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North Shore Blue Economy Phase I: Findings & Vision Forward

September 2021

ACKNOWLEDGEMENTS

The University of Massachusetts Amherst Gloucester Marine Station and the University of Massachusetts Dartmouth would like to thank the following for funding and supporting this work: Commonwealth of Massachusetts, in particular Senator Bruce Tarr, Representative Ann-Margaret Ferrante and Secretary Mike Kennealy; UMass Amherst Department of Environmental Conservation and the Center for Agriculture, Food & the Environment (CAFE); DOI Northeast Climate Adaptation Science Center; Gloucester Economic Development & Industrial Corporation (EDIC); the City of Gloucester; Cape Ann Chamber of Commerce; North Shore Technology Council; and the Essex County Community Foundation. Thank you to the nearly 300 businesses and community leaders who shared their insights with the project's authors.

Special thanks to the North Shore Blue Economy Phase I Steering Committee (in alphabetical order):

- **Tom Balf**, Founder & Principal, OceanVest LLC and member of the Gloucester EDIC
- **Jill Cahill**, Community Development Director, City of Gloucester
- **Tom Chmura**, Board member, North Shore Technology Council
- **Martha Farmer**, Board member and Founder, North Shore InnoVentures
- **Stratton Lloyd**, Executive Vice President & COO, Essex County Community Foundation
- **Ken Riehl**, CEO, Cape Ann Chamber of Commerce

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Suggested citation: Kahl, K., D. Borges, M. Goodman, E. Rapoza, M. McCarthy. 2021. North Shore Blue Economy Phase I Findings & Vision Forward. https//www.umass.edu/nsblueeconomy

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North Shore Blue Economy Phase I: Findings & Vision Forward

EXECUTIVE SUMMARY

September 2021

OVERVIEW

The North Shore's history, economic base and culture are built around the ocean and the quality of life it provides. Traditional maritime industries including fishing, tourism, seafood processing and boat building are woven into the regional identity. Today, innovation across industry, science and technology is expanding how we think about the maritime environment to also include new and emerging industries such as marine robotics, ocean sensing, marine biotechnology, aquaculture, offshore wind and coastal resilience design, engineering and construction.

> Blue Economy: The sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health.

Terminology has changed to reflect this broader understanding—instead of referring to the "Maritime Economy," we now talk about the "Blue Economy," which is defined by the World Bank as "The sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health[1]." While our maritime economy has been studied for decades, exploring our North Shore Blue Economy is an approach to view our ocean as a resource that can generate economic growth, while also addressing and improving ecosystem health that supports long-term sustainability for the region. Accordingly, the goal of the North Shore Blue Economy initiative over the next ten years is to build and implement a resilient, sustainable, equitable and integrated Blue Economy network which builds upon our strengths and positions the region to capitalize on emerging opportunities in the Blue Economy.

A FOUNDATION TO BETTER UNDERSTAND THE NORTH SHORE'S COMPETITIVE POSITION IN THE BLUE ECONOMY

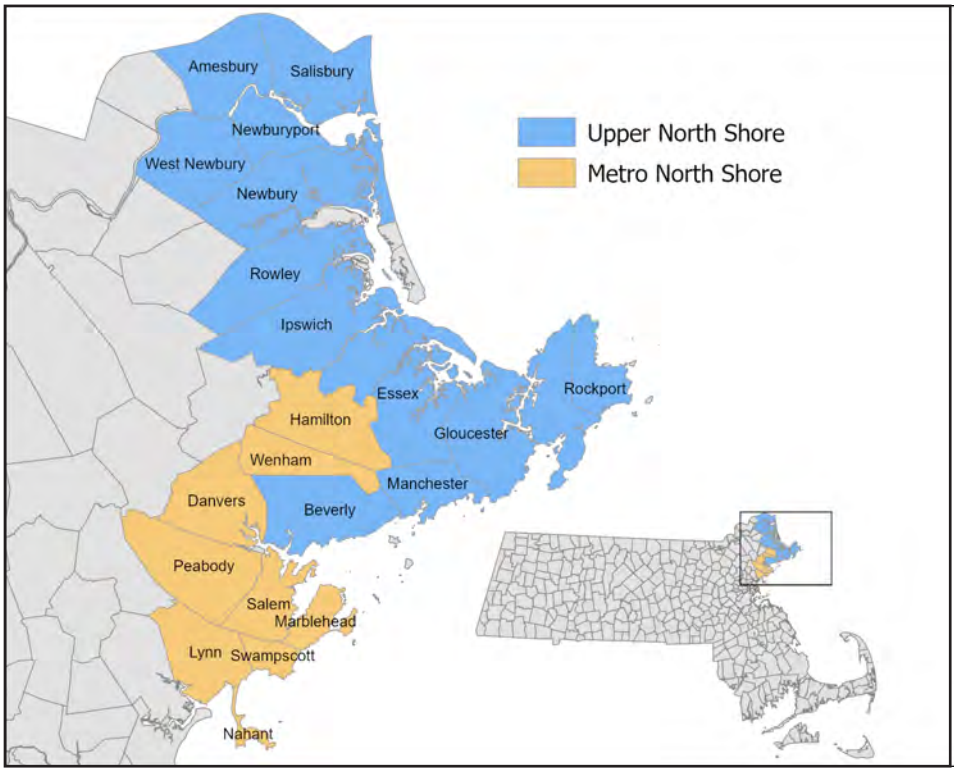
The experience of other regions across the state and nation makes it clear that regional economic development efforts that build on existing strengths are best positioned to achieve success and prosperity. The Blue Economy is becoming recognized as an important driver of jobs, innovation and economic growth globally (OECD, United Nations Goal 14), nationally (US Senate Oceans Caucus, NOAA 2021-2025 Blue Economy Strategy, US Economic Development Administration), in Massachusetts (Seaport Economic Council) and regionally (South Coast, Cape Cod). Now is the time to collectively mobilize the North Shore region. This report offers a foundation for business and community leaders to understand our competitive position in the sectors that make up the North Shore Blue Economy.

This study provides a comprehensive baseline assessment that quantifies the regional economic base, identifies leading and emerging industry clusters, provides a profile of the current regional population and workforce, and describes the composition, size and growth opportunities for Blue Economy businesses. The Project Team also engaged nearly 300 stakeholders to assess their perceptions of regional strengths and challenges, their visions for developing a vibrant Blue Economy and the steps needed to achieve those visions. The report shares findings, four interconnected opportunities to develop resilient, sustainable, and equitable Blue Economy strategies and a vision forward to catalyze and capitalize upon them.

[1] World Bank Group (2017). http://www.worldbank.org/en/news/infographic/2017/06/06/blue-economy

GEOGRAPHY

For the purposes of this study, the North Shore is defined as 21 primarily coastal communities, from Nahant in the south to the New Hampshire state line. These communities are home to an estimated 435,065 people, comprising 56% of Essex County and 6.4% of the Commonwealth[2]. Overall, the North Shore region is strongly tied economically to the Greater Boston area. However, an analysis of regional commuting patterns shows that there are "Metro North Shore" communities, where the majority of workers commute to Greater Boston and "Upper North Shore" communities, which have more inter-commuting relationships within the North Shore than with Greater Boston. This differentiation is perceived as a regional strength, in that it has both a strong coastal "self-sufficient" economy, as well as communities with a "front door" to Greater Boston's finance, life science and technology innovation economy.



KEY FINDINGS: DEMOGRAPHIC & ECONOMIC BASELINE ANALYSIS

The regional population is growing. The region's population grew by 4.9% from 2010 to 2019 and is projected to grow by 7.8% between 2010 and 2040.

The workforce is highly educated. North Shore residents age 25 and older possess high levels of education, with 42.2% having earned at least a Bachelor's degree. However, some of the region's most populated communities have the lowest levels of educational attainment, including Lynn, Peabody and Gloucester.

Residents have high incomes. The median household incomes of 16 of the region's 21 communities exceed the statewide median of $81,125.

[2] U.S. Census Bureau, 2015–2019 ACS 5-year estimates

There is a large number of workers moving into and out of the region for work on a daily basis. Local opportunities that match these workers' skills or new ideas that incubate regional opportunities present an opportunity to keep the region's most highly-skilled workers employed in the region.

Housing is a challenge. While the aforementioned bode well for economic growth and job creation, the high cost of housing in the area and the lack of affordable rental units in many North Shore communities presents a major challenge for economic growth and for attracting young families to the region.

The region's overall industry profile is similar to the national economy, but the region has competitive advantages relative to the nation as a whole. North Shore industry clusters that have a location quotient (LQ) above 1.0 means the region is more specialized in this industry than the nation as a whole. The region is most specialized in the Fishing and Fishing Products industry cluster, as well as several technology-based industry clusters such as Aerospace & Defense, Medical Devices, and IT & Analytics. These industries, along with other regionally specialized and emerging industries (e.g., Biopharmaceuticals, Marketing, Design, Publishing) show competitive advantage and highlight opportunities for growing and promoting the region's Blue Economy in both traditional and tech-oriented Blue Economy sectors.

Industry Cluster	LQ	Employment
Fishing/Fishing Products	11.2	900
Aerospace Vehicles & Defense	8.4	6,921
Biopharmaceuticals	4.7	1,782
Medical Devices	4.7	1,762
IT & Analytics	2.9	4,861
Education/Knowledge Creation	1.9	8,181
Marketing, Design, Publishing	1.6	3,631
Food Processing and Mfg.	1.5	2,281
Performing Arts	1.2	980
Lighting & Elec. Equipment	1.2	483
Downstream Chemical Products	1.1	400
Financial Services	1.1	2,851

SOURCE Emsi, 2020

The strength of our North Shore Blue Economy is a combination of mature and emerging specialized industry clusters and opportunities in both traditional maritime industries and technology-based industries not always perceived as being connected to the ocean.

THE NORTH SHORE'S BLUE ECONOMY

The Blue Economy, as defined in this assessment, includes six primary sectors[3,4]: Coastal Tourism & Recreation, Living Resources, Marine Transportation, Marine Construction, Ship & Boat Building & Repair and Offshore Minerals.

- These sectors employ 16,485 workers and account for 7.9% of the total jobs in the region.
- Coastal Tourism & Recreation accounts for the vast majority of employment, with 87% of the total number of Blue Economy jobs, followed by Living Resources (8.4% of total) and Marine Transportation (2.9% of total)[5].

Sector	Jobs 2020	Proportion 2020	# Change 2004-2020	% Change 2004-2020
Coastal Tourism & Recreation	14,350	87.0%	2,920	25.5%
Living Resources	1,393	8.4%	-517	-27.1%
Marine Transportation	474	2.9%	242	103.8%
Marine Construction	172	1.0%	15	13.6%
Ship & Boat Building & Repair	81	0.5%	38	90.0%
Offshore Minerals	16	0.1%	-54	-77.2%
Total:	**16,485**	**100%**	**2,644**	**19.5%**

- Blue Economy jobs grew faster than the regional economy as a whole; from 2004 to 2020, the number of people working in the Blue Economy grew by 19.5% in the North Shore (+2,644 jobs), which compares to 12.2% growth for all industries in the region over this period.
- The majority of job gains were in the Coastal Tourism & Recreation sector (+2,920), while job losses were experienced in the Living Resources (-517) and Offshore Minerals (-54) sectors.

The Living Resources sector is a regional strength in terms of its size, history and specialization. However, employment in the sector declined 27% between 2004 and 2020. This is consistent with other available data regarding the decline of the fishing fleet on the North Shore. Moving forward, coordinated and sustainable seafood business strategies that harness the region's assets, experience, expertise and access to ocean resources are needed to revolutionize this sector, which is foundational to many other elements of the regional Blue Economy.

While Coastal Tourism & Recreation represents 87% of the employment, it also represents the lowest average annual wage ($24,979), with most employment based in service jobs with no direct connection to the sustainable use of ocean resources. In comparison, the average annual wage for Living Resources ($75,924), Marine Construction ($72,055) and Ship & Boat Building & Repair ($64,268) are two to three times the average salary for a worker in the Coastal Tourism & Recreation sector. It will be important going forward to tease out sustainable Blue Economy jobs within the Coastal Tourism & Recreation sector (e.g., boat dealers, marinas, marine supplies, restaurants promoting local seafood, eco tours) and focus regional strategies around leveraging opportunities in those sectors.

[3] The six sectors comprise 23 industries in the Economics - National Ocean Watch (ENOW) data series (https://coast.noaa.gov/digitalcoast/tools/enow.html) as defined by their North American Industry Classification System (NAICS) code. Data from the Census Bureau's American Community Survey (ACS) were also used.

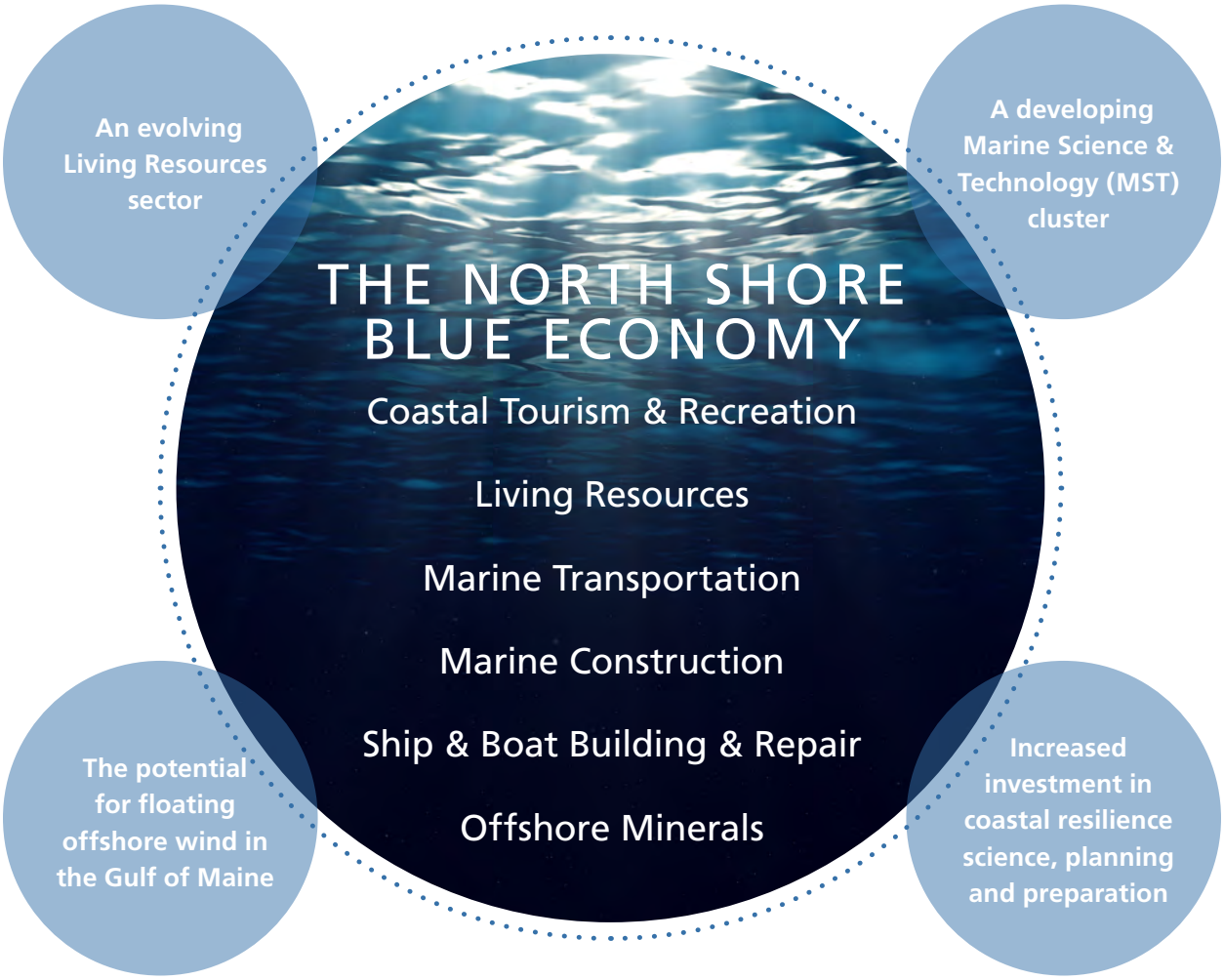
[4] See Appendix D in the full report for a list of the 23 ENOW industries within the six sectors.

[5] The number of jobs reported in the Living Resources sector is likely an undercount, because many of the workers in this sector, particularly seafood processing workers, are hired as contract workers through employment services agencies and are therefore not accounted for in the Living Resources data. These workers are included in the Temporary Help Services sector, which cannot be broken out to identify employees working in the Living Resources sector.

New areas, such as offshore wind or marine genomics, are only now being captured in employment and wage data, but are anticipated to be evolving opportunities moving forward. Climate change is a threat, but we have an opportunity to seize increased investments being made by state and federal government and to demonstrate leadership and innovation by incorporating climate resilient approaches into our Blue Economy strategies.

Nearly 300 regional stakeholders reported that a thriving Blue Economy must have better coordinated planning, investment strategies, targeted workforce training and marketing. Discussion around the tangible steps we can take to achieve prosperous and sustainable Blue Economy success revolved around doing a better job of 1) Planning: developing a coordinated plan for the region, mapping our assets and assessing business models; 2) Investing in infrastructure (dockage, transportation, housing) while retaining our unique culture; 3) Engaging young people and attracting new workers by developing targeted workforce training in our strength sectors; and 4) Marketing and promoting the region's successes, assets and vision forward, while creating a regional brand that all can envision themselves being a part of.

Nonprofit and Public Institutions play a crucial role in our regional Blue Economy. These organizations and institutions produce research that drives innovation, implement and manage marine and coastal regulations, educate our children and the public, and convene dialogues and support action. While not fully captured in our economic data, these organizations are critical to the work ahead. This report makes it clear that the North Shore Blue Economy ecosystem is populated, at every level, with enterprises doing important work that contributes to the regional Blue Economy.



FOUR INTERCONNECTED OPPORTUNITIES TO GROW THE NORTH SHORE BLUE ECONOMY

are Tied to the Region's Existing Strengths and Emerging Growth Prospects

1. An evolving Living Resources sector: Regional support of innovation and coordination in sustainable approaches to harvest healthy groundfish populations and build markets for underutilized fish species can reinvigorate the industry. In addition, continued support for the lobster fishery as it responds to pressures of climate change and gear restrictions may help continue the growth and infusion of jobs and revenues that lobstering has seen in the last decade, while exploratory research and pilot projects with shellfish and kelp aquaculture could diversify seafood resources and revenues. Additional areas to expand the Living Resources sector include, but are not limited to, seafood and value-added processing, food science research, innovations in the seafood supply chain network and marine biomaterials science.

2. A developing Marine Science & Technology (MST) cluster: Innovation often occurs at the intersection of existing industry clusters. Sustainable seafood management, ocean research and engineering, biomanufacturing, marine genomics, drone applications and big data management are ripe for new networks and expansion in the region. Access to diverse laboratory, coastal and marine environments, relatively affordable and available office space, and easy rail connections to and from Boston positions the region's developing MST sector to thrive. Capacity in MST also positions the region as a destination for training, research and development and ocean application. The connection to Boston's life science, technology and investment communities is a critical factor in growing MST partnerships and supporting opportunities for homegrown MST workers within the region rather than having them commute outside the region.

3. The potential for floating offshore wind in the Gulf of Maine: Offshore wind will soon be a major new industry in the United States. State-level incentives and mandates have created a market of about 30 gigawatts of nameplate capacity at the time of this report. Northeast States are exceptionally well-positioned to benefit from offshore wind, since they have the most offshore wind potential, the cheapest costs of deployment and the potential for substantial economic benefits[6,7]. The North Shore's potential role in the emerging offshore wind market is evolving, but we, as a region, must ensure a seat at the table for coordinated decision-making and be in a position to seize the opportunities. Potential opportunity to support offshore wind development includes boat repair and maintenance services, ocean engineering, construction workers, boat captains, marine sensing and monitoring technologies and the use of fishing/lobstering fleets for cooperative research and support, among other opportunities.

4. Increased investment in coastal resilience science, planning and preparation: A rising sea level represents a significant threat to coastal ecosystems, communities and infrastructure through land loss, altered habitats and increased vulnerability to coastal storms, nuisance flooding and damaging wave actions such as erosion. The Commonwealth, the federal administration and the region are making strategic funding, policy, training and infrastructure investments. The North Shore must continue to seek creative ways to live with water, innovate around resilient best practices in coastal design, architecture, engineering and construction and be aware of and compete for robust federal funding strategies with a suite of collaborators, to safeguard our ports, properties and people.

[6] Beiter, P., Musial, W., Kilcher, L., Maness, M., & Smith, A. (2017). An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030 (No. NREL/TP-6A20-67675). National Renewable Energy Lab. (NREL), Golden, CO (United States).

[7] Musial, W., Heimiller, D., Beiter, P., Scott, G., & Draxl, C. (2016). 2016 Offshore Wind Energy Resource Assessment for the United States (No. NREL/TP-5000-66599). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

VISION FORWARD: A RESILIENT, SUSTAINABLE & EQUITABLE NORTH SHORE BLUE ECONOMY

This report aims to help local leaders to better understand the region's competitive position in the sectors that make up the regional Blue Economy. The analysis offers a foundation upon which to build resilient, sustainable and equitable economic development and community engagement strategies. We envision strategies that can both advance ocean-related economic interests and the ocean ecosystem health on which regional economies depend. The work of leadership begins with capacity building. Phase II will focus on how to apply Phase I findings to advance four broad targets:

1. Grow the North Shore Blue Economy Network. A Network of a diverse, regionally-representative thought leaders across Blue Economy sectors will provide coordinated advisory leadership, inclusive community engagement and serve as a hub for creative economic development and engagement strategies. The Network will collaboratively design, guide and inform: (a) strategy development, (b) funding opportunities and (c) research needs.

2. Develop workforce training and education to drive Blue Economy job creation. Integrated partnerships between regional research and higher education institutions, government and nonprofit enterprises and workforce incubators will be designed and catalyzed to shape and meet these new employment opportunities. By coordinating workforce development with economic development, we aim to open career pathways with a strong living wage that supports a high quality of life and serves to retain the talent we train.

3. Brand and market the North Shore's vision of a resilient, sustainable and equitable Blue Economy. Promote the region's successes and demonstrate Blue Economy activities and assets to attract new businesses, entrepreneurs, investors, scientists and engineers to areas of opportunity, as well as help the existing and traditional working waterfront enterprises succeed and expand in this larger market.

4. Fundraise and increase access to capital that will foster entrepreneurship and incubate Blue Economy enterprises and initiatives. Develop a cross-sector coordinated and targeted portfolio of state, federal and private funding opportunities to advance the North Shore Blue Economy and the infrastructure that supports its growth.

LEADERSHIP

The NSBE Initiative is led by the University of Massachusetts Amherst Gloucester Marine Station. A Steering Committee of representatives from the Gloucester Economic Development and Industrial Corporation, Cape Ann Chamber of Commerce, City of Gloucester, North Shore Technology Council, North Shore InnoVentures and Essex County Community Foundation provided support for this study and served in an advisory role. Additional funding support was provided by the Commonwealth of Massachusetts. Economic analysis was led by the University of Massachusetts Dartmouth Public Policy Center and completed by Springline Research Group.

1. INTRODUCTION

The North Shore was a center for maritime commerce before the founding of the United States. Even prior to the colonization of New England's shores, the fertile ocean resources in the Gulf of Maine attracted European fishing and whaling fleets. We know from colonial records that Native American tribes used the waterways around Cape Ann as trade routes because this was easier than traversing the rocky, glacial till and granite outcroppings that dotted the landscape[1]. It was this terrain that created a dependency on the seas for the survival of the early English settlers.

