NARRAGANSETT BAY WATERSHED ECONOMY

The ebb and flow of natural capital

Agriculture Overview

Given the loamy soil and temperate climate, lands in the Narragansett Bay watershed (NBW) have a long history of being inhabited and cleared for agricultural production and trade, dating back to settlement of native tribes. During early agricultural times, there were fewer farms, but the average farm size was large, covering 80-100 acres.[1] Over time, however, the agricultural industry met challenges due to industrialization and competition from large-scale farms in the Western U.S. These factors led to a decrease in farm numbers and size, as farmers left their businesses to move to the West or work in factories.[2]

Despite past challenges, modern-day agriculture is experiencing a revival. This is in part due to the "go local" and farmers' market movements. The number of farms in Rhode Island (RI) and Massachusetts (MA) has been growing since 1992 and has strong potential for continued growth.[3] For example, in 2012, nearly 2,000 farms employed over 4,400 individuals in the NBW. These farms generated a total annual market value of $121 million (in 2016 dollars).[4] However, due to evidence provided by an RI agricultural economic impact study, these should be considered significant underestimates.[5] These underestimates are due to perceived inaccuracies in Federal Government figures, as it is difficult for a statistical example to be representative of the state as a whole.

History

Throughout history, the growing-conducive climate and soil of the NBW have made it an ideal agricultural zone. Native tribes, such as the Algonquins, Narragansetts, and Wampanoags, would burn forest underbrush to clear land for farming. In 1524, Italian explorer Giovanni da Verrazzano entered Narragansett Bay, stating to King Francis that the area was "suitable to every kind of cultivation—grain, wine, or oil."[6] In the Massachusetts Bay Company of 1629, the Puritans were primarily agricultural people with most inhabitants living in villages and on their privately-owned fields. In addition to farming for sustenance, industrial agriculture has also been prevalent in the NBW for centuries. Agriculture for business dates to the 17th century when Roger Williams discovered the fertile land with a lack of predators and ideal grazing pastures on Prudence, Patience, and Hog Islands. These characteristics made RI the most important producer of livestock in New England by 1661 and helped power the early, rapid growth of Newport.[7]

By the 18th century, agricultural businesses in the NBW fell upon hard times due to the dominating merchant and industrial economies and the agricultural states of the West making it hard to compete on a large scale.[8] In response to this, starting in 1770, NBW agriculture changed from extensive—small inputs (time, materials, manure/soil enhancers) relative to land area—to intensive—large inputs relative to land area—and specialized farming practices.[9] This switch diminished acreage of farms, but the decline in land area was offset by efficiency gains with crops producing higher net income per acre.[10]

The same trend of increasing efficiency continued into the 20th century in the RI portion of the watershed. During this time, Irish potatoes, corn for silage, apples, and clovers and timothy for hay were the most widely produced agricultural goods. In 1920 in RI, for example, 2,987 farms produced over 293,000 bushels of Irish potatoes, and in 1930 1,044 apple orchards produced 216,226 bushels of apples, 509 farms produced over 42,600 tons of corn for silage, and 789 farms produced 18,450 tons of clover and timothy for hay.[11] Some of these goods experienced a decline in production over the decades; for example, in 1969, the number of farms producing apples dropped to 29, which produced almost 90,000 bushels on 23,000 acres. The same applies to hay production, which dropped to 137 farms producing almost 8,000 tons on 4,000 acres. Other goods, such as corn and Irish potatoes, experienced increased output despite dwindling acreage due to the aforementioned increase in efficiency. For example, the number of farms producing Irish potatoes dropped to 54 in 1969, although they produced 1.7 million bushels on 4,500 acres. Similarly, 99 farms produced 50,825 tons of corn for silage on just over 3,000 acres of land.[12] Shortly after this, in the 1970s and 80s, when potato farming was declining (by 1992, 19 farms produced 625,000 bushels of potatoes on 1,300 acres), nursery and greenhouse related activities, such as sod production, became more prominent, especially as empty potato and dairy farms were converted to sod farms.[13] To this day, potato and apple production remains low, while as of 2012, hay, sod, corn for silage, and nursery crops were the top acreage crops in RI.[14] This increase in sod production and nursey and greenhouse products also goes hand-in-hand with increasing suburbanization—a 1972 study found that 55% of the state's nurseries were established between 1950 and 1969. Suburbanization is tied with a shift in agricultural products—while production of crops such as potatoes may have declined, the production of other agricultural products, such as flowers and plants produced in greenhouses, rose with the spread of suburbanization as these new settlements required manicured lawns and controlled vegetation.[15]

