broken into 10 codes, which can be combined as needed. The project team combined codes by metropolitan areas (codes 1 to 3), micropolitan areas (codes 4 to 7), and small-town and rural areas (codes 8 to 10) (USDA, 2020).

2.3 COVID-19-Related Migration: Results

On March 13, 2020, the COVID-19 pandemic was declared a national emergency (FEMA, 2020). This event is represented by the red line in Figure 3. While COA requests are subject to seasonal fluctuations, the jump in requests that happened in March 2020 was unprecedented. Compared with the same month in the previous year, requests almost tripled.

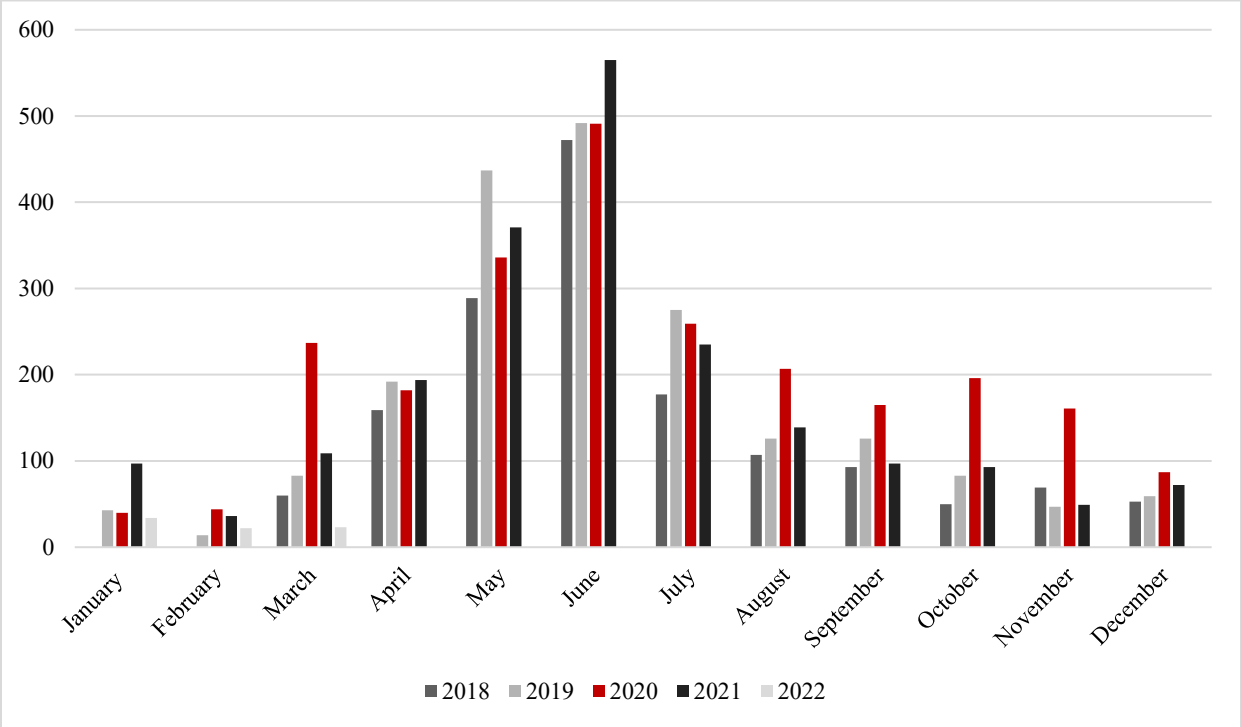
Figure 3 - Total COA Requests to the Project Area, April 2018 to February 2022



Source: (Shannon Sabo & Sandra Johnson, 2022; USPS, 2022)

Figure 4 utilizes the same data but is organized to easily compare months, year to year. In the months following the start of the pandemic, COA requests were down slightly starting in August, however, requests were up again by over 64%. November 2020 saw the biggest increase in requests from the previous year, up over 243% from 2019.

Figure 4 - Total In-Bound COA Requests by Month, Yearly Comparison, 2018-2022

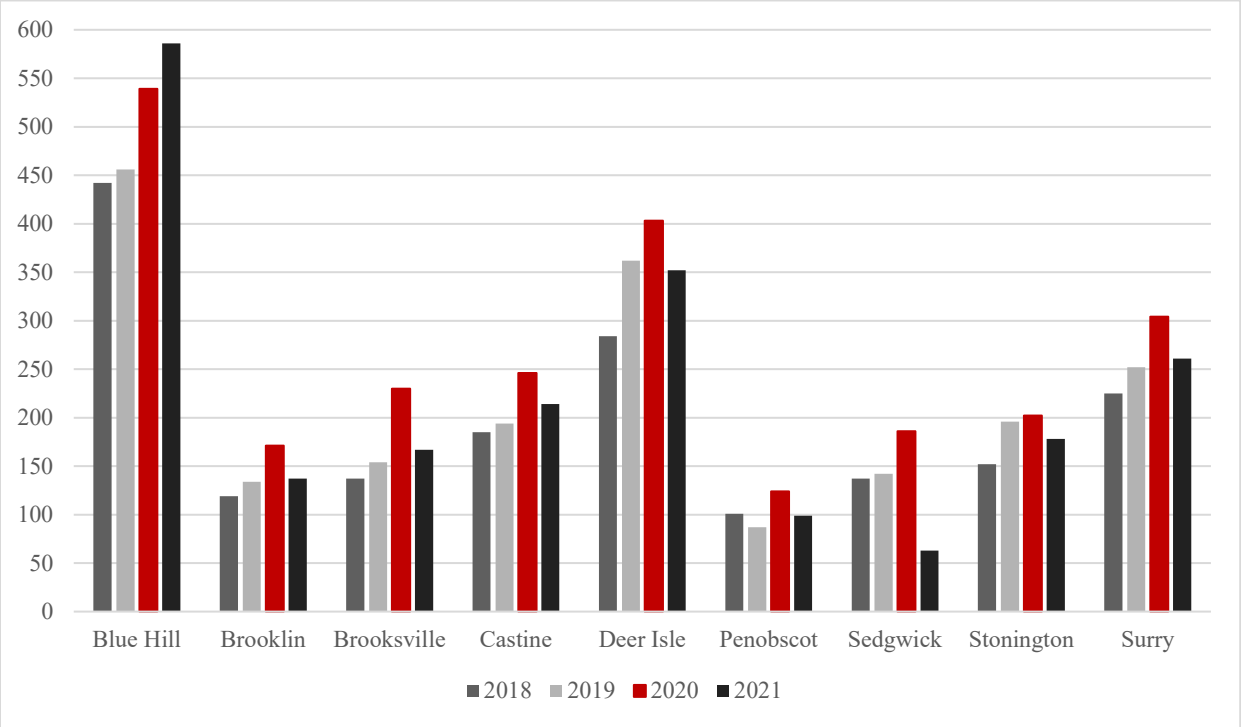


Source: (USPS National Customer Support Center Addressing & Geospatial Technology, 2021)

Figure 5 below, shows in-bound COA requests for each town over time. All the towns in the project area saw an increase in the number of in-bound requests in 2020. Brooksville saw the largest increase of almost 50%, followed by Penobscot with an almost 43% increase. Overall, there was an almost 22% increase in in-bound COA requests to the Peninsula. For the majority of towns, however, requests were still up from where they were prior to the pandemic, particularly in Brooksville, Castine, and Penobscot. Sedgwick had a rather significant decline in requests compared to pre-pandemic numbers, and Blue Hill continued to see an increase in requests.

Table 4 shows the percentage change in in-bound COA requests from the previous year (The average number of requests from 2018 to 2021 is included for comparison) As data were not available for the first two months of 2018, any percentage increase in the number of COA requests from 2018 to 2019 shown in Table 4 is likely slightly higher than the number shown.

Figure 5 - In-Bound COA Requests by Town, 2018-2021



Source: (USPS National Customer Support Center Addressing & Geospatial Technology, 2021)

Table 4 - Percentage Change in In-Bound COA Requests, 2019-2021

Town	2019	2020	2021	4-Year Average [1]
Blue Hill	3.2%	18.2%	8.7%	506
Brooklin	12.6%	27.6%	-19.9%	140
Brooksville	12.4%	49.4%	-27.4%	172
Castine	4.9%	26.8%	-13.0%	210
Deer Isle	27.5%	11.3%	-12.7%	350
Penobscot	-13.9%	42.5%	-20.2%	103
Sedgwick	3.6%	31.0%	-66.1%	132
Stonington	28.9%	3.1%	-11.9%	182
Surry	12.0%	20.6%	-14.1%	261
Peninsula	10.9%	21.6%	-14.5%	2,055

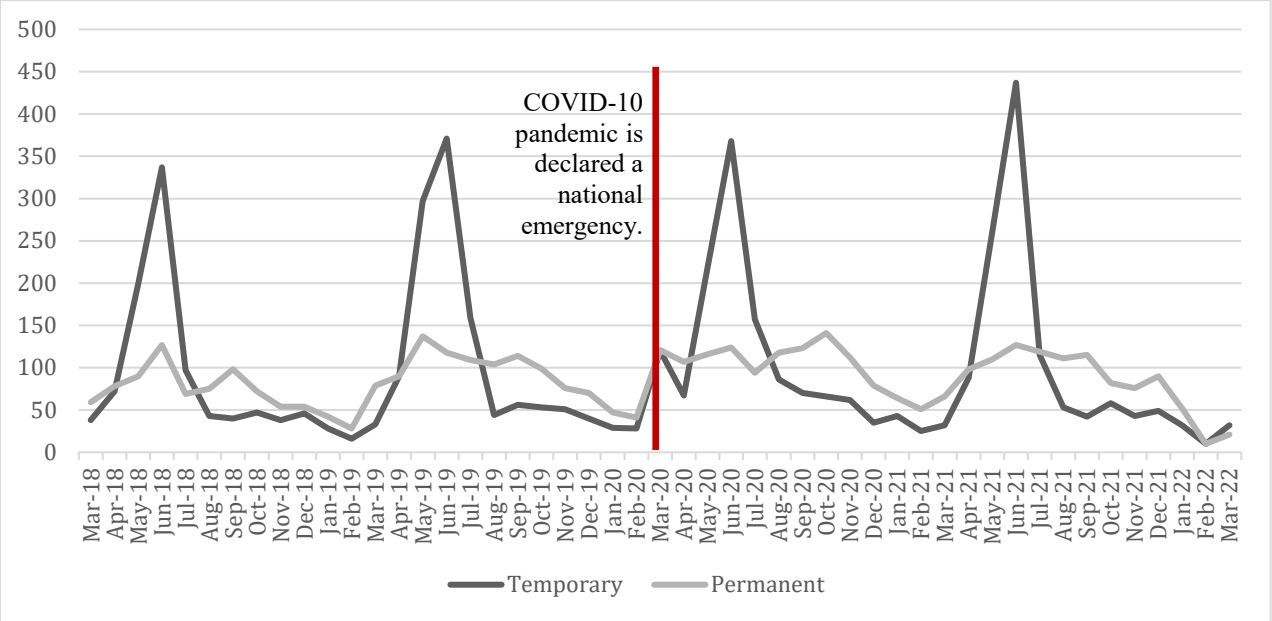
Source: (USPS, 2022)

Figure 6 below shows temporary and permanent COA requests from April 2018 to February 2022. Both temporary and permanent migration spiked in March 2020. Compared to the March

[1] The average number of requests from 2018 to 2021 is included as to give an idea of the "typical" number of in-bound requests each town receives each year.

2019, permanent COA requests were up over 53%, while temporary change-of-address requests were up by almost 264%.

Figure 6 - Temporary and Permanent Migration, March 2018 to March 2022



Source: (USPS, 2022.)

Both temporary and permanent net migration to the project area was negative in the years preceding the pandemic (Table 5)[2].

Table 5 - Net Migration to the Project Area by Request Type, 2018-2021

Request Type	2018	2019	2020	2021
All	-384	-455	110	-197
Temporary	-133	-4	128	31
Permanent	-232	-251	8	-198

Source: (USPS National Customer Support Center Addressing & Geospatial Technology, 2021)

As shown in Table 6, net migration was primarily negative for the majority of the towns in the years before the pandemic, as it was for Maine. This table shows total net migration, which includes both temporary and permanent moves. With the exception of Castine and Stonington, all of the towns in the project area had positive net migration in 2020. Overall, Blue Hill saw the biggest change in net migration, followed by Sedgwick. In 2020, Sedgwick had the highest positive net migration of any of the towns in all of the included years. As of 2021, net migration is once again negative for the majority of the towns in the project area.

[2] As the project team has to adjust for zeros due to the USPS's privacy protection methods, temporary and permanent net migration may not align with total net migration.