Across Massachusetts, but particularly on the North Shore, colonists found farming difficult and relied on the abundant cod and herring fisheries to sustain themselves and, in turn, they cultivated an export for trade. The old growth forests that stretched to the shore provided materials to create a fishing fleet and other goods to export back to an increasingly deforested England[2]. As the regional economy grew, the maritime economy expanded along with it. Shipwrights from Essex to Amesbury crafted innovative new vessels to support the fishing fleet that valued speed and maneuverability to secure the best market price for its catch. Trading centers such as Salem saw boom and bust as shipping merchants consolidated in Boston and industrialization brought railroads and flash freezing—a Gloucester invention by Clarence Birdseye—that allowed the region's famed cod to reach new markets. The region also became a tourist destination, as artists such as painter Fitz Henry Lane and poet Henry Wadsworth Longfellow conjured romantic images of the North Shore's coast and people, making it a destination for city dwellers seeking to connect with a disappearing way of life and natural splendor[3].

Throughout much of this history, our understanding of the ocean's role in the economy was largely centered on the traditional maritime industries described above—fishing and seafood processing, vessel building and repair, marine transportation and seaside tourism and recreation. Today, however, we are expanding how we think about the maritime environment to include new and emerging industries, such as marine robotics, ocean sensing, marine biotechnology, offshore wind and coastal resilience design. Terminology has also changed to reflect this broader understanding—instead of talking about the maritime economy, we now talk about the Blue Economy, which is defined by the World Bank as "The sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health[4]."

We are expanding how we think about the maritime environment to include new and emerging industries, such as marine robotics, ocean sensing, marine biotechnology, offshore wind and coastal resilience design.

This shift in how we perceive our ocean resources has opened up many new opportunities in both traditional and emerging sectors. Concurrent with developing new approaches to sustainably generate economic value from the oceans, substantial economic opportunities continue to arise from the search for new ways to conserve the ocean ecosystem.

[1] Kenny, H.A. (1971). Cape Ann: Cape America. J.B. Lippincott Co.: New York.

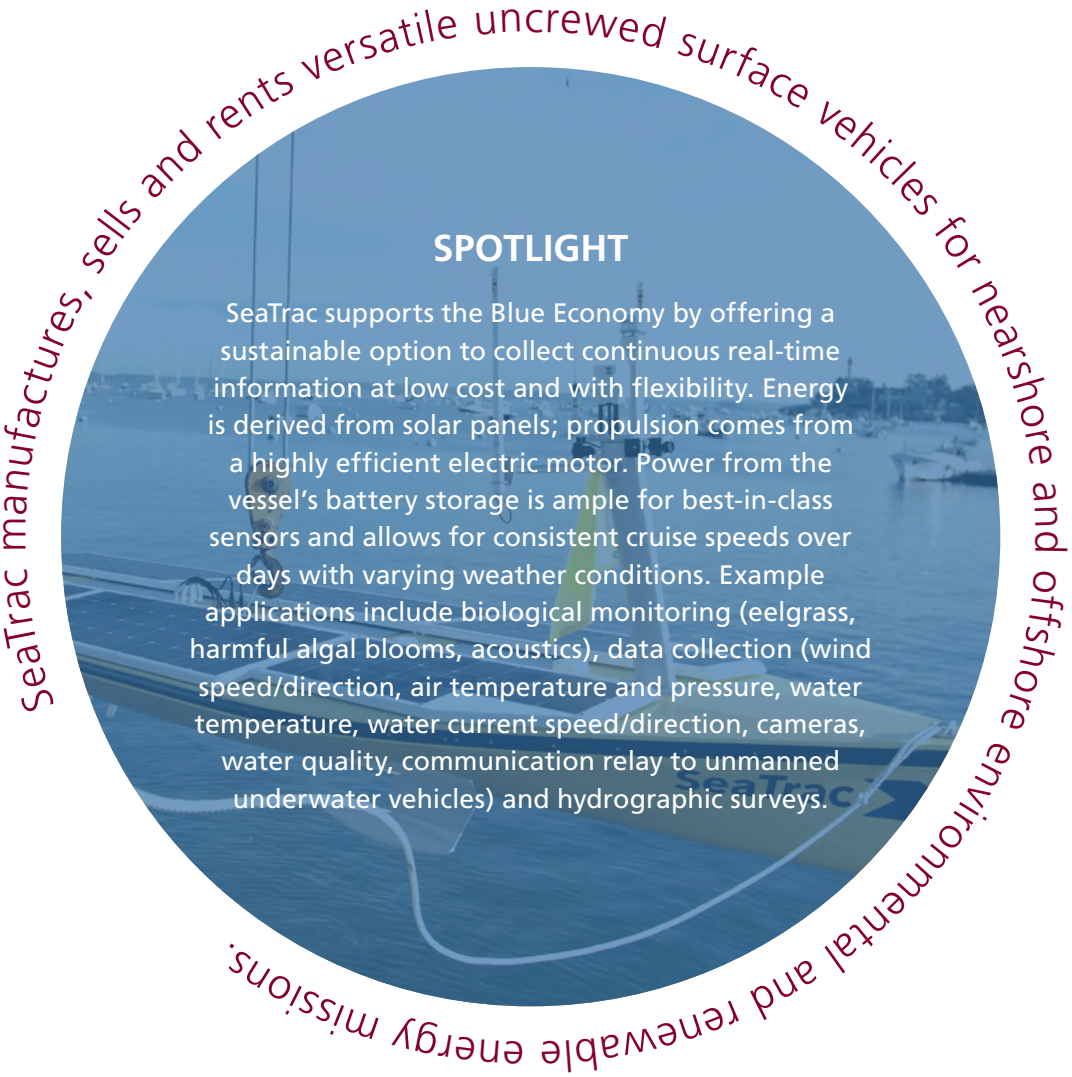
[2] Perunko, J., Bisher, K., & Davis, S. (2007). Maritime history of Massachusetts. Washington, DC: National Park Service.

[3] "Unfolding Histories: Cape Ann before 1900." Cape Ann Museum. 2018.

[4] World Bank Group (2017). Blue Economy infographic. Retrieved from http://www.worldbank.org/en/news/infographic/2017/06/06/Blue-Economy.

The North Shore region currently lacks a comprehensive economic development strategy that builds on its traditional strengths and positions the region to capitalize on new and emerging opportunities in the Blue Economy. A robust strategy is particularly necessary to respond to the effects of climate change and to develop sustainable approaches to natural resource management in the face of ocean warming, ocean acidification and the changes in abundance and location of certain marine species, which the region's traditional maritime sector has relied on for centuries.

The experience of other regions across the state and nation makes it clear that regional economic development efforts that build on existing strengths are best positioned to achieve success and prosperity. The Blue Economy is becoming recognized as an important driver of jobs, innovation and economic growth globally (OECD, United Nations Goal 14), nationally (US Senate Oceans Caucus, NOAA 2021-2025 Blue Economy Strategy, US Economic Development Administration), in Massachusetts (Seaport Economic Council) and regionally (South Coast, Cape Cod). Now is the time to collectively mobilize the North Shore region. This report offers a foundation for business and community leaders to understand our competitive position in the sectors that make up the North Shore Blue Economy.



1.1 PROJECT BACKGROUND AND SCOPE

In order to develop a regional blue economic development strategy, we aim to provide local leaders with a way to better understand their competitive position in the sectors that make up the regional Blue Economy. The experiences of other regions across the state and nation make it clear that evidence-based, regional economic development efforts that build upon existing strengths and assets best position regions to organize for success and prosperity. This assessment seeks to establish a foundation of understanding by:

- Undertaking an analysis of the economic base of the North Shore and its constituent communities (where data are available), including the identification of leading and emerging industry clusters;
- Developing a demographic profile of the current regional population and workforce with an analysis of regional commuting patterns that inform the degree to which the resident population is employed in the region;
- Describing the composition, size and growth trajectory for Blue Economy businesses and relevant research and development activities located in the North Shore region;
- Identifying opportunities in the Blue Economy sector;
- Engaging stakeholders in a series of meetings to inform meaningful analysis including sector-specific identification of strengths, challenges, regional vision and the tangible steps needed to achieve the vision.

This report is organized into seven sections.
This section provides background to the project.

SECTION 2
discusses the North Shore geography and the report's data sources and methodology.

SECTION 3
provides a sociodemographic analysis of the region
and an overview of the region's economic base.

SECTION 4
presents an assessment of the North Shore's Blue Economy.

SECTION 5
dives deeper into the assessment of the region's Blue Economy
with an analysis of its sectors.

SECTION 6
discusses the region's Marine Science and Technology assets.

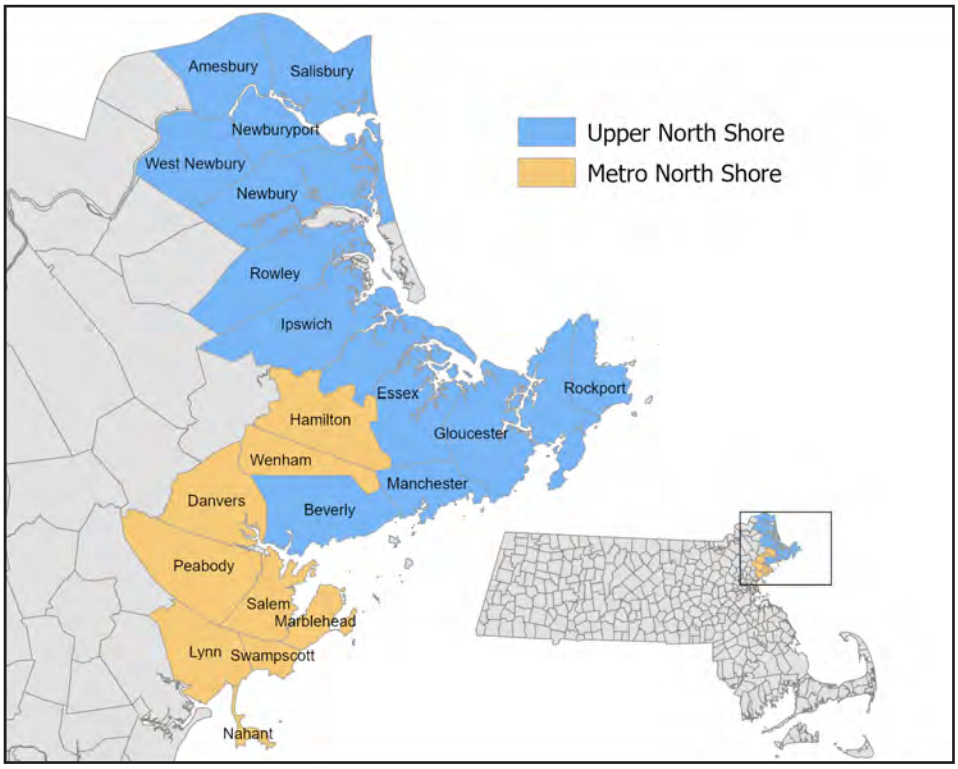
SECTION 7
describes the strength-based opportunities for the region in the Blue Economy
and provides a vision for moving forward into Phase II
of the North Shore Blue Economy Initiative
in which strategies will be developed and implemented.

2. GEOGRAPHY AND METHODOLOGY

2.1 HOW IS THE NORTH SHORE DEFINED?

The North Shore as a geographic entity is defined in many ways, whether it be based on cultural and historical definitions that have developed over time or by empirical analysis undertaken by various government and nonprofit agencies. This report defines the North Shore region empirically based on an analysis of commuting patterns[5]. Consistent with the approach used by the USDA, which is a non-core-based approach to delineating commuting zones, an agglomerative hierarchical clustering method was used to combine cities and towns. Agglomerative clustering is the most common type of hierarchical clustering used to group objects in clusters based on their similarity[6]. Overall, the North Shore region as a whole is strongly tied to the Greater Boston area economically. However, applying the methodology described above and taking into account regional commuting patterns, we find that the North Shore can be defined as 21 communities that primarily run along the coast of northeast Massachusetts (see Figure 1).

Figure 1 | North Shore Communities, Upper North Shore and Metro North Shore



Source: Public Policy Center

The region is divided into "Metro North Shore" communities and "Upper North Shore" communities, with the Upper North Shore communities having more inter-commuting relationships within the region than with Greater Boston. Conversely, the commuting relationships of the Metro North Shore communities closer to Boston show the substantial influence of the Greater Boston economy. Workers who live in Upper North Shore communities are more likely to work within

[5] Commuting data are from the U.S. Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) program, which publishes the Origin-Destination Employment Statistics (LODES) dataset. The LEHD program matches employment data collected from unemployment insurance filings with survey data and other administrative records collected through the Statistical Administrative Records System (StARS) database. This allows the Census Bureau to match residential addresses to work addresses on an individual basis. The data is then anonymized and noise is added to protect confidentiality. 2017 data were used, looking at all jobs.

[6] More information describing the methodology can be found in Appendix A.

the region than commute to Greater Boston, while the reverse is true for residents of Metro North Shore communities. Simply put, there will always be economic opportunities in and around Boston that draw in workers from other parts of Massachusetts, although the Metro North Shore communities also have commuting, economic and other relationships with the Upper North Shore communities. In addition, the Metro North Shore communities are in some ways the "front door" or the "bridge" to the Greater Boston economy and are most strongly attached to future economic opportunities on the North Shore, particularly in terms of developing technologies that spin-out from Greater Boston.

2.2 PRIMARY DATA SOURCES

Nine meetings were held or attended to solicit the input of regional leaders and to gather feedback on strengths, challenges and opportunities available to shape a North Shore Blue Economy.

1. Think Lab: Exploring the North Shore Blue Economy October 2, 2019

A diverse set of 78 stakeholders joined the Think Lab, held in partnership with Essex County Community Foundation's Empowering Economic Opportunity initiative[7] (see Figure 2). Mike Kennealy, Massachusetts Secretary of Housing and Economic Development, provided a keynote address supporting the initiative and providing statewide context for the importance of the Blue Economy. Senator Bruce Tarr provided concluding remarks. Dr. Kahl (UMass Amherst Gloucester Marine Station) provided research and data defining the need for the NSBE initiative as well as context defining the Blue Economy, including key themes and learnings that could be leveraged from state, national and global examples. Dr. Goodman (UMass Dartmouth Public Policy Center) presented early findings highlighting how much North Shore coastal communities rely on a healthy ocean for economic security. Presentations were followed by interactive, facilitated sessions to gather participant feedback on a vision for the North Shore Blue Economy and the enabling and limiting factors to achieve that vision. The target audience included business leaders, nonprofit organizations, municipal and community leaders, researchers, Blue Economy sector experts, philanthropists and investors.

Industry Perspective Meetings This series of five meetings with 54 regional Blue Economy industry leaders (see Figure 3) sought a diversity of perspectives relative to business type/expertise, age, gender, race and regional values. Meeting participant lists can be found in Appendix C.

The goals of each meeting were to:

1. Understand how each individual felt they/their business was connected to the Blue Economy.

2. Identify the local and regional enabling conditions and limiting factors.

3. Describe the tangible actions needed to advance the North Shore Blue Economy in their sector as well as across sectors.

4. Ask who else should be engaged to help inform knowledge of the sector and integrated opportunities across sectors.

[7] A report from the Think Lab can be found in Appendix B or at https://www.umass.edu/ses/gloucester-marine-station/north-shore-blue-economy

The five Industry Perspective meetings are listed with the date, number of participants and location at which the meeting was hosted by Kahl (UMass Amherst Gloucester Marine Station):

2. **Marine Science & Technology: Life Sciences**
   December 16, 2019
   7 participants; North Shore InnoVentures, Cummings Center, Beverly.

3. **Marine Science & Technology: Marine Sensing, Robotics**
   January 8, 2020
   12 participants; North Shore InnoVentures, Cummings Center, Beverly.

4. **Living Resources**
   February 7, 2020
   11 participants; UMass Amherst Gloucester Marine Station, Gloucester.

5. **Tourism & Recreation**
   February 27, 2020
   5 participants; Essex Heritage, Salem.

6. **Coastal Resilience**
   September 9, 2020
   21 participants; Hosted via Zoom

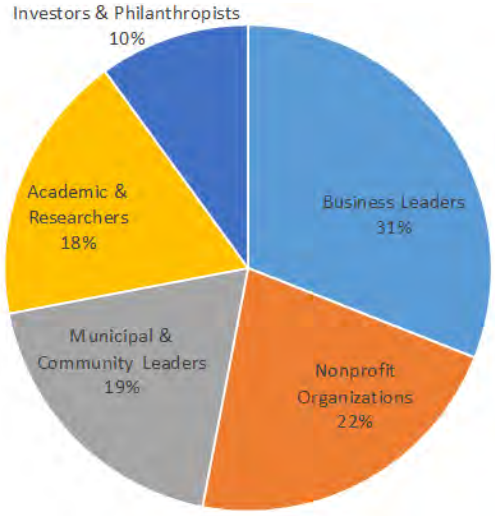


Figure 2 | Think Lab participants totaled 78 cross-sector leaders spanning the North Shore

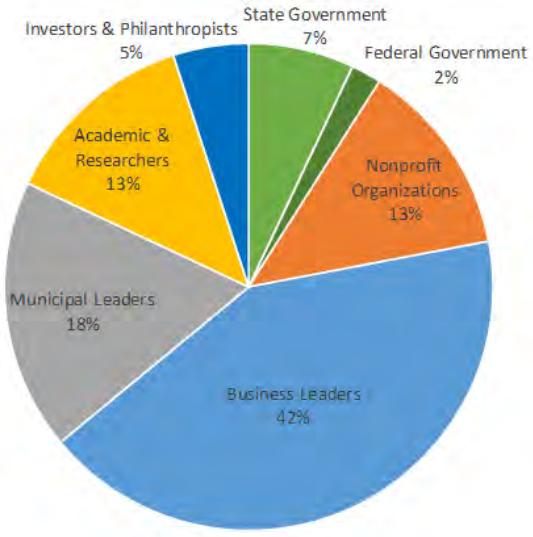


Figure 3 | North Shore Blue Economy Industry Perspective Group Participants

Presentations to regional bodies of planners, mayors and business owners Three invitations to regional meetings provided an opportunity to achieve some of the same Industry Perspective Meeting objectives in a less structured format with nearly 200 stakeholders. Participants were provided with presentations offering context defining the Blue Economy, examples of Blue Economy businesses and the objectives of the North Shore Blue Economy initiative. They were then asked, in group discussion format, the same questions about their regional Blue Economy vision, enabling and limiting factors and next steps needed to advance their vision.

7. **North Shore Alliance for Economic Development Annual Planners Meeting**
   February 14, 2020
   9 participants; Peabody Department of Public Services

8. **North Shore Coalition of Mayors, hosted by the Metropolitan Area Planning Council**
   February 27, 2020
   17 participants; Old Town House in Marblehead

9. **North Shore Chamber of Commerce Policy Breakfast Forum**
   March 4, 2020
   150 participants; Peabody Marriott Hotel

Additional conversations were held with industry leaders in Marine Transportation, Ship & Boat Building & Boat Repair and Offshore Wind Energy to seek greater understanding of sector-specific perspectives around enabling conditions, limiting factors and tangible next steps we can take as a region across Blue Economy sectors.

2.3 SECONDARY DATA SOURCES

For the purposes of this report, the Blue Economy is defined to be consistent with the recent statewide analysis of the "maritime economy" prepared for the Massachusetts Seaport Council by the Public Policy Center (PPC) at UMass Dartmouth. The data in the statewide analysis was derived from the Economics - National Ocean Watch (ENOW) data series, which is produced by the National Oceanic and Atmospheric Administration's (NOAA) Office for Coastal Management[8]. There are six sectors comprising 23 industries in the ENOW series as defined by their North American Industry Classification System (NAICS) code (see Table 1 and detailed industry descriptions in Appendix D). The principal strength of defining the Blue Economy using this methodology is that the data permits consistent measurement of the ocean economy across time and geographic regions. This allows researchers and policymakers to annually update much of the data contained in this report and to compare the North Shore to other regions to better understand the region's competitive advantages relative to other geographic areas. A similar methodology was employed by the PPC in its assessment of the statewide maritime economy and its Marine Science and Technology study conducted for the U.S. Economic Development Administration[9]. Using a similar methodology for this project enhances the potential to seek future Commonwealth-wide strategies.

[8] For more on the ENOW data, see https://coast.noaa.gov/digitalcoast/tools/enow.html.

[9] See Borges et al. (2017), Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy, The Public Policy Center at UMass Dartmouth and Borges, et al. (2019). Charting the Course: An Assessment of Southeastern New England's Marine Science & Technology Sector. The Public Policy Center at UMass Dartmouth. Dartmouth, MA.

One caveat is that rather than collecting the data directly from ENOW, the PPC used data from Economic Modeling Specialists (Emsi), which utilizes the same Quarterly Census of Employment and Wages (QCEW) employment data as ENOW, but also includes data on sole proprietors, which is important for estimating employment in industries such as Fishing, where self-employment is common[10]. The Emsi data is also more recent than the ENOW data[11,12].

Importantly, industries sometimes do not fit neatly into NAICS sectors, and consequently, industry overlap occurs. For example, marinas include many activities that cross both recreational and commercial sectors, such as commercial fishing, boat building and repair, sail making, retail, fuel, food and beverage and bait. However, the vast majority of boats in marinas are recreational boats and so Marina industry is assigned to the Tourism & Recreation sector. Another example is Search & Navigation Equipment, where products such as sonar, radar and GPS may be used in marine transportation, recreational boating and aviation systems. ENOW assigns Search & Navigation to the Marine Transportation sector, since the largest dollar volume of marine-related products is in the commercial transportation side of the business.

Table 1 | Maritime Economy Sectors and Industries

Sector	Industry
Living Resources	Fish Hatcheries & Aquaculture
	Fishing
	Seafood Markets
	Seafood Processing
Marine Construction	Marine Related Construction
Offshore Minerals	Oil & Gas Exploration & Production
	Sand and Gravel Mining
Ship & Boat Building	Boat Building & Repair
	Ship Building & Repair
Tourism & Recreation (Coastal)	Amusement & Recreation Services
	Boat Dealers
	Eating & Drinking Places
	Hotels & Lodging Places
	Marinas
	RV Parks & Campgrounds
	Scenic Water Tours
	Sporting Goods
	Zoos, Aquaria
Transportation	Deep Sea Freight
	Marine Passenger Transportation
	Marine Transportation Services
	Search & Navigation Equipment
	Warehousing

The PPC also relies on data from the Census Bureau's American Community Survey (ACS). The ACS is a collection of survey-based estimates designed to assist with data analysis in the years between decennial censuses by providing statistics on social, economic, housing and demographic characteristics. The Census Bureau develops one- and five-year estimates based on survey data collected over 12- and 60-month periods, respectively. Because they are built using the greatest number of survey years and have the largest sample size, the five-year estimates are considered the most accurate in capturing the conditions in smaller cities and towns. However, these five-year estimates are controlled to represent the average of the five-year period. For clarity, we may refer to these five-year estimates by their final year (i.e., the 2015–2019 ACS estimates are sometimes referred to as just the 2019 ACS), but we caution readers to bear in mind that the data represent an average of the five-year span and not solely the circumstances of the final estimate year.

[10] See https://www.economicmodeling.com/data/.

[11] In the recent release of the ENOW series "An additional industry, Fish and Seafood Merchant Wholesalers (NAICS 424460) was added to the Living Resources sector's Seafood Market industry for data years 2016 and beyond. The industry was not applied to earlier years." The addition of this industry significantly distorts annual comparisons and timeline analysis of the Seafood Market sector and Living Resources totals when compared to previous years.

[12] See Appendix D for a list of the ENOW industries.

