

NARRAGANSETT BAY WATERSHED ECONOMY

The ebb and flow of natural capital



Forestry Overview

Forests and open space play vital roles in almost every facet of our daily lives, both in rural and urban areas. They are much more than places to visit for recreational purposes: forests provide a variety of valuable goods and services for our economy. For example, forest products are used to build and furnish houses, produce paper, and are present in the food we eat. The forest products industry accounts for nearly 5% of U.S. manufacturing output (GDP). This amounts to over \$200 billion in products annually, employing almost 900,000 workers in 2016.¹

In addition to generating a monetary contribution and supporting jobs, forests provide a multitude of ecological benefits that include carbon sequestration, air pollution removal, carbon storage, and water filtration, among others. A 2010 study illustrated that in the study year alone, trees and forests in the U.S. removed over 17 million metric tons of air pollution. This amounted to human health effects valued at nearly \$7 billion.²

The significance of forests is also apparent in the Narragansett Bay watershed (NBW): in 2015, the 611,000 acres of forest helped employ over 5,000 individuals.³ This report estimates that in 2013, all forest-based sales generated in the Rhode Island (RI) portion of the NBW reached a total of \$698 million (in 2016 dollars). In addition, the forest product and recreational sectors accounted for over 3,000 jobs. This report also estimates that in 2006 in the Massachusetts (MA) portion of the NBW, the forest-based sector employed over 2,000 individuals. In total, this accounted for over \$170 million in employee wages (in 2016 dollars).

History

Forest lands in the NBW have faced many changes over the years, due to both human action and natural forces. These changes include urban development, human manipulation, aging, and other natural processes such as windstorms, snowstorms, and floods, all of which impact forest development.⁴ Due to these effects, the cover and health of forests in the watershed has fluctuated throughout history.

Beginning in the early 17th century when European settlers such as Roger Williams began to colonize RI and MA, forest still covered much of the watershed. In RI, 90% of land in the state was forested in 1630 (Figure 1). These large areas of forest were drastically reduced beginning in 1767, decreasing to less than 25% by 1887.⁵ The rapid reduction of forested land was mainly due to the peak of agriculture when farmers deforested land at staggering rates to make room for crops.⁶