Table 6 - Total Net Migration, 2018-2021

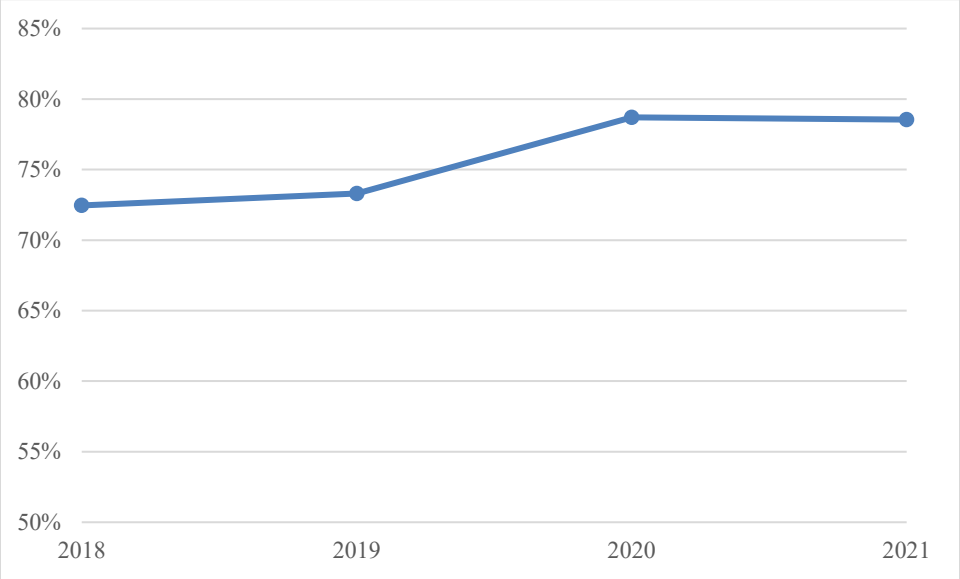
Town	2018	2019	2020	2021
Blue Hill	-112	-130	20	-21
Brooklin	-59	-50	13	-9
Brooksville	-1	-30	51	2
Castine	-25	-123	-55	-48
Deer Isle	-9	23	11	-14
Penobscot	16	2	14	-2
Sedgwick	17	-12	86	-14
Stonington	-88	-91	-54	-70
Surry	-38	-44	24	-21
Peninsula	-299	-455	110	-197

Source: (USPS National Customer Support Center Addressing & Geospatial Technology, 2021)

2.4 Patterns in Origin of Migration

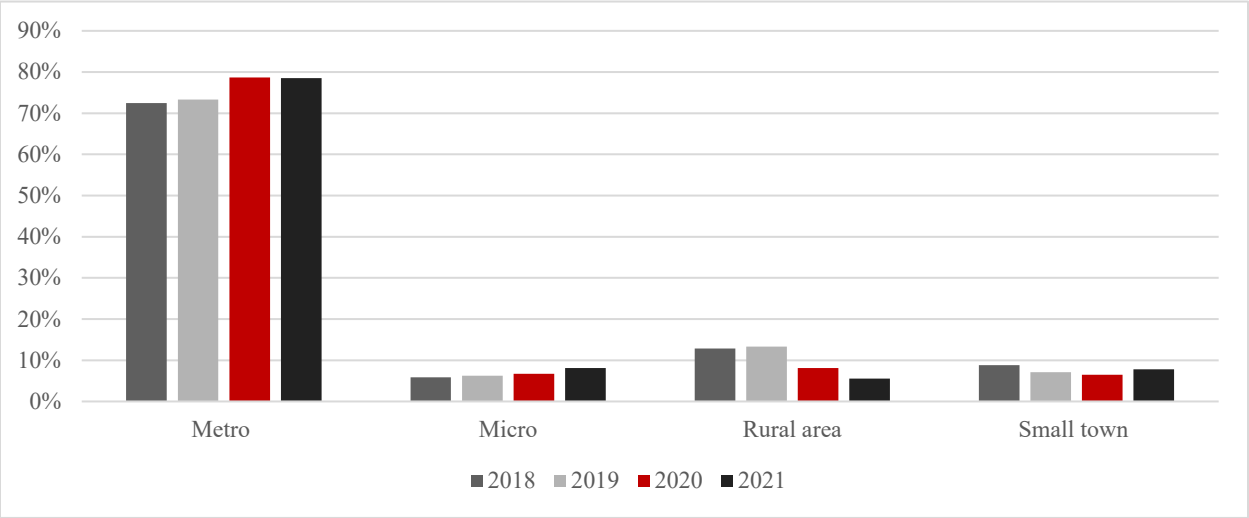
The pandemic accelerated the urban exodus that had already begun across the nation. In 2019, over 73% (258 requests) of in-bound COA requests to the Blue Hill Peninsula were from households originating from metropolitan zip codes. In 2020, this percentage increased to almost 79% of requests, as shown in Figure 7.

Figure 7 - Percentage of In-Bound COA Requests from Metropolitan Zip Codes, 2018-2021



Source: (Peachtree Data, personal communication, 2022)

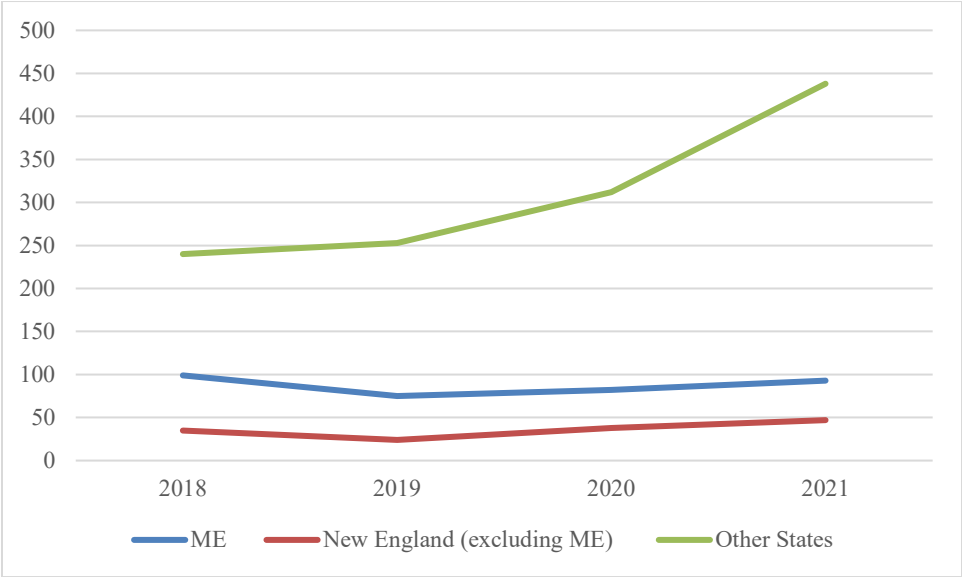
Figure 8 - Percentage of In-Bound COA Requests by Community of Origin Type



Source: (Peachtree Data, personal communication, July 2022)

During the pandemic, the number of homes purchased in Maine by out-of-staters rose from about 25% to approximately 35% (Vail, 2021). As shown in Figure 8, consistent with pre-pandemic levels, the percent of COA requests made by people from metropolitan areas is the highest. Figure 9 shows the number of in-bound COA requests by households originating from Maine, New England, and states outside of New England. In 2020, there was a 23% increase in the number of COA requests from households originating from states outside of New England. These requests made up just over 72% of all in-bound COA requests in 2020.

Figure 9 - In-Bound COA Requests to the Blue Hill Peninsula by Region, 2018 to 2021



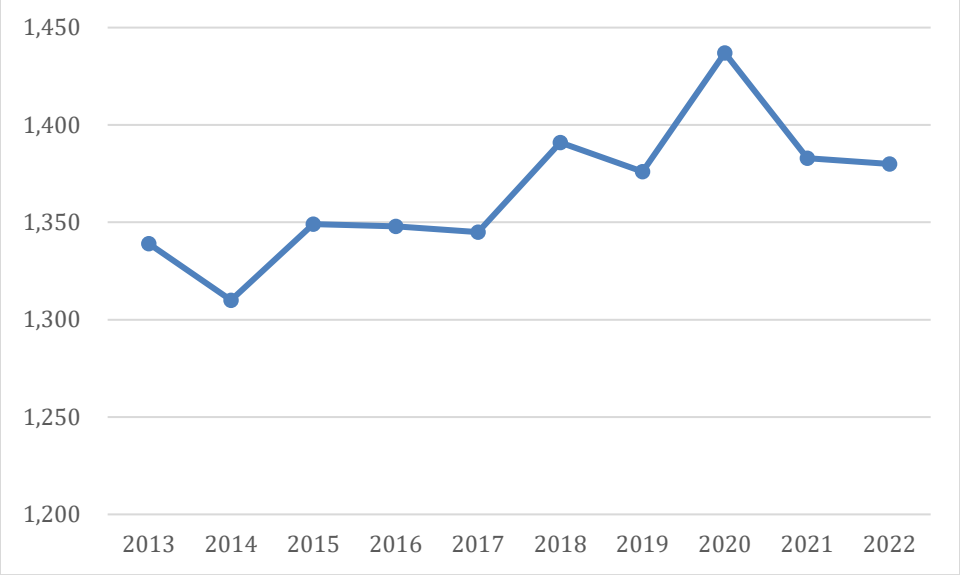
Source: (Peachtree Data, personal communication, July 2022)

2.5 Patterns in School Enrollment

Nationally, public school enrollment dropped 3% from 2019 to 2020. This has largely been attributed to the pandemic as many families decided to hold off on sending young children to pre-K and kindergarten, enrolled their children in charter schools or private schools, or chose to homeschool their children (Kamenetz et al., 2021). Maine saw a 4.4% decrease in enrolled publicly funded students in 2020, with only a modest 0.4% increase in enrollment in 2021. The State saw a 53% increase in home-schooled from 2019 to 2021 (Paolellasun, 2022). School enrollment for each of the towns within the project area was assessed using data from the Maine Department of Education's Data Warehouse on enrollment in public school districts.

School enrollment in the project area since the start of the pandemic differs from trends in the state of Maine and across the country. Figure 10 shows the number of publicly funded students enrolled in school districts within the Blue Hill Peninsula from 2013 to 2022. From 2019 to 2020, an additional 61 students were enrolled for a total of over 1,400 students. In 2020, an additional 61 students, or 4.2%, were enrolled compared to the previous year. The total of over 1,430 enrolled students is the highest enrollment number in just under a decade. In 2021, enrollment returned to its pre-pandemic levels.

Figure 10 - Publicly Funded Students in Districts Within the Blue Hill Peninsula, 2013 – 2022



Source: (Maine Department of Education, 2020)

Table 7 shows the change in the number of students enrolled in public school districts in the project area. Surry Public Schools saw the biggest change in enrollment in 2020, in both whole numbers and as a percentage. In the years prior to 2020, the biggest change was a 4.2% increase in enrollment, or seven students, that occurred in 2018. In 2020, Surry Public Schools had an influx of 46 students, an over 27% increase, for a total of 212 students, the highest the town has

seen in the past decade. In the following year, enrollment decreased by 12 students, 7.2%, which is the highest decrease the town has seen in the past decade.

Except for 2016, enrollment in the Deer Isle-Stonington CSD had been on the decline since 2013. In 2020, Deer Isle-Stonington CSD saw a 7.2% increase in enrollment. Curiously, 2021 saw an almost proportional decrease in enrollment back to pre-pandemic levels, only to have a 5.2% increase in enrollment in 2022.

For the most part, enrollment in Blue Hill Public Schools had been gradually rising prior to the pandemic. Only one additional student was enrolled in 2020. In the two years following, enrollment has decreased from 408 students in 2020 to 370 in 2022.