3. SOCIOECONOMIC AND ECONOMIC BASE ANALYSIS

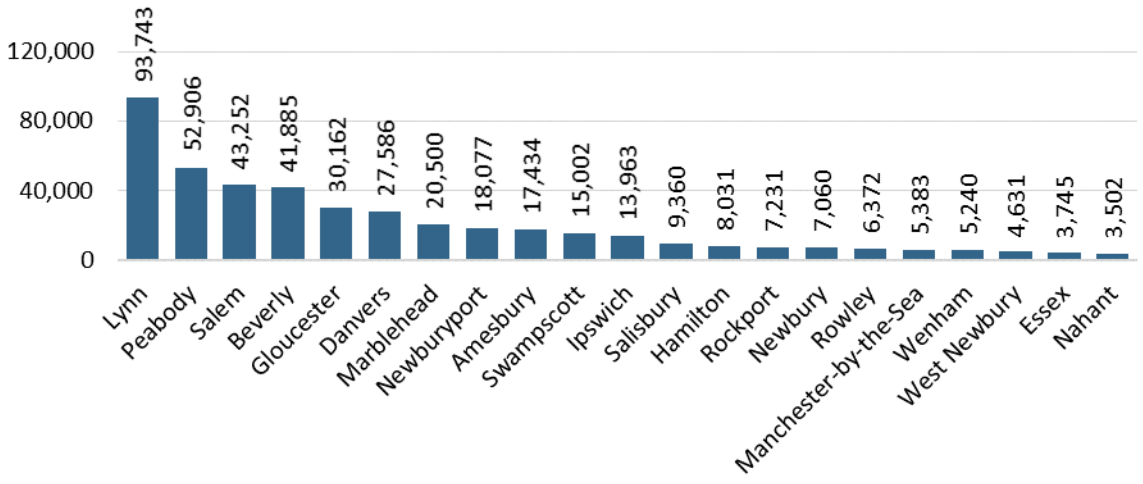
The socioeconomic and economic base analysis presents a snapshot of the region's people in terms of population, education, income, wages, housing and commuting patterns, as well as the major industries that drive the region's economy. Overall, the region's population is fairly similar to the state in terms of race, age groups, education and income levels. While the majority of the North Shore's population identifies as white, the region has become slightly more racially diverse since 2000. The region's population is growing at a slightly higher pace than the state as a whole since 2010, although population growth is exacerbating the shortage of affordable housing, which is an issue endemic to the state as a whole.

Population growth is also intensifying pressure on the transportation infrastructure in parts of the region, particularly since many of the region's roadways were not designed to handle the number of automobiles that traverse the North Shore daily. Congestion is aggravated by the significant exchange of workers commuting in and out of the region, with the most highly educated workers commuting outside the region, primarily to high paying jobs in the Greater Boston area. This highly skilled and educated workforce represents untapped opportunity that could better serve the North Shore region if comparable jobs and emerging opportunities were available within the region.

3.1 THE REGION'S POPULATION IS GROWING

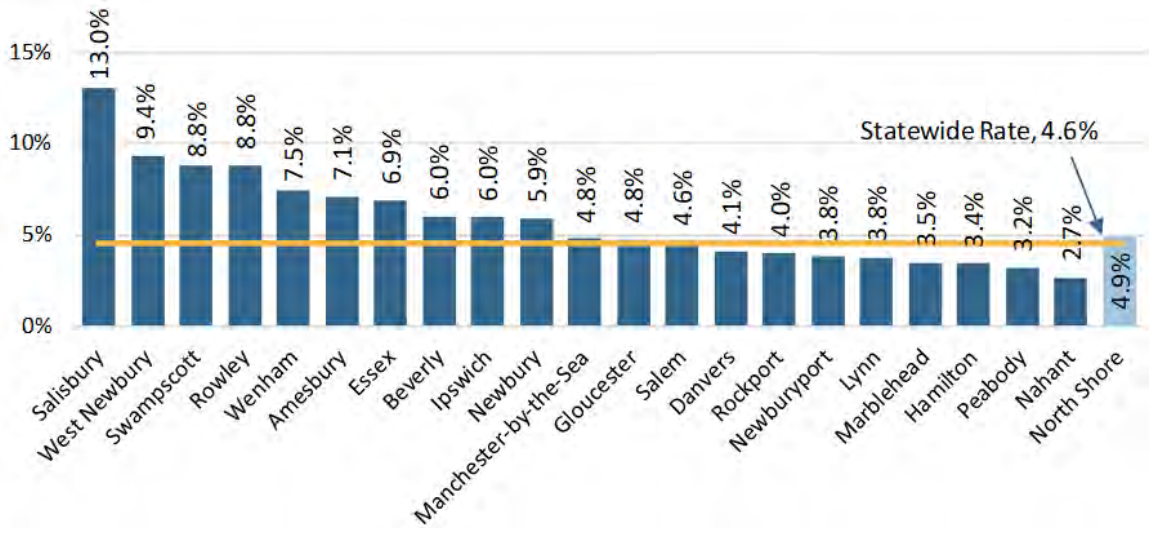
The North Shore consists of 21 communities ranging in population from Lynn, with 93,743 residents, to Nahant, which is home to 3,502 residents (see Figure 4). The region's population grew by 4.9 percent from 2010 to 2019, which is higher than the statewide rate of 4.6 percent. Population increased in each of the region's communities over this period, with 12 communities growing faster than the state average (see Figure 5). Smaller communities grew the fastest: Salisbury (13.0%), West Newbury (9.4%), Rowley (8.8%) and Swampscott (8.8%) experienced the largest percentage growth since 2010. Conversely, the population of the region's larger communities grew more slowly than the statewide average, including Lynn (3.8%) and Peabody (3.2%), although these communities, due to their size, drove absolute population growth as a whole since 2010.

Figure 4 | Population, North Shore communities, 2019



Source: U.S. Census Bureau, 2015–2019 ACS 5-year estimates, Table B01003

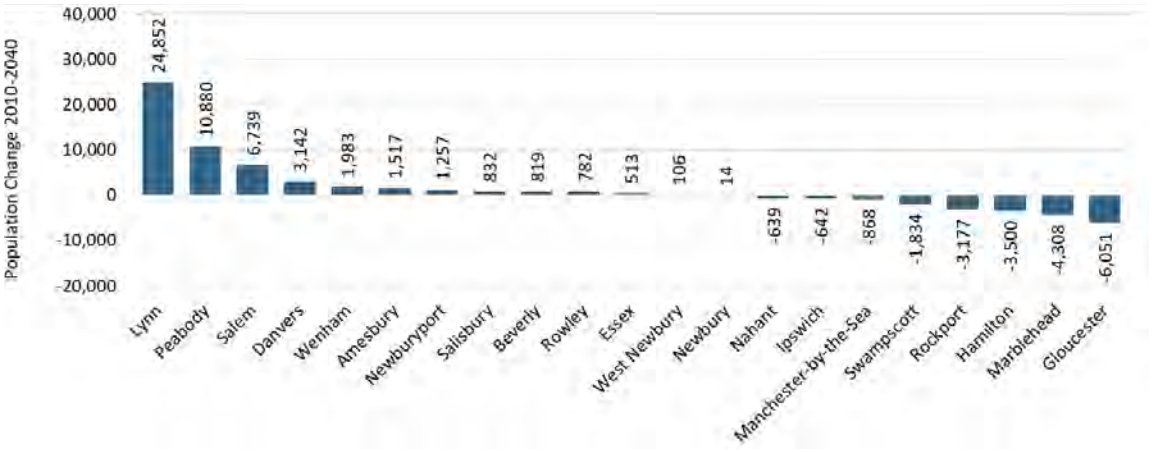
Figure 5 | Population percentage change, North Shore communities and Massachusetts, 2010-2019



Source: U.S. Census Bureau, 2015–2019 ACS 5-year estimates, Table B01003

The North Shore's population is expected to grow by about 7.8 percent from 2010 to 2040, or by 32,417 people. Most of the growth is anticipated to occur in the region's larger communities such as Lynn (+22,852 residents), Peabody (+10,880 residents), Salem (+6,739 residents) and Danvers (+3,142 residents) (see Figure 6).

Figure 6 | Projected population, North Shore communities, 2010-2040

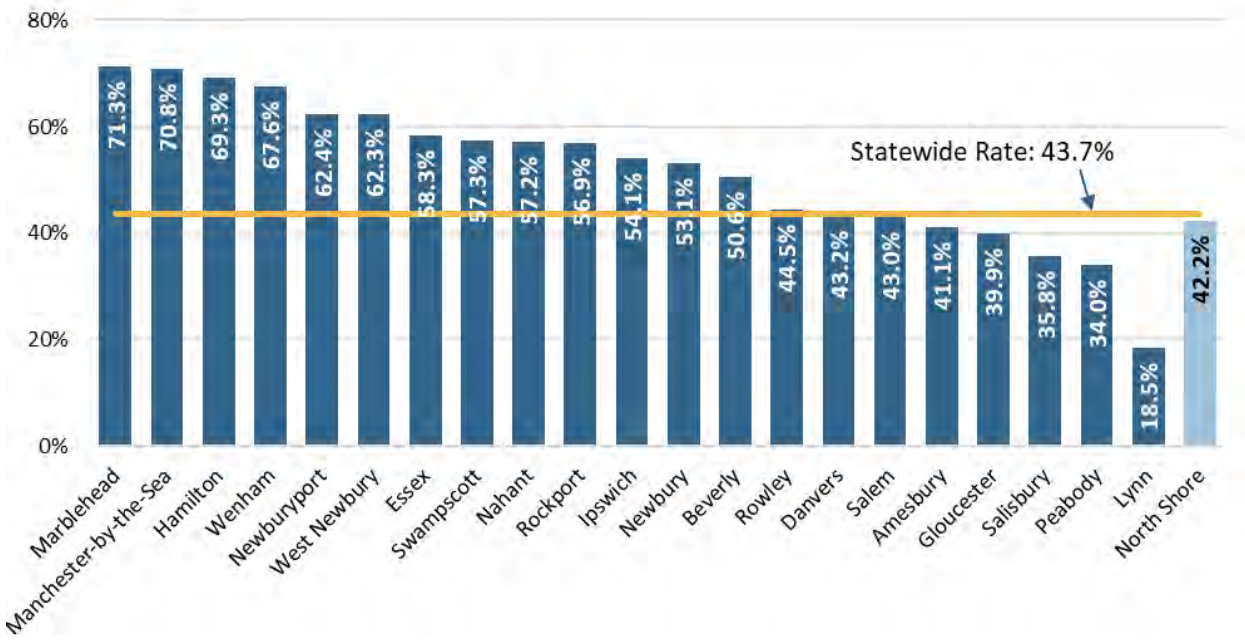


Source: UMass Donahue Institute, Massachusetts Population Estimates Program

3.2 NORTH SHORE RESIDENTS AS A WHOLE ARE HIGHLY EDUCATED

North Shore residents age 25 and older possess high levels of education, with 42.2 percent having earned at least a Bachelor's degree. This compares to 43.7 percent of residents age 25 and older statewide. However, some of the region's largest communities have the lowest levels of educational attainment, including Lynn, Peabody and Gloucester (see Figure 7). The North Shore's highly educated workforce presents an opportunity for the region to develop homegrown opportunities for workers rather than having these residents commuting to high-skill, high-wage jobs in the Greater Boston area.

Figure 7 | Residents age 25 years & older with at least a Bachelor's degree, North Shore communities & Massachusetts, 2019

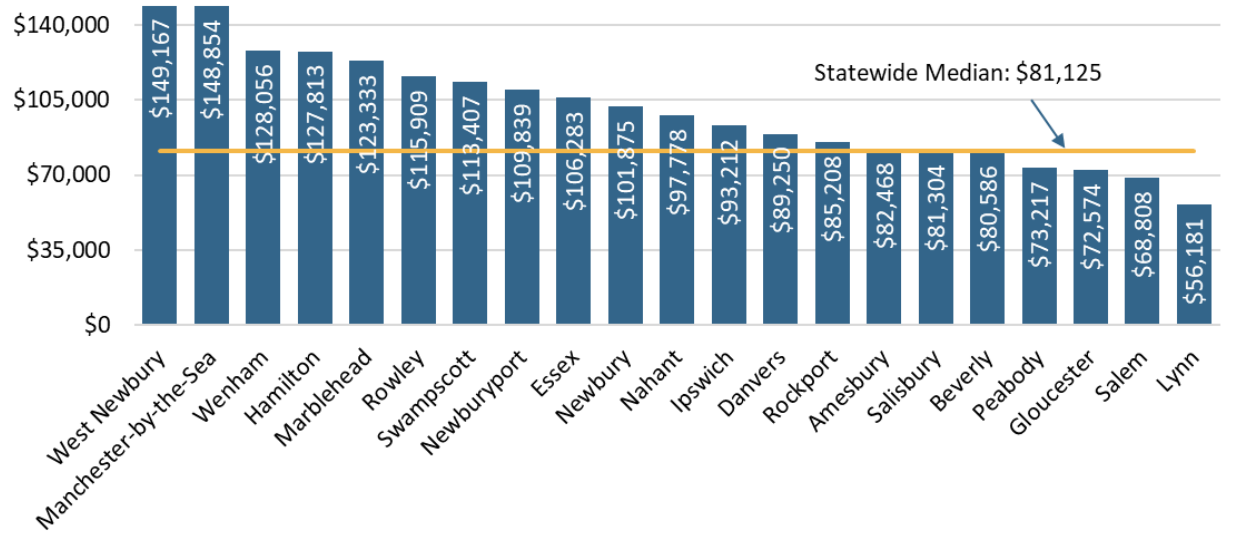


Source: 2015–2019 ACS 5-year estimates, Table S1501

3.3 NORTH SHORE RESIDENTS OVERALL HAVE HIGH INCOMES AND LOW POVERTY LEVELS

High levels of education are typically associated with high incomes, and this is certainly the case in the North Shore, where the median incomes of 16 of the region's communities exceed the statewide median of $81,125. Notably, many of the wealthier towns in the North Shore have small populations, while the region's larger communities have incomes below the statewide median, such as Lynn ($56,181), Salem ($68,808), Gloucester ($72,574) and Peabody ($73,217) (see Figure 8)[13]. Not surprisingly, communities with higher incomes tend to have lower levels of poverty (see Figure 9).

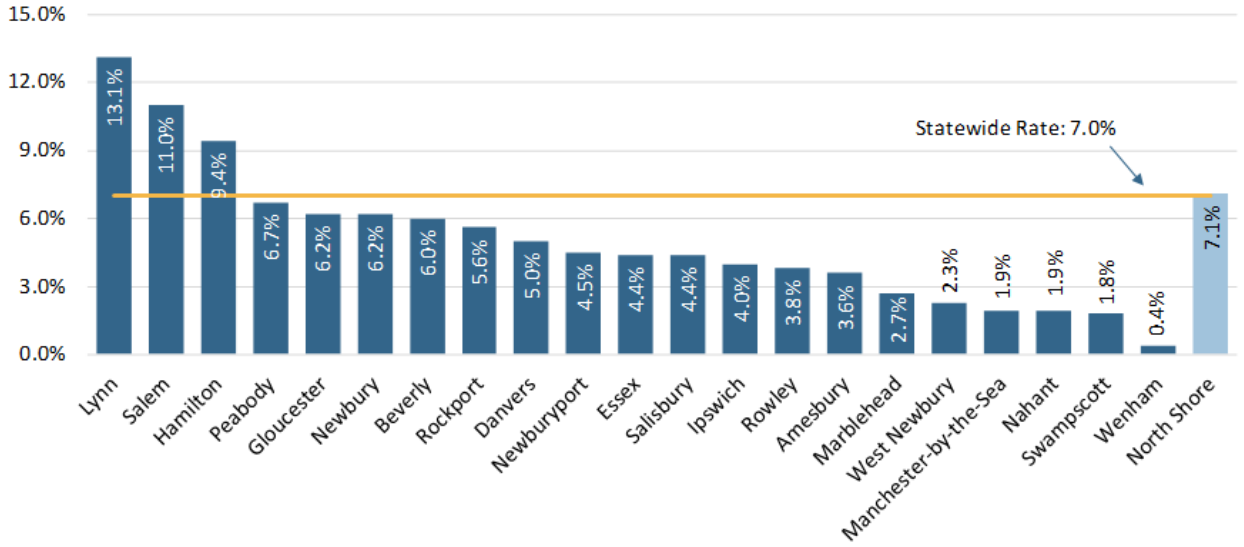
Figure 8 | Median household income, North Shore communities & Massachusetts, 2019



Source: 2015-2019 ACS 5-year estimates, Table S1903

[13] A regional median household income cannot be calculated.

Figure 9 | Families below the poverty level, North Shore communities & Massachusetts, 2019

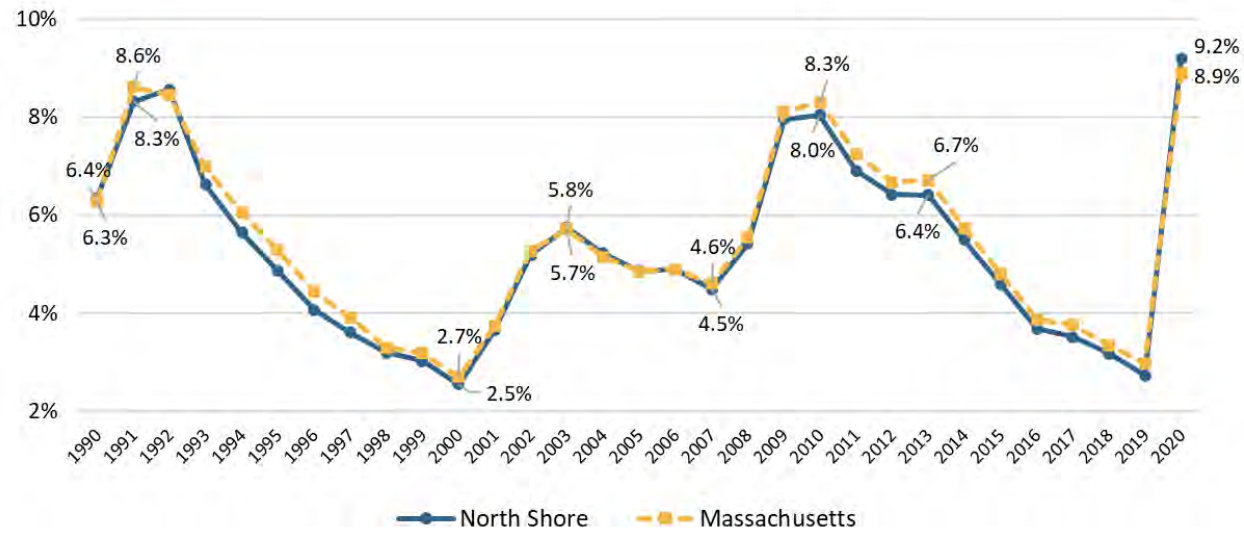


Source: 2015-2019 ACS 5-year estimates, Table S1702

3.4 HIGH LEVELS OF EDUCATION AND INCOMES TRANSLATE INTO LOW UNEMPLOYMENT RATES

The region has essentially mirrored the state in terms of its unemployment rate over the last three decades, although the state rate is slightly higher for the most part throughout the business cycle (see Figure 10). The extreme spike in 2020 represents unemployment shock as a result of the Covid-19 pandemic.

Figure 10 | Unemployment Rates, North Shore & Massachusetts, 1990–2020



Source: Massachusetts Executive Office of Labor & Workforce Development LAUS data (Not Seasonally Adjusted), 1990–2020.

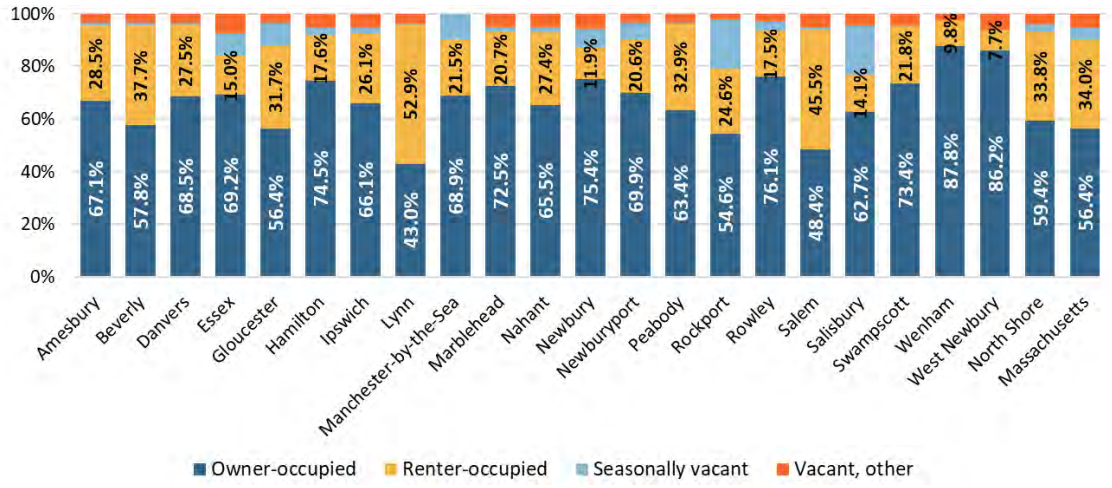
The North Shore's highly educated workforce presents an opportunity for the region to develop homegrown opportunities for workers rather than having these residents commuting to high-skill, high-wage jobs in the Greater Boston area.

3.5 HOUSING AFFORDABILITY WILL CONTINUE TO BE AN ISSUE

The majority of the housing stock on the North Shore consists of single-family homes (57.0%) and 59.4 percent of the region's housing units are owner-occupied (see Figure 11). Renters have few options in most communities, with only Lynn and Salem having a concentration of renter-occupied units above 45 percent. A lack of a rental supply can lead to artificially high rents and limited options for workers who cannot yet afford homeownership, which can lead to worker shortages in many of the region's industries, particularly in its traditional blue-collar industries, although housing affordability is an issue that affects many along the income spectrum.

Overall, the housing stock is also fairly old, with 57.8 percent of units constructed prior to 1960 and only 8.3 percent constructed in 2000 or later. A large portion of the units constructed prior to 1960 are in the region's larger and more industrial communities, including Lynn and Salem, which account for 23.0 percent and 12.3 percent respectively of the region's housing units constructed prior to 1960. Much of the new housing construction in the region appears to be single-family homes, which most likely will become owner-occupied housing units.