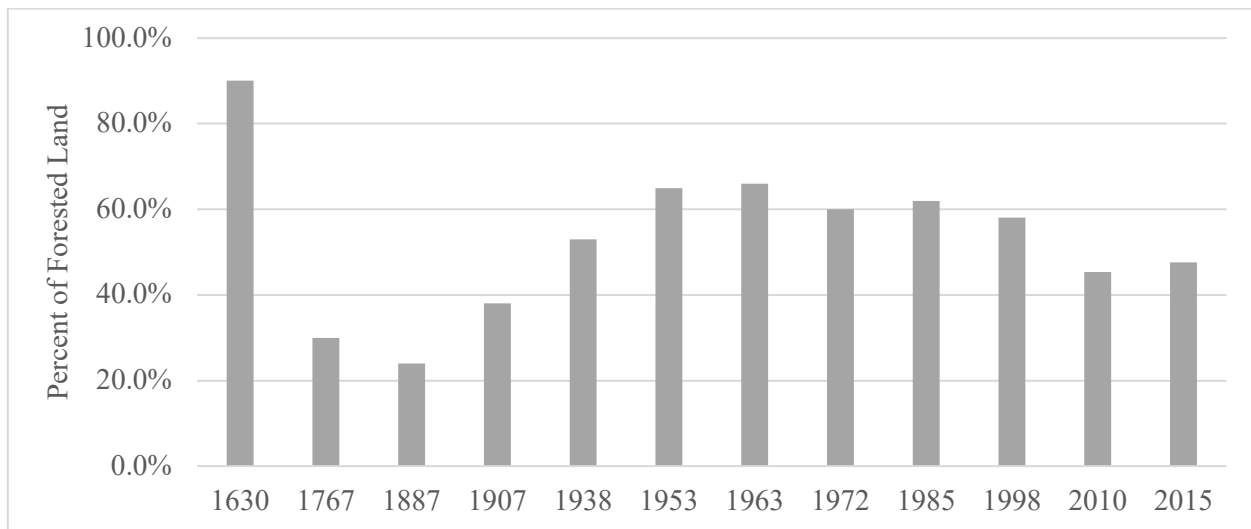


Figure 1: Percent of Forested Land in Rhode Island: 1630, 1767, and 1887-1998⁷

Source: RIDEM, 2002; NBEP, 2017

Note: The decline in coverage between 1630 and 1767 was due to European settlement, as colonists collected wood for fire and cleared land for agriculture (previously, the Native American tribes were nomadic and did not stay in one location and clear extensively for settlement). The Industrial Revolution marked a pivotal shift in forest coverage in the state—as migration shifted towards cities, agriculture was abandoned and forests began to grow on vacant farms.⁸

Major deforestation occurred later in MA than in RI, with the peak of clearing occurring between 1830 and 1885. During this time, 70% of forested land in MA was cleared for harvesting forest products and agricultural pursuits including pastures, cropland, and orchards.⁹

Between the late 1800s and the mid-1900s, agriculture in the NBW began to decline as the Industrial Revolution took hold and populations shifted away from farms and into cities to work in factories. This led to a rise in the growth of urban-industrial population centers and an increase in abandoned farms, allowing forests to make a comeback in the 20th century.¹⁰

Although a revival occurred for forests in the NBW, it was short-lived. Since 1952, the area of forest land in RI has decreased by 15%, from an estimated 434,000 acres to an estimated 367,000 acres in 2015. This remaining forest coverage in 2015 accounts for approximately 55% of total land area in the state.¹¹ During the same period in MA, forest land has decreased less dramatically at 9%, from an estimated 3.3 million acres of forest cover to an estimated 3.0 million acres. This 2015 forest cover

accounts for approximately 61% of total land area in the whole state, including the non-NBW portion.¹² A large amount of this forestland is privately owned (Figure 2).¹³

