



# GIS Analysis of Coastal Development in the North Shore of Massachusetts

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## Abstract

The purpose of this project is to determine if the population along Massachusetts’ North Shore coast has been increasing since the 1990’s. If so, these areas of growth would be in harms way due to rising sea levels and expanding flood zones. Using data from MassGIS, the Commonwealth of Massachusetts’s Bureau of Geographic Information, I gathered block level Census data (1990, 2000, & 2010) for cities in the North Shore region and identified which Census blocks experienced growth or decline over this time period. I converted the polygons into a raster layer and reclassified the data to display only the pixels that had shown growth. The raster was clipped to the Federal Emergency Management Agency (FEMA) Flood Hazard zones with a 1% annual risk of flooding. Finally, I calculated the total percent of growth that occurred within these flood zones for each city and town in the North Shore. This is increasingly an important area to study as sea level rise and flooding pose greater threats to those living in proximity to the coast. If development along the coast continues, more people will be effected and the overall damage of flood events will be greater than in the past. From my findings, on average 15% pf population development occurring in the North Shore region is within annual flood zones, in some cities as much as 50%.

Figure 1: North Shore Region as defined by Massachusetts Coastal Zone Management

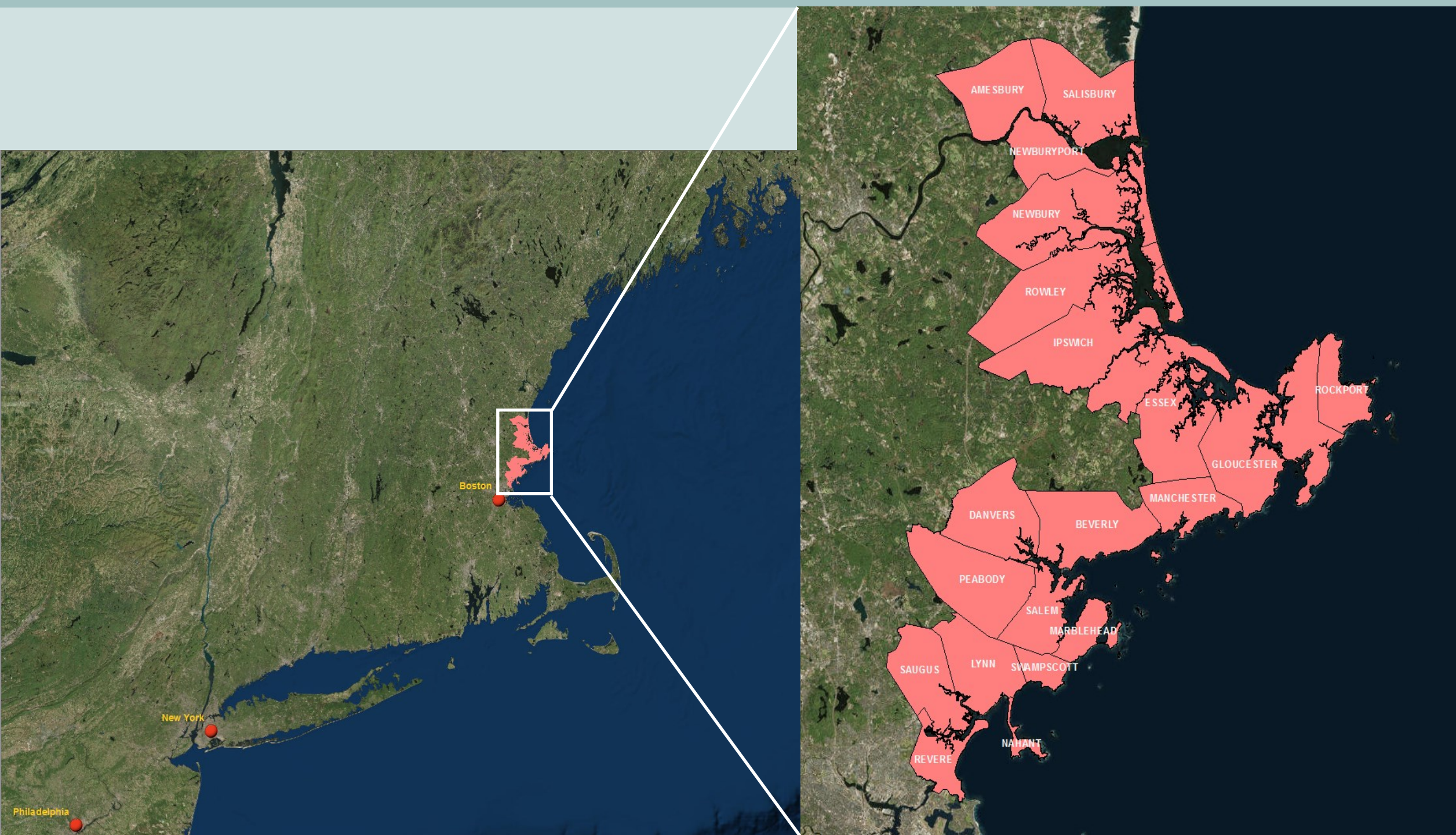
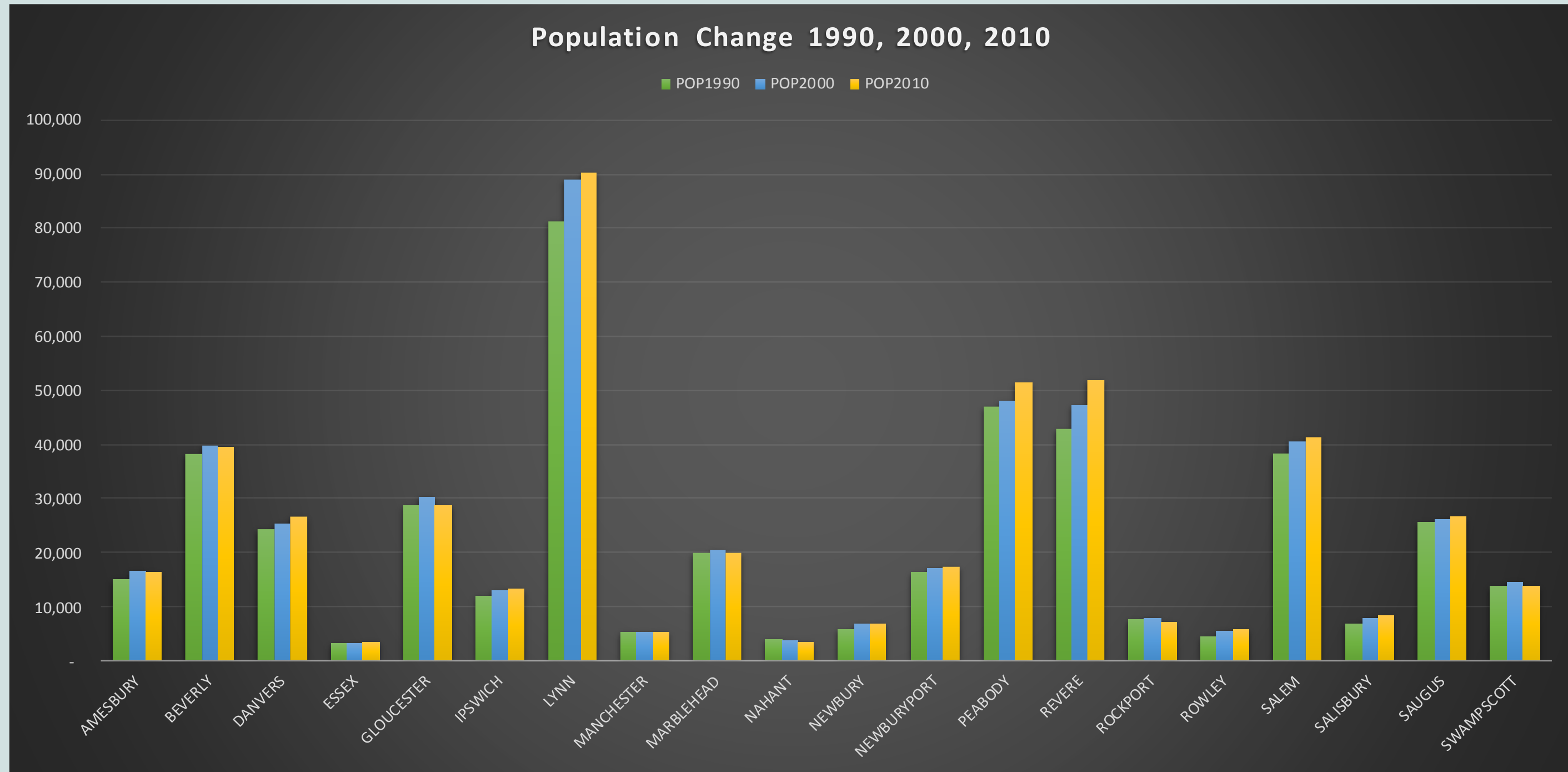