Figure 11 | Housing units by occupancy status, North Shore communities & Massachusetts, 2019



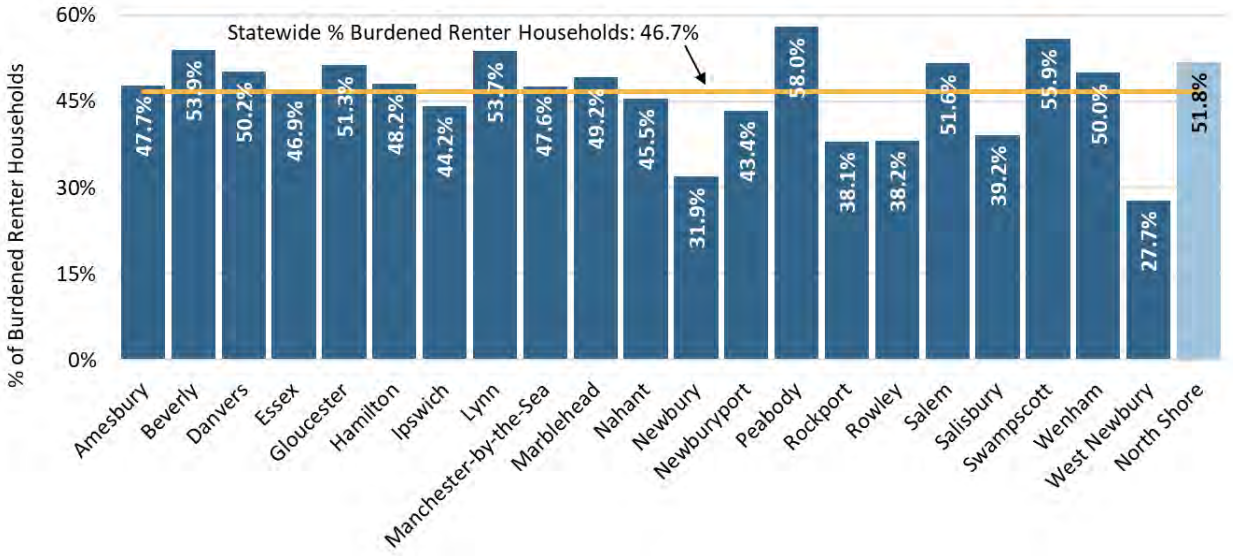
Source: 2015-2019 ACS 5-Year Estimates, Table B25004

Projected population growth will continue to place stress on the housing market and housing affordability issues will persist without a significant influx of new homes and mixed-income development. Housing affordability is placing particular burdens on people who are employed in Blue Economy jobs such as fish processors and service industry workers in the Coastal Tourism & Recreation sector. However, the housing affordability issue also extends into middle income households, which includes many who work in Blue Economy occupations such as skilled tradespeople (e.g., boat mechanics, welders). Some communities also have a significant number of units that are seasonal housing, which sit vacant for much of the year and lowers the potential supply of year-round housing for workers. This includes Rockport, Salisbury and Manchester-by-the-Sea (18.8%, 18.7% and 9.5% of housing units seasonally vacant respectively).

A significant number of households in the North Shore, especially renters, are spending over 30 percent of their income on rent/mortgage and utility payments.

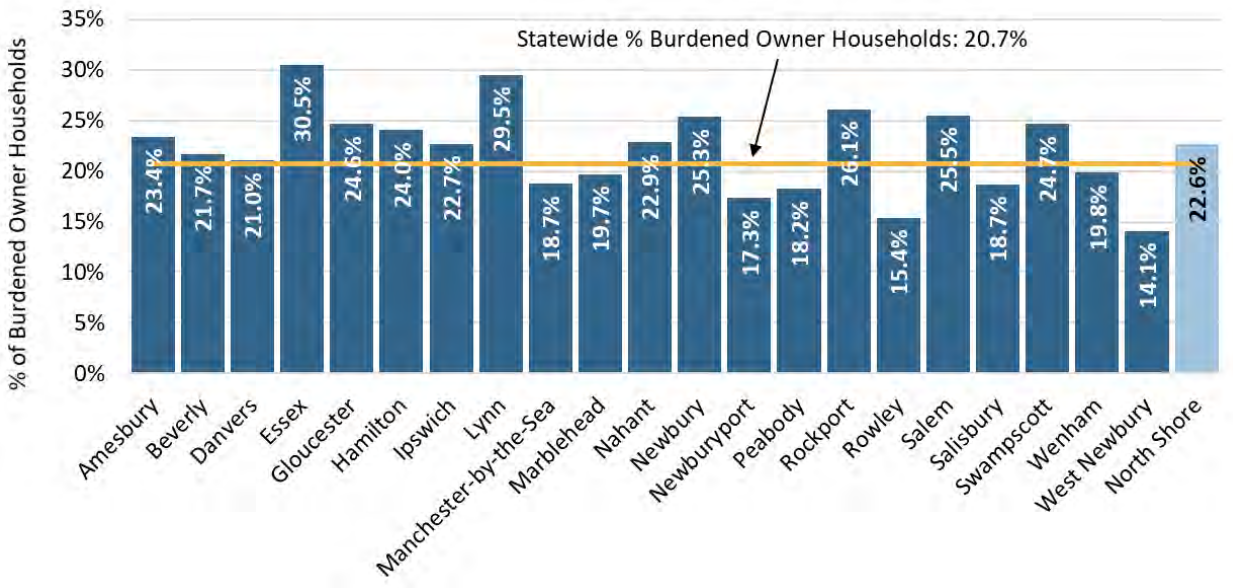
Figure 12 and Figure 13 show that a significant number of households in the North Shore, especially renters, are spending over 30 percent of their income on rent/mortgage and utility payments[14]. A majority of communities have a burden that is higher than the statewide percentage for both renters and homeowners. Notably in Lynn and Salem, where the majority of the region's rental housing is concentrated, more than half of all renters devote 30 percent of their household income to housing costs.

Figure 12 | Housing cost burdened households, Renters, North Shore communities, 2019



Source: 2015-2019 ACS 5-Year Estimates, Table DP04

Figure 13 | Housing cost burdened households, Owners, North Shore communities, 2019



Source: 2015-2019 ACS 5-Year Estimates, Table DP04

[14] A household is "burdened" by housing costs if they spend 30 percent or more of their income on rent/mortgage and utility payments.

3.6 THERE IS A SIGNIFICANT EXCHANGE OF WORKERS DAILY COMMUTING TO AND FROM THE REGION

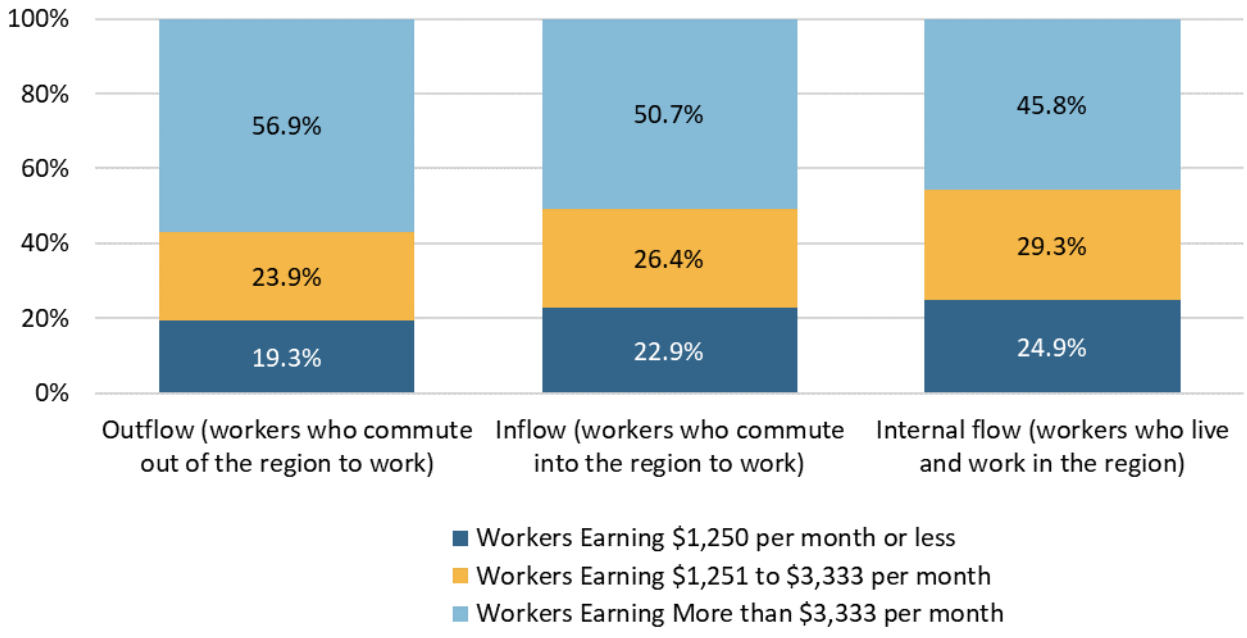
There is a large number of workers moving into and out of the region for work on a daily basis; 82,946 who work in the North Shore commute from outside the region, 126,524 people commute to jobs outside the region and 95,475 both live and work in the region (see Figure 14)[15].

Figure 14 | Commuting inflow and outflow, North Shore, 2018

Source: OnTheMap, U.S. Census Bureau LEHD Origin-Destination Employment Statistics (LODES); Inflow/Outflow Analysis, All Jobs, 2018

Outflow commuters (i.e., workers who live in the region but work elsewhere) earn more monthly than inflow commuters or workers who live and work in the region (see Figure 15). This difference is explained by the fact that many outflow commuters are driving to the Greater Boston area to high-paying jobs that do not exist in abundance in the region. In fact, 33,629 of these outflow commuters are commuting directly into Boston (see Figure 16). Consequently, this group of outflow commuters presents a pool of potential workers to attract with suitable local opportunities.

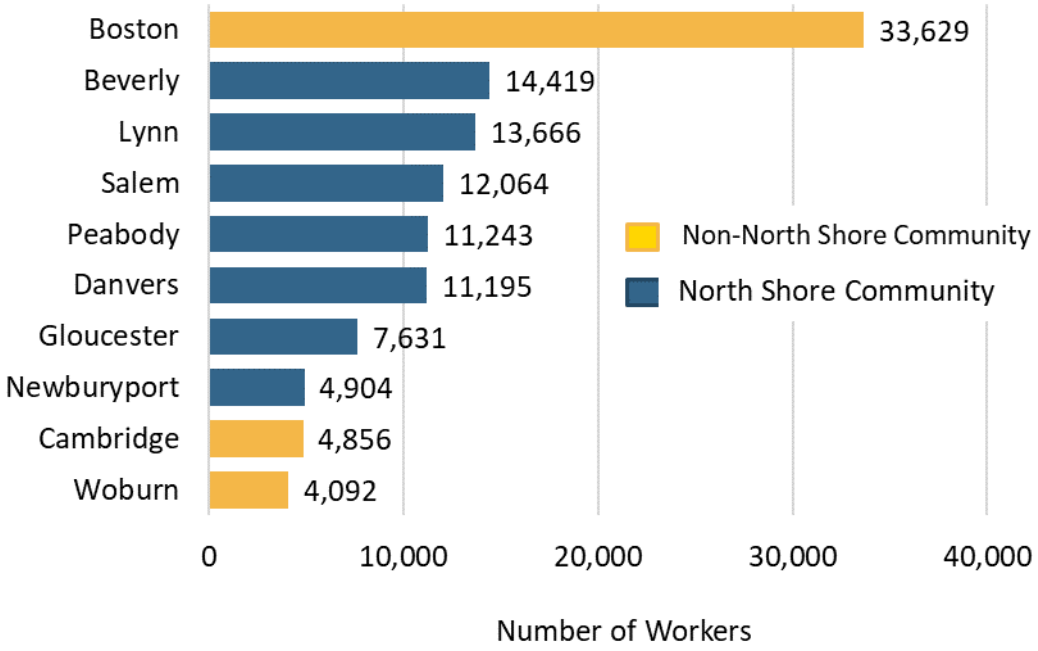
Figure 15 | Inflow/Outflow monthly job earnings, North Shore, 2018



Source: OnTheMap, U.S. Census Bureau LEHD Origin-Destination Employment Statistics (LODES); Inflow/Outflow Analysis, All Jobs, 2018

[15] Latest data available.

Figure 16 | Top 10 communities where North Shore residents work, 2018



Source: OnTheMap, U.S. Census Bureau LEHD Origin-Destination Employment Statistics (LODES)

To further explore commuting data, the PPC utilized data from the ACS Public Use Microdata Sample (PUMS) to create custom tabulations to compare the demographics of people with commutes of 45 minutes or greater with those with commutes of 45 minutes or less, under the assumption that people with longer commutes are more likely to be commuting out of the region to work[16,17]. Workers who commute longer distances are more likely to have higher levels of education than people who have shorter commutes (see Table 2). Correspondingly, people who commute 45 minutes or greater are travelling to jobs with higher salaries; during 2015–2019, commuters with a drive time of 45 minutes or greater earned an average of $85,333, compared to $49,103 for shorter commuters.

Table 2 | Educational attainment of North Shore residents by commuting time, 2015–2019 average

Education Level	Commute < 45 Minutes	Commute > 45 Minutes
Less Than High School	86.5%	13.5%
High School Diploma	82.4%	17.6%
Some College	78.9%	21.1%
Associate's	79.4%	20.6%
Bachelor's	64.5%	35.5%
Professional Degree	61.4%	38.6%
Master's	68.4%	31.6%
Doctorate	64.3%	35.7%

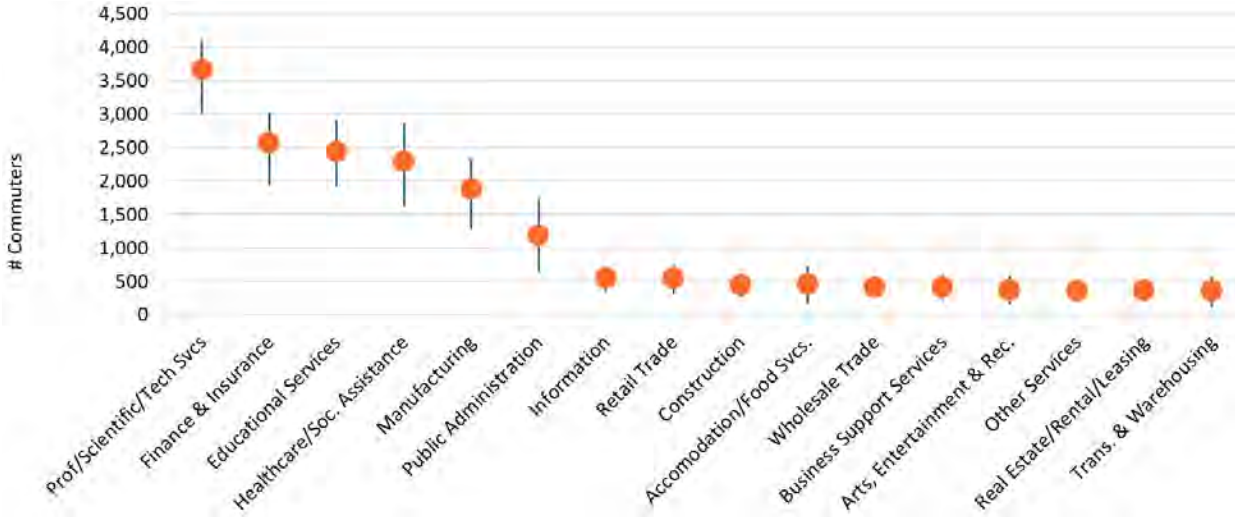
Source: U.S. Census Bureau, 2015–2019 ACS 5-Year PUMS

[16] The main unit of geography for ACS PUMS data is the Public Use Microdata Area (PUMA). The PUMA for the North Shore is very close to the geographic definition used for this report, with the exception that it excludes the core community of Amesbury and most of the edge communities except Salem and Marblehead.

[17] The top quartile of commuting times consists of North Shore residents who spend over 45 minutes commuting to work. Therefore, it was decided that 45 minutes would be the cutoff to determine which people in the sample are likely commuting out of the region to get to work.

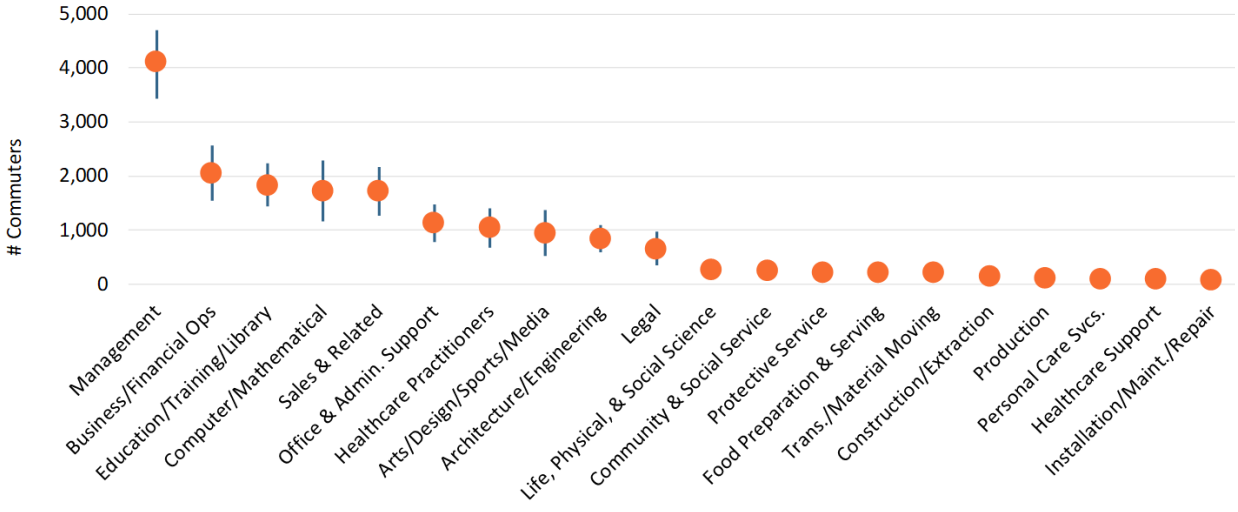
There are roughly 20,000 college-educated North Shore residents that commute over 45 minutes to work. The top industries in which they are employed are Professional, Scientific & Technical Services; Finance & Insurance; Educational Services; Healthcare & Social Assistance and Manufacturing (see Figure 17). Management is by far the most common occupation among people in this group, representing over 20 percent of all college-educated, long-distance commuters (see Figure 18). In addition, among 271 North Shore residents in Life, Physical & Social Science occupations that commute over 45 minutes to work, an estimated 195 are in the natural sciences. These workers represent a lost opportunity to the region as it develops its Blue Economy, since it is exporting these highly educated and skilled residents to employers in the Greater Boston region.

Figure 17 | Employment by industry of college-educated long-distance commuters, North Shore PUMA, 2015–2019 average and margin of error[18]



Source: U.S. Census Bureau, 2015–2019 ACS 5-Year PUMS; Blue lines represent standard error

Figure 18 | Employment by occupation of college-educated long-distance commuters, North Shore PUMA, 2015–2019 average and margin of error



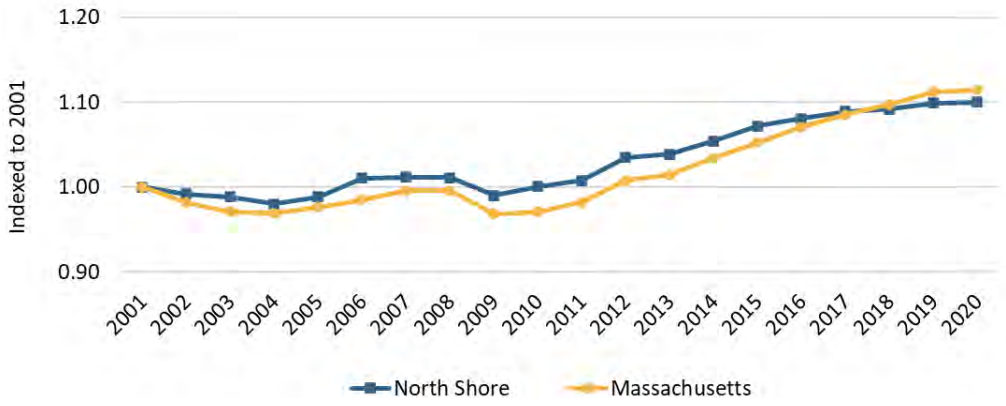
Source: U.S. Census Bureau, 2015–2019 ACS 5-Year PUMS; Blue lines represent standard error

[18] Employment estimates for the following industries were statistically insignificant (the margin of error contains zero): Utilities; Agriculture, Forestry, Fishing, & Hunting and Management of Companies & Enterprises.

3.7 THE NUMBER OF JOBS IN THE REGION IS GROWING

An average of 209,711 jobs were located within the North Shore in 2020, with the number of jobs increasing by 10.0 percent since 2001; nearly all of these job gains occurred from 2010 to 2020[19]. This compares to a statewide increase in the number of jobs of 14.8 percent and 11.4 percent respectively. The region's year-to-year job growth was higher than the state from 2001 to 2017, but has been less robust in more recent years (see Figure 19)[20].

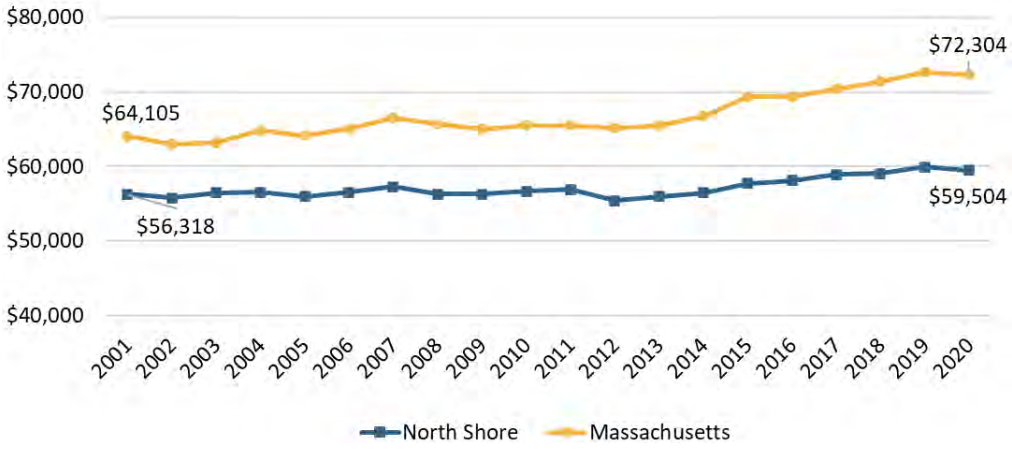
Figure 19 | Total employment indexed to 2001, North Shore & Massachusetts, 2001–2020



Source: Emsi, 2020

North Shore workers have historically earned less than the statewide average. This trend continues today, with North Shore residents earning an average of $59,504 in 2020, which is about 82 percent of the statewide annual average earnings of $72,304 (see Figure 20)[21]. Furthermore, North Shore workers have only seen a 5.7 percent increase in their real annual earnings since 2001, compared to an increase of 12.8 percent across the state. However, there is a regional dichotomy in the wage narrative; lagging wage growth is primarily driven by the region's larger communities such as Lynn and Salem. Conversely, most of the region's smaller communities have experienced wage growth much greater than Massachusetts as a whole, which is likely driven by high levels of educational attainment in those communities.

Figure 20 | Average annual earnings (2020 Inflation-adjusted), North Shore & Massachusetts, 2001–2020



Source: Emsi, 2020

[19] This data measures the number of jobs located within the North Shore, regardless of where workers live.

[20] This data measures the number of North Shore residents who are employed, regardless of where they work.

[21] The earnings in this section include wages, salaries, supplements (additional employee benefits) and proprietor income. Data is for individuals, not households.

3.8 THE NORTH SHORE'S INDUSTRIAL PROFILE IS SIMILAR TO THE STATE, BUT THE REGION DOES HAVE COMPETITIVE ADVANTAGES

The North Shore's economy is based on an industrial mix very similar to the state, with Restaurants & Eateries being the largest industry, followed by Local Education (i.e., K-12 public education) and Individual and Family Services (see Table 3). The region has a much higher concentration of Aerospace Manufacturing, which is primarily a result of employment at General Electric Aviation in Lynn.