Along with this suburbanization, however, came actions to protect and aid agricultural lands in the NBW, including the Farm, Forest and Open Space Act (RI), the Farmland Preservation Program (RI), Right to Farm Acts (RI, MA), Agricultural Preservation Restrictions (MA), and Farm Viability Enhancement Program (MA).[16] These acts encouraged the preservation of farm land through incentives such as tax breaks. Since the various acts and programs were enacted, agriculture in the NBW has experienced a revival after decades of decline (Table 1). In 2012, there were nearly 4,600 farms in the NBW, an increase of 44% from the 3,191 farms in 1997. Despite this increase, farm acreage in the NBW has remained essentially constant during this time period, changing from 279,116 acres to 279,746 acres.[17]

Table 1: Percentage Changes in Farm Numbers and Size in RI and MA, 1950-2012

	1950-1997	1997-2012
	MA	
Number of Farms	-79%	+36%
Acreage in Farms	-65%	-6%
Average Size Farms	+36%	-41%
	RI	
Number of Farms	-72%	+69%
Acreage in Farms	-71%	+26%
Average Size Farms	+2%	-25%

Source: USDA, 1950, 1997, 2012 Census of Agriculture

Today, not only is the agricultural sector in the NBW surviving, it is thriving. Across towns and cities within the watershed, there have been increases in farmers' markets, community supported agriculture (CSA) programs, and farm stands. These increases can in part be attributed to the larger farmers' market and "go local" movements that have been gaining in popularity in recent years.[18] The desire to eat healthier is another possible reason for the increase in local farmers' markets. Within the NBW, 59.7% of adults in MA and 62.7% of adults in RI are overweight/obese, and one way to battle this statistic is to eat more natural, fresh, and local foods.[19] With the concept of eating food grown locally catching on, there must be enough supply to meet demand.

Agriculturists in the NBW have become more innovative and have started to capitalize on the increasing demand for local agricultural products. To address the issue of short growing seasons and lack of storage crops, several NBW growers are participating in a USDA-funded pilot to test high tunnels, a non-fossil fuel-based approach to winter food.[20] In addition, within the watershed there exist many programs that connect and benefit farmers, communities, and shoppers in the region. These include a local food cooperative, farmers' market both online and in person, and farms offering CSA shares.[21] [22] This local mentality paired with tremendous positive energy behind the movement has positioned the watershed as a national leader in food-planning efforts concerning local food and agriculture. Given these factors, it is an area well positioned for growth and innovation.[23]

Data Sources and Limitations

Estimates of the economic impact of agriculture within the NBW include sales, number of farms, and employment. These data are derived from local studies and national studies at the state and county level, including the United States Department of Agriculture (USDA) Census, the Bureau of Economic Analysis (BEA), and the Economic Impact of Rhode Island Plant-Based Industries and

Agriculture. The USDA Census contains data on total number of farms, acreage of farms, and market value of agricultural products sold between 1992 and 2012. The BEA data provided information on employment on farms, including proprietors, between 2001 and 2015. Finally, the RI Economic Impact study provided data on the overall value of RI agriculture in 2012, including sales and employment.

To estimate the agricultural economic impact value within the NBW using published data at the county level, county figures for 2012 were adjusted by the share of the land area within the watershed.[i] For example, nearly 72% of the land in Bristol County (MA) is located within the NBW. Therefore, the USDA estimate of 717 farms in the county translates into 513 farms in the watershed portion of Bristol County (for a map of the watershed, please reference the "Geography" section).

However, due to conclusive evidence provided by the RI Economic Impact study, these should be considered significant underestimates. These underestimates are due to perceived inaccuracies in Federal Government figures, as it is difficult for a statistical example to be representative of the state as a whole. In addition, underreporting due to proprietorship can also be a reason for underestimates in the agricultural industry.

For additional information on the methodology employed in this report, please reference the "Methodology" section.