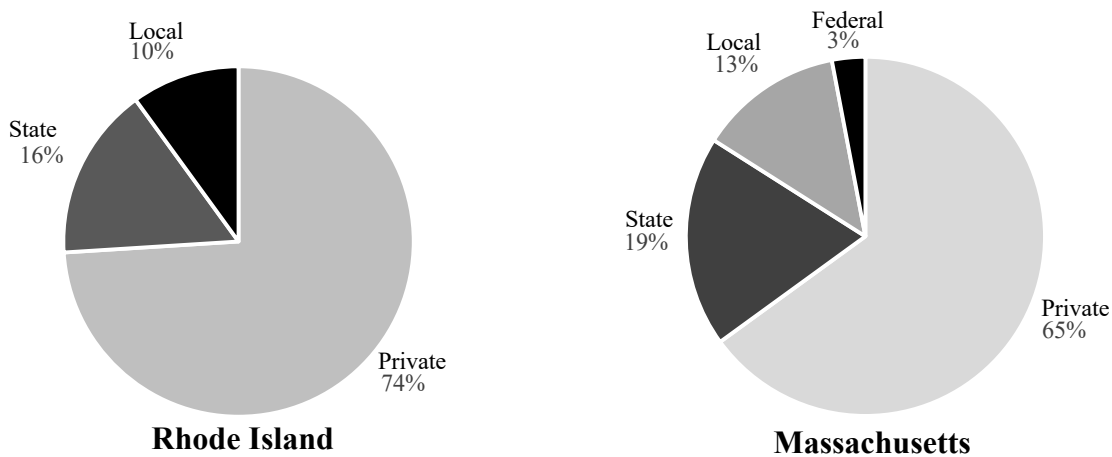


Figure 2: Forest Ownership of Rhode Island and Massachusetts, 2013

Sources: USDA Forests of Rhode Island, 2013; USDA Forests of Massachusetts, 2013

Despite major historic losses in forest coverage for both states, forest area has been increasing in the past few years. For example, from 2010 to 2015, there was a 5.1% increase in total forestland, increasing from 352,000 to 369,800 acres in RI.¹⁴ In MA from 2010 to 2015, the improvement is smaller with a less than 0.3% increase in forestland, from 3,014,600 to 3,024,900 acres; similarly, it is estimated that 38,000 acres of forest and wetlands were lost between 2005 and 2013, accounting for a loss of 1.2%.¹⁵ ¹⁶ The exact cause of this increase is not identified in reports, but cites the economic recession and potential unidentified factors as the cause of the increase, although this trend may be reversing. In addition to marginal forest coverage increases, timberland—forestland that produces commercial crops of timber—has seen an increase in the last five years. In RI, timberland area has increased nearly 5% and MA has witnessed a 1% increase.¹⁷

Although there have been recent positive improvements to forested land in RI and MA, forests have become more fragmented.¹⁸ Fragmented forestland is a growing concern in the watershed due to its potential impact on local water cycles, reduction of wildlife habitat, isolation and loss of species and gene pools, and fostering the invasion of exotic plant species.¹⁹ In response, public agencies and non-profit organizations have begun to purchase forested land in RI and MA to prevent this fragmentation. Since 1952, the acreage owned by state and local municipalities has increased by 14% in RI.²⁰ In MA, there are 943,000 acres of forest permanently protected from development in the state.²¹

Data Sources and Limitations

Estimates of forest land value, sales, employment, and wages are provided for the economic impact of forests within the NBW. These data are derived from local studies and national studies at the state level, including the United States Department of Agriculture Forest Service state reports, the Economic Importance of Rhode Island's Forest Based Economy, and an Assessment of the Forest Resources of Massachusetts.

Unfortunately, attaching a monetary value to the numerous benefits generated by forests can be a challenge. Many residents within the NBW only recognize financial gains from their forest lands when they sell their property.²² Despite this difficulty, this report still estimates the monetary value of forests given available information. To estimate the forest-based economic impact within the NBW, this report uses published data at the state level. State figures were adjusted by the share of land area within the watershed: for RI, this is 62.5% and for MA, 12.6%. For example, the USDA estimate of 367,000 acres of forest in RI translates to 230,000 acres of forest (62.5% of total forest coverage in the state) in the RI portion of the watershed (for a map of the NBW, please reference the "Geography" section).

For additional information on the methodology used in this report, please refer to the "Methodology" section.

Current Status & Trends

Today, individuals across the country enjoy the benefits of forests, including recreational and environmental services. These include water filtration, carbon sequestration, air filtration, as well as recreational benefits, such as aesthetic values and benefits for hikers, rock climbers, wildlife watchers, horseback riders, leaf peepers, hunters, and fishermen. A 2010 study showed that in that year alone, trees and forests in the U.S. removed over 17 million metric tons of air pollution. This amounted to human health effects valued at nearly \$7 billion, including the estimated avoidance of more than 850 incidences of human mortality and 670,000 incidences of acute respiratory symptoms.²³

Forests also provide high economic values for many individual firms and industries. For instance, forests supply firewood and timber products for industries such as logging, shipbuilding, lobster traps, and real estate. In addition, forests provide non-timber products that have economic values for some people, including witch hazel, maple syrup, mushrooms, berries, and floral greenery.

The significance of forests in the U.S. is also apparent in the NBW, where it provides many important benefits to residents of and visitors to the region. The forest industry generates value through the sale of products and by providing jobs to NBW residents. The State of Rhode Island conducted a study in 2013 to estimate the direct overall value of RI's forest-based economy and found that all forest-based sales generated in the RI portion of the NBW reached a total of \$698 million (in 2016 dollars; Table 1). In addition, the forest product and recreational sectors accounted for over 3,000 jobs.