Table 3 | Largest industries, North Shore, 2020

Industry	Jobs	% Total Jobs	State % Total Jobs
Restaurants & Eateries	15,093	7.2%	6.1%
Local Education	10,648	5.1%	4.3%
Individual & Family Services	7,533	3.6%	2.7%
Aerospace Manufacturing	7,022	3.3%	0.3%
Hospitals	6,593	3.1%	4.2%
Grocery Stores	6,299	3.0%	2.1%
Local Government	5,528	2.6%	2.4%
Offices of Physicians	5,077	2.4%	1.5%
Building Services	4,113	2.0%	1.9%
Home Health Care Services	3,426	1.6%	1.1%

Source: Emsi, 2020

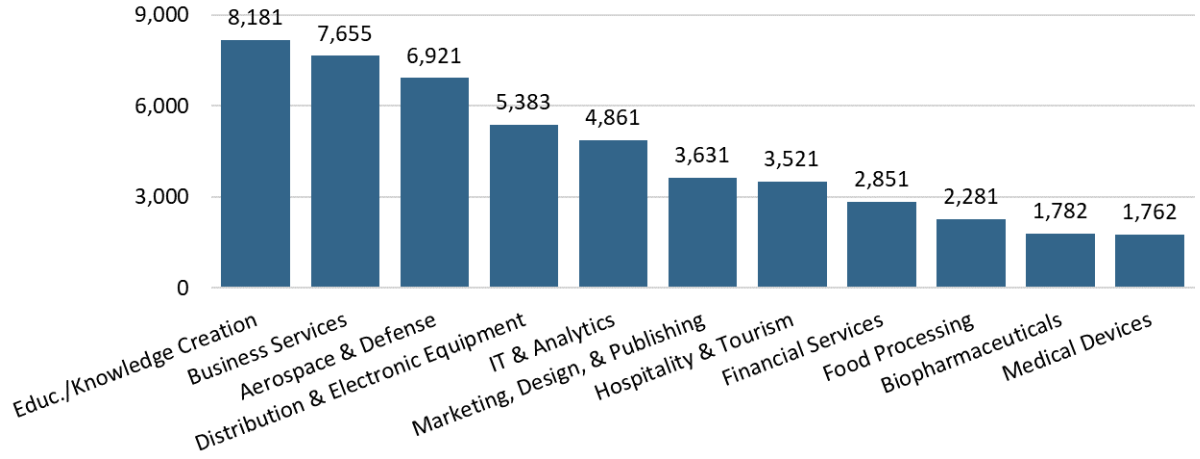
Another way to understand the region's industrial economic base is to examine industry clusters, which consist of groups of related industries in a defined geographic area that share common markets or are interrelated in some way[22]. Essentially, industry clusters are groups of individual industries such as those reported above. Often, clusters develop when industries share resources, including common markets, technologies and labor, or when they require similar natural resources (e.g., the ocean).

Figure 21 displays the North Shore's largest industry clusters in terms of number of employees, while Table 4 displays the top 10 growth clusters in terms of employment from 2010-2020. Business Services is both the largest cluster and has added the most jobs since 2010. This cluster is also one of the largest clusters statewide and it includes a wide variety of industries that support businesses, from taxi and limousine services to consultants and payroll services. The region is also home to four technology clusters, including Aerospace & Defense, IT & Analytics, Biopharmaceuticals and Medical Devices, although many of the region's top clusters are at least partly technology-related. Two clusters are major components of the Blue Economy, including Hospitality & Tourism, which is the largest Blue Economy cluster, and Food Processing, which is primarily related to the seafood industry.

Two clusters are major components of the Blue Economy, including Hospitality and Tourism, which is the largest Blue Economy cluster, and Food Processing, which primarily relates to the seafood industry.

[22] Michael Porter, who popularized the concept of industry clusters, defines them as "geographic concentrations of interconnected companies, specialized suppliers, service providers, companies in related industries and associated institutions." See Porter, M. E. (2000). "Location, competition and economic development: Local clusters in a global economy." Economic development quarterly, 14(1), 15-34. The clusters analyzed in this section were based on the Michael Porter cluster methodology. See http://clustermapping.us/content/cluster-mapping-methodology.

Figure 21 | Eleven largest industry clusters, North Shore, 2020



Source: Emsi, 2020

Table 4 | Ten Fastest Growing Industry Clusters, North Shore, 2010–2020

Industry Cluster	Increase in Jobs ('10–'20)	% Increase in Jobs ('10–'20)
Business Services	2,097	35.3%
Marketing, Design, & Publishing	1,161	42.1%
Food Processing & Manufacturing	776	53.0%
Hospitality & Tourism	696	23.7%
Medical Devices	421	31.0%
Performing Arts	238	35.5%
Transportation & Logistics	200	48.8%
Communication Equip. & Services	145	53.2%
Biopharmaceuticals	128	50.0%
Education and Knowledge Creation	195	4.1%

Source: Emsi, 2020

3.9 INDUSTRY CLUSTERS BY LOCATION QUOTIENT

The previous analysis highlights the region's largest industry clusters, but does not examine in which clusters the North Shore has a competitive advantage, that is, the industries and activities the region specializes in in relation to the nation as a whole. Location quotient (LQ) is a method that quantifies how concentrated a particular industry cluster is in a region compared to the nation. Clusters that have both a high LQ and relatively high total job numbers typically form a region's economic base. An LQ above 1.0 means that the region has an above average concentration of employment in that industry cluster compared to the nation.

Table 5 presents the North Shore's industry clusters that have an LQ above 1.0, which means the region is more specialized in this industry than the nation as a whole. Not surprisingly, the North Shore is most specialized in the Fishing/Fishing Products industry cluster and also specializes in Food Processing & Manufacturing, driven by the seafood industry. Many of these clusters are in the innovation space, including Aerospace Vehicles & Defense, Biopharmaceuticals, Medical Devices and IT & Analytics and shows that the region has a significant skills-based workforce that lends itself to innovation. Even if many of these workers are not employed in Blue Economy industries, they represent a workforce pipeline if and when emerging opportunities in the region's Blue Economy develop.

Table 5 | Industry clusters with an LQ above 1.00, North Shore, 2020

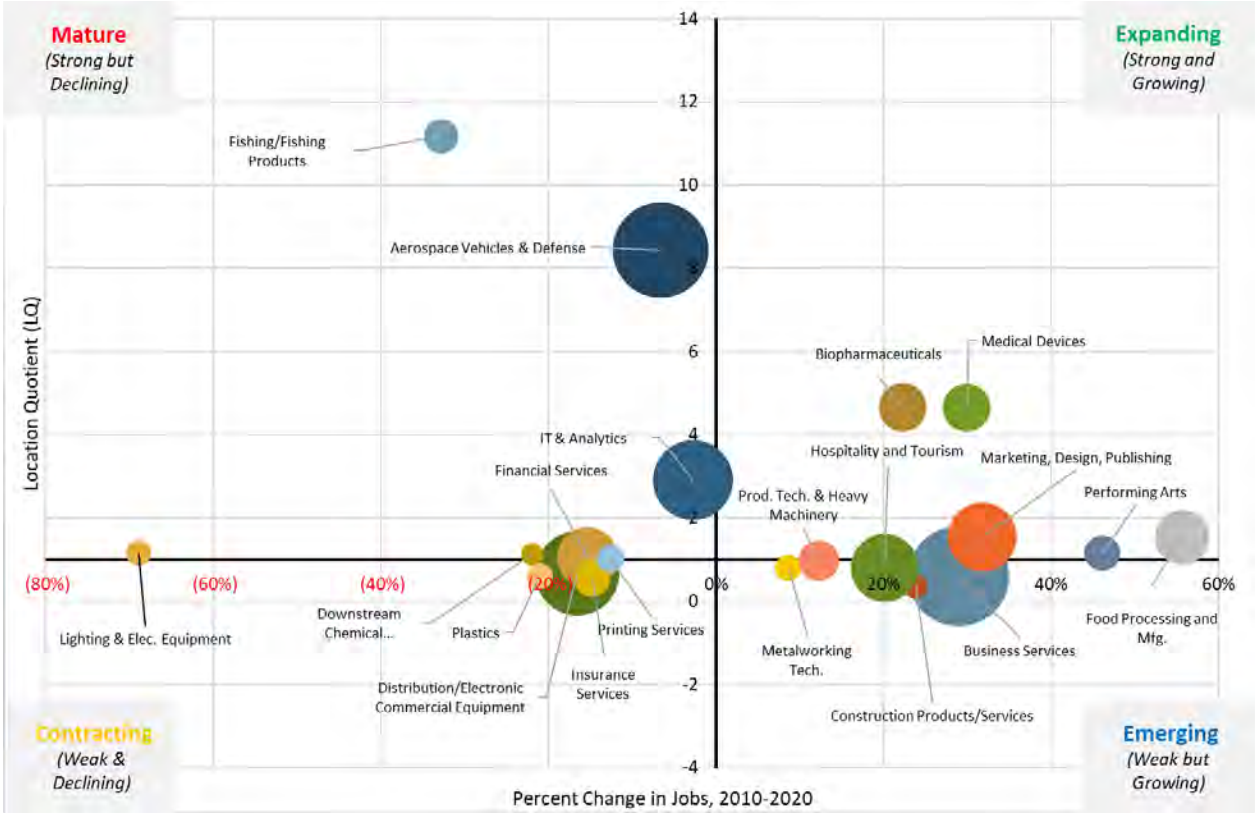
Industry Cluster	LQ	Employment
Fishing/Fishing Products	11.2	900
Aerospace Vehicles & Defense	8.4	6,921
Biopharmaceuticals	4.7	1,782
Medical Devices	4.7	1,762
IT & Analytics	2.9	4,861
Education/Knowledge Creation	1.9	8,181
Marketing, Design, Publishing	1.6	3,631
Food Processing and Mfg.	1.5	2,281
Performing Arts	1.2	980
Lighting & Elec. Equipment	1.2	483
Downstream Chemical Products	1.1	400
Financial Services	1.1	2,851

Source: Emsi, 2020

Importantly, an industry cluster may have a high LQ, but low levels of employment or declining employment and therefore may not be as vital to a region's economy in comparison to clusters with lower LQs. Figure 22 displays the LQ for each of the industry clusters in relation to their size and employment growth from 2010 to 2020, with the size of each circle representing total employment. For example, Living Resources and Aerospace Vehicles & Defense are "Mature" industry clusters, with high employment concentrations, indicating regional specialization, but with shrinking labor forces. Biopharmaceuticals and Medical Devices are examples of "Expanding" clusters, meaning they have above average employment concentrations and are experiencing employment growth.

Clusters that have both a high LQ and relatively high total job numbers typically form a region's economic base. An LQ above 1.0 means that the region has an above average concentration of employment in that industry cluster compared to the nation.

Figure 22 | Industry clusters by location quotient and employment growth, North Shore, 2010–2020[23]



Source: Emsi, 2020.

Overall, we have seen that the North Shore is similar to the state in many ways, with a growing population, high educational attainment rates and low poverty levels. There is a significant level of daily commuting to and from the region, which congests roads and lowers productivity with workers spending so much time behind the wheel. Local opportunities that match these workers' skills or new ideas that incubate regional opportunities present an opportunity to keep the region's most highly-skilled workers employed in the region.

The region's industrial profile highlights several areas of expertise relative to the nation as a whole, including Fishing & Processing, as well as several technology-based industry clusters such as Aerospace Vehicles & Defense, Biopharmaceuticals, Medical Devices and IT & Analytics. These industries, along with several emerging industry clusters such as Education/Knowledge Creation, highlights areas of opportunities for growing the region's Blue Economy in both traditional and technology-oriented Blue Economy sectors.

Local opportunities that match these workers' skills or new ideas that incubate regional opportunities present an opportunity to keep the region's most highly-skilled workers employed in the region.

[23] Clusters with fewer than 200 jobs are not labelled for presentation purposes.

4. BLUE ECONOMY SECTOR ASSESSMENT

The Blue Economy is a collection of interconnected industries and sectors. On the North Shore, and throughout colonial and post-revolution coastal Massachusetts, the Blue Economy centered on shipping and exporting the region's natural resources—primarily old-growth timber, dried cod and granite. The success of the region's fisheries depended on locally built schooners and dories, innovative designs that allowed for a more efficient catch. The famed fishery and the hardy crews that worked the stormy seas of the North Atlantic contributed to the romantic image of the New England fishing village and the courageousness of those who made their living from the sea. It was this romance that Longfellow captured in the *Wreck of the Hesperus*, which conflated a few shipwrecks around Norman's Woe and drove tourism to the region to see the infamous reef[24]. To some degree a romanticized image of the sector persists, even as the modern Blue Economy has evolved and recent challenges have forced traditions to change.

As noted, the Blue Economy, as defined in this assessment, includes six primary sectors: Coastal Tourism & Recreation, Living Resources, Marine Transportation, Marine Construction, Ship & Boat Building & Repair and Offshore Minerals. These sectors as a whole employ 16,485 workers and account for 7.9 percent of the total jobs in the region (see Table 6). The six Blue Economy sectors contribute varying levels of employment to the region's economy. Coastal Tourism & Recreation accounts for the vast majority of employment, with 87.0 percent of the total number of Blue Economy jobs, followed by Living Resources (8.4% of total) and Marine Transportation (2.9% of total)[25].

Blue Economy jobs grew faster than the regional economy as a whole; from 2004 to 2020, the number of people working in the Blue Economy grew by 19.5 percent in the North Shore (+2,644 jobs), which compares to 12.2 percent growth for all industries in the region over this period. The majority of job gains were in the Coastal Tourism & Recreation sector (+2,920), while job losses were experienced in the Living Resources (-517) and Offshore Minerals (-54) sectors (see Table 7). Additionally, total Blue Economy employment in the North Shore compares favorably to other major sectors of the region's economy.

Table 6 | Blue Economy employment by sector, North Shore, 2020

Sector	Employment	Share of Regional Employment
Blue Economy	**16,485**	7.9%
Public Elementary & Secondary Schools	16,167	7.7%
Health Care Services	14,196	6.8%
Professional, Scientific, Tech Services	10,829	5.2%
Social Assistance	11,086	5.3%
Specialty Trade Contractors	8,124	3.9%
Administrative and Support Services	7,626	3.6%
Hospitals	7,177	3.4%
Educational Services	7,074	3.4%
Nursing and Residential Care Facilities	6,854	3.3%

Source: Emsi, 2020

[24] "Unfolding Histories: Cape Ann before 1900." Cape Ann Museum. 2018. Retrieved from: https://wayback.archive-it.org/11179/20181018194442/http://onlineexhibitions.capeannmuseum.org/s/unfoldinghistories/page/home.

[25] The number of jobs reported in the Living Resources sector is likely an undercount, because many of the workers in this sector, particularly seafood processing workers, are hired as contract workers through employment services agencies and are therefore not accounted for in the Living Resources data. These workers are included in the Temporary Help Services sector, which cannot be broken out to identify employees working in the Living Resources sector.

Table 7 | Top employment sectors, North Shore, 2020

Sector	Jobs 2020	Proportion 2020	# Change 2004-2020	% Change 2004-2020
Coastal Tourism & Recreation	14,350	87.0%	2,920	25.5%
Living Resources	1,393	8.4%	-517	-27.1%
Marine Transportation	474	2.9%	242	103.8%
Marine Construction	172	1.0%	15	13.6%
Ship & Boat Building & Repair	81	0.5%	38	90.0%
Offshore Minerals	16	0.1%	-54	-77.2%
Total:	**16,485**	**100%**	**2,644**	**19.5%**

Source: Emsi, 2020, 3-digit NAICS level

4.1 AVERAGE ANNUAL WAGES

The region's average annual wage for the Blue Economy is $30,969, much lower than the average annual wage of $72,703 statewide and $59,504 for all industries in the North Shore[26]. Annual wages range from a low of $24,979 in the Coastal Tourism & Recreation sector, where the vast majority of Blue Economy workers are employed, to a high of $110,082 in the Offshore Minerals sector, which has the lowest level of employment among the six sectors (Table 8). Low wages in the Coastal Tourism & Recreation sector are a result of the high number of service positions in the sector that are typically part-time or tipped-based, such as waitstaff or bartenders[27]. Living Resources is the second largest sector in terms of jobs and has the second highest average wage at $75,924. However, this figure may be misleading, because as noted, many of the low-wage workers employed in this sector are hired through employment services agencies and are therefore not included in the average annual wage calculation[28].

Table 8 | Average annual wages by Blue Economy sector, North Shore, 2020

Sector	Jobs	Average Annual Wage
Offshore Minerals	16	$110,082
Living Resources	1,393	$75,924
Marine Construction	172	$72,055
Marine Transportation	474	$56,934
Ship & Boat Building & Repair	81	$64,268
Coastal Tourism & Recreation	14,350	$24,979
All Blue Economy Sectors	**16,485**	**$30,969**
All North Shore Industries	**209,711**	**$59,504**
All Statewide Industries	**4,049,458**	**$72,703**

Source: Emsi, 2020

4.2 TOP OCCUPATIONS

[26] Annual average wages include wages, salaries and proprietor earnings.

[27] For example, two of the top occupations in Coastal Tourism & Recreation are waitstaff and bartenders, whose tips often account for a significant portion of their income, which is not reported in these figures.

[28] Most of the workers hired through employment agencies are paid at or just above minimum wage.

Table 9 presents the region's top Blue Economy occupations, not including eating and drinking establishment occupations[29]. Many of the top jobs are in the Living Resources sector, including fishing and seafood processing. Median hourly earnings vary, with jobs in the seafood processing industry—Packers & Packagers and Fish Cutters & Trimmers—having some of the lowest earnings. Most all the top occupations require very little formal education[30]. While efforts to vertically integrate and automate the Living Resources may help to strengthen the sector, these efficiencies may also contribute to job losses without further innovative planning.

Table 9 | Top Blue Economy occupations, 2020

Occupation	Jobs	Median Hourly Earnings	Typical Entry Level Education
Fishers & Related Fishing Workers	266	$16.36	None
Laborers & Freight Movers	150	$15.33	None
Packers and Packagers	145	$13.02	None
Stockers and Order Fillers	112	$13.95	High school/GED
Fish Cutters & Trimmers	85	$16.45	None
Heavy and Tractor-Trailer Truck Drivers	81	$23.27	Certificate/Training
Packaging & Filling Machine Operators	66	$13.85	High school/GED
Industrial Truck and Tractor Operators	60	$17.85	None
Sales Representatives (except Tech)	60	$30.91	High school/GED
General and Operations Managers	42	$52.17	Bachelor's degree

Source: Emsi, 2020

4.3 STATE COMPARISON

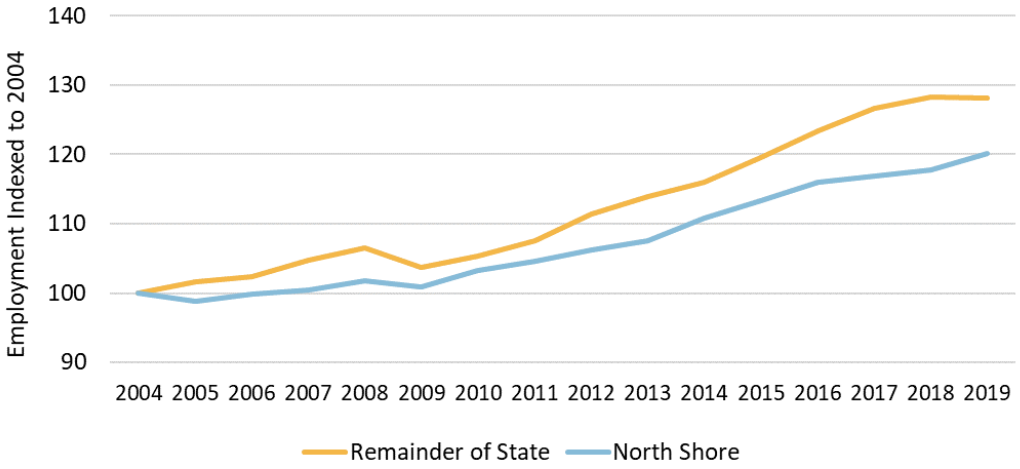
Figure 23 presents Blue Economy employment growth between 2004 and 2020 for the North Shore versus the remainder of coastal communities in Massachusetts. The growth in Blue Economy jobs was more robust elsewhere in the state over this period, with the number of jobs increasing by 28.4 percent compared to 19.5 percent in the North Shore. Much of the job growth was fueled by the Coastal Tourism & Recreation sector.

From 2004-2020, the growth in Blue Economy jobs was more robust elsewhere in the state, with the number of jobs increasing by 28.4 percent compared to 19.5 percent in the North Shore.

[29] The top occupations in the region's eating and drinking sector are waitstaff (1,522 jobs), food prep (1,167 jobs), cooks 711 jobs), bartenders (435 jobs) and dishwashers (306 jobs).

[30] As noted, Fish Cutters & Trimmers are likely undercounted because many are hired as contract employees through temporary agencies.

Figure 23 | Blue Economy Employment Growth, North Shore versus Remainder of Massachusetts Coastal Communities, 2004–2020



Source: Emsi, 2020; Author's Calculations

Table 10 shows both Massachusetts and the North Shore have experienced significant growth in the Coastal Tourism & Recreation sector (25.5% and 31.0%, respectively). Employment in the Living Resources sector declined both statewide and in the North Shore, although the decline is much more extreme in the North Shore (-27.1% compared to -3.2% elsewhere in other Massachusetts' coastal communities).

Table 10 | Job growth by sector, North Shore versus remainder of Massachusetts, 2004-2020

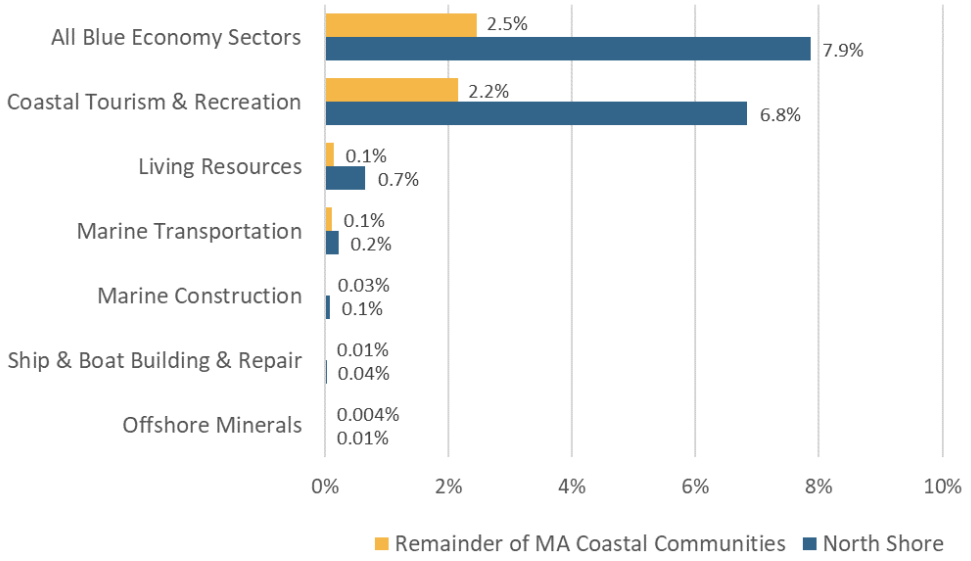
	North Shore		Massachusetts Coastal Communities	
Blue Economy Sector	# Change	% Change	# Change	% Change
Coastal Tourism & Recreation	2,920	25.5%	20,679	31.0%
Living Resources	-517	-27.1%	-201	-3.2%
Marine Transportation	242	103.8%	1,445	45.7%
Marine Construction	58	50.5%	245	25.6%
Ship & Boat Building & Repair	38	90.0%	80	16.4%
Offshore Minerals	-54	-77.2%	-120	-44.3%
All Sectors	**2,686**	**19.5%**	**22,129**	**28.4%**

Source: Emsi, 2020; Author's Calculations

Figure 24 compares the proportion of Blue Economy jobs to total jobs for the North Shore and the remainder of Massachusetts' coastal communities. The North Shore has a higher proportion of total Blue Economy jobs as a percent of total jobs in comparison to the remainder of Massachusetts' coastal communities (7.9% versus 2.5%), while the Coastal Tourism & Recreation sector accounts for a larger proportion of the total jobs in the North Shore than in the remainder of the state's coastal towns (6.8% versus 2.2%) as does the Living Resources sector (0.7% versus 0.1%).