Current Status and Trends

A good indicator of the success and economic impact of the agricultural industry in the NBW is examining recent growth. Over the last two decades, the number of farms has increased in all watershed counties. Between 1997 and 2012, total number of farms in the NBW counties increased by 44% with changes varying by county (Figure 1).[24]

To understand the large economic impact of agriculture in the NBW today, the market value of agricultural products sold, number of farms, and total acreage of farms are estimated (Table 2). Based on previously stated assumptions, the lower-bound estimated total annual market value of agricultural products in 2012 was $121 million (in 2016 dollars). Of these sales, 83% of the sales were in crops. Agricultural sales took place on nearly 2,000 farms in the NBW, totaling nearly 85,000 acres. In RI, Providence County has the highest number of farms in addition to the highest market value. In MA, Bristol County has the highest number of farms, yet Plymouth County has the highest total market value of agricultural sales. [25] Plymouth County is home to cranberry production with 2,990 acres of cranberry bog in the Taunton River Basin. In 2017, the gate value of cranberry production in this area was approximately $13.8 million.

[i] In Rhode Island, results are: Bristol (100%), Kent (74.67%), Newport (82.37%), Providence (95.69%), and Washington (16.48%). In MA, results are: Bristol (71.55%), Norfolk (18.88%), Plymouth (36.34%), and Worcester (20.30%). Middlesex is excluded due to being <1% within the watershed.

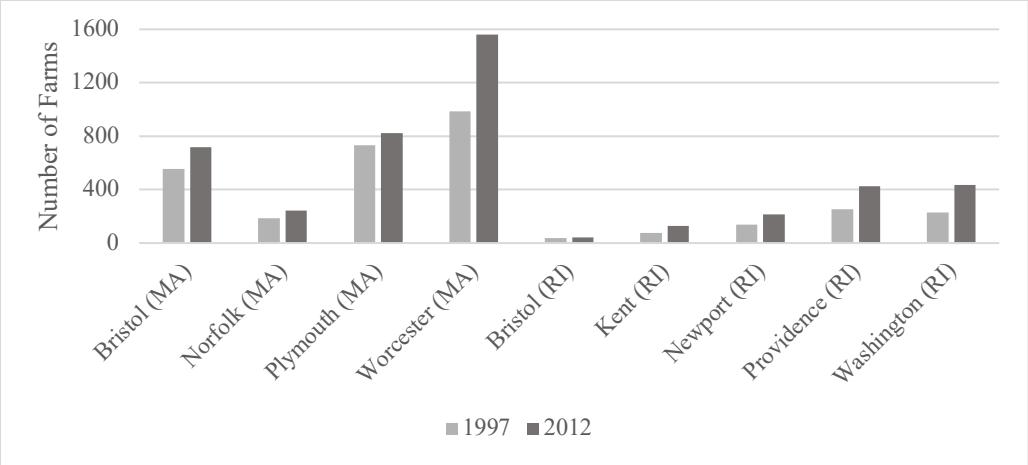

Figure 1: Growth in Number of NBW Farms by County, 1997-2012
Source: USDA, 1997 & 2012 Census of Agriculture

Table 2: Estimated Agricultural Impact in the NBW by County (2012) (in 2016 dollars)

County	Number of Farms	Land (Acres)	Market Value of Sales ($1000s)	Crops ($1000s)	Livestock ($1000s)
			RI		
Bristol	42	(D)	$2,790	$2,244	$546
Kent	94	(D)	$3,398	$2,730	$667
Newport	176	9,521	$12,596	$10,464	$2,132
Providence	407	(D)	$14,081	$10,955	$3,125
Washington	72	4,501	$4,121	$3,485	$637
Total, RI	791	14,022	$36,986	$29,878	$7,107
			MA		
Bristol	513	24,949	$28,163	$22,361	$5,803
Norfolk	46	1,784	$2,467	$1,870	$597
Plymouth	300	23,271	$41,056	$37,861	$3,195
Worcester	317	20,666	$12,195	$8,396	$3,798
Total, MA	1,176	70,670	$83,881	$70,488	$13,393
Total, All	**1,967**	**84,692**	**$120,867**	**$100,366**	**$20,500**

Note: (D) Data withheld to avoid disclosing data for individual farms.
Note: Counties are scaled by the ratio of watershed area to county land area.
Source: USDA, 2012 Census of Agriculture