Table 7 - Change in Publicly Funded Students Enrolled in School Districts in the Project Area, 2014 – 2020

School District	2014	2015	2016	2017	2018	2019	2020	2021	2022	10-Year Average Enrollment
Blue Hill Public Schools	4	32	-	9	15	-1	1	-15	-23	385
Brooklin Public Schools	18	-8	-9	-	10	-7	1	6	-9	86
Brooksville Public Schools	-9	4	-6	-2	7	8	-	-	-4	92
Castine Public Schools	-	-9	9	-	-8	-6	4	1	4	74
Deer Isle-Stonington CSD	-30	-10	13	-6	-8	-	21	-22	15	303
Surry Public Schools	-2	5	4	2	7	-6	46	-12	6	175
Sedgwick Public Schools	1	21	-7	-7	26	-10	-8	-2	5	144
Penobscot Public Schools	-11	4	-5	1	-3	7	-4	-10	3	107

Source: (Maine Department of Education, 2020)

2.6 Trends in Housing Prices

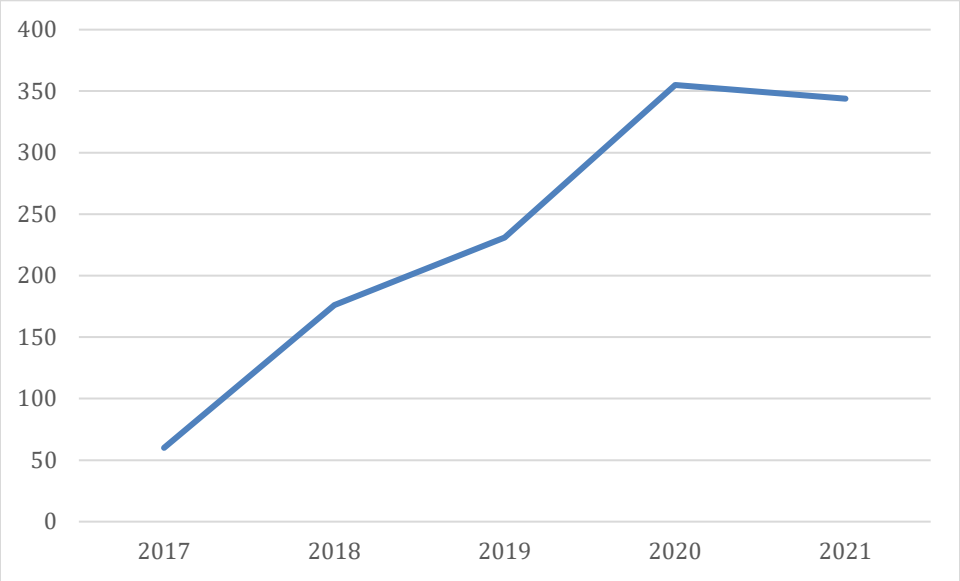
Data on sales of home and vacant land in the towns in the Peninsula were collected from the Maine Revenue Service Real Estate Transfer Tax Declaration Public Search.

The total number of all types of residential properties and vacant properties were determined, along with the average price of all residential properties. Properties that sold for under $10 were excluded from both the total number of sales and average price.[3] The average price for all years was then adjusted for inflation to 2021 dollars.

[3] Often a property is sold for a low price if someone is gifting it to a family or friend.

The number of residential homes sold in the Peninsula has been on the rise. From 2017 to 2018, there was a 193% increase in the number of residential homes sold. In 2020, there was a 54% increase in the number of homes sold (Figure 11).

Figure 11 - Number of Homes Sold in the Peninsula, 2017 to 2021



Source: (Maine Revenue Services, 2020)

Home sales have trended upward for almost all of the towns in the project areas from 2017 to 2020, with the exception of Penobscot in 2019 (Table 8). Castine, Penobscot, Stonington, and Surry continued to see an upward trend in sales in 2021 while the remaining towns saw a decline.

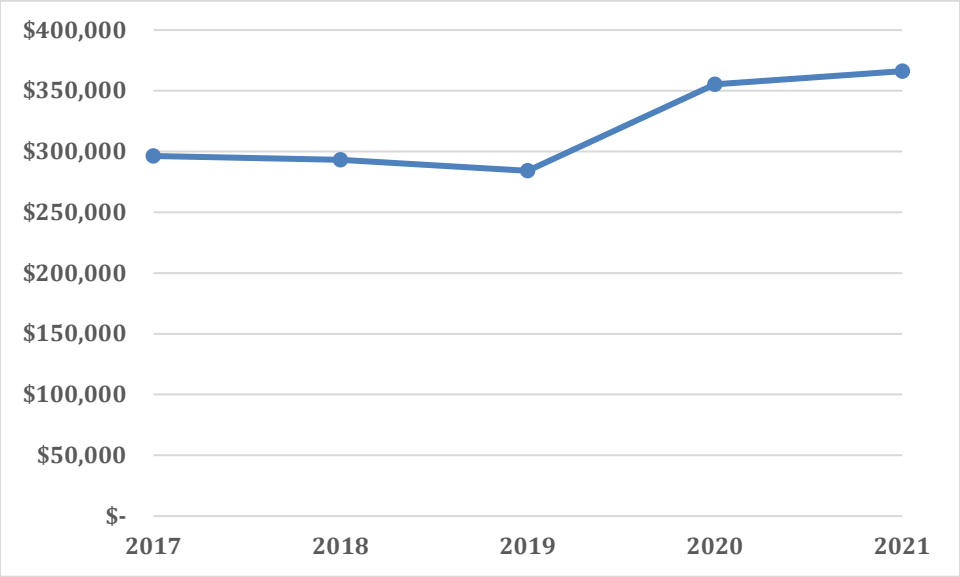
Table 8 - Number of Homes Sold by Town, 2017 to 2021

	2017	2018	2019	2020	2021
Blue Hill	20	35	42	75	66
Brooklin	3	13	20	35	24
Brooksville	4	12	21	32	28
Castine	4	12	19	28	33
Deer Isle	3	28	33	45	44
Penobscot	8	28	15	25	33
Sedgwick	8	16	28	36	24
Stonington	3	19	26	27	35
Surry	6	9	26	46	56
Peninsula	59	172	230	349	343

Source: (Maine Revenue Services, 2020)

While residential home sales have been trending upward since 2017, the average housing price for the Peninsula was relative stable until 2020. In 2020, there was a 25% increase in the average housing price (Figure 12).

Figure 12 - Average Housing Price in the Blue Hill Peninsula, 2017 to 2021 (adjusted to 2021 dollars)*



Source: (Maine Revenue Services, 2020)

Data on the number of building permits come from the Housing and Urban Development (HUD) Office of Policy Development and Research's (PD&R) State of Cities Data System (SOCDS). Building permit data available was not available for all the towns in the project area. Other than 16 multi-family structures built in Castine in 2014, all of the units built in the included towns were single-family units.

With the exception of Castine, all of the towns with available data saw an increase in the 5-year average of the number of building permits given from 2015 to 2020 compared with the previous period, as shown in Table 9.

Table 9 - Building Permits, 2017-2020

Town	2017	2018	2019	2020	2010-2015 Average	2015-2020 Average
Castine	2	2	0	3	3.2	1.5
Deer Isle	7	8	8	5	2.7	5.3
Penobscot	3	12	1	1	1.7	3.2
Stonington	5	2	1	1	2	3
Surry	13	4	5	11	3.3	8.3

Source: (US Census Bureau, 2022d)

2.7 COVID-19 Migration Trends: Conclusion

The COVID-19 pandemic and the resulting surge in migration to the Peninsula provide insight into how people relocate during a crisis. The Peninsula proved to be a desirable area during the pandemic due to its rural location and abundance of natural resources. If early trends are any indication, the rise of remote work, along with other factors, will likely continue to shift migration away from urban areas toward rural locations. Places like the Peninsula will continue to see increased growth. Pandemic-related migration allowed us to assess some of the potential impacts that population growth may have on the Peninsula, such as rising housing prices and strain on local resources. The potential impacts of changing migration patterns are discussed further in Sections 3 and 4.

3 Climate Migration

3.1 Climate Migration in the United States

Climate migration studies have historically focused on the impacts of climate change in the developing world. This focus has shaped our view of who climate migrants are and why they move. It has only been very recently that studies on climate migration have begun to look at the impacts in the United States. The COVID-19 pandemic and the resulting migration from urban to rural areas has brought attention to how a crisis event impacts the movement of people in the United States. Researchers are beginning to apply what was learned from COVID migrations to studying climate migration in the US.

There are three main challenges that arise when looking at climate change migration in the United States:

- The cultural view of who is a climate migrant
- Determining who is moving and why
- Data limitations

3.1.1 Cultural view of who is a climate migrant

When we imagine what a typical climate migrant might look like, we don't generally imagine a person from the United States. Our image of a climate migrant has been shaped by the studies that, until recently, have focused on other parts of the world and on societies that are primarily agricultural. These are groups that are often forced to move due to the impacts of climate change and are not moving preemptively or by choice as is the case in the United States. This view has resulted in making climate migration less visible in the United States (Mullins & Bharadwaj, 2021; Partridge et al., 2017).

3.1.2 Who is moving and why

While temporary displacement is common in the United States after an event such as a wildfire or a hurricane, the majority of people who are displaced will generally remain in the same area after the event has passed. This is particularly true of poorer communities where people are unable to afford to move far from the region or repair their homes, and so remain in the area, often moving into lower quality housing (Smith et al., 2006).

The households in the United States that are moving due to climate change are doing so by choice before they are forced to move. They are generally more affluent than the average American household and have employment that is not dependent on a particular location, allowing them a wider choice of location options when they decide to move. Current migrants

also do not tend to move due to one particular event, and are more likely to relocate only after experiencing the cumulative impacts of multiple events (Partridge et al., 2017).

3.1.3 Data Limitations

There are multiple ways to track migration and movement patterns in the US. Sources such as USPS change-of-address information and Internal Revenue Service (IRS) migration data provide substantial amounts of information on the movements of people from place to place; however, they don't provide information on *why* people are choosing to move. Our report relies on information gleaned from other studies including surveys that have inquired about climate change related reasons for moving, and storm and weather information from the National Oceanic and Atmospheric Association (NOAA) (Gross, 2006; Internal Revenue Service, 2022).

3.2 Methodology

To assess whether or not climate migration to the study region is occurring, two areas of inquiry need to be explored:

1. Is climate migration occurring in the United States? If the answer is yes, who is migrating? Where are they coming from and where are they going to?
2. Are any of those who are migrating due to climate change moving to Maine and the towns of the Blue Hill Peninsula? How many people are coming to the region? Who are they and where are they coming from?

Our methodology for answering these two questions follows.

3.2.1 Literature Review

As part of developing our methodology we conducted a review of the available literature about climate migration in the United States. Climate migration studies in the United States are a relatively new phenomenon. Past studies in the United States focused predominantly on the immediate impacts of large climate events such as hurricanes.

The COVID-19 pandemic also presented a unique opportunity for gathering information on the movement of populations due to a crisis event resulting in several studies and reports that give insight into why people choose to migrate and where they migrate to. We reviewed several of these studies in our analysis as well.

Two studies in particular that helped to frame our inquiry were *COVID-Induced Migration and Potential Climate Destinations in New York State* published by the American Society of Adaptation Professionals (Gendler et al., 2022) and *Vulnerable City, Recipient City, or Climate Destination? Towards a Typology of Domestic Climate Migration Impacts in US Cities* (Marandi

& Main, 2021). These gave particular insight into migration in the US and how people choose where they will seek refuge.

3.2.2 Migration patterns:

Our team looked at migration patterns at the state and county level for the years from 2012 - 2020. We used IRS migration data to estimate the number individuals and households that moved to Maine and where they moved from. The IRS data are not available at the town level, so to estimate migration to the study area we looked at migration for Hancock County.

Demographic information on the age and income of households moving to the State of Maine was compiled from the IRS *Individual Income Tax Returns: Gross Migration for Selected Income Items by State, Size of Adjusted Gross Income, and Age of Taxpayer* data. We also used *Individual Income Tax Returns: Selected Income and Tax Items by State, County, and Size of Adjusted Gross Income* for income information for Hancock County for comparison.

This data includes:

- Origin from – the county or region from which people migrate to Maine or Hancock County. The IRS shares these data at the county level if there are 10 or more individuals migrating from that county. In the interest of privacy protections, if there are under 10 individuals from a particular county, the number is not shown in the county detail. These individuals and households are instead grouped into four regions: Northeast, Midwest, South, and West. Origin data in this section of the report that is not summarized by state is generally summarized by these regions.
- Number of returns – this number is used to estimate the number of households that moved. While this number is not exact, as there may be households with multiple unmarried adults who file separately, the IRS notes only about 2% of married couples do not file jointly. Therefore this still presents a fairly accurate count of the number of households that have moved (Tax, 2021).
- Number of personal exemptions claimed – this is used to estimate the total number of individuals that moved.
- Total adjusted gross income (AGI) – the total AGI for all filers. We used this number to determine the average household income of those who moved in and out of Maine and Hancock County. We also used this data to estimate and compare the incomes of current residents.
- State level data also includes data grouped by the age of a household's primary tax filer. This includes number of returns, number of exemptions, and total AGI for the group.

3.2.3 Climate event data

To determine if households were moving due to climate change impacts our team looked at three types of climate events: storms, high heat, and wildfires. These were chosen as they have readily accessible trend data, and they are events that have been tied to climate change.

We then looked at regions that have experienced increases in these climate related events to determine if these are the same regions of origin for migrants to Maine. We also reviewed and utilized data from studies that had conducted surveys on the reasons people choose to move.