Figure 2: Essex Bay of New England’s Great Marsh (Source Searls 2008)



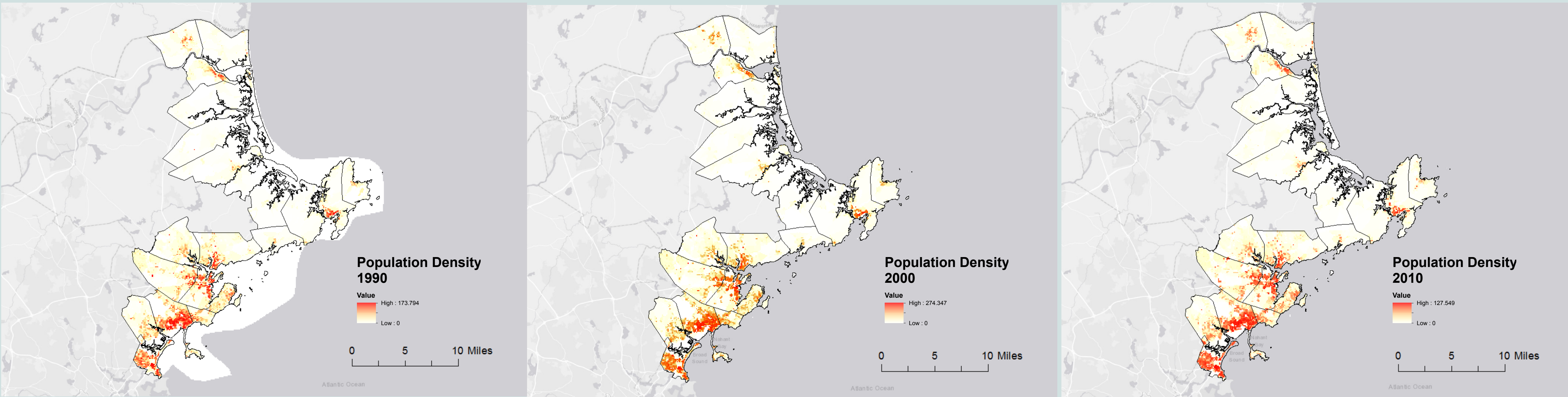
Figure 3: Chart showing population change for each of the cities in the study area over the twenty year period. (Data



## Introduction

An Op-ed article from the New York Times *This Map Shows How the Carolinas Became More Vulnerable to Hurricanes* written by Stephen M Strader a professor at Villanova University was the catalyst for the research. In the article he showed how housing density increasing in the Carolinas corridor. The North Shore is home to approximately 476,000 people (2010), attractive to homeowners as it represents the balance of New England living. Close proximity to Boston with quiet beaches hidden from the noise of the city and suburbs waiting to be explored. I chose this area since I did not know of any assessment like this being done for here and being a student of this area I was interested in the phenomenon.

Figure 7: (Left to Right) Raster Densities 1990—2000—2010



## Methods

Block level census data was collected for 1990, 2000, & 2010

Block area converted to acres

Data was transformed into raster for the purpose of spatial analysis

Density calculated using (population/acres) for each year  
Change was calculated subtracting 2010 from 1990

Reclassified into two categories Growth and Loss

Gathered FEMA data from MassGIS

Overlaid Growth categories with 1% Annual flooding (A, AE, AH, AO, X)