Farming employment is also an important aspect to investigate when estimating the economic impact of the agricultural industry. In the NBW, employment on farms, including proprietors, is a small percentage of overall employment. Despite the small percentage of total employment, farms still employed over 4,400 individuals in the NBW in 2015 (Table 3).[26] Of this number, farm proprietor employment totaled over 1,700, nearly 40% of all agricultural employment. This is substantially

higher than other economic sectors and demonstrates the large amount of self-employed, small farms in the watershed. In addition, the high number of farm proprietor employment in part reflects an undercount of employment in the agricultural sector and the low costs of entry. In RI, Providence County has the highest number of total agricultural employment. In MA, Bristol County has the highest number of total agricultural employment .[27]

Table 3: Estimated Agricultural Employment in the NBW by County (2015)

County	Farm Proprietors Employment	Farm Employment
	RI	
Bristol	32	34
Kent	82	103
Newport	150	290
Providence	372	511
Washington	63	106
Total, RI	699	1,044
	MA	
Bristol	473	778
Norfolk	33	76
Plymouth	229	379
Worcester	292	398
Total, MA	1,027	1,631
Total, All	**1,726**	**2,675**

Note: Counties are scaled by the ratio of watershed area to county land area.
Source: BEA

The recent expansion of the agricultural sector in the NBW can be further witnessed through employment growth. Between 2001 and 2015, farming employment in RI grew three times faster than overall employment growth in the state (Figure 2). In the MA portion of the watershed, double-digit declines in Bristol and Norfolk counties offset large gains in Worcester county. This amounts to a net decline of 1% in farm employment.

As a complement and counterpoint to the USDA Census and BEA, RI conducted its own original study in 2015 estimating the overall value of RI agriculture in 2012.[28] This report gave conclusive evidence of severe underestimation of the economic impact of the agricultural sector in RI, given that the 2012 census uses lower-bound estimates while the 2015 report uses mean estimates, making it a more accurate estimation of the impact of agriculture in the state. This report estimated that agricultural sales in RI reached $239 million and that the agriculture sector accounted for over 2,500 jobs plus an additional 2,000 jobs held by farm owners, operators, and their family members for a total of over 4,500 jobs. These estimates were valued at four times the USDA's estimates for output

and 2.6 times the USDA's calculations for the number of jobs.[29] [ii] If the same underestimation assumptions are applied to the portions of RI and MA within the NBW, the estimated agricultural market value of sales would be nearly $142 million in RI and over $321 million in MA.

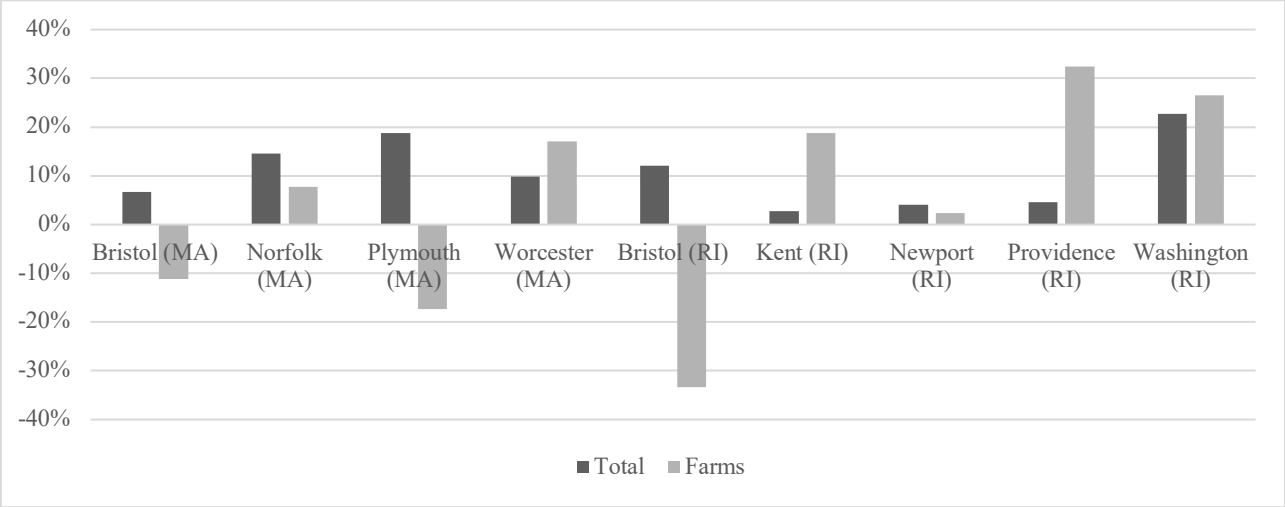

Figure 2: Total and Farm Employment Growth in NBW Counties, 2001-2015
Source: BEA