3.3 Analysis

3.3.1 Is climate migration happening in the United States and in Maine?

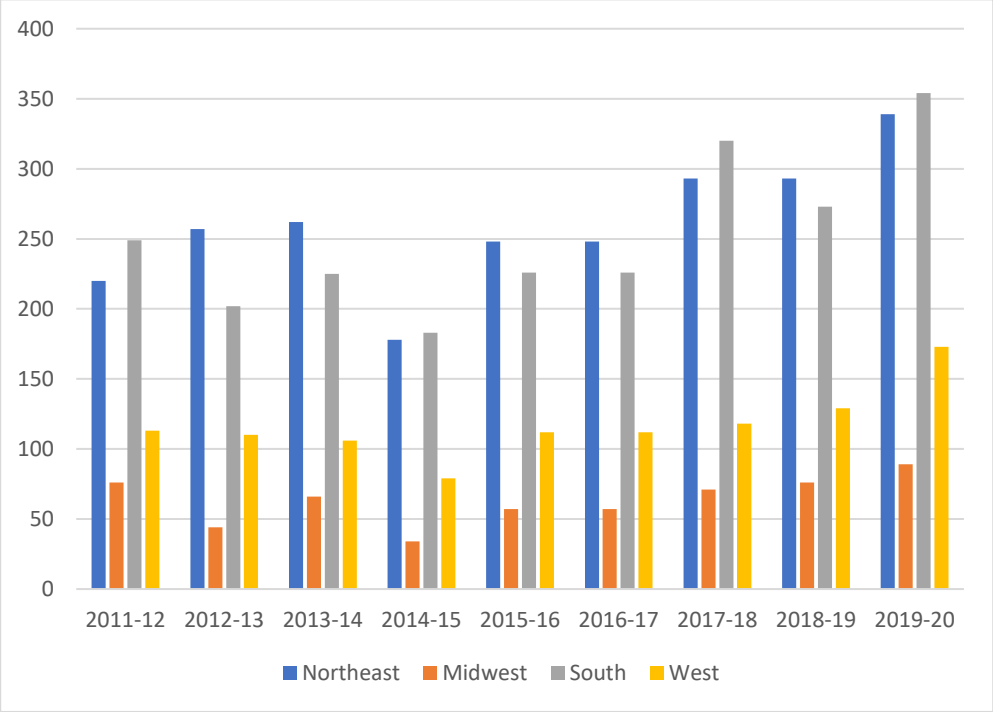
Predicting or estimating the number of individuals who choose to migrate due to climate change can be difficult, but study in this area increases indications that climate change plays a significant role in why people choose to move, and in selecting a place to move to. In May of 2022 Forbes Home released the results of a nationwide survey of 2,000 people that showed that 30% of respondents stated that climate change was the primary reason for their move. That number climbed to 64% if we include those who said they are moving "for better weather" (Allen, 2022). An earlier survey of 30 people who moved to Vermont during the pandemic also indicated that about 30% of respondents included climate change in their criteria for choosing a place to move to (Hurdle, 2022).

Wildfires in the western United States and increased flooding events due to storms along the Gulf Coast and southern Atlantic coastal regions have contributed significantly to increased climate migration. Our review of IRS migration data show that these same regions, the south and the west, make up a significant number of the people who are moving to Maine. California, Florida, South Carolina, Texas, and Virginia are in the top ten states that people moved from to Maine since 2016. All of these states have experienced an increase in wildfires, hurricanes, and flooding due to the impacts of climate change (Xu et al., 2020) (Allen, 2022).

In order to help determine if people are moving to Maine from areas impacted by climate change our team reviewed migration from other states. The numbers and estimations that follow do not include migration that occurred within the State of Maine.

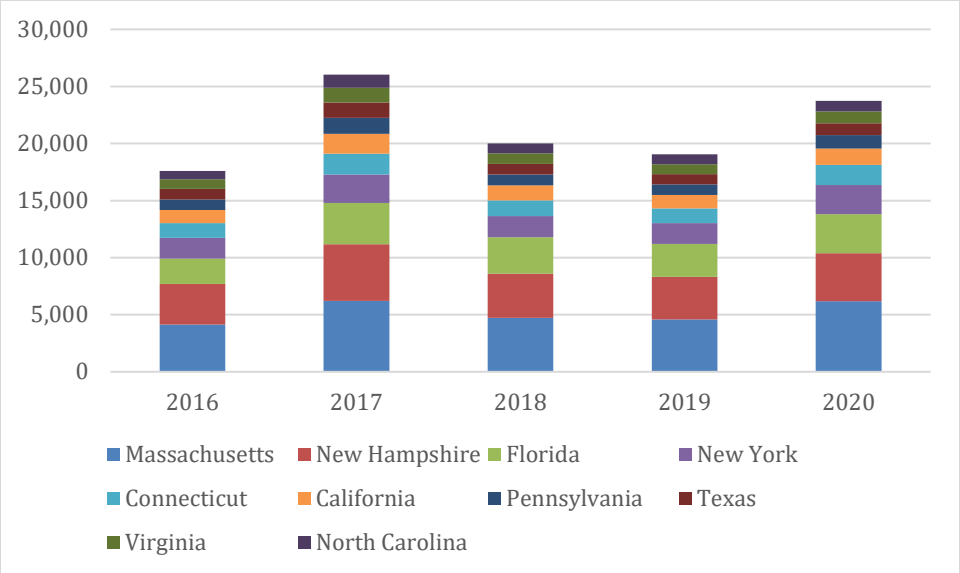
The origins of people moving to Hancock County from outside the state of Maine may not be exact as the IRS does not share the county of origin if there are fewer than 10 households that originate from that county. County origin data for Hancock County is presented here by region (Figure 14. The primary region of origin is the Northeast followed by the South and West, with the Midwest contributing the least number of households moving to Maine.

Figure 13 - Hancock County Household Inflow by Region of Origin, 2011-2020



Source: (Internal Revenue Service, 2022)

Figure 14 - Maine Inflow Migration: Top Ten States by Year, 2016 – 2020



Source: (Internal Revenue Service, 2022)

The top ten states people migrate from to Maine all fall into the Northeast and South regions, with the exception of California.

3.3.2 Migration Trends

Having established that climate change migration is indeed happening in Maine, the next step is to review inflow migration history to estimate how many people are moving to Maine and how many of those people may have come here due to climate change.

Using the 30% and 64% figures referenced in the Forbes Home article (Allen, 2022) and IRS migration data, we can estimate how many people may have moved to Maine and to Hancock County because of climate change as depicted in Tables 10 and 11.

Table 10 - Total in Migration to Maine from the United States and the Number of People Who Moved to Maine Due to Climate Change, 2015-2020

	2015-16	2016-17	2017-18	2018-19	2019-20
Total in migration to Maine from out of state	26,161	39,545	29,601	28,429	35,152
Climate change movers	7,848	11,864	8,880	8,529	10,546
Climate change & better weather movers	16,743	25,309	18,945	18,195	22,497

Source: (Allen, 2022; Internal Revenue Service, 2022)

Table 11 - Total in Migration to Hancock County from Other States and the Number of People Who Moved to Hancock County Due to Climate Change, 2015-2020

	2015-16	2016-17	2017-18	2018-19	2019-20
Total in migration to Hancock County from out of state	1,173	1,161	1,405	1,290	1,731
Climate change movers	352	348	422	387	519
Climate change & better weather movers	751	743	899	826	1108

Source: (Allen, 2022; Internal Revenue Service, 2022)

While not exact, the 30% - 64% figures and other factors that will be discussed in Section 4, may be used to help estimate future climate migration to Maine, and Hancock County.

3.3.3 What part of Maine are people moving to?

Just over 50% of Maine's inflow migration from other states is to Cumberland and York Counties. Since 2015-2016 Hancock County has seen a steady increase in its percentage of the total state migration from 4.4% of total migration to 5.0%. Other counties that have seen similar increases in percentage of state inflow migration include Aroostook, Knox, Lincoln, and Piscataquis counties.

Table 12 - County Household In-Migration as Percentage of Total State Migration from Other States, 2015-2020

Household in migration by county as percentage of total migration					
	2015-16	2016-17	2017-18	2018-19	2019-20
State	100.00%	100.00%	100.00%	100.00%	100.00%
Androscoggin County	4.3%	4.5%	4.7%	4.8%	4.1%
Aroostook County	2.6%	2.9%	3.1%	2.9%	3.1%
Cumberland County	30.6%	29.4%	28.8%	30.2%	29.5%
Franklin County	1.7%	1.5%	1.6%	1.5%	1.6%
Hancock County	**4.4%**	**4.2%**	**4.7%**	**4.5%**	**5.0%**
Kennebec County	6.2%	6.0%	5.9%	6.1%	6.1%
Knox County	3.3%	3.4%	3.0%	3.0%	3.4%
Lincoln County	2.9%	3.1%	3.0%	2.7%	3.2%
Oxford County	3.6%	3.7%	3.6%	3.6%	3.6%
Penobscot County	8.0%	5.2%	8.0%	8.4%	7.5%
Piscataquis County	0.8%	0.9%	0.9%	1.0%	1.3%
Sagadahoc County	2.5%	2.7%	2.8%	2.4%	2.3%
Somerset County	5.5%	2.3%	2.3%	2.2%	2.2%
Waldo County	2.8%	2.8%	2.6%	2.6%	2.8%
Washington County	1.6%	1.8%	2.0%	2.0%	2.3%
York County	22.8%	22.8%	22.8%	22.6%	22.5%

Source: (Internal Revenue Service, 2022)

3.3.4 Inflow Migration Demographics:

IRS migration data provides household age and income information at the state level. The data has some limitations as the age and income indicated are for the primary tax filer in the household, but some clear demographic trends become evident.

In 2020 the largest incoming household age group was those aged 26 to under 35 representing 30% of incoming migration. They have consistently been the largest incoming group to the state (Table 13). The second largest group has been those in the 65+ group which has been steadily increasing since 2016.

Table 13 - Inflow Households by Age of Primary Tax Filer, 2015-2020

Inflow households by age of primary tax filer					
	2016	**2017**	**2018**	**2019**	**2020**
Under 26	17%	14%	16%	16%	14%
26 to under 35	30%	30%	29%	30%	30%
35 to under 45	15%	15%	14%	14%	15%
45 to under 55	12%	12%	11%	11%	10%
55 to under 65	12%	13%	13%	12%	12%
65 +	14%	16%	17%	17%	19%

Source: (Internal Revenue Service, 2022)

Table 14 - Outflow Households by Age of Primary Tax Filer, 2016-2020

Outflow households by age of primary tax filers					
	2016	**2017**	**2018**	**2019**	**2020**
Under 26	21%	18%	19%	19%	19%
26 to under 35	28%	28%	28%	28%	27%
35 to under 45	14%	13%	12%	14%	13%
45 to under 55	12%	11%	11%	10%	10%
55 to under 65	11%	12%	12%	11%	11%
65 +	15%	16%	17%	18%	20%

Source: (Internal Revenue Service, 2022)

It is worth noting that these are also the two largest groups moving out of the state (Table 14). The main difference between the incoming and outgoing groups is one of income with households moving into the state having significantly higher incomes than those who currently live in the state or those moving elsewhere (Table 15).

Table 15 - Average Adjusted Gross Income by Household for Maine, Non-Migrants, Inflow, and Outflow, 2016-2020

Year	State	Non-Migrant	Inflow	Outflow
2016	$ 63,323	$ 63,896	$ 122,225	$ 59,443
2017	$ 65,105	$ 65,641	$ 82,010	$ 59,520
2018	$ 67,329	$ 67,883	$ 105,464	$ 65,840
2019	$ 70,274	$ 70,857	$ 108,837	$ 66,435
2020	$ 72,925	$ 73,065	$ 89,990	$ 67,166

Source:(Internal Revenue Service, 2022)

Household size also varies by age group. While the 26 to 35 group have the largest number of households moving to the state, they do not have the largest household size (Table 16). The 35 to under 45 age group has consistently had a larger household size with a range of 2.0 to 3.1 people

per household, while the 26 to under 35 age group has had a household size ranging from 1.4 to 2.1. IRS data does not indicate if the exemptions noted are for a spouse or child but given who is allowed to be claimed as an exemption on tax forms, higher average household size likely also indicates that age group has a higher number of households with children.

Household size for all age groups moving to Maine in 2020 was smaller than in 2019.