Calculated Area of overlap for each town

NAME	Total Area (Acres)	Growth Area (Acres)	Growth Percentage	Total Growth in Flood zone (Acres)	Percent Growth in Flood zone
Amesbury Town	8783.9	1100.51	12.53	107.3049	9.75
Beverly	9863.26	1672.54	16.96	137.3652	8.21
Danvers	8822.9	1885.32	21.37	195.8618	10.39
Essex	9124.23	183.988	2.02	21.5475	11.71
Gloucester	17088.6	1018.42	5.96	141.0001	13.85
Ipswich	21162.5	812.064	3.84	75.3171	9.27
Lynn	7391.06	2295.51	31.06	179.3382	7.81
Manchester-by-the-Sea	4982.76	206.085	4.14	9.3278	4.53
Marblehead	2790.72	772.267	27.67	35.1815	4.56
Nahant	802.922	138.162	17.21	25.2003	18.24
Newbury	15475.8	322.028	2.08	92.6583	28.77
Newburyport	5595.63	1149.46	20.54	111.3486	9.69
Peabody	10754.1	2653.67	24.68	277.4885	10.46
Revere	3944.19	1709.66	43.35	511.318	29.91
Rockport	4490.8	626.318	13.95	54.0335	8.63
Rowley	11865	378.942	3.19	34.1707	9.02
Salem	5339.8	1333.45	24.97	233.5042	17.51
Salisbury	10113	679.03	6.71	340.4012	50.13
Saugus	7257.74	1538.19	21.19	234.6853	15.26
Swampscott	1984.47	483.335	24.36	37.6836	7.80
Total	167633.4	20958.9	12.5	2854.7	13.6

Figure 6: Table of Final Calculations

Raster Block Density Difference of North Shore 1990-2010

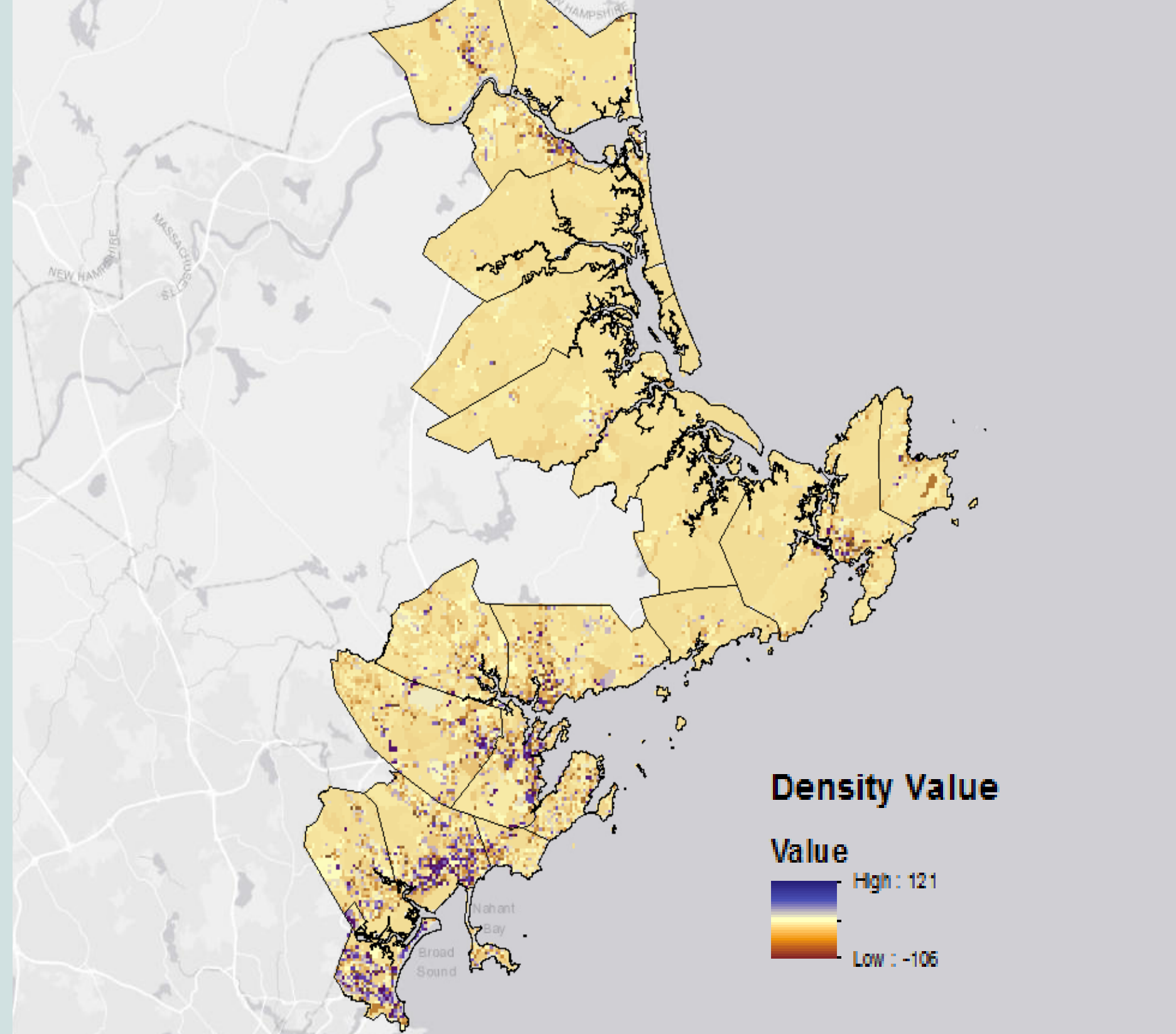


Figure 4: Raster layer created in ArcMap using block data comparing 2010 and 1990 population densities