In terms of subsectors, greenhouse, bursary, and floriculture production is the largest subsector, generating an estimated $110.1 million in sales and 1,251 jobs. This is followed by crop production ($63.1 million, 776 jobs), animal production ($44.1 million, 336 jobs), grape vineyards ($18.5 million, 65 jobs), and aquaculture ($3.0 million, 105 jobs; for more information specifically on aquaculture, please reference the "Aquaculture" section of this report).

Future Threats and Opportunities

Land use | Temperature | Precipitation

As population in the NBW increases, land use patterns change. Although population growth has historically occurred in urban areas, recent trends show signs of settling in previously underdeveloped areas away from urban centers ("suburbanization"). This expansion and development decreases the amount of natural land and, along with it, the amount of land available for agriculture. For example, Mass Audubon estimated that between 1999 and 2005, about 10,000 acres of agricultural land in MA were developed for human use. This trend goes hand in hand with the 8.5% increase in urban land in the NBW from 2001 to 2011, up to approximately 380,000 acres, or 35% of total land coverage.[30] For example, cranberry farming (a significant portion of agricultural activity in the MA portion of the

[ii] The USDA estimate of 1,743 jobs for RI contains proprietors and other employees. For purposes of comparison, the 2,000 jobs of proprietors/family members were added to the RI state-level estimate of 2,563 jobs, totaling 4,563 jobs. Although USDA figures are not exactly comparable to the state-level study figures, they provide some insight into the discrepancies and underestimation of the USDA report.

watershed) is experiencing considerable development pressure. Furthermore, a recent challenge facing farmland is the placement of renewable energy projects. In the past few years in RI, the government has recognized the importance of balancing the need for renewable energy and preserving farmland; it is becoming increasingly lucrative for farmers to place renewable projects, such as wind turbines and solar fields, on their land to help mitigate farming expenses and increase income. In 2017, the RI General Assembly amended the Farm, Forest, Open Space Land program, which provides tax incentives to preserve these lands, to allow participants to continue claiming tax exemptions if the total acreage of the land is less than 20% renewables.[31] Additionally, in July 2018, RI Governor Raimondo announced a new initiative that incentivizes construction of renewable projects on brownfields, carports, and rooftops as a way to protect green space, such as farmland, from being developed for these renewable energy projects.[32]

Along with these potential threats to available agricultural land, however, comes the opportunity for increased agricultural activity through changing climate patterns. From 1960 to 2015, the air temperature in the NBW increased by 2.5-3° F. This rate is expected to accelerate in coming years with a predicted 5 to 10° F increase within the next 100 years; a 7° F increase most likely. This average increase in temperature would leave Rhode Island with a climate similar to that of modern-day South Carolina or Georgia.[33] Furthermore, accompanying this warmer weather will be an overall increase in precipitation. RI and MA currently receive approximately 40 inches of precipitation per year and this is predicted to increase by one to three inches in the future. Furthermore, there will be a decrease in snowfall, an increase in rain during winter months, and the potential for drought in summer months.[34]

As stated above, this change in weather and precipitation patterns provides the opportunity for agriculture similar to that of South Carolina, which grows tobacco, tomatoes, cotton, corn, soybeans, melons, hay, peanuts; in 2017 alone, agriculture contributed nearly $1.3 billion to the state's economy. However, it is important to note that aside from climate, South Carolina has soils that are conducive to the growth of these agricultural products and their viability on soil in the NBW may not be as productive.[35]

Overall, although population growth and urban sprawl pose threats to agricultural land, proper management can help protect and maintain this land and the newfound opportunities that come with it as a result of climate change. Changes in climate and precipitation will also present new opportunities and potential shifts in the agricultural sector within the NBW.