Table 16 Maine Inflow Migration - Household Size by Age of Primary Tax Filer, 2016-2020

	2016	2017	2018	2019	2020
Under 26	1.3	1.1	1.2	1.3	1.2
26 to under 35	2.1	1.4	1.9	1.9	1.5
35 to under 45	3.1	2.0	2.8	2.9	2.4
45 to under 55	2.6	1.7	2.4	2.4	2.2
55 to under 65	2.4	1.5	2.0	2.1	1.7
65 +	2.9	1.7	2.1	2.1	1.6
All Ages	2.3	1.6	2.0	2.1	1.7

Source: (Internal Revenue Service, 2022)

3.3.5 Hancock County Inflow Migration Demographics

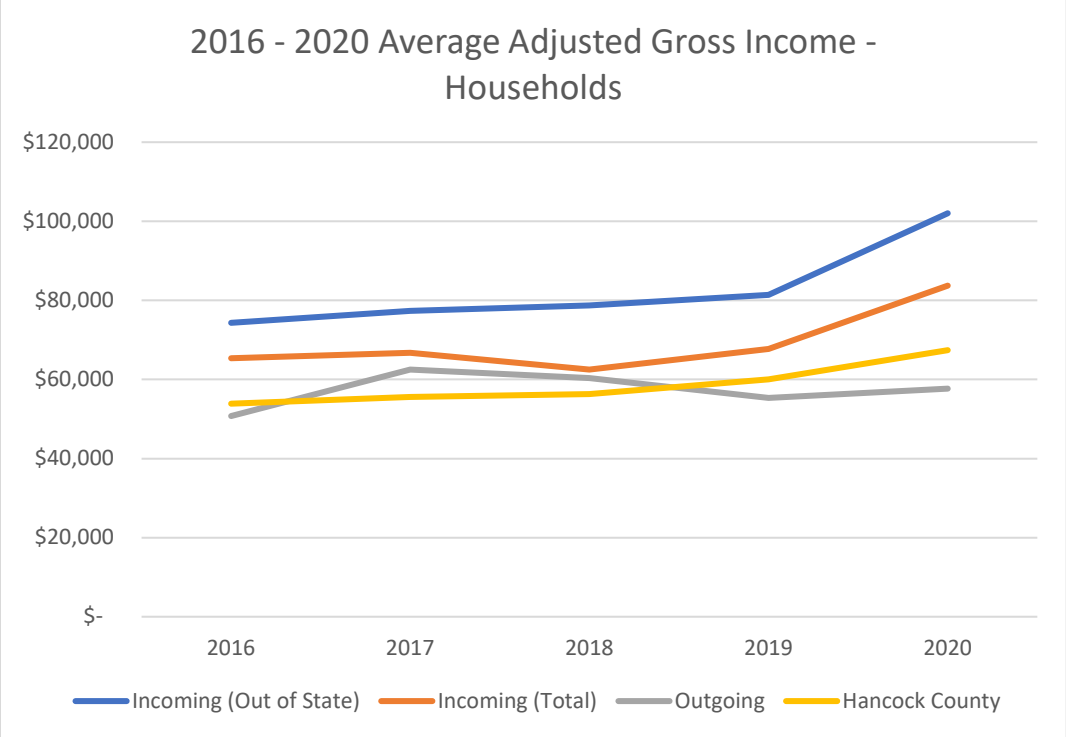
The IRS does not provide detailed demographic data at the county level. However available data do show migration patterns similar to those noted at the state level.

As with state inflow migration, the income of those moving to Hancock County from other states is higher than those who currently live in the county. In 2016, households that moved to Hancock County from out of state had incomes 28% higher than the those already living in the county. By 2020, this difference had increased to 34%.

Those moving away from the county had incomes 10% lower than those moving into the county from out of state in 2016; that difference increased to 43% in 2020.

When migration from within the state is included, the AGI of all incoming residents has averaged 15% higher than current residents. The average income for those migrating to Hancock County is approximately 31% higher than those leaving the county.

Figure 15 – Average household adjusted gross income (AGI) 2016 - 2020 - Hancock County



Source: (Internal Revenue Service, 2022)

Household size in of incoming households from other states is the same as the average household size for Hancock County and the state of Maine (Table 17). Household size information at the state level indicate that there are many multi person households with children. It is not known how many of these children are school age.

Table 17 Average Household Size for Inflow Migration From Out of State and Current Residents of Hancock County, 2016,2020

	Inflow Households (other states)	Hancock County Households
2016	1.8	1.8
2017	1.7	1.7
2018	1.7	1.7
2019	1.7	1.7
2020	1.7	1.7

Source: (Internal Revenue Service, 2022)

Recent studies on the impacts of weather events and climate change on migration within the United States have shown that current migration is predominantly being driven by those households that have the income to move by choice (Allen, 2022). The data reviewed for this report indicates that this same trend is currently occurring in Maine.

This trend is dramatically demonstrated when looking at the income of those who moved to Hancock County from out of state in 2019 and 2020, when the COVID-19 pandemic hit. Families that migrated to Hancock County in 2019 had an average AGI of $81,429 while those who migrated to the county in 2020 had an average AGI of $102,030; an increase of 20%. By contrast, from 2016 – 2019 the income for incoming households increased only 2% - 4% over the prior year. This information does support the findings of other studies that show that the more affluent households are likely to migrate first to escape whatever the perceived danger is: wildfires, flooding, hurricanes, or a pandemic.

3.4 What are the impacts of climate migration?:

3.4.1 Non-voluntary vs. Voluntary climate migration

The impacts of climate migration on receiving communities can be quite sudden when caused by events such as storms, flooding, or wildfires all of which can result in emergency mass evacuations. Neighboring communities can find themselves trying to manage a rapid increase in population and the impacts that accompany it. Sharp increases in housing costs are common as is the displacement of existing residents due to these rising costs.

One example is Chico, California which experienced a 15-20% increase in population due to the destruction of the nearby town of Paradise by the Camp fire in late 2018. Sewage and water use increased by 16%, and housing costs rose 21% in the span of a few months. The number of evictions also rose creating a secondary wave of displacement. In addition, while some businesses experienced a boom, many others found themselves struggling to find employees to work for them as the cost of living rose (Marandi & Main, 2021).

This movement of people is generally non-voluntary. The danger is immediate as is the need to escape it. In these instances, many of the people will return to the area they fled. Those that choose to move elsewhere generally fall into the middle-income brackets and may even choose to stay in the new location. Wealthier people who return home tend to focus on adaptation and protecting their homes from a future disaster, while lower income households predominantly return or move to other damaged areas (Mullins & Bharadwaj, 2021; Smith et al., 2006).

Unlike non-voluntary migration after a catastrophe or disaster, where nearly everyone in an impacted area leaves nearly simultaneously, climate change related voluntary migration in the United States is predominantly made up of people who are proactively moving to escape the impacts of climate change where they live (Allen, 2022). They are not prompted to move by a single event, but have generally experienced several climate events or impacts, enough that they perceive staying in the area as no longer safe (Mullins & Bharadwaj, 2021).

These individuals and households tend to be wealthier than current residents, and often have employment that is not dependent up on location. This may in part be why the 26 to 35 age group is the largest group to migrate into Maine, as remote work studies show this group making up a substantial part of the remote workforce, and that they are nearly 40 times more likely to relocate to a place away from the office than their older counterparts (OWL Labs, 2021). People who choose to migrate may also be more likely to be retired, as the second largest group to migrate to Maine over the past several years is the 65+ age group (Internal Revenue Service, 2022).

The climate migration currently taking place in Hancock County appears to be predominantly voluntary.

3.5 Social and Economic Impacts

3.5.1 Housing:

As demonstrated earlier in this report, the people who are proactively moving to escape the impacts of climate change are generally wealthier than the people of the communities that they move to. One of the early impacts of this is an increase the cost of housing. Our review of the impacts of COVID migration on the Blue Hill Peninsula showed a 25% increase in the cost of buying a home. This is similar to the 21% increase in housing costs that occurred in Chico, California after the influx of people escaping the Camp fire.

There is evidence that migration of this sort results in the displacement of current residents due to the rise in housing costs. Renters are at particular risk as they are less likely to find housing in the same area should their rent increase by an unaffordable amount. Evictions have also increased in some receiving communities (Marandi & Main, 2021).

Loss of affordability is also one of the indicators that may make a community less likely to be seen as a climate refuge and may reduce voluntary climate migration in the longer term (Gendler et al., 2022; Marandi & Main, 2021).

3.5.2 Labor Market:

As noted earlier, a large number of those moving to Maine due to the pandemic or climate change are either remote workers or retirees. Those individuals who are employed remotely are not displacing a worker, or taking a job that might otherwise have gone to someone local. Because of this their impact on the labor market may not be seen as direct. However, there may be a significant indirect impact.

The rise of housing costs in Maine during the pandemic had the side effect of making towns, particularly those dependent on seasonal labor, unaffordable for the people who currently live

and work there. Hotels and restaurants were particularly hard hit (McGuire, 2022). This same impact has been documented in other regions that have seen sudden large increases in population (Marandi & Main, 2021).

3.5.3 Infrastructure:

Towns that have experienced a sudden inflow of people have documented increased pressure on community infrastructure. Water and sewer systems in particular feel the pressure with an unexpected increase in population. Other impacts, such as strain on public transportation systems, or access to public laundry facilities, tend to be seen in more urban areas and may not apply as much to the Blue Hill area.

The pandemic demonstrated the need for high-speed internet access for people working remotely. In the early days of the pandemic the shift from working in the office to home strained internet services across the state (Valigra, 2020). An influx of remote workers due to climate migration could have a similar impact on internet infrastructure in the Blue Hill region. Maine is investing in broadband upgrades in rural areas of the state that may relieve this if the Blue Hill Peninsula is included in the plan. (State of Maine, 2022)

3.5.4 School enrollment:

Household size can help determine if households moving to the region have children. Hancock County has an average household size of 1.7 people. When looking at County level migration data, incoming households also have an average size of 1.7 people (Internal Revenue Service, 2022).

The state data, which is broken down by age group, does indicate that some age groups have households larger than the county average. The 26 to 35-year old age group, which is the largest group moving to Maine, tend to have smaller households (1.5 people per household) than other groups. The 36-45 and 46-55 age groups average household sizes of 2.4 and 2.2 respectively. This may indicate that these latter households are more likely to have children (Internal Revenue Service, 2022). Further study in this area is needed as the relevant data are not available at finer geographic levels.

3.6 Summary

As climate change impacts play out over the coming decades, it is estimated that as many as 50 million Americans could make their way to New England (Hurdle, 2022). While the timing and size of expected migration can be difficult to predict, there are some things that are known or are likely to occur.

The migration will not be linear - Current climate migration is primarily voluntary and is likely to fluctuate depending upon how climate change impacts continue to play out in other parts of the country.

Who is moving matters - Those who migrate early are likely to be of higher income than current residents of the receiving communities. There is some evidence of the displacement of residents who cannot afford the increase in the cost of housing that occurs when wealthier buyers/renters enter the local housing market (Hurdle, 2022).

The Blue Hill Peninsula may not always be seen as a climate refuge – When people choose to migrate due to climate change, they are most likely to choose a place they see as not having the same type of threat as the place they are leaving. They may, however, still be moving to a place that has other types of climate impacts. There has been extensive documentation of people moving from places impacted by heat and wildfires to coastal regions that face the threat of sea level rise and increased storm events (Marandi & Main, 2021). Many of the people migrating to Maine are coming from areas impacted heavily by fires, heat waves, and flooding, events they may not perceive as occurring often in coastal Maine. However, Maine has its own climate risks.

The website climatecheck.com, which rates the risk of climate change impacts for homeowners and realtors, assigns a risk score from 1 – 100 for storms, flooding, fires, and other climate events in a given location. The closer the score is to 1 the lower the risk of climate related events and the closer the score is to 100 the higher the risk of such events occurring.

All of the towns in the study area have a rating of 100 for storm risk, indicating the area has an extreme risk of experiencing storms of greater intensity and frequency. Three towns in the study area, Brooklin, Sedgwick, and Surry were indicated to be at significant risk of flooding. If these impacts occur as predicted, or increase, they will influence whether people continue to see the Blue Hill Peninsula as a climate refuge. (*Climate Risk Report for Homes and Real Estate - Fire, Flood, Storm, Heat / ClimateCheck*, 2022)

Climate migration and its impacts are no longer complete unknowns. While climate migration is still a new area of study, communities such as those on the Blue Hill Peninsula can use currently available data to track trends and estimate future migration. They can also use this information to establish plans for mitigating these impacts. The next section of this report looks at these potential future trends and the impacts they are likely to have on the study area.

4 Carrying Capacity of the Blue Hill Peninsula

4.1 Introduction to Carrying Capacity

Carrying capacity is broadly defined as the number of organisms that an ecosystem can accommodate without compromising its ecological integrity (Merriam-Webster Dictionary, 2022).

BHHT has tasked rbouvier consulting with estimating the carrying capacity of the Blue Hill Peninsula, with an eye towards predicting how the region might be transformed with the influx of population that is expected to accompany climate change. This section of the report defines the carrying capacity of the Blue Hill Peninsula, determines sustainable thresholds, and assesses how close the Blue Hill Peninsula is to exceeding those thresholds, both now and in the near future.

Estimating the carrying capacity of a complex region like the Blue Hill Peninsula is complicated by the fact that it is not an isolated system: it is reliant on resources (labor, fuel, food) from outside the region to sustain itself. The days of local self-reliance are long gone: most people who live on the peninsula may work or shop elsewhere, and the economy of the peninsula is in large part dependent upon tourism and outside demand for the goods and services produced in the region.