Areas of Growth with FEMA 1% Annual Chance Flood Zones

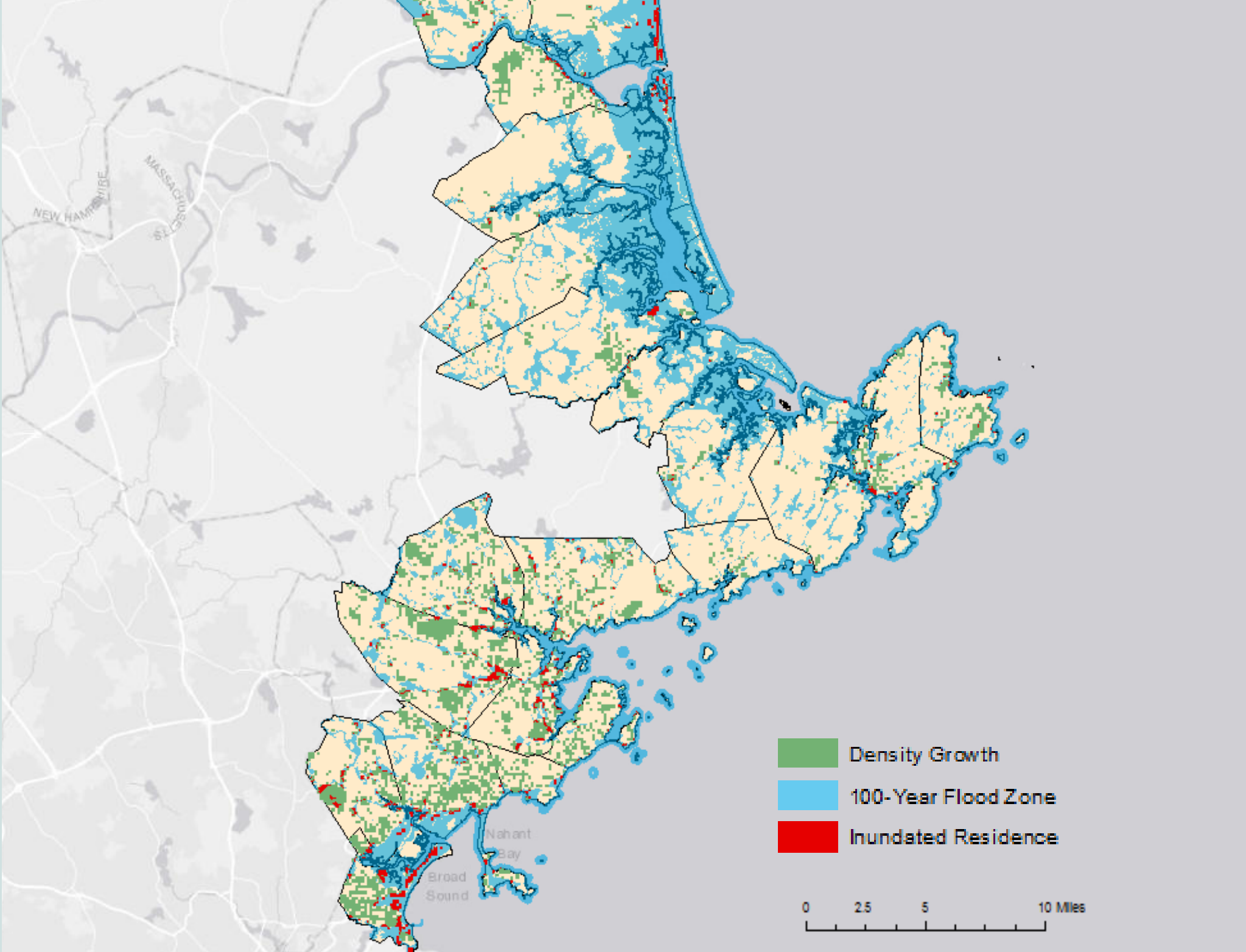


Figure 5: Map overlaying areas of density growth with FEMA flood zones for a 100-year flood event. Areas in red are anticipated to be flooded.