The North Shore has a higher proportion of total Blue Economy jobs as a percent of total jobs in comparison to the remainder of Massachusetts' coastal communities.

Figure 24 | Blue Economy Jobs as a Proportion of Total Jobs, North Shore versus Massachusetts, 2020



Source: Emsi, 2020; Author's Calculations

4.4 LOCATION QUOTIENT

The location quotient (LQ) measures the concentration of employment in the Massachusetts Maritime Economy sectors relative to employment in these sectors elsewhere in coastal Massachusetts. An LQ above 1.00 means that the North Shore has an above average concentration of employment in that sector compared to the other coastal areas in the state. Overall, the North Shore's Blue Economy has an LQ of 1.04, which means that the region is slightly more dependent on Blue Economy sectors as a source of employment than other coastal areas of the state. Living Resources is the region's most specialized Blue Economy sector, with an LQ of 1.45 (see Table 11).

Table 11 | Location Quotient, 2020

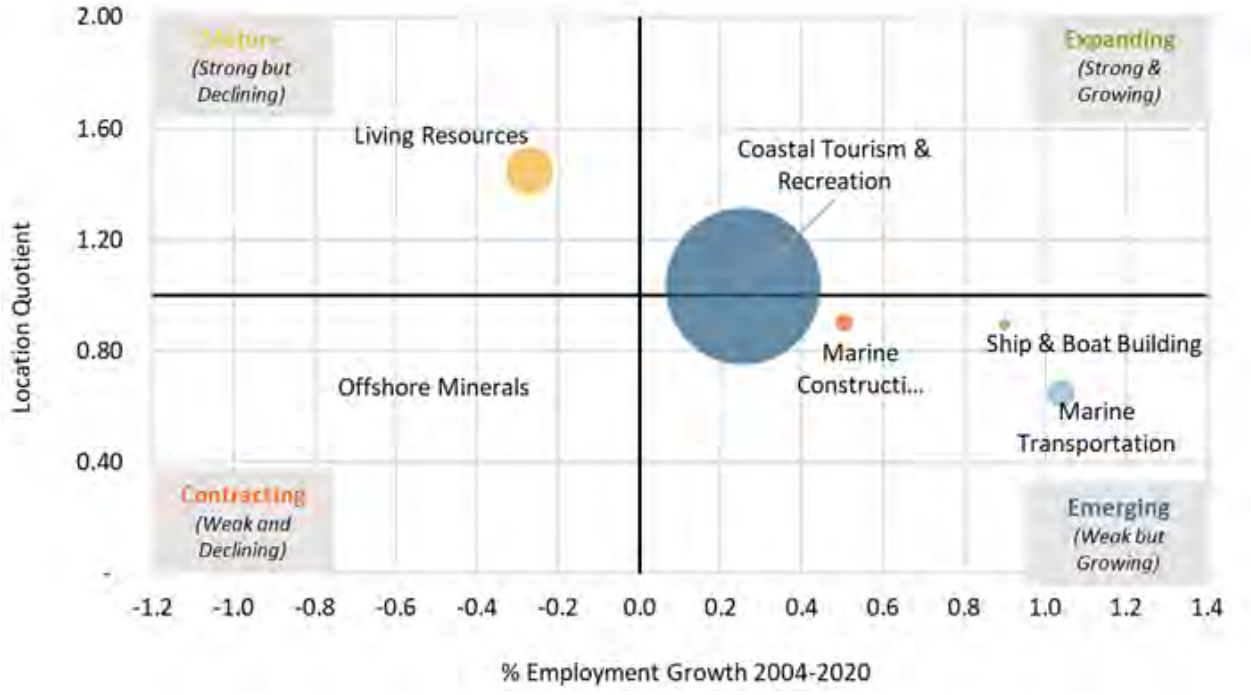
Industry Category	LQ
Living Resources	1.45
Marine Construction	0.90
Coastal Tourism & Recreation	1.03
Ship & Boat Building/Repair	0.89
Offshore Minerals	0.66
Marine Transportation	0.65
Blue Economy Total	**1.04**

Source: Emsi, 2020; Author's Calculations

Importantly, an industry may have a high LQ but low levels of employment or declining employment, and therefore may not be as vital to a region's economy in comparison to industries with lower LQs. Figure 25 displays the LQ for each of the sectors in relation to their size and employment growth from 2004 to 2020, which presents a more holistic view of the strength of each industry. Coastal Tourism & Recreation is the only industry in the Expanding quadrant, having an LQ slightly above 1.0 and employment growth since 2004. Living Resources is in the Mature quadrant, with a higher concentration of employment, but declining employment levels since 2004. Three sectors are in the Emerging quadrant, which means that the North Shore is less specialized

in these sectors in comparison to other coastal areas of the state, but are growing in employment, albeit not significantly in absolute terms.

Figure 25 | Location Quotient, Growth and Size of Major Maritime Economy Sectors, 2020



Source: Emsi, 2020; Author's Calculations

4.5 THE BLUE ECONOMY PUBLIC AND NONPROFIT ECOSYSTEM

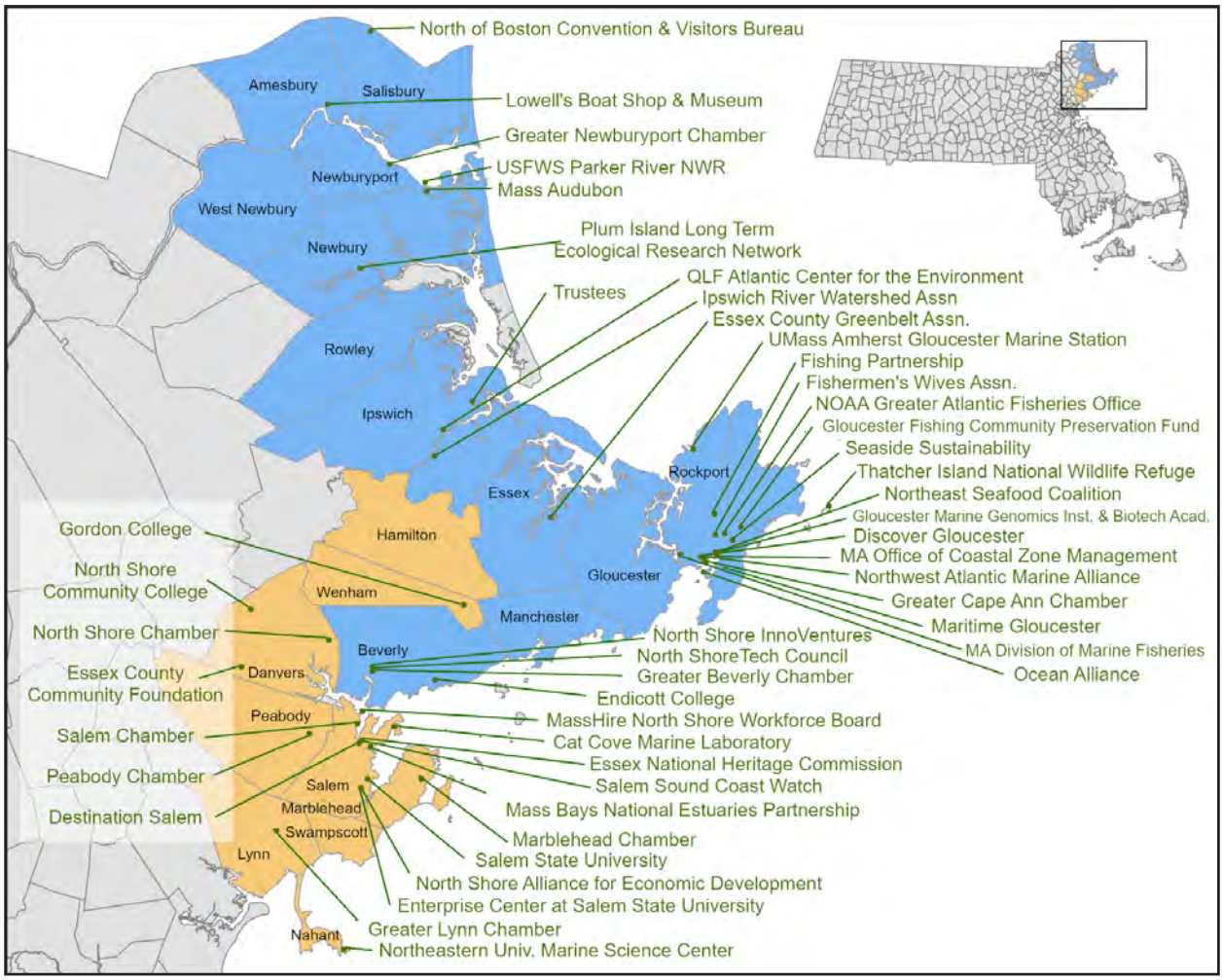
Nonprofit organizations and public institutions play a crucial role in the Blue Economy. Nonprofits and public institutions produce research that drives innovation, collaborating with private sector partners to address problems facing the industry and advocating for causes that will sustain the long-term viability of traditional maritime industries. Figure 26 maps many of the nonprofit organizations and public institutions on the North Shore that are relevant to the Blue Economy.

The region's public and nonprofit organizations that are in the Blue Economy sphere can be categorized broadly into three groups, although some organizations have multiple roles. First, there are those that support economic and business development. Some of these organizations support novel and innovative approaches to problem-solving in emerging industries and provide resources for testing and prototyping new technologies. They may use marine biological resources as inputs or solve a Blue Economy problem by integrating new technology into a traditional setting. Groups like Gloucester Marine Genomics Institute explicitly support the Blue Economy, while others, such as North Shore InnoVentures, incubate technology companies that may have a relation to the Blue Economy. There are also regional conveners and advocates for established local industry clusters like the North Shore Technology Council, which, for example, can focus on supporting the development of emerging offshore wind and marine science technology industries by connecting existing businesses with new opportunities. Chambers of Commerce that support local and regional businesses can promote the region's Blue Economy assets.

Second, there are organizations directly tied to the traditional Blue Economy industries that are engrained in the regional identity. Many support the seafood industry through advocacy and lobbying for more industry-friendly regulations, financial and community assistance for locally

owned and small fishing operations, marketing locally caught species and environmental activism aimed at preserving the ocean and coastal resources upon which the industry depends. Others, such as Maritime Gloucester, connect the modern and history by exploring the traditional maritime industries that made the North Shore a center for fishing, shipbuilding and trade. State and federal offices provide locally-based knowledge, funding and connection to broader state and regional program alignment.

Figure 26 | Nonprofit and public institutions on the North Shore, 2020



Source: UMass Amherst Gloucester Marine Station.
Upper North Shore communities (blue) and Metro North Shore communities (yellow).
Special thanks to Ethan Plunkett, UMass Amherst Department of Environmental Conservation, for map development.

Finally, there is the role of academic institutions in supporting research, collaborating with community partners and advancing science. Although the region is not home to a major research institution, it hosts three marine research centers (UMass Amherst Gloucester Marine Station, Salem State University with MA Division of Marine Fisheries and Northeastern University). Together, they demonstrate the region's importance as a laboratory for studying the ocean, supporting research and problem-solving in the areas of coastal resilience, blue economic development, sustainable seafood and marine ecology. Research collaborations with state and federal agencies, nonprofit organizations and regional coalitions and councils, within the region and beyond, contribute to a network of fundraising for transdisciplinary ocean and coastal research, engagement, education and on-the-ground action, bringing millions of dollars of funding to these coastal marine stations and partner entities.

5. BLUE ECONOMY SECTORS

While the sectors of the Blue Economy are interconnected, it is not a monolith. This section explores each sector in more detail to provide context for targeted, informed decision-making on how to foster growth across the Blue Economy in the North Shore.

5.1 LIVING RESOURCES

The North Shore of Massachusetts has a rich history of relying on its abundant coastal and ocean living resources for food and trade. Our native, indigenous people relied on shellfish and coastal finfish, from the Merrimack River to the Great Marsh to Massachusetts Bay, for food and sustenance. Early settlers, from Marblehead to Amesbury, fished the bountiful waters of the northwest Atlantic Ocean for finfish, especially cod and other groundfish such as haddock, halibut and flounder. Following the disruptions of the American Revolution and the War of 1812, the United States and England finalized treaties for fishing rights in and around the Grand Banks and the Gulf of Maine. Thus, North Shore's fishing industry began its ascent fueled by swift schooners, hardy crews and a spirit of competition.

The epicenter of fishing was Gloucester. As "America's first seaport", the fishing industry flourished in this well-protected harbor with direct access to rich fishing grounds. In its heyday at the turn of the 20th century, it was said there were so many fishing schooners you could walk across the harbor without getting your feet wet. Innovations such as steam-powered engines and flash freezing allowed the North Shore's catch to be extracted faster, stored better and shipped farther than ever before, but it also brought more and more foreign factory ships to the rich fishing grounds of the North Atlantic. By the 1950s, instead of just competing with Canadians, the fishers of the North Shore had to contend with Russian vessels equipped with state-of-the-art technology, capable of extracting incredible amounts of fish from the ocean. Though the Manguson-Stevens Act put an end to this overfishing in 1976, cod stocks had been severely depleted and have not recovered since. While exaggeration and story-telling are key components of fishing mythology, Gloucester was arguably the fishing capital of the world. The story, and the numbers, are different today.

The Living Resources sector of the North Shore Blue Economy includes five industries that employ 1,393 workers, according to our employment databases. The majority of workers in this sector are in Seafood Product Preparation & Packaging, followed by Fish/Seafood Merchant Wholesalers, Finfish Fishing, Shellfish Fishing and Fish & Seafood Markets (see Table 12). Employment in the sector has been falling since 2011, due to reductions in the fishing fleet, loss of fish processing, international seafood competition and costs/risks of pursuing a fishing career[31]. Overall, employment declined by 27.1 percent from 2004 to 2020, compared to a decline of 3.2 percent in the sector statewide over this period (see Figure 27)[32].

Because sustained decreases in the sector's employment did not begin until 2014, as the state was pulling itself out of the Great Recession, the reduction of jobs in the sector is primarily related to trends specific to its industries rather than macroeconomic conditions. Also, some of the job figures may underreport the number of self-employed lobstermen and clammers.

[31] T Balf. 2020. Groundfishing in New England – New Truths. New Rules. New Game. Oceanvest, LLC. https://ocean-vest.com

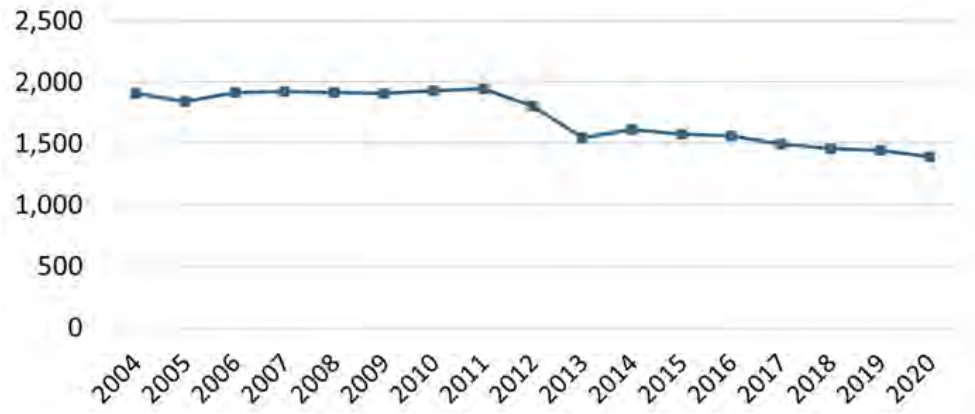
[32] The number of employees in the Seafood Product Preparation & Packaging Industry is likely an undercount, since many of the low-skilled line workers in this industry are hired as contract employees through temporary employment agencies. This practice also artificially inflates wages, since the lowest paid workers are not accounted for in the average wage calculation. Additionally, these employment figures appear to underestimate the number of self-employed lobstermen and clammers.

Table 12 | Employment & Annual Average Wages in the Living Resources sector, 2020[33]

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Seafood Product Prep & Packaging	546	$79,749	109.7%
Fish/Seafood Merchant Wholesalers	398	$71,748	98.7%
Finfish Fishing	179	$80,730	111.0%
Shellfish Fishing	166	$89,816	123.5%
Fish & Seafood Markets	103	$41,157	56.6%

Source: Emsi, 2020

Figure 27 | Historical employment in the Living Resources sector, North Shore, 2004–2020



Source: Emsi, 2020

5.1.1 STRENGTHS, CHALLENGES AND OPPORTUNITIES IN LIVING RESOURCES

Finfish Fishing

Gloucester is the 20th largest port in the U.S. ranked by the value of its catch and the 4th ranked in New England (see Table 13). Gloucester continues to be the #1 port for groundfish in New England, although New Bedford is expanding its groundfish harvesting capacity.

The Finfish portion of the sector continues to decline both statewide and on the North Shore. Many smaller and less profitable fishing businesses have had to close or join larger companies as a result[34]. Many smaller, older or less profitable vessels have sold their boats and, more importantly, their permits which prescribe what fish and how many fish they are allowed to catch. (Note: The permits are more complicated than this, but the statement is generally true for most fishermen.)

The weight and value of Gloucester's catch has declined considerably since the early 1980s. In 1981, Gloucester was the state's largest port in terms of pounds landed (166 million pounds). Comparatively, New Bedford was the second largest port in 1981 and landed less than half that amount. This trend reversed over the last two decades, with New Bedford landing nearly twice the

[33] The number of employees in the Seafood Product Preparation & Packaging Industry is likely an undercount, since many of the low-skilled line workers in this industry are hired as contract employees through temporary employment agencies. This practice also artificially inflates wages, since the lowest paid workers are not accounted for in the average wage calculation.

[34] Urbon, S. (2016). "40 years of change: For fishing industry, the spring of 1976 was the start of a new era." The Standard Times. Aug. 15, 2016. Retrieved from: https://www.southcoasttoday.com/news/20160618/40-years-of-change-for-fishing-industry-spring-of-1976-was-start-of-new-era.

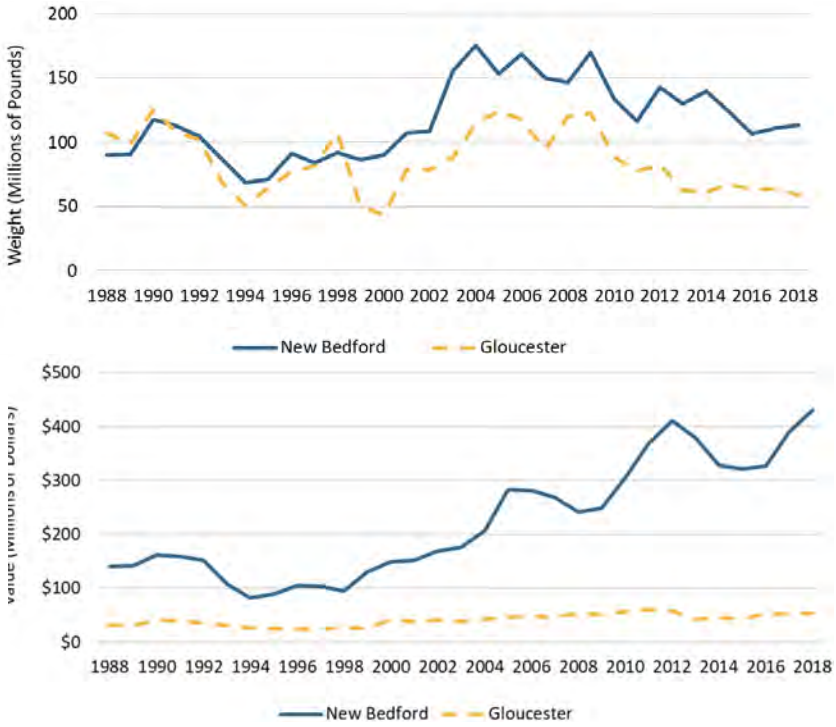
weight of seafood in 2018 in comparison to Gloucester. The difference in value of catch between the two ports is even larger, with New Bedford landing $431 million worth of seafood in 2018, compared to just $53 million in Gloucester (see Table 13). New Bedford's growth is due, in large part, to the success and price/lb. of the scallop fishery. Gloucester's decline, despite its success as the Commonwealth's #1 lobster port, is tied principally to the decline in the size of the fishing fleet and the proportional loss of fish landings (see Figure 28a, 28b). A decade ago, there were 64 vessels in the Gloucester groundfishing "Sector" and a few others who fished for groundfish on their own. Today, there are less than half of that participating in the Gloucester groundfish "Trawl" sector, and the gill netting sector is so small that it has combined with the Trawl Sector, according to information submitted to NOAA.

Table 13 | Top ten New England commercial fisheries ranked by dollars, 2018

U.S. Rank	Port	Value ($Millions)	Pounds (Millions)
1	New Bedford, MA	$431	114
11	Point Judith, RI	$64	48
17	Stonington, ME	$60	18
20	Gloucester, MA	$53	59
27	Vinalhaven, ME	$39	9
29	Portland, ME	$36	46
33	Provincetown/Chatham, MA	$35	22
43	Newington, NH	$27	4
45	Friendship, ME	$24	5
47	Beals Island, ME	$24	7

Source: NOAA Fisheries of the United States report for 2018

Figure 28 | Weight (28a) and Value of Landings (28b), Gloucester & New Bedford, 1981–2017



Source: NOAA Commercial Fishery Statistics Database

161 Year Old Shipyard on Rocky Neck Continues to Service Vessels

SPOTLIGHT

Established in 1859 on Rocky Neck, Gloucester Marine Railways Corp. (GMRC) is one of the oldest continuously operating shipyards in the United States. Beginning as a rapidly-growing fisheries business, there was a need to maintain and repair fishing vessels, prompting the company's founders to construct a marine railway on the property. Since then, GMRC has serviced vessels from wooden schooners to modern day steel and fiberglass boats. A steam engine was used to haul vessels until the 1970s and was replaced with an 85-ton Travelift and two marine railways, which is an alternative to dry docking and includes an inclined plane from the shoreline to the water and uses a cradle system to haul ships. GMRC has maintained and repaired thousands of vessels, and offers welding, pressure washing, dry docking, in-water repairs, shipwright services and more.

These woes have been exacerbated by the decline of a fish that once made Gloucester and Massachusetts the envy of the world—cod. In just 10 years, Massachusetts cod landings decreased over 88 percent, with a catch of 13.7 million pounds in 2007 and 1.5 million pounds in 2017[35]. This is due, in large part, to the more than 90 percent reduction in quota for cod. The Northeast Fisheries Science Center's groundfish stock assessment concluded that Atlantic cod stocks in the Gulf of Maine and Georges Bank are overfished and, while fishing is still allowed, it is done at significantly reduced levels[36]. Conversely, New Bedford's port continues to flourish because it pivoted to the more lucrative and abundant scallop. Despite this fact, most of the seafood processed in New Bedford and Gloucester, and statewide for that matter, is caught elsewhere in the world[37].

It should be noted that boats with commercial fishing licenses for bluefin tuna and striped bass, among other species, have increased in recent years as the charter fishing business industry has grown and the market demand for tuna remains generally strong. While data is not available for the North Shore, in 2018 bluefin tuna had a Massachusetts landed value of $5.2 million and striped bass a value of $3.9 million[38].

[35] Data for individual communities is not available.

[36] Northeast Fisheries Science Center. (2019). Operational Assessment of 14 Northeast Groundfish Stocks.

[37] Borges et al. (2017), Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy, The Public Policy Center at UMass Dartmouth.