Therefore, the task of establishing a carrying capacity of a complex open system is to some extent dependent on variables outside the region. Estimating the carrying capacity of an interconnected physical-human system is in some ways like shooting at a moving target, as the capacity of a system to sustain itself can vary with human activity, climate change, and the level and extent of connections with "outside." In the words of Holling, one of the founders of the discipline of ecological economics, "there is an inherent unknowability, as well as unpredictability, concerning these evolving, managed ecosystems and the societies with which they are linked" (Holling, 1993).

However, although the concept of carrying capacity originated from the natural sciences, it has been used in other disciplines as well: notably tourism studies and community or regional analysis, where the concept of carrying capacity is expanded to include an economic and a social component as well as a physical one. Studies that have examined carrying capacity in these areas have primarily focused on the amount of tourism that an area can sustain, or the rate of

population growth that an area can absorb. We can therefore look to the literature in those disciplines to guide our analysis.

In what follows, we rely heavily on the definition of "regional sustainability" proposed by Graymore et al (Graymore, 2008).). They claim that:

> …[for] regional sustainability to be achieved, human activities impacting on a region have to be within its ecological limits, including those occurring outside the region that impact on the region. At the same time, the impacts of human activities must also remain within a region's social and economic limits to ensure these systems are able to continue supporting its population by providing adequate health care, education, employment, welfare and all the other services required in an equitable manner… Thus, a sustainable region is one where human activity does not cause net negative impacts on the ecological, social or economic supporting systems… [that] support the population (Graymore, 2008).

Therefore, we conceptualize carrying capacity as having three components: physical, economic, and social. While there is a large degree of overlap between the three components, presenting them in this way has the benefit of simplicity.

The factors that affect the *physical carrying capacity* of a region include:

- the size of that region (in acres or in square miles);
- the resources that are available (for example, fresh water, farmland, or habitat), and
- other physical characteristics such as developable land and unique resources or features of the area that need to be preserved. While not a "natural" feature of the land, physical carrying capacity could also include infrastructure, such as roads and bridges, housing, drinking water filtration capacity, waste disposal capacity, and the like.

Economic carrying capacity may include:

- the amount and type of labor in the area,
- the level and distribution of income in the area,
- measures of housing affordability,
- the number of vacant businesses or storefronts, the cost of living,
- tax rates, and the like.

Finally, *social carrying capacity* may include:

- the number of civic institutions in an area,
- the level of social engagement in town government, and
- attitudes and behaviors both to change and to newcomers.

After examining the literature on physical, economic and social carrying capacity at the regional level, we propose the following methodology:

- Develop a list of indicators for each of the components (physical, economic, and social) based upon the existing literature;
- Screen the recommended indicators for data availability and accessibility;
- Collect data on the current level of that indicator to establish a baseline;
- Establish threshold levels for each of those indicators that would signal that the Blue Hill Peninsula had exceeded or was approaching its carrying capacity in that area;
- Evaluate each indicator relative to that threshold;
- Categorize each indicator on a scale of 1 to 5, with 1 indicating no constraint, 2 indicating some constraint, 3 indicating moderate constraint, 4 indicating severe constraint, and 5 indicating that the indicator has exceeded capacity.

4.2 Recommended Indicators and Thresholds

Inherent in the idea of a carrying capacity is the concept of a threshold beyond which the system (physical, economic, social, or a combination of the three) begins to break down. Physically, that threshold may be relatively straightforward to estimate, as it is a function of the rate of inputs into the system, the current state of the system, and the resilience or absorptive capacity of the system. Economically or socially, the concept of a threshold is a bit more complicated. Fortunately, in some cases, the existing literature gives us some guidance as to the indicators we can look at for signals as to when a system is approaching its capacity. In other cases, statewide policies and guidance can suggest a threshold. Where the existing literature or policy does not suggest a clear threshold, we consulted with BHHT and/or used our professional judgment. In some cases, we used the average in the State of Maine or in Hancock County as a benchmark.

Table 19 lists our recommended indicators and a suggested threshold level for each, where one could be easily determined. There are two types of threshold levels proposed: an absolute threshold and a relative threshold. Absolute thresholds are given for those indicators for which a concrete level can be established. Relative thresholds, where the indicator is measured against the state, the County, or past performance, are those for which a concrete threshold level is not readily apparent.

Table 18 Table 20: Recommended Carrying Capacity Indicators and Suggested Thresholds

Indicator	Description	Proposed Threshold	Source
PHYSICAL/INFRASTRUCTURE			
Wastewater treatment facility capacity	Percent of permitted capacity	Above 75% capacity	https://echo.epa.gov/detailed-facility-report

Indicator	Description	Proposed Threshold	Source
Water usage	Domestic water usage in million gallons per day, groundwater and surface water	See notes.	https://waterdata.usgs.gov/me/nwis/water_use
Well water quality	Percent of wells that exceeded maximum contaminant level of nitrate	5%	https://data.mainepublichealth.gov/tracking/data-topics/privatewells
Developable land available	Developable land (after environmental constraints have been removed) as percentage of total	Maximum threshold 0%, although town zoning may affect this.	National Land Cover Dataset
Farmland	Acres actively farmed	NA	2017 data. Only available at County Level. https://www.nass.usda.gov
Percent farmland soils conserved	Soils that are determined to be of prime farmland or farmlands of statewide importance.	5%	USDA-NRCS Soils Dataset - accessed via Beginning with Habitat and State of Maine
Conserved land	Acres conserved	2%	Maine GeoLibrary
Impaired waterbodies	Waterbodies that do not meet applicable water quality criteria.	Any impaired waterbody	Accessed via 2022 Integrated Water Quality Monitoring and Assessment Report
Waterbody classification status	Federal Clean Water Act allowed usage.	Class C or SC	Maine Department of Environmental Protection
Shellfish harvesting bed closures	Closing of shellfish harvesting beds due to red tide or other toxins.	Any positive value	Maine Department of Marine Resources
Air quality	Data are collected for ozone, visibility, particulate matter, and atmospheric deposition of nitrogen, sulfur, and mercury.	Poor condition.	Closest air quality monitoring site is in Bar Harbor. Latest available annual trend data are from 2019 and based on a five year average. National Park Service.
School ratings	Grade based on an index of scores on academics, data	C-	https://www.niche.com/about/data/#dataSources

Indicator	Description	Proposed Threshold	Source
	on teachers, culture and diversity, and others.		
Student-teacher ratio	Ratio of students to teacher	17:1 in elementary schools, based on Essential Programs and Services Funding Model	https://www.niche.com/about/data/#dataSources
Road grades	Lowest grade of road quality in municipality	C-	https://www.maine.gov/mdot/mapviewer/
ECONOMIC			
Cost of living (various)	Based on a national average, where 100 = national average.	110 (ten percent above national average)	https://www.bestplaces.net/
Homeownership affordability	Ratio of home price affordable at median income / median income. Less than 1 indicates unaffordable.	Ratio of home price affordable at median income / median income = 1	https://mainehousing.org/
Seasonal housing units	Percent of homes vacant or seasonal.	20 percent above the county average	https://api.census.gov/data/2019/acs/acs5
Poverty rate	Percent of households making less than the poverty threshold.	Higher than the state average.	https://api.census.gov/data/2019/acs/acs5
Gini index	A measure of income inequality.	0.5 and over is considered highly unequal.	https://api.census.gov/data/2019/acs/acs5
Free and reduced student lunch	Percentage of students eligible for free and reduced student lunch.	Higher than the state average.	https://neo.maine.gov/DOE/neo/Nutrition/Reports/
Food stamps	Percent of households receiving food stamps in the last 12 months	Higher than the state average.	https://api.census.gov/data/2019/acs/acs5
Local labor force	Percent of local labor force that lives off peninsula.	NA. Depends on municipality and how far it is from the mainland. A lower number	https://onthemap.ces.census.gov/

Indicator	Description	Proposed Threshold	Source
		generally indicates greater self-sufficiency.	
Remote workers	Percentage of population working remotely.	NA.	https://api.census.gov/data/2019/acs/acs5
Health insurance coverage		Below county average.	https://api.census.gov/data/2019/acs/acs5
SOCIAL			
Nonprofits per person	Number of nonprofits per 100 people.	Relative to past rates	https://www.irs.gov/charities-non-profits/tax-exempt-organization-search
Voter participation rate	Percentage of registered voters voting in off-year elections.	Relative to past rates	Various sources.
Crime rate	Crimes against property and violent crimes per 1,000 people.	Relative to past rates	Only available at County level. Hancock Sherriff's Office.
Newspaper coverage of development related conflicts	Search of local newspapers for mention of development related conflicts	Relative to past rates	Data not readily available.
Attendance at town meetings	Percentage and diversity of population attending town meetings	Relative to past rates	Data not readily available.

4.3 Establishing a Baseline: Current Conditions

The spreadsheet accompanying this report classifies each of the indicators on a scale of 1 to 5, with 1 indicating no constraint, 2 indicating some constraint, 3 indicating moderate constraint, 4 indicating severe constraint, and 5 indicating that the indicator has exceeded capacity. Here, we will present each of the three dimensions of carrying capacity – physical, economic, and social. Results indicate the current conditions of the Blue Hill Peninsula relative to its carrying capacity.

4.4 Indicators of Physical Carrying Capacity (Including Infrastructure)

4.4.1 Land, Farmland and Natural Resources

4.4.1.1.1 Land

Results of this analysis demonstrate mixed results when considering the amount of land available for development. While a full build-out analysis is beyond the scope of this report, an analysis of the developable land on the peninsula (after accounting for environmental constraints) reveals that 17 percent of the total land area is available to be developed (although local zoning may reduce that even further). However, whereas over 30 percent of the land in Penobscot and Sedgwick may be available for development, less than 20 percent is available in Brooklin and Castine.

Conserved land is land that is in federal, state, municipal and non-profit ownership, including easements. Results show that over five percent of land in Blue Hill, Brooksville, and Castine is held in conservation, while the other towns have less than five percent. Deer Isle has less than one percent of its land in conservation. This does not mean, of course, that any un-conserved land is vulnerable to development: that land may have other environmental constraints which prevents it from being developed in the future. However, it may act as a guide for BHHT from which to target land for conservation.

4.4.1.2 Farmland

The amount of land currently in farming is more difficult to track than one might imagine. The 2017 Census of Agriculture, released by the United States Department of Agriculture (USDA) compiles data on farms at the national, state and county levels, but not at smaller geographical levels (USDA, 2020). Overall, the State of Maine saw a 10 percent decline in the number of acres of farmland since 2012, the most recent time the census was taken. However, Hancock County saw a 22 percent increase in the amount of farmland (National Agricultural Statistics Service United States Department of Agriculture, 2017). This increase in the amount of land

farmed was tempered by a decrease in farm-related income, indicating the difficulty of supporting oneself by farming.

The New England Food Vision Document describes a "future in which New England produces at least half of the region's food—and no one goes hungry" (Donahue & et al., 2014, p. 6). In that vision – which is an aspiration, not a prediction or a prescription – the authors calculate that, on average, "over 1 acre of land [per person] is needed to grow all the food that the region consumes" (p. 8). We used that number (1.1 acres per person) to estimate the amount of farmland that would be needed in Hancock County to meet that goal. Currently, the population of Hancock County is approximately 55,500, implying that slightly over 61,000 acres would be needed under this vision. According to the latest Census of Agriculture, there are over 65,000 acres currently being farmed in the County, indicating that at least on an aggregate level, Hancock County has enough farmland to meet that threshold. However, as population continues to grow, the amount of farmland required to meet those needs will increase.

On the peninsular level, determining sustainability is more difficult, as data on the number of acres currently being farmed is not readily available. However, we can make some assumptions. According to the 2019 ACS, there are approximately 13,000 people residing in the Blue Hill Peninsula (US Census, 2020). If we apply the 1.1 acre per person rule, nearly 14,500 acres of farmland, or 3.4 percent of the total acreage of the Blue Hill Peninsula, would be needed to meet the residents' needs.

We also examine a related metric: the percentage of farmland soils that are presently conserved. Farmland soils are defined as soils that are determined to be prime farmland or farmland of statewide importance. Although these acres are not necessarily actively farmed, they are available for these uses; in other words, they "could be in cropland, pastureland, rangeland, forest land, or other land, but not urban built-up land or water." According to the USDA-NRCS soils dataset, only 2,542 acres of farmland soils are currently conserved (although there are over 29,000 acres of farmland soils available on the peninsula). In other words, whereas the peninsula has more than enough farmland soils to meet the guidelines set out in the New England Food Vision, only a small portion of those farmland soils is conserved. Results show that over 10 percent of the farmland soils are currently conserved in Blue Hill, Brooksville, and Castine, while between six and nine percent are conserved in Stonington, Penobscot, and Sedgwick. Brooklin, Deer Isle, and Surry all have five percent or less in conserved status. Comparing the percentage of farmland soils that are presently conserved versus those that are not may give BHHT some guidance as to where additional conservation activity should take place.

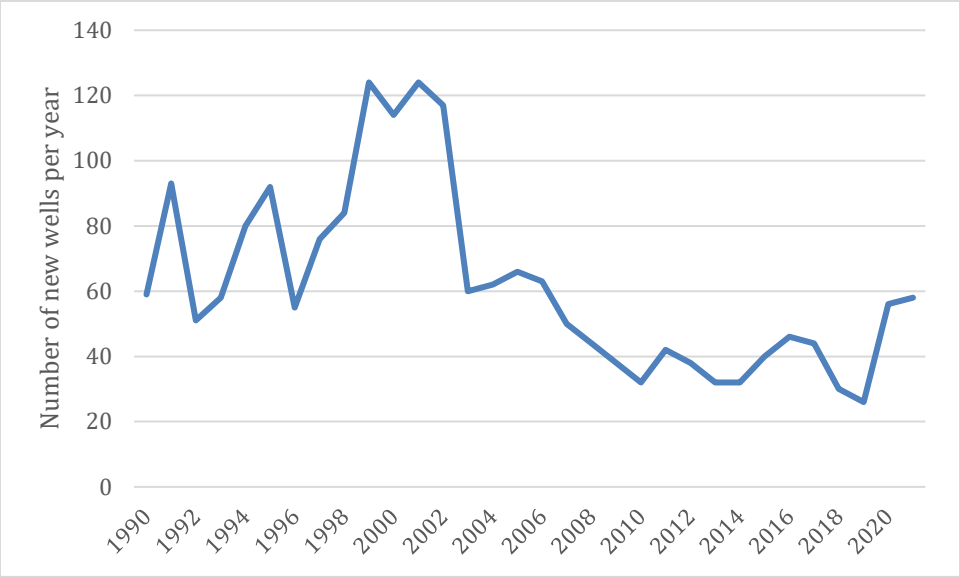
4.4.1.3 Natural Resources

Results are also mixed when we consider other natural resources, such as water usage and water quality. Generally speaking, the Blue Hill Peninsula is not currently constrained when it comes to water usage. A 2007 report to the Natural Resources Committee of the 123rd Maine Legislature found that none of the watersheds in or around the Blue Hill Peninsula was considered a "watershed at risk," defined as "a watershed where the sum of the required in-stream flows plus the consumptive water withdrawals exceed some percentage of the total runoff generated within the watershed" (Land & Water Resources Council, 2007). The study chose both 80 and 90 percent as the at-risk indicator. Results showed that "the majority of watersheds-at-risk are in areas with relatively high population densities. This suggests that, at this level of analysis, areas undergoing rapid development and population growth are most likely to experience problems with non-sustainable water withdrawals in the future" (p. 9).

However, the study was conducted fifteen years ago, and has not been repeated. Several trends in the intervening years bear monitoring: mean annual winter precipitation and consumptive use. Mean annual winter precipitation is part of the equation used to estimate recharge rates. According to data from the NOAA Climate at a Glance (National Centers for Environmental Information & National Oceanic and Atmospheric Administration, 2022), mean annual winter precipitation has not varied much over time in coastal Maine. The New England Water Science Center shows that overall water withdrawals in Maine decreased over time between 1990 and 2015, from 1,140 million gallons a day in 1990 to 509 million gallons a day in 2015 (New England Water Science Center USGS, 2019). More recent data are not available. Taken together, these two facts indicate that water sustainability in the Blue Hill Peninsula has not worsened since 2007, at least according to 2015 withdrawal rates.

One possible indicator of water withdrawal is the number of new wells being dug on the peninsula. Using data from the Maine Well Database from the Maine Geological Survey, the team was able to determine the number of new wells dug per year. Results are shown in Figure 16, and demonstrate that after a boom in the late 1990s and early 2000s, the rate of new wells in the Blue Hill Peninsula declined until 2019 (Maine Geological Survey, 2022). In 2020, 56 new wells were dug, while in 2021, an additional 58 wells were constructed. While available data do suggest that water availability is not currently a concern, the matter does bear monitoring if current trends continue.

Figure 16: New Wells in Blue Hill Peninsula Per Year,1990 to 2021



Source: (Maine Geological Survey, 2022)

Surface water in the Blue Hill Peninsula is generally good. The majority of waterbodies on the peninsula are rated class B or above for water quality, indicating that while there are fewer restrictions on usage than for class A or AA, water quality is still considered good.[4] Some segments of Carleton Stream are still dealing with decreased water quality due to its industrial past (Department of Agriculture, Conservation & Forestry, 2022).

4.4.2 Pollution and Wastes

We investigate several indicators of pollution and waste: the capacity of area wastewater treatment facilities, shellfish bed closures, and air pollution.

- Regarding pollution and pollutant levels, the Blue Hill treatment facility is nearing its permitted discharge capacity.[5] The Castine and Stonington facilities are both at less than half their permitted discharge capacity.
- While shellfish beds peninsula-wide seem to be in good health, over 29% of shellfish harvesting acres off Penobscot and over 13% in Surry are either restricted, conditionally restricted, or prohibited altogether as of the writing of this report. However, shellfish beds

[4] Water classification standards should be viewed more as a hierarchy of risk than a measure of water quality. Ecosystems that are in good health are expected to be more resilient to natural or human caused stressors (Maine Department of Environmental Protection, 2022).

[5] A recent article in the Bangor Daily News also indicated that the wastewater treatment facility, which serves eight towns on the peninsula, is at risk from rising sea levels(https://www.bangordailynews.com/2022/01/23/news/hancock/rising-tides-threaten-blue-hills-wastewater-treatment-facility-joam40zk0w/).

can be closed for a variety of reasons: bacterial contamination, naturally occurring red tides, or simply heavy rain. It is not necessarily an indication of excessive pollution.

- The closest comprehensive air quality monitor is located in Acadia National Park, north of the Blue Hill Peninsula. Results from the latest five-year trend data (2015 – 2019) indicate that while air quality was considered good for particulate matter and ozone (for vegetative health), it was considered poor for sulfur deposition and fair for ozone (human health), visibility, and nitrogen deposition (NPS, 2022)[6] Sulfur and nitrogen deposition and smog (which contributes to lessened visibility) primarily arise from the burning of fossil fuels. However, much of the air pollution detected at Acadia National Park is attributed to its location, as downwind of large urban and industrial areas in the states to the south and west (NPS, 2022), rather than to sources in or near the park itself.

4.5 Schools and Infrastructure

Overall, the peninsula is not facing restrictions as far as its schools or roads. The student:teacher ratio is well below that recommended by the National Academy for the Education of Young Children (National Association for the Education of Young Children, 2018). Roads, which are graded on the basis of safety, condition, and service (MDOT, 2012), are rated highly.

Table 19 - Current Conditions: Physical Carrying Capacity (Including and Infrastructure)

Indicator	Description	Results
Wastewater treatment facility capacity	Percent of permitted capacity	**Mixed**. The Blue Hill wastewater treatment facility is at 84% of its permitted discharge. The Castine facility is at 41% of its permitted capacity, while the Stonington facility is well below its capacity.
Water usage	Domestic water usage in million gallons per day, groundwater and surface water.	**Generally unconstrained** according to available data, but bears monitoring.
Well water quality	Percent of wells that exceeded maximum contaminant level of nitrate.	**Generally unconstrained**. Common sources of nitrate contamination include fertilizers, septic systems, animal feedlots, industrial waste, or food processing waste.
Developable land available	Developable land as percentage of total.	**Constrained**. Peninsula-wide, developable land is only 17% of total land, although town zoning (if any) may affect how much and where development may occur. In Penobscot and Sedgwick, developable land is over 30% of the total. However, in Brooklin and Castine, developable land is less than 20% of the total land.

[6] For more information on how the trends are calculated, please visit https://www.nps.gov/articles/air-analysis-methods-latest.htm.

Indicator	Description	Results
Percent of farmland soils conserved	Soils that are determined to be prime farmland or farmlands of statewide importance.	**Somewhat constrained to severely constrained.** While Blue Hill, Brooksville, and Castine all have over 10 percent of their farmland soils in conserved status, Brooklin, Deer Isle and Surry all have 5 percent or less.
Protected land	Acres preserved	**Mixed.** Blue Hill, Brooksville, and Castine all have over five percent of their land in conservation, while Brooklin, Deer Isle, and Surry have less than three percent.
Impaired waterbodies	Waterbodies that do not meet applicable water quality criteria.	**Generally unconstrained.** Carleton Stream in Blue Hill is impaired for 1.23 miles between First and Second Pond, below the former mine. This stream segment is impaired for aquatic life due to non-attainment for benthic macroinvertebrates. This segment is also impaired for iron. All other water segments on the Peninsula are non-impaired.
Waterbody classification status	Federal Clean Water Act allowed usage.	**Generally unconstrained.** Two Carleton stream segments are classified as class C waters. This is the lowest water quality designation, but is still good quality.
Shellfish harvesting bed closures	Closing of shellfish harvesting beds due to red tide or other toxins.	**Mixed.** While Peninsula-wide shellfish closures or restrictions are less than 5% of the total, more than 29% of the shellfish beds off of Penobscot and 13% of the shellfish beds off of Surry are restricted, conditionally restricted, or prohibited.
Air quality	Data are collected for ozone, visibility, particulate matter, and atmospheric deposition of nitrogen, sulfur, and mercury.	**Mixed.** Based on the 2015-2019 five year average: the visibility and haze index is in fair condition, the ground-level ozone concentrations are in fair condition for human health, the ground-level ozone concentrations are good for vegetation health, the wet nitrogen deposition levels create fair condition for ecosystem health, the wet sulfur deposition levels create poor condition for ecosystem health, and the particulate matter concentrations for human health are in good condition (3-year average).
School ratings	Grade based on an index of scores on academics, data on teachers, culture and diversity, and others.	**Mixed.** School ratings are mostly good. Sedgwick schools receive a D- and Castine schools receive an A-.
Student-teacher ratio	Ratio of students to teacher	**Generally unconstrained.**
Road grades	Lowest grade of road quality in municipality	**Generally unconstrained.**

4.6 Indicators of Economic Carrying Capacity

7.6.1 Cost of Living

Assessing the economic carrying capacity of the peninsula reveals somewhat concerning results (Table 21). The first category investigated, cost of living, considered the cost of certain common expenditures relative to the average cost of those expenditures in the rest of the nation. In almost all categories, the cost of living in the Blue Hill Peninsula was above the national average. The exception was transportation, where the cost was below the national average.

Of course, the fact that certain categories of expenses are more expensive than the national average does not necessarily translate to unaffordability. To make that claim, we must factor in income as well. It may be that comparing the cost of living in the Blue Hill Peninsula to the national average actually *understates* the level to which living on the peninsula is either unaffordable or becoming unaffordable, as the median household income in Hancock County is lower than the national median ($57,178 in Hancock County in 2019, versus $65,712 nationally). Therefore, categories that are more expensive than the national average actually constitute a larger percentage of the median Hancock County household's budget.

7.6.2 Housing

Home ownership affordability statistics come from the Maine State Housing Authority, which considers the ratio of area median home price (or an area 2-bedroom rental) to area median household income. According to this ratio, homes in this area are generally considered unaffordable, to varying degrees.

The percentage of seasonal housing units is an indicator of both economic and social carrying capacity: economic because seasonal housing is not available for year-round housing, and may have the effect of driving up housing costs; social because a community with a large percentage of seasonal housing may experience conflicts in the summer months, as local residents and seasonal residents may have differing views on issues such as land conservation and development (American Community Survey, 2021) (Deller et al., 2012). On the other hand, seasonal housing may be necessary for seasonal workers, such as those who work in agriculture or in the restaurant industry.

On the peninsula, the percentage of seasonal housing units range from a low of 30 percent in Stonington to a high of 60 percent in Brooklin (although it must be kept in mind that the margin of error on these estimates is plus or minus 20 percent). For comparison purposes, 33 percent of

the housing stock in Hancock County is considered seasonal, whereas only 17 percent of the state's housing stock falls into that category. While there is no official threshold for the percentage of seasonal housing in a community that indicates unsustainability or exceedance of carrying capacity, negative attitudes towards seasonal residents and conflicts around development and natural resource utilization may be an indicator that the system is under strain.

7.6.3 Poverty, Inequality, and Health Insurance

The poverty rate on the peninsula ranges from a low of 4 percent in Brooklin to a high of 18 percent in both Stonington and Sedgwick (Castine comes in a close third, with a poverty rate of 17 percent). Since these numbers are taken from the ACS, and therefore may have a wide margin of error, the project team also looked at the percentage of households receiving food stamps in the most recent 12 months as well as the percentage of students in the local schools who qualify for free or reduced cost school lunch. Results generally corroborate the poverty data, with Stonington and Sedgwick demonstrating relatively high percentages in both categories. Castine, on the other hand, has relatively low percentages in both, most likely due to the high percentage of students living at the Maine Maritime Academy, who may not have a high income, but may not need food stamps or reduced fee student lunches.