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[6] Sources: National Humanities Center, n.d.; Pastore, 2014.
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[9] Source: Jones, 1991.
[10] Source: Sproul & Elsner, 2013.
[11] Sources: USDA 1920 Census of Agriculture, 1922; USDA 1930 Census of Agriculture, 1932
[12] Source: USDA 1969 Census of Agriculture, 1972
[13] Sources: USDA 1992 Census of Agriculture, 1994; Sproul & Elsner, 2013
[14] Source: USDA 2012 Census of Agriculture, 2014
[15] Source: Payne, n.d.
[16] Sources: MassGov, 2017; Sproul & Elsner, 2013.
[17] Sources: Massachusetts Department of Agricultural Resources, n.d.; Rhode Island Food Policy Council, 2016; USDA NASS, 2014.
[18] Source: Rhode Island Food Policy Council, 2016.
[19] Source: KFF, 2015.
[20] Source: Natural Resource Conservation Service, n.d.
[21] Source: Massachusetts Local Food Cooperative., n.d.
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[23] Sources: ecoRI, 2016; Sproul & Elsner, 2013; Rhode Island Food Policy Council, 2016; http://www.farmfresh.org/markets; North American Procurement Council, 2016.
[24] Source: USDA NASS 1992 Census of Agriculture, 1994; USDA NASS 2012 Census of Agriculture, 2014.

[25] Source: USDA NASS 2012 Census of Agriculture, 2014. Data on cranberry blog acreage and gross gate value were provided by the Cape Cod Cranberry Growers' Association.
[26] Source: Bureau of Economic Analysis, 2015.
[27] Source: Bureau of Economic Analysis, 2015.
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[30] Source: NBEP "Land Use," 2017
[31] Source: Faulkner, 2018.
[32] Source: Office of Energy Resources, 2018.
[33] Source: NBEP "Temperature," 2017
[34] Source: NBEP "Precipitation," 2017
[35] Source: NASS USDA, 2017.

Appendix:

Table A1: Growth in Number of MA and RI Farms in NBW Counties, 1992-2012

	Bristol	Kent	Newport	Providence	Washington	Bristol	Norfolk	Plymouth	Worcester
Farms, 1992	27	70	120	232	200	523	186	668	997
Farms, 2012	42	126	214	425	436	717	245	825	1560

Source: USDA, 1992 & 2012 Census of Agriculture

Table A2: Agricultural Impact in MA & RI NBW Counties, 2012

County	Number of Farms	Land (Acres)	Market Value of Sales ($1000s)	Crops ($1000s)	Livestock ($1000s)
			RI		
Bristol	42	(D)	$2,669	$2,147	$522
Kent	126	(D)	$4,353	$3,498	$855
Newport	214	11,559	$14,630	$12,153	$2,477
Providence	425	(D)	$14,079	$10,954	$3,125
Washington	436	27,305	$23,921	$20,229	$3,692
Total, RI	1,243	69,589	$59,652	$48,981	$10,671
			MA		
Bristol	717	34,869	$37,658	$29,899	$7,759
Norfolk	245	9,448	$12,498	$9,473	$3,025
Plymouth	825	64,032	$108,083	$99,671	$8,412
Worcester	1,560	101,808	$57,478	$39,575	$17,903
Total, MA	3,347	210,157	$215,717	$178,618	$37,099
Total, All	**4,590**	**279,746**	**$275,369**	**$227,599**	**$47,770**

(D) Data withheld to avoid disclosing data for individual farms.
Source: USDA NASS, 2012

Table A3: Agricultural Employment in MA & RI NBW Counties, 2015

County	Farm Proprietors Employment	Farm Employment
	RI	
Bristol	32	34
Kent	110	139
Newport	183	354
Providence	389	535
Washington	380	645
Total, RI	1,094	1,707
	MA	
Bristol	658	1,082
Norfolk	171	399
Plymouth	629	1,039
Worcester	1,434	1,956
Total, MA	2,892	4,476
Total, All	3,986	6,183

Source: BEA

Figure A4: Total and Farm Employment Growth in NBW Counties, 2001-2015

County	All Employment, 2001	All Employment, 2005	Farm Employment, 2001	Farm Employment, 2005
Bristol	20,427	22,895	51	34
Kent	95,683	98,401	117	139
Newport	54244	56495	346	354
Providence	350,604	366,821	404	535
Washington	64,285	78,907	510	645
Bristol	270,561	288,580	1,219	1,082
Norfolk	412,189	472,337	370	399
Plymouth	224,100	266,297	1,256	1,039
Worcester	406,906	446,874	1,672	1,956

Source: BEA

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