PERCENT GROWTH IN FLOOD ZONES

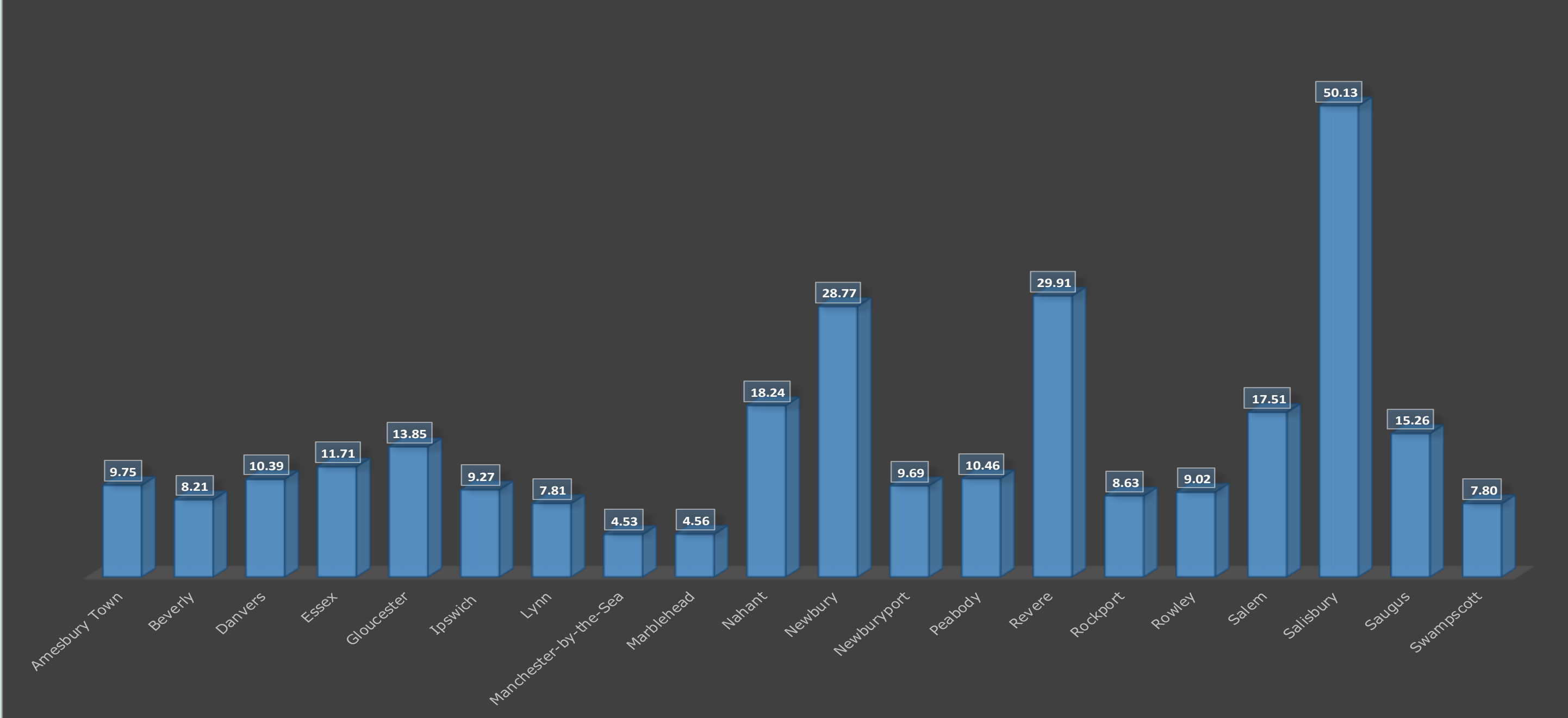


Figure 8: Calculation of growth occurring in 100 year flood zones based upon total growth that had occurred

## Results

Population along the Northern coast of Massachusetts has increased slightly over the twenty year span I looked at. The change is indicative a natural population progression occurring here in Massachusetts but raises an idea of where developments are occurring in relation to the coast and low-lying areas that would be at risk of flooding, 13.6%. Using FEMA flood risk maps I learned that the extent of the areas shown are conservative in nature and do not weigh factors such as climate change meaning the numbers may be much higher than depicted here.