Table 1: Estimated Value of Forest-Based Manufacturing and Recreation for Sales and Employment in RI Portion of the NBW, 2013 (in 2016 dollars)

	Sales (\$1000s)	Jobs
Forestry & Logging	\$1,286	63
Wood Products Manufacturing	\$104,168	413
Furniture and Related Product Manufacturing	\$131,174	813
Paper Manufacturing	\$201,263	750
Wood Energy	\$15,433	16
Christmas Trees and Maple Syrup	\$3,215	25
Total Forest Products	\$456,538	2,080
Forest Recreation Sales	\$241,129	938
Total	\$697,667	3,018

Source: North East State Foresters Association, 2015

In 2006, MA conducted a similar original study and estimated the overall value of the forest-based economy in the state.²⁴ Based on previously stated assumptions, this report estimated that in 2006 in the MA portion of the NBW, the forest-based sector employed over 2,000 individuals (Table 2). In total, this accounted for over \$170 million in employee wages (in 2016 dollars).

Table 2: Estimated Value of Forest-Based Establishments, Employment, and Wages in MA Portion of the NBW, 2006 (in 2016 dollars)

Licensed Foresters	Licensed Harvesters	Employees	Wages (\$1000s)
22	64	2,117	\$170,106

Source: de la Cretaz, et al., 2010

Beyond these extractive benefits, forests also provide non-extractive benefits. These include providing a steady and dependable supply of clean air and water through purification, regulating climate, and offsetting human carbon dioxide emissions. Forest ecosystems are the largest terrestrial carbon sinks on earth— on average, one acre of forest can store approximately 85 tons of carbon.²⁵ Many of the water supply reservoirs in the NBW are surrounded by forests due to their important role of filtering out pollutants and maintaining water quality.²⁶ Attaching a monetary value to this type of benefit generated by forests is an extremely difficult challenge, and one that is not addressed in this phase of the project.

Table 3: Forested Land in the Narragansett Bay Watershed, 2015

	Acres (1000s)
Rhode Island	230
Massachusetts	382
Total	612

Sources: Forests of Massachusetts, 2015; Forests of Rhode Island, 2015

Forests are an extremely vital and valuable part of the NBW. Not only do they generate revenue in the region and provide employment and wages for residents, but forested ecosystems contribute to the quantity and quality of available water, and impact the health of surrounding ecosystems. For example, forests act as a sponge by capturing and storing water when it is abundant and releasing it during dry periods. Without forests and the various provided benefits, agricultural production, quality of life, and human health would be jeopardized.²⁷

Future Threats and Opportunities

Land use | Temperature | Precipitation

Land use within the NBW varies greatly with respect to population density: in more densely populated areas, like the Providence River Estuary, up to 85% of land is urbanized, while less developed areas can be up to 70% forest. Even though there is substantial forest coverage in certain places in the NBW, this remaining forest land has been under threat over the past decades, especially from human development. From 2001 to 2011, the amount of forest land in the NBW decreased by 4.3% from 443,800 to 424,642 acres, while the amount of urban land increased by 8.5% from 350,369 to 379,804 acres.²⁸ Furthermore, climate change can impact tree species composition and coverage: trees that are under the most pressure include the Eastern hemlock, red maple, and eastern white pine (this will also impact industries reliant on these specific species, such as timber harvesting and maple syrup collection).

Aside from human expansion, the effects of climate change will also shape the future of forests in the NBW. Air temperature in the area has been slowly increasing over the past few decades, but this increase is expected to accelerate in years to come; if global carbon emissions continue to follow a trajectory similar to that in recent decades, the climate in the NBW will be similar to that of modern-day Georgia or South Carolina, with a likely seven-degree increase in average summer temperature to an estimated 77° F.²⁹ Accompanying this change in temperature is a change in precipitation patterns. The overall amount of precipitation is expected to increase in RI and MA: since the 1980s, the two states have averaged 40 inches of rainfall per year—this is expected to increase by up to three inches by 2100.³⁰

Both the temperature increase and change in precipitation can have impacts on the forest ecosystems in the NBW. These changes in forest composition will alter everything from the type of wood harvested for furniture and houses to the amount of carbon they sequester to the types of animals they shelter. The impact will vary from tree species to tree species depending on their adaptability, but the USDA predicts major losses in Eastern hemlock, red maple, and eastern white pine, as well as an increase in prevalence of blackgum, flowering dogwood, sassafras, American basswood, Eastern cottonwood, pignut hickory, and white oak. Other species will experience minor changes in population or none at all.³¹ Additionally, the trees that are decreasing in population will be moving

further north and further west due to increases in temperature and changes in precipitation in their current habitat.³²

Overall, it is difficult to qualify the potential threats or benefits that may arise from the new composition of forests. However, this forest coverage will continue to be threatened by a growing population and increased human development of open space and forest land.