[38] Massachusetts Division of Marine Fisheries 2018 Annual Report - Source: ACCSP Data Warehouse 4/22/19

These changes in the industry and marketplace have impacted employment, as fish processing companies have turned to temporary employment agencies in an effort to cut costs and avoid liabilities. Some fisheries have also hired more workers on a seasonal contract basis to cope with thinning profit margins. Other companies such as Gloucester Seafood Processing, an integral part of the Gloucester Fresh local seafood marketing campaign, is no longer operating in Gloucester. Additionally, National Fish & Seafood closed after 40 years in business, leaving 154 jobless[39]. Fortunately, buyers under a new name Atlantic Fish and Seafood have the business operating again. The loss of fish processing capacity in Gloucester is more significant than in other competing ports, such as Boston and New Bedford, where they have been able to retain or even attract seafood/fish processing businesses.

The challenges of upgrading infrastructure, building new vessels, educating and expanding a younger workforce and building increased seafood processing capacity require significant investment and state and regional leadership.

While fish processing has diminished on the North Shore, Gloucester maintains two active fish auction houses and wholesale seafood (fish, lobster, shellfish) companies and shellfish processing enterprises continue to operate successfully although recent international trade wars and Covid-19 related declines in seafood sales to hotels and restaurants have impacted these companies.

Despite these challenges, there are opportunities. The North Shore, and Gloucester in particular, still retains a fishing infrastructure, institutional knowledge, supply chains and skilled (but aging) workforce. Most importantly, based on the current federal groundfish quota for the Northeast Multispecies Fishery (e.g., groundfish), only 9.6 percent of the Georges Bank haddock, 35.2 percent of Gulf of Maine Haddock and 9.3 percent of the pollock quota, have been harvested according to NOAA's 2019 data. (FY 2019 Northeast Multispecies Percent of Annual Catch Limit Caught (%))[40]. Haddock, pollock and redfish stocks are abundant and underharvested. Millions of dollars of prospective landings are potentially being unrealized[41].

The challenges of upgrading infrastructure, building new vessels, educating and expanding a younger workforce and building increased seafood processing capacity require significant investment and state and regional leadership.

Lobster

The North Shore – and Cape Ann in particular – has become the epicenter of lobstering in Massachusetts, which was an $88 million industry in 2018[42].

Gloucester is ranked the #1 port in the Commonwealth of Massachusetts for lobster landings and Rockport #2 (see Table 14). Thirty seven percent of the State's lobstermen and 42 percent of the landings occur within the North Shore communities identified in Table 14. Multiple wholesale

[39] Hillard, J. (2019). "Gloucester-based seafood company closes abruptly, leaving 150 jobless." Boston Globe. May 11, 2019. Retrieved from: https://www.bostonglobe.com/metro/2019/05/11/gloucester-based-seafood-company-closes-abruptly-leaving-unemployed/QYpkWmq8cZ8fD6AFA9eLpI/story.html.

[40] www.greateratlantic.fisheries.noaa.gov/ro/fso/reports/Sector_Monitoring/FY19_Mults_Catch_Estimates_Emergency.pdf

[41] "Groundfishing in New England – New Truths. New Rules. New Game. (August 2020), Oceanvest, LLC.

[42] 2018 Annual Report. Massachusetts Division of Marine Fisheries

lobster companies dot the North Shore and Mortillaro Lobster in Gloucester is one of the Commonwealth's largest wholesaler/exporter of live lobsters[43]. In 2017, the company invested $3 million and built a new 6,000-square foot, two-story processing building and lobster storage tank on Gloucester Harbor.

The quantity of landings in the lobstering subsector in Massachusetts increased by 23 percent from 14,894,724 pounds in 2012 to 18,259,160 in 2018. The value of that landing was $88,478,876 in 2018, an increase of 66 percent as the average price rose from $3.57 in 2012 to $4.85 in 2018. The estimated value of landings for the North Shore was $37.2 million.

Lobstering is a mature industry and the number of commercial permits available are restricted. The cost of entry for a young lobsterman or woman is expensive, but young people continue to enter the workforce and the steady and predictable revenues over the past decade can support traditional financing for the purchase of boats/permit.

Table 14 | Number of active commercial lobstermen and lobster landings, not including seasonal permits, by homeport for 2018 (Mass DMF) for the North Shore communities covered in this report. Percent refers to data for all of Massachusetts.

City/Town	# Fishermen	Rank	Pounds Landed	Percent	Rank	# Traps	Percent	Rank
Gloucester	141	1	3,649,245	19.99%	1	68,820	17.12%	1
Rockport	52	3	1,424,290	7.80%	2	22,022	5.48%	4
Marblehead	35	7	660,415	3.62%	9	18,331	4.56%	6
Beverly	22	14	852,767	4.50%	7	13,840	3.44%	10
Manchester	16	17	191,547	1.05%	22	5,623	1.40%	21
Nahant	13	20	423,478	2.32%	13	6,590	1.64%	18
Swampscott	12	23	227,392	1.25%	21	5,331	1.33%	23
Salem	10	26	139,918	0.77%	25	3,675	0.91%	30
Essex/Ipswich	9	27	24,264	0.13%	41	1,356	0.34%	39
Salisbury	5	35	62,734	0.34%	33	1,135	0.28%	41
Danvers	3	41	44,970	0.25%	36	1,450	0.36%	38
Total	**318**		**7,701,020**	**42.02%**		**148,173**		

Challenges face this subsector as well. Rising ocean temperatures and ocean acidification are at the top of the list. Lobsters are moving northward as a result of rising ocean temperatures and ecosystem changes associated with a changing climate and coastal land use. The abundance of lobsters in Massachusetts territorial waters, where nearly 60 percent of lobster landings take place, is uncertain as this northward shift continues.

Another major issue facing the lobster subsector is the threatened North Atlantic Right Whale, new gear restrictions, seasonal and area closures and operational changes imposed as a result of litigation or regulatory actions (Atlantic Large Whale Take Reduction Plan regulations (50 CFR 229.32)). Such changes are likely to impact the business of lobstering.

[43] AtoZ Database

Shellfish: Clams & Aquaculture

The North Shore is known for its shellfish, owing to its rich mudflats along the Great Marsh and its brand as the "birthplace" of the fried clam in Essex in 1916. The majority of the region's coastal "clamming" harvests soft-shelled clams and sea worms under commercial state licenses and recreational municipal licenses[44]. Gloucester, Rockport, Essex, Ipswich, Rowley and Newbury have approved or conditionally approved areas for shellfish harvest.

Massachusetts landed 3,430,406 pounds of soft-shelled clams for a value of $6,542,580 in 2018[45]. The State issued 878 permits to residents in 2018[46]. We were not able to obtain an accurate estimate of landings or value for the North Shore communities covered by this report. Each of the towns/cities identified has a shellfish warden/department that issues commercial permits and enforces the local ordinance and applicable state regulations, such as food safety issues.

A number of wholesalers in these communities process and redistribute these products. Enterprises include such companies as Ipswich Shellfish Company in Ipswich and Intershell in Gloucester. The Massachusetts Division of Marine Fisheries (DMF) also operates a Shellfish purification plant in Newburyport, MA. Similar to the Lobster subsector, shellfish harvest is a mature business. Growth is generally tied to more demand, or identification of new uses for these products, or their byproducts.

Challenges include warming ocean waters and increasing ocean acidification, stormwater pollution/nitrogen loading and the invasive European Green Crab, which is an effective predator.

Aquaculture

Aquaculture offers an opportunity to expand the Living Resources sector in the North Shore. In 2018 alone, the Massachusetts DMF issued shellfish propagation permits to 391 private aquaculture license site holders and 25 municipalities (for public propagation activities) operating shellfish aquaculture projects in over 30 coastal municipalities throughout the state[47]. The majority of the shellfish farms are off the southeastern part of the state.

Massachusetts aquaculture landings and value are currently minimal for the North Shore. Statewide, the American Oyster aquaculture harvest had a reported value of $27.6 million in 2018, with minimal landings for the North Shore[47]. Less than two percent of the private shellfish propagation permits and less than two percent of the acreage under cultivation within the greater Commonwealth are located on the North Shore. Three North Shore towns secured aquaculture permits in 2019[48]: Essex, one permit for an 8.5 acre oyster farm; Ipswich, three permits covering 3 acres for a private soft-shell farm operation; Rowley, three permits for a total of 4 acres, for oyster and soft-shell clam. In addition to these 6 permits, there is also a research permit for a commercial kelp farm off Manchester-by-the-Sea.

However, the industry faces several challenges, particularly as they relate to shellfish. For example, federal, state and local permitting requirements are extensive and the process is not always clear for prospective municipalities and growers. Shellfish are also vulnerable to environmental changes, such as sea level rise, changes in intensity and frequency of heavy precipitation, rising water and air temperatures and ocean acidification, which can destroy farms or put harvesting on hold until

[44] https://www.mass.gov/service-details/commercial-shellfish-sea-urchin-regulations

[45] According to the 2019 Atlantic Coastal Cooperative Statistics Program (ACCSP) Data Warehouse

[46] Massachusetts Division of Marine Fisheries 2018 Annual Report

[47] See https://www.mass.gov/service-details/dmf-annual-reports.

[48] https://www.mass.gov/doc/2019-dmf-annual-report/download

the environmental conditions improve. Local opposition due to conflicting uses can also make the licensing process onerous.

While aquaculture has been slow to develop on the North Shore, the region possesses several assets to capitalize on and advance the burgeoning aquaculture industry including:

- **Massachusetts' Aquaculture Program**, located within the Division of Agricultural Conservation and Technical Assistance, fosters the development of marine life and the aquaculture industry through the MA Aquaculture Strategic Plan[49] and funds three Aquaculture Centers in the Commonwealth[50].

  1. Cat Cove Laboratory at Salem State University, managed by MA DMF, hosts the Northeastern Massachusetts Aquaculture Center (NEMAC).

  2. UMass Amherst hosts the Western MA Sustainable Aquaculture Center (WMSAC). The UMass Amherst Gloucester Marine Station, located in Hodgkins Cove was recently equipped with a state-of-the-art sea water system for shellfish and other marine invertebrate research.

  3. Southeastern Massachusetts Aquaculture Center (SEMAC) is housed with Cape Cod Cooperative Extension.

  Opportunities exist to bridge resources between these Centers to advance coordinated and integrated aquaculture investment, research and education.

- **Northeastern University Marine Science Center** is a leading marine research and educational facility in Nahant. While not targeting aquaculture research, its work on climate change, fisheries, ecosystem services and coastal ecology is relevant to the success of aquaculture in the Gulf of Maine and off the coast of Massachusetts.

These regional resources along with municipal shellfish programs, a local Massachusetts DMF office, and NOAA's Greater Atlantic Regional Fisheries Office offer assets to capitalize on, coordinate and advance the North Shore sustainable aquaculture opportunities to supplement the traditional fishery, secure diversity of local food, educate and train a new industry[51].

Despite these challenges, this most traditional of Massachusetts industries is reinventing itself to address these new realities, such as employing technologies and third party assessments that assist with resource management, employing more automation in processing seafood, and promoting local catch and selling direct to consumers.

[49] https://www.mass.gov/service-details/massachusetts-aquaculture-white-paper-and-strategic-plan

[50] https://www.mass.gov/service-details/aquaculture

[51] Special thanks to Tom Balf from OceanVest, LLC for reviewing information included in this section.

5.2 COASTAL TOURISM & RECREATION

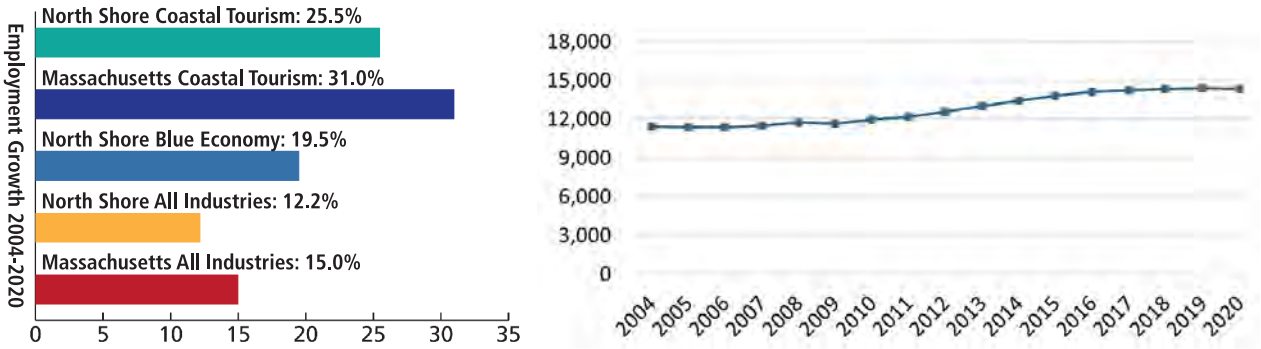
Coastal Tourism & Recreation includes nine industries that employ a total of 14,350 workers. The Eating & Drinking Places industry accounts for the majority of workers in the sector, followed by Hotels & Lodging and Marinas (see Table 15). Employment in the sector grew by 25.5 percent from 2004 to 2020, with year-to-year growth fairly consistent over this period (although growth has leveled out slightly since 2016) (see Figure 29). The rate of employment increase in the sector is more than double that for all North Shore industries (12.2%) and higher than employment growth for the North Shore Blue Economy as a whole (19.5%)[52].

Table 15 | Employment & Annual Average Wages in the Coastal Tourism & Recreation, 2020[53]

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Eating & Drinking Places	11,916	23,582	32.4%
Hotels & Lodging	986	28,878	39.7%
Marinas	475	42,150	58.0%
Amusement & Recreation	467	23,105	31.8%
Sporting Goods Stores	300	27,639	38.0%
Boat Dealers	113	60,195	82.8%
Scenic Water Tours	72	30,412	41.8%
RV Parks & Campsites	18	Insf. Data	Insf. Data
Zoos/Aquaria	2	Insf. Data	Insf. Data

Source: Emsi

Figure 29 | Historical Employment in Coastal Tourism & Recreation, North Shore, 2004–2020



Source: Emsi

5.2.1 STRENGTHS, CHALLENGES AND OPPORTUNITIES IN COASTAL TOURISM & RECREATION

The Coastal Tourism & Recreation sector is highly dependent on the vitality of the economy as a whole, since leisure activities are dependent on consumers' disposable income. However, at least in terms of employment, the sector as a whole was not affected significantly by the Great Recession (2007-2009). The sector's ability to weather the economic downturn might be partly the result of

[52] Average annual wage statistics likely overstate the wage differential for Eating & Drinking Places (the sector's largest industry), since some of the region's restaurants are seasonal operations that pay out their "annual" wages over a shorter period. Wage data also do not include tips, which can account for a substantial portion of employee earnings in restaurants and bars.

[53] Annual average wages not available for RV Parks & Campsites and Zoos/Aquaria.

spending by wealthier tourists. In addition, North Shore residents as a whole have higher incomes in comparison to the state and are more highly educated (hence, more likely to be employed during poor economic conditions); thus macroeconomic factors may have presented less downward pressure than they might have otherwise.

Historic and Natural Beauty

The North Shore has a rich and significant historical legacy which underpins the formation of the United States dating back to the early 17th century. The region boasts over 250 sites listed on the National Register of Historic Places. Regional historic preservation efforts through the congressionally designated Essex National Heritage Area and Historic New England, the oldest and largest regional heritage organization in the nation, are further supported by many local community preservation efforts.

The region has a diversity of conserved natural areas and parks with hundreds of miles of inland and coastal trails that can be explored on foot. River, coastal and salt marsh water trails can be explored by boat. The beaches, fishing charters, sightseeing tours and other shoreline access points accessible for recreational use and ecological exploration are an important draw for tourists and the regional economy.

The region's natural and historic beauty are conserved through the efforts of the Commonwealth state parks, the U.S. Fish & Wildlife Service's Parker River National Wildlife Refuge and through the

collaborative efforts of dozens of nonprofits including the Essex County Greenbelt, Trustees and Mass Audubon. These organizations work collaboratively with other regional nonprofits and with state, federal and local government entities to preserve the region's historic and cultural legacy, ecological value and natural beauty (see Figure 26).

Access

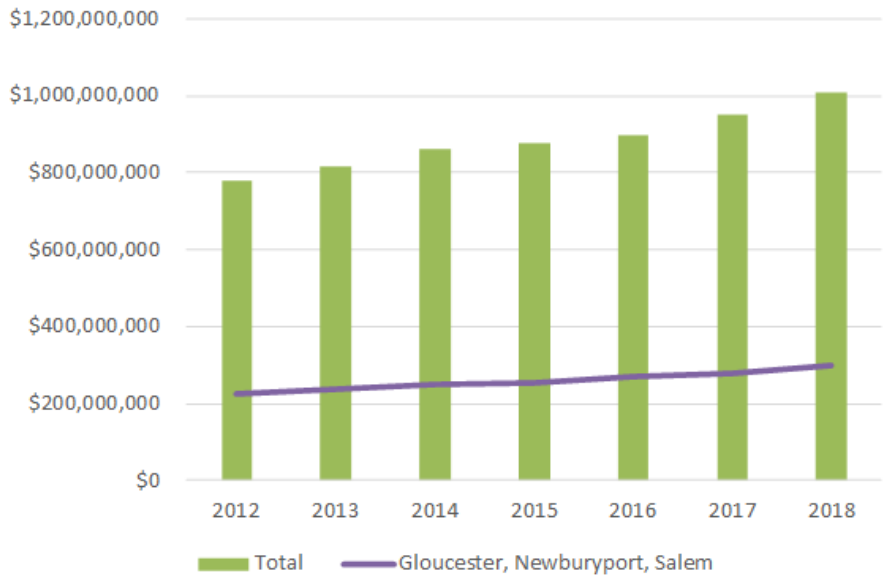
Tourism and recreation on the North Shore are further bolstered by easy access to the region, both nationally and internationally, through Boston's Logan International Airport. Much of the North Shore is between 20-40 miles from Boston via highway and public transportation. Rail service between Boston and the North Shore ease both commuting and tourism and recreation access.

Several tourism marketing organizations promote the region, including the North of Boston Convention and Visitors Bureau and North Shore Chamber of Commerce. Localized organizations like Destination Salem and Discover Gloucester as well as Chambers of Commerce including the Cape Ann, Greater Newburyport and Greater Beverly Chambers of Commerce promote sub-regions of the North Shore.

Visitor Expenditures

Three of the largest contributors to North Shore visitor expenditures are from Gloucester ($112M), followed closely by Salem ($110M) and Newburyport ($57M) (see Figure 30). Gloucester, Newburyport and Salem have in common their rich history, natural vistas, vibrant downtowns, eating and drinking establishments and attractions on or near the waterfront to encourage and enable visitor businesses.

Figure 30 | North of Boston Visitor Expenditures from Gloucester, Salem, Newburyport compared to the North of Boston Region (Total), 2012-2018



Sources: Massachusetts Office of Travel and Tourism, US Travel Association

While tourism has been on the rise in past years, the Covid-19 pandemic has brought intense challenges to local businesses in 2020 and into 2021. Based on a conservative estimate of 40 percent travel spending losses during 2020 due to Covid-19, the North of Boston region expects to realize $485 million in lost revenues, $26 million in state tax losses, $12.7 million in tax losses to our cities and towns and more than 3,400 jobs (see Table 16).

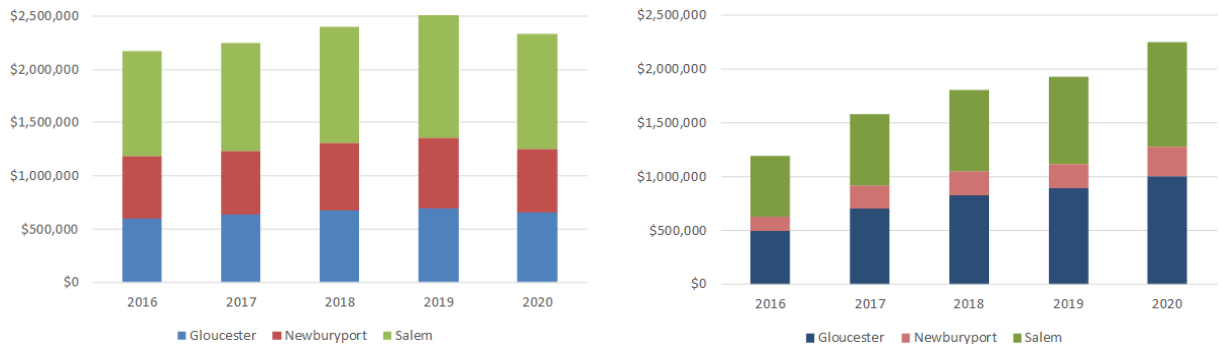
Table 16 | Coastal tourism losses attributed to Covid-19

	Spending loss	Revenue loss	State tax loss	Tax losses to cities and towns
United States	38%	$562 billion		
Massachusetts	53%	$15 billion	$451 million	$234 million
North of Boston	40%	$485 million	$26 million	$12.7 million

Sources: Data are best estimates compiled from multiple sources: US Travel Association, Tourism Economics, STR, Destination Analysts, AirDNA, Arrivalist, Massachusetts Office of Travel and Tourism, Bureau of Labor Statistics, MA Blue Book Tax Collections, North of Boston Convention and Visitor's Bureau

Local Options Rooms Tax and Meals Tax have increased between 2011-2021 (see Figure 31). The 12 percent increase in Room Tax in 2016/2017 is attributed to Gloucester's Beauport Hotel opening in June of that year. The decrease in Meals Tax revenue in 2021 is due to the Covid pandemic. The Rooms Tax has not declined during the Covid pandemic because it includes new short term rental tax collections. Local Options Rooms Tax and Meals Tax does not separate out local consumers from visitors (i.e., the Massachusetts Office of Travel and Tourism considers a visitor as a person traveling at least 50 miles one way).

Figure 31 | Gloucester, Newburyport and Salem Local Options Meals Tax (0.75%, Fig. 31a on left) and Rooms Tax (6%, Fig. 31b on right)



Source: Massachusetts Department of Revenue, Division of Local Services

Challenges

The Coastal Tourism & Recreation sector is not without its challenges. Coastal communities must balance coastal and ocean resources in a way that makes them accessible and appealing to visitors, while mitigating the negative impacts of increased use. As such, commercial development is constrained for practical and environmental reasons, with local, state and federal regulations also constraining coastal tourism growth at the important expense of preserving traditional maritime activities along the waterfront. Consequently, there is an inherent tension in balancing the economic needs of the coastal tourism sector with other Blue Economy industries and those who are working to preserve the beauty and ecological value of the region's coastal beaches, salt marshes, rocky shores and scenic vistas that are so attractive to its residents and visitors.

Rising sea level, more frequent and intense storms and flooding all represent significant threats to coastal communities, supporting ecosystems, infrastructure and businesses in this sector, particularly those located directly on the water such as marinas, hotels and restaurants.

While Coastal Tourism & Recreation represents 87 percent of the regional Blue Economy employment (Table 6), it also represents the lowest average annual wage ($24,979), with most employment based in service jobs with no direct connection to the sustainable use of ocean

resources. The portion of sustainable Blue Economy jobs within the Coastal Tourism & Recreation sector (e.g., boat dealers, marinas, marine supplies, restaurants promoting local seafood, eco tours) needs to be better quantified to leverage interconnected Blue Economy opportunities in those areas.

Low wages affect residents' quality of life overall, particularly in terms of housing affordability. Many of the workers who are vital to the industry are increasingly unable to afford to live near the places where they work, particularly coastal areas where housing prices tend to be the highest, and where some of the housing stock is reserved for seasonal rentals. Essentially, a large percentage of the Blue Economy workforce is being priced out of the housing markets in the communities in which they work. Preserving and creating housing that is affordable to these workers is essential to maintaining the vitality of this sector.