Income inequality is measured by the Gini index, which measures the distribution of income within a society. The index theoretically ranges from 0 to 1, with 0 indicating complete equality and 1 indicating complete inequality. In reality, Gini coefficients in the United States rarely dip below 0.40 or rise above 0.53. (For example, according to the 2019 ACS, Utah had the lowest Gini coefficient at 0.42, and New York had the highest Gini coefficient at 0.50.) Maine's Gini coefficient was 0.45 in 2020 (Horowitz et al., 2020). The Gini coefficient for the towns in the Blue Hill Peninsula range from a low of 0.42 in Brooklin and Stonington to a high of 0.55 in Deer Isle. This indicates a high degree of inequality in Deer Isle. Brookville also has a relatively high Gini coefficient at 0.50.[7]

On the other hand, the percentage of households covered by health insurance is relatively high. More than 80 percent of the households in each municipality are covered by some form of health insurance, with the exception of Stonington, where the percentage stands at 78 percent.

[7] As the Gini coefficient relies on income before taxes and transfers, it may mask the "lived" level of inequality. Taxes and transfers may serve to reduce the level of income inequality in a region. Furthermore, the Gini coefficient does not take into account self-provisioning (hunting or farming, for example), or unreported income.

Table 20 Current Conditions: Economic Carrying Capacity

Indicator	Description	Results
Cost of living	Based on a national average, where 100 = national average.	Either constrained or severely constrained in most areas. Health care costs and housing the most severely constrained. Transportation costs the least constrained.
Home ownership affordability	Ratio of home price affordable at median income / median income. Less than 1 indicates unaffordable.	Either severely constrained or constrained.
Seasonal housing units	Housing units that are for seasonal, recreational, or occasional use.	Somewhat constrained to severely constrained. Blue Hill, Stonington and Sedgwick have seasonal units at or near the county average. Brooklin, Brooksville, Castine, and Deer Isle have a seasonal housing rate of over 50 percent.
Poverty rate	Percent of households below the official poverty rate in the previous 12 months.	Mixed. Castine, Stonington, and Sedgwick have relatively high poverty rates (above 15 percent), but Brooklin has a 4 percent poverty rate.
Gini index	Index measuring the distribution of income in an area. A higher number indicates higher inequality.	Mixed. Brooksville and Deer Isle have relatively high Gini coefficients, while the rest are near the state and county average.
Food stamps	Percentage of households receiving food stamps in the previous six months.	Mixed. Stonington and Sedgwick have relatively high percentages of households receiving food stamps, but the rest of the towns are below the county average.
Free/reduced lunch	Percent of students qualifying for free or reduced fee student lunch.	Very high in Deer Isle, Stonington, and Sedgwick. Other towns are at or below state average.
Health insurance coverage	Percentage of households covered by commercial or government health insurance.	Relatively unconstrained. More than 80 percent of the population in each of the towns has some form of health insurance, except for Stonington.

7.6.4 Indicators of Social Carrying Capacity

Indicators of social carrying capacity are much more difficult to gather from quantitative data. Interviews and surveys would provide a better picture of how close the peninsula is to its social carrying capacity, and whether the social structure on the peninsula could withstand an influx of people "from away." Such a qualitative effort is beyond the scope of this study. However, the team was able to gather some data that are indicative of the health of the social system on the peninsula. Such indicators and the results are listed in Table 22. While we do not include thresholds, as we did with physical and economic indicators, these data points will be important to monitor in the future. We were also unable to obtain data on attendance at town meetings, which could be a good indicator of civic cohesion. The towns on the peninsula do not generally keep attendance records.

Table 21 Current Conditions: Social Carrying Capacity

Indicator	Description	Results
Number of nonprofits per 100 people	Nonprofits per capita may be an indicator of a feeling of civic responsibility.	Blue Hill and Castine have the highest number of nonprofits per capita, while Penobscot has the lowest.
Voter participation rates	Voter participation in the Presidential and Senate elections.	Sedgwick had the highest voter participation rate in the most recent Presidential election, at 94.7%. Castine had the lowest, at 40 percent. In the most recent Senate election, Brooklin, Brooksville, and Surry had the highest turnout at nearly 40 percent, while Stonington had the lowest at only 12 percent.
Crimes against property	Number of crimes against property per capita.	Only available at the county level.
Violent crimes	Number of violent crimes per capita.	Only available at the county level.

7.6.5 Population

BHHT has asked rbouvier consulting to specifically consider the impact of a doubling of the peninsula's population within the next 10 to 15 years. The results of this analysis suggest that such an occurrence is unlikely (the population would have to increase by five percent per year for such a doubling to occur, whereas the current rate is less than half a percent per year).

However, our analysis has uncovered a trend that mere growth rates may mask: a shifting of the socio-demographic composition of the population. Table 17 in section 3.3.4 shows that the largest demographic groups moving to Maine from out-of-state were aged 26 to under 35, and those over 65. Those two groups were also the largest age groups moving out of the state. However, those moving in had a substantially greater median household income than those moving out, implying a socio-demographic shift. Assuming those trends hold in the Blue Hill Peninsula as well, in-migrants will likely have higher disposable incomes and different expenditure patterns than those they displace.

What are the implications of this shift for carrying capacity? Generally speaking, those with higher incomes tend to have a higher per capita impact on the environment: they tend to use more land, water, fuel, electricity, and consume more meat on average than low income households (Why Green Economy, 2022). Therefore, although a doubling of the peninsula's population is not likely in the near future, the impact of a wealthier, more urban population may affect the carrying capacity of the peninsula.

5 Key Findings

As an old Danish proverb once said, "it is difficult to make predictions, especially about the future."[8] However, the analysis contained in this report does lead to some conclusions about the effects of both COVID-19 and climate-related migration on the Blue Hill Peninsula.

- Overall, the population on the Blue Hill Peninsula has increased by 6.3 percent since 2000 (section 3.1), an annual increase of about 0.27 percent.
- Change-of-address requests indicate that the Blue Hill Peninsula experienced a very large increase in in-migration in 2020, but that trend has slowed somewhat in 2021 (section 3.2).
- The majority of those migrating to the Blue Hill Peninsula in 2020 were from urban areas (section 3.2).
- Home sales on the Peninsula have been on a general upward trend in the past five years. Housing prices were relatively stable from 2017 to 2020, but have increased by nearly 25 percent (in real terms) in 2021. Building permits have been on the rise as well (section 3.2).
- Climate migration is occurring in the United States, although it is difficult to prove that migration patterns are due to specific climate change events. Climate migrants tend to have higher than average incomes, come from urban areas, and work remotely at a higher proportion than current residents (section 4.1).
- New migrants to Hancock County have a substantially higher adjusted gross income than current residents of the county (section 3.3.4).
- This trend (higher-income migrants, higher rates of remote work) will likely continue as climate change accelerates (section 3.6).

Combining these conclusions with the carrying capacity analysis in section 4.3, we can arrive at some general predictions.

1. Buildable land is generally scarce on the peninsula, although it is more constrained in some towns than in others.
2. Currently, preserved farmland is not enough to meet BHHT's goals.
3. Water (either quality or quantity) does not appear to be constrained at this time.
4. The wastewater treatment facility in Blue Hill is not likely to be able to withstand a significant increase in population. Moreover, the facility is at risk from sea level rise.

[8] While this quote has been variously attributed to Neils Bohr, Samuel Goldwyn, Mark Twain, Yogi Berra, and others, the exact origin is unknown.

5. Air quality is generally fair in the area (although the nearest air quality monitoring site is at Acadia National Park, and so may not be indicative of the air quality on the peninsula). An increase in fossil fuel combustion from more vehicles and other sources will increase the amount of airborne pollutants. However, the direct effect on the peninsula is difficult to ascertain, due to the fate and transport of these contaminants. It is fair to assume that air quality in the area will likely deteriorate somewhat due to increased migration and economic activity.
6. Roads and schools are likely to remain unconstrained for the foreseeable future.
7. Economic indicators such as affordability and cost of living are likely to worsen, as is the economic inequality in the region. The median household income is likely to rise, accompanied by a decrease in the poverty rate and related aggregate measures of economic deprivation. However, one must be cautious of these metrics. A better metric might be the *absolute number* of households in poverty and related statistics, rather than the rate. Statistics that summarize (like median, average, or percentage) can sometimes mask the outliers.
8. Housing affordability will almost certainly worsen without a concerted effort to build more affordable and workforce housing, as wealthier in-migrants settle into the area.
9. Social conflicts are likely to accelerate between long-term residents and new arrivals.

Glossary

Term	Definition
Adaptation	Refers to the changes organisms make to be better suited to their environment in order to improve their chances at survival in that specific environment.
Adjusted Gross Income	Measured by gross income minus adjustments to income. Gross income includes wages, dividends, capital gains, business income, retirement distributions as well as other income. Adjustments to income refers to the taxes paid on the gross income.
Business	A commercial operation or company.
Carrying Capacity	A species' average population size in a habitat that is limited by environmental factors. If these needs are not met, the population will decrease until the resources are replenished.
Climate Migration	Climate migration describes a subset of environmental migrants who are forced to flee "due to sudden or gradual alterations in the natural environment related to at least one of three impacts of climate change: sea-level rise, extreme weather events, and drought and water scarcity."
Consumptive Use	The total seasonal water loss from an area of land due to plant growth and evaporation usually being expressed in acre-feet.
Cost of Living Index	Compare what it costs to live in one place against another. Scores are presented in relation to the national average of 100. If a place’s COL index is below 100, it’s cheaper than the national average. If it’s over 100, it’s more expensive than the national average.
Direct impact	Initial production changes or expenditures resulting from a policy or an activity.
Discharge Capacity	The amount of wastewater flows and substances that a user is entitled to discharge into the city's wastewater collection and treatment system under a valid wastewater discharge permit.
Environmental Constraints	Factors that limit the growth of a species in a particular habitat.

Family	A family group is any two or more people (not necessarily including a householder) residing together, and related by birth, marriage, or adoption.
Gini Index	The Gini Index is a summary measure of income inequality. The Gini coefficient incorporates the detailed shares data into a single statistic, which summarizes the dispersion of income across the entire income distribution. The Gini coefficient ranges from 0, indicating perfect equality (where everyone receives an equal share), to 1, perfect inequality (where only one recipient or group of recipients receives all the income). The Gini is based on the difference between the Lorenz curve (the observed cumulative income distribution) and the notion of a perfectly equal income distribution.
Household	A household is maintained by a householder who is in a family and includes any unrelated people who may be residing there.
Impaired Waterbodies	Waters are assessed as impaired when an applicable water quality standard is not being attained. Impaired waters require a total maximum daily load (TMDL) or alternative restoration plan to reduce pollutant loadings and restore the waterbody.
Indirect Impact	Consists of the purchases that firms within an industry make from other businesses in the area (through the supply chain).
Inflow Migration	Refers to the movement of people within the US from one location to the peninsula.
Isolated System	A physical system so far removed from other systems that it does not interact with them.
Margin of error	The range of values below and above the sample statistic in a confidence interval. The confidence interval is a way to show what uncertainty is with a certain statistic.
Net Migration	The number of immigrants minus the number of emigrants.
Outflow migration	Refers to the movement of people within the peninsula to a new location within the United States.
Permanent Displacement	When an individual is forced to leave an area long-term and cannot later return to the area.

Smog	Fog or haze combined with smoke and other atmospheric pollutants.
STEAM Industries	Jobs in fields related to science, technology, engineering, arts, and mathematics.
Temporary Displacement	When an individual is forced to leave an area for a short period of time but can later return to the area.
Watershed	A watershed is the land area that drains to a common waterway. Rivers, lakes, estuaries, wetlands, streams, and oceans are catch basins for the land adjacent to them. Ground water aquifers are replenished by water flowing through the land area above them.

Appendix A: Maps of the Blue Hill Peninsula

The following maps of the Blue Hill Peninsula are attached. Maps were created by FB Environmental and include:

- Developable Land Area: Includes town boundaries, developed land, and land that is environmentally constrained.
- Farmland and Water Quality Features: Includes protected farmland and environmental characteristics such as impaired waterways and shellfish bed closures.
- Infrastructure features map: Includes key infrastructure such as hospitals, airports, fire stations, and the like.
- Natural Resources: Includes habitat, natural communities, and vernal pools, among other natural resource features.

Appendix B: Physical Carrying Capacity Database

The attached spreadsheet, created by FB Environmental, entitled “Carrying Capacity Database,” includes natural resources, farmland features, developable land, pollution features, and infrastructure by town.

Appendix C: Carrying Capacity Assessment

The attached spreadsheet entitled “At a Glance: Assessment of the Physical, Economic, and Social Carrying Capacity of the Blue Hill Peninsula" contains the results of our assessment of the Blue Hill Peninsula’s carrying capacity, sustainability thresholds, and benchmark conditions.

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