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³ Sources: de la Cretaz et al., 2010; North East State Foresters Association, 2015.

⁴ Source: de la Cretaz et al., 2010.

⁵ Source: U.S. Forest Service, RIDEM, 2002.

⁶ Source: U.S. Forest Service, RIDEM, 2002.

⁷ Source: U.S. Forest Service, RIDEM, 2002.

⁸ Source: U.S. Forest Service, RIDEM, 2002.

⁹ Source: de la Cretaz et al., 2010.

¹⁰ Sources: de la Cretaz et al., 2010; U.S. Forest Service, RIDEM, 2002.

¹¹ Sources: U.S. Forest Service, RIDEM, 2002; North East State Foresters Association, 2015.

¹² Source: Butler, Forests of Massachusetts, 2016.

¹³ Sources: Butler, Forests of Massachusetts, 2014; Butler, Forests of Rhode Island, 2014.

¹⁴ Source: Butler, Forests of Rhode Island, 2015.

¹⁵ Source: Butler, Forests of Massachusetts, 2015.

¹⁶ Source: Mass Audubon, 2014.

¹⁷ Sources: Butler, Forests of Massachusetts, 2016; U.S. Forest Service, RIDEM, 2002; North East State Foresters Association, 2015.

¹⁸ Sources: Forests of Massachusetts, 2013 & Forests of Rhode Island, 2013.

¹⁹ Source: U.S. Forest Service, RIDEM, 2002.

²⁰ Source: RI Division of Forest Environment, 2010.

²¹ Sources: de la Cretaz et al., 2010; Massachusetts Department of Conservation and Recreation, 2017.

²² Sources: Krieger, 2001; Pimentel et al. 1997; Costanza et al. 1997.

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- ²³ Sources: Nowak, DJ et al., 2014.
- ²⁴ Source: de la Cretaz, et al., 2010.
- ²⁵ Source: Avril L. de la Crétaz, et. al. 2010.
- ²⁶ Sources: United States Forest Service Historical Trends, 2014; U.S. Forest Service, RIDEM, 2002.
- ²⁷ Sources: Butler, Forests of Rhode Island, 2016; U.S. Forest Service, RIDEM, 2002.
- ²⁸ Source: NBEP “Land Use”, 2017
- ²⁹ Source: NBEP “Temperature”, 2017
- ³⁰ Source: NBEP “Precipitation”, 2017
- ³¹ Sources: URI, RIDEM, RIAES, USDA, n.d.
- ³² Source: Fei, et al., 2017

Appendix:

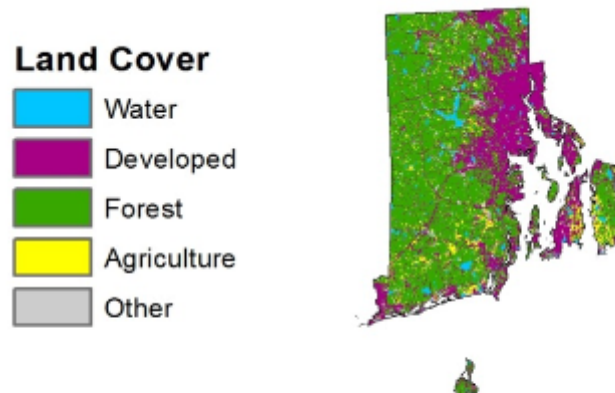


Figure A1: Forest and Other Land Cover of Rhode Island, 2011

Sources: USDA Forests of Rhode Island, 2015; National Land Cover Database (Jin et al. 2013)