While the Coastal Tourism & Recreation sector has been challenged in 2020 due to the Covid-19 pandemic, the Federal Paycheck Protection Program and the U.S. Small Business Administration's Economic Injury Disaster Loan program have been critical to allowing many North Shore businesses and nonprofits to stay in business. The regional Chambers with municipal leaders are playing a vital role in working with the U.S. Small Business Administration and local lenders to support the business community.

As the region's Blue Economy opportunities become better known through coordination with and promotion by regional organizations like chambers of commerce and the North of Boston Convention and Visitors Bureau, existing regional talent in our strength sectors as well as professionals and new graduates will be drawn to the region, helping to fill new Blue Economy jobs and attracting work in our growing North Shore Blue Economy[54].

5.3 SHIP & BOAT BUILDING & REPAIR

Building and maintaining ships constituted much of the maritime economic activity in the North Shore by the late seventeenth century. As a testament to the importance of shipbuilding, Essex bears a ship on stocks as its town seal and this was where the region's first recorded ship was built in 1654[55]. By the time of the American Revolution, the communities on and around Cape Ann had developed such a reputation for constructing and crewing ships that it is no surprise that, when he was frustrated by the Continental Congress' slow naval procurement process, George Washington turned to the merchants and fishers of the North Shore to commission privateers to support the siege of Boston, starting with the Hannah, which was based in Marblehead and crewed with seamen from Beverly[56].

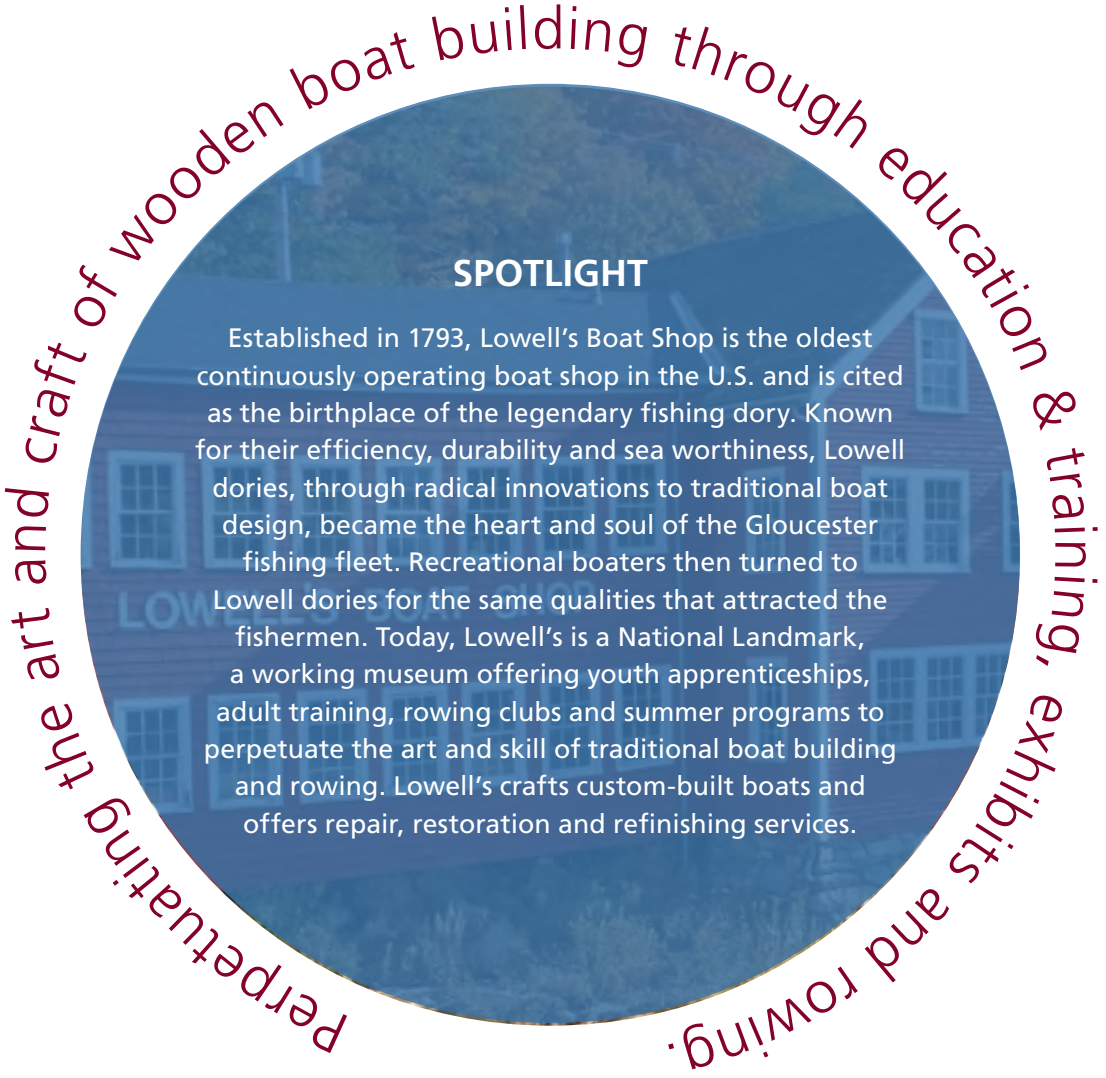
Within a century of the revolution, the regional ship and boatbuilding industry was at its peak, with 15 active shipyards in Essex alone. Local shipwrights were recognized internationally for their innovative designs such as the schooner and the Cape Ann dory, which supported the local fishing industry by providing a means for quickly sailing to and from the banks and weathering the rough seas[57]. A shift to steel and steam over wood and sail marked the decline of ship and boat building in Massachusetts, but the industries survive today in the North Shore by serving niche markets, adopting modern methods and also by preserving the rich history of wooden, handcrafted sailing vessels.

[54] Special thanks to Ann Marie Casey, North of Boston Convention & Visitors Bureau and Ken Riehl, Cape Ann Chamber of Commerce for additional data sources used in this section.

[55] Kenny (1971).

[56] "Hannah (Schooner)." Naval History and Heritage Command, 2015. Retrieved from: www.history.navy.mil/content/history/nhhc/research/histories/ship-histories/danfs/h/hannah-schooner.html.

[57] Perunko, J., Bisher, K., & Davis, S. (2007).



Ship & Boat Building & Repair sector includes two industries that employ a total of 81 workers (see Table 17). Employment in the sector grew by 90.0 percent from 2004 to 2020, with year-to-year growth fairly consistent since 2013, although growth was low in absolute terms (see Figure 32)[58]. Nationally, the drivers of this sector differ by industry. Ship & Boat Building & Repair relies heavily on government contracts and there are no longer large shipyards in the region that do this kind of work. Ship & Boat Building & Repair is highly dependent on growth in the overall economy, particularly in terms of disposable income available to purchase and repair recreational vessels which drops predictably during recessions, such as that of 2008 (see Figure 32). Notably, reported employment figures for Ship & Boat Building & Repair are likely low, since repairs also occur at marinas, thus some Ship & Boat Building & Repair employment is accounted for in that industry's job counts.

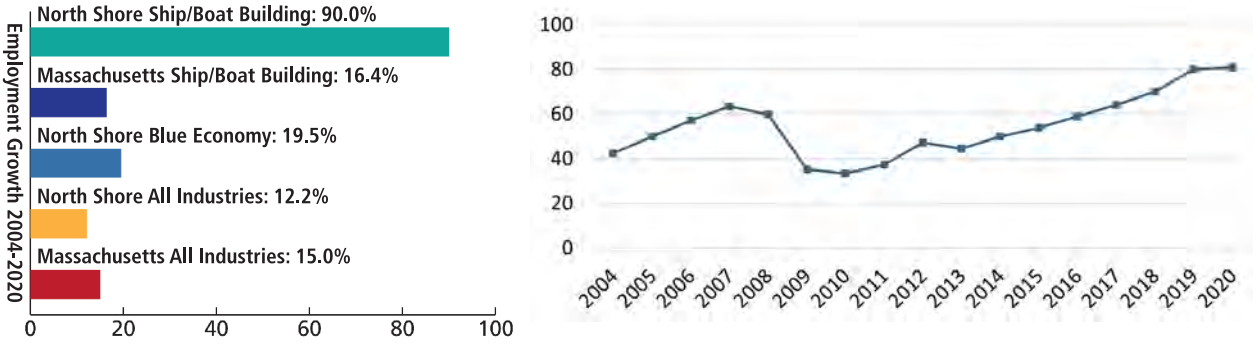
Table 17 | Employment & Annual Average Wages in the Ship & Boat Building & Repair sector, North Shore, 2020

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Boat Building	66	$59,718	82.1%
Ship Building & Repairing	15	$84,973	116.9%

Source: Emsi, 2020

[58] Annual Average Wage data for Shipbuilding is suppressed due to confidentiality.

Figure 32 | Historical employment in the Ship & Boat Building & Repair sector



Source: Emsi

5.3.1 STRENGTHS, CHALLENGES AND OPPORTUNITIES IN SHIP & BOAT BUILDING & REPAIR

The Ship & Boat Building & Repair sector is interconnected with other Blue Economy sectors. For example, when the Fishing industry is thriving, there is more business for boat builders, boat repairers and boat mechanics. The sector is also linked to Coastal Tourism & Recreation, driven by the demand and repair of ferries, charters and sightseeing tours. Consequently, recessionary forces can have a significant impact on the sector. Due to these factors and the size of the firms located in the North Shore, the activity in this sector will most likely continue to be niche boat builders and the repair of boats at the region's various marinas. That said, new opportunities (e.g., vessel maintenance) exist through the development of offshore wind in the Gulf of Maine.

Work conducted by the Public Policy Center at UMass Dartmouth on behalf of the Massachusetts Seaport Economic Council indicates that a shortage of qualified workers is creating difficulties for some employers in this sector, particularly boat builders and repairers. For instance, 80 percent of respondents in a survey conducted by the Massachusetts Marine Trades Educational Trust indicated that the growth of their businesses was inhibited by an inability to hire qualified employees[59]. Likewise, stakeholders are concerned about being unable to find replacements for the aging workforce. With few vocational programs available at the high school level, it is unclear from where the new generation of boat and ship builders and repairers will come[60].

As discussed above, the history of boat and ship building in the region means that the sector is intrinsically linked to the identity of the North Shore and many boat builders survive today by emphasizing their link to this history. Boat building is an important part of the North Shore's heritage, and the oldest operating boat shop in the United States is located in Amesbury. Lowell's Boat Shop, founded in 1793, is dedicated to preserving the art and craft of wooden boat building. The boat shop is a national historic landmark, working museum and offers educational programs. Additionally, they construct custom boats using locally sourced lumber and also offer repair and maintenance services[61].

H.A. Burnham Boat Building & Design in Essex constructs vessels and sails, and runs a saw mill to provide wood for their building projects. In 2011, the company launched the *Ardelle*, a vessel operating out of Maritime Gloucester. The boat is used for public and private sails and serves as a research and educational vessel. There are also boat builders located in Marblehead, including Redd's Pond Boatworks and Ribcraft. Ribcraft builds for a diverse set of clients from first responders and military to yacht clubs and recreation. A sleek design and a V-shaped fiberglass bottom allows for a smoother, drier ride, contributing to a growing recreational market for the vessels.

[59] Workforce Survey, Massachusetts Marine Trades. Massachusetts Marine Trades Educational Trust. April 2016.

[60] Borges et al. (2017), Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy, The Public Policy Center at UMass Dartmouth.

[61] http://lowellsboatshop.com/

As a result of the industry's decline, many remaining companies have had to seek additional sources of revenue or reduce their size. It is common for boat builders in the region to participate in the marine tourism and other related industries. Many offer educational programs, storage services, furniture building, or run museums, own parts of the supply chain and operate charter services to help increase profit. Essex shipwright Harold Burnham, a National Heritage Fellowship recipient, pointed out that because the industry is experiencing "the worst slump since records were kept in 1860, and likely the worst since … the early seventeenth century," he built the schooner *Ardelle* to "provide a more sustainable income for his family[62]." Changes in the industry have impacted the way boat builders in the North Shore run their companies, as shifting trends led many to adapt their business models. There are some efforts aimed at preserving the industry, such as the Massachusetts Boat Builders coalition, which was formed to jointly promote vessels constructed in the Commonwealth.

5.4 MARINE TRANSPORTATION

Marine Transportation developed on the North Shore as a necessity. Ships were built to fish but they were also built to transport the dried cod to the Caribbean and return with rum. As a result, Salem and nearby Boston became hubs in the triangle trade. As the region became renowned for its granite, the freight industry was responsible for exporting this valuable building material across the globe[63]. Advent of the railroad allowed the region's fish and granite to more efficiently reach their destinations, and, along with the consolidation of merchant interests in Boston, crippled the North Shore's shipping industry[64]. However, the sector as we define it today includes refrigerated warehousing, an industry in which Gloucester's Clarence Birdseye was a pioneer, and whose legacy continues today as the city is still a hub for storing, processing and distributing seafood caught in the Gulf of Maine and beyond[65].

The North Shore's Marine Transportation sector includes five industries that employ 474 workers. The majority of workers in this sector are in Refrigerated Warehousing and Storage industry, which primarily supports the seafood processing industry and also play a role in international and short sea shipping (see Table 18)[66]. Employment in the sector increased by 103.8 percent from 2004 to 2020, compared to 45.7 percent for the sector statewide. Although the industry was hit hard by the Great Recession, it has recovered to pre-recessionary levels (see Figure 33). Importantly, this sector includes Search and Navigation Equipment, which is a key component of the Marine Science & Technology sector, and will be discussed in more detail in Section 6.

Table 18 | Employment & Annual Average Wages in the Marine Transportation sector, 2020

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Refrigerated Warehousing	431	$57,521	79.1%
Marine Trans. Services	18	$65,383	89.9%
Deep Sea Freight Trans.	19	Insf. Data	Insf. Data
Marine Passenger Trans.	3	Insf. Data	Insf. Data
Search & Nav. Equip	3	Insf. Data	Insf. Data

Source: Emsi

[62] https://schoonerardelle.com/our-story.php

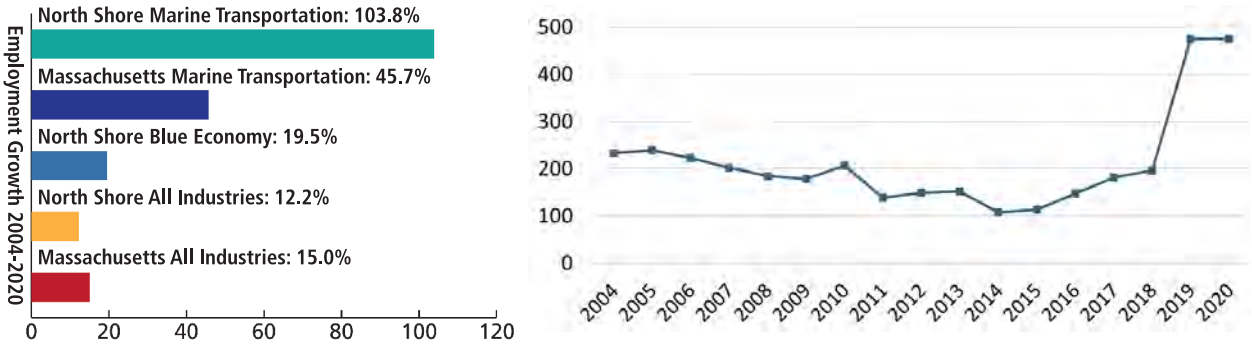
[63] Cape Ann Museum. 2018.

[64] Kenny, H.A. (1971).

[65] Ibid.

[66] Average annual wage data for most industries in this sector is suppressed.

Figure 33 | Historical Employment in the Marine Transportation sector, 2020



Source: Emsi

5.4.1 STRENGTHS, CHALLENGES AND OPPORTUNITIES IN MARINE TRANSPORTATION

The region's Marine Transportation sector is dominated by the Refrigerated Warehousing industry, which primarily supports the Living Resources sector. Additional water transportation workers may be in demand if the burgeoning offshore wind industry takes hold in the Gulf of Maine along the northern New England coast. These workers play a crucial role by transporting people and materials to the wind farm and patrolling the exclusion zone during construction. Water transportation workers also support marine science and technology research operations, such as assisting in the deployment of ocean sensors, autonomous underwater vehicles (AUVs) and "internet-of-things" (IoT) devices.

The Marine Passenger Transportation industry is strongly influenced by commuting and tourism. The North Shore currently has seasonal ferry services provided to Salem from Boston, which may be expanded in the future. More than half of the ridership are Salem residents, and the use of the ferry accounts for nearly 20 percent of MBTA Salem to Boston trips that originate from the ferry. Much of the demand for more commuting options is driven by the explosive growth of the South Boston waterfront and Seaport District, which would be readily accessible via commuter rail from the north if the proposed North-South Rail Link were built. The City of Salem has also invested in transportation infrastructure to improve the convenience, safety and access to the ferry.

In 2014, Lynn began a two-year seasonal pilot program to test a ferry route's popularity, running three round trips from Lynn each weekday to Central Wharf in Boston. The service had 13,300 riders its first year and 14,577 riders the second year. The ferry continues to be assessed by the Massachusetts Department of Transportation. Seasonal water taxis and shuttles along the North Shore continue to be discussed as part of a long-term marine transportation services, although it has been noted that it will be difficult for water taxis or connector vessels to be financially viable without significant federal or state subsidies.

Overall, the expansion of the Salem ferry service may be the priority in the near future, particularly since ferry services are increasingly recognized by local leaders as necessary to both minimize traffic congestion on the North Shore and to efficiently transport commuters to the Seaport District. However, marine transportation services may not be viable without federal and state financial support. There is also an opportunity to continue to study the viability of short-route water shuttles and ferry connectors over the next few years. In a larger context, an expanding Marine Transportation sector, whether it be for offshore wind, passenger service, deploying marine science and technology software, or other opportunities, supports other industries in the Blue Economy such as Ship & Boat Building & Repair and Coastal Tourism & Recreation[67].

[67] Special thanks to Tom Balf from OceanVest, LLC for researching and writing much of the information included in this section.

5.5 MARINE CONSTRUCTION

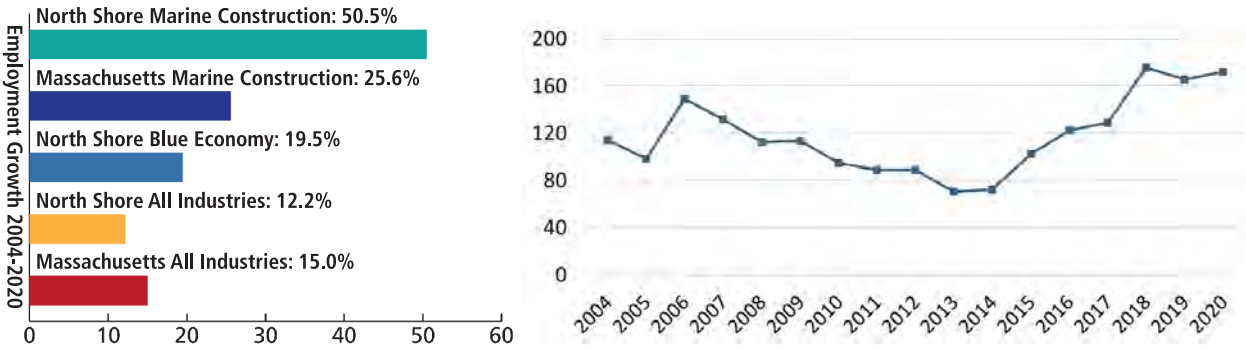
The Marine Construction industry engages in the construction of submarine oil and gas pipelines, as well as other heavy and civil engineering activities such as harbor dredging, pier and marine construction, beach nourishment and estuary restoration. Since regulations prohibit offshore drilling in Massachusetts waters, there is limited need for the construction of submarine oil and gas pipelines. Therefore, most of the employment in this sector is in the Heavy and Civil Engineering Construction industry. Employment in the sector increased by 50.5 percent from 2004 to 2020, compared to 25.6 percent statewide, although the increase was small in absolute terms (see Table 19 and Figure 34).

Table 19 | Employment & Annual Average Wages in the Marine Construction Sector, 2020

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Other Heavy & Civil Engineering Construction	134	$78,620	108.1%
Oil & Gas Pipeline & Related Structures Construction	38	$48,922	67.3%

Source: Emsi

Figure 34 | Historical Employment in the Marine Construction Sector, 2020



Source: Emsi

5.5.1 STRENGTHS, CHALLENGES AND OPPORTUNITIES IN MARINE CONSTRUCTION

The future of the Marine Construction sector in the North Shore depends on capturing activity related to the state's nascent offshore wind industry, securing funds to improve port infrastructure and responding to the threats posed by climate change and sea level rise. Although the only current wind lease areas are in the Atlantic waters south of the Commonwealth, the short supply of industrial port land available throughout the heavily built-up Northeast means that developers will most likely need to create a patchwork of staging areas and temporary marshalling grounds for components that will be, at least at first, shipped in from Europe.

In some cases, ports would need to be upgraded to receive and house large wind turbine components. More importantly, in the PPC's work for the Seaport Economic Council, we noted that "recent studies have identified significant capital investment needs at the state piers and Designated Port Areas, including dredging, repairing pile supports, replacing decking and building

repairs or replacements[68,69]. Investments in these areas will likely benefit Massachusetts' Marine Construction firms, although currently there are not many firms located in the North Shore who can undertake these large projects.

5.6 OFFSHORE MINERALS

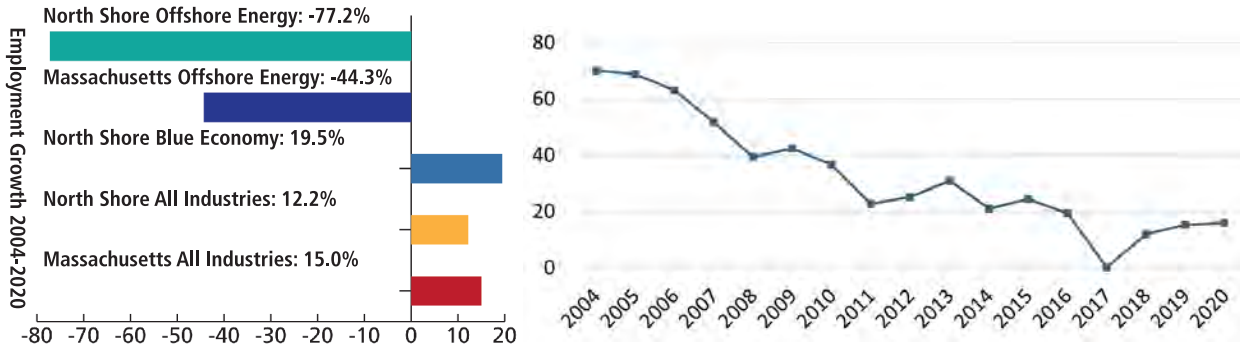
Nationally, employment in this sector is mostly concentrated in offshore drilling and related industries. However, Massachusetts does not produce its own natural gas, and oil drilling was banned from the coasts of California, Florida and Massachusetts in 1988 by President Ronald Reagan[70]. Limestone, Sand & Gravel Mining, the one Offshore Minerals industry with some presence in the Commonwealth, has experienced multiple losses in recent years, and the firms in this industry are located outside of the North Shore. Therefore, this sector does not have a major presence in the state or on the North Shore; it only employed 16 people in 2020 (see Table 20). Employment in the sector has generally declined since 2004 (see Figure 35). Due to the low level of activity and the regulations impacting this sector, there are not any anticipated opportunities for growth in the region