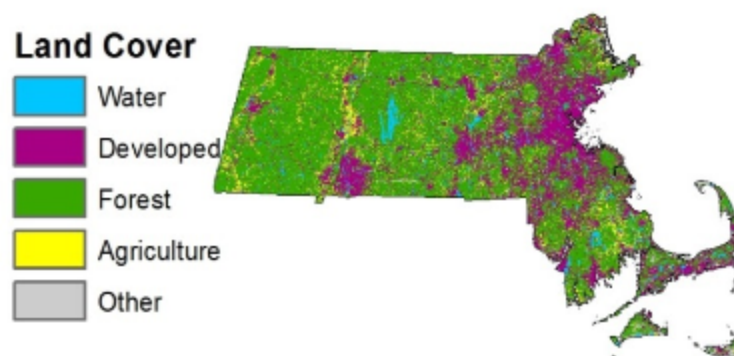


Figure A2: Forest and Other Land Cover of Massachusetts, 2011

Sources: USDA Forests of Massachusetts, 2015; National Land Cover Database (Jin et al. 2013)

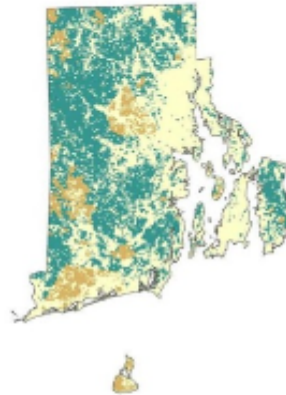


Figure 6.—Private (■) and public (■) forest ownership

Figure A3: Forest Ownership of Rhode Island

Source: USDA Forests of Rhode Island, 2013 (Hewes et al. 2014)

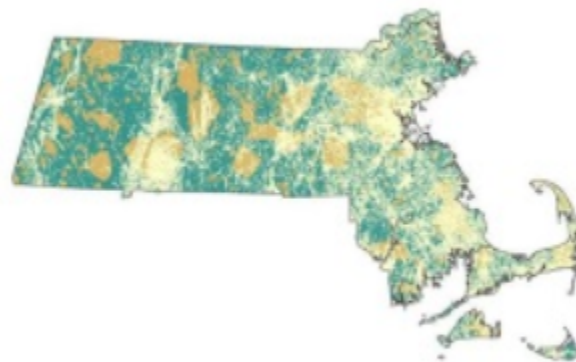


Figure 6.—Private (■) and public (■) forest ownership

Figure A4: Forest Ownership of Massachusetts

Source: USDA Forests of Massachusetts, 2013 (Hewes et al. 2013)

Table A1: Value of Forested Land in Rhode Island and Massachusetts, 2015 (\$1994)

	Acres (1000s)	Value (\$1000s)*
Rhode Island	370	\$45,214
Massachusetts	3,025	\$369,655
Total	3,395	\$414,869

Note: *Based on the Costanza et al., 1997 estimate of \$122.2 per acre of forest

Sources: Forests of Massachusetts, 2015; Forests of Rhode Island, 2015

Table A2: Estimated Value of Forest-Based Manufacturing and Recreation for Sales and Employment in Rhode Island, 2013

	Sales (\$1000s)	Jobs
Forestry & Logging	\$2,000	100
Wood Products Manufacturing	\$162,000	660
Furniture and Related Product Manufacturing	\$204,000	1,300
Paper Manufacturing	\$313,000	1,200
Wood Energy	\$24,000	25
Christmas Trees and Maple Syrup	\$5,000	40
Total Forest Products	\$710,000	3,325
Forest Recreation Sales	\$375,000	1,500
Total	\$1,085,000	4,825

Source: North East State Foresters Association, 2015

Table A3: Estimated Value of Forest-Based Establishments, Employment, and Wages in Massachusetts, 2006

Licensed Foresters	Licensed Harvesters	Employees	Wages (\$1000s)
174	504	16,800	\$1,130,000

Source: de la Cretaz, et al., 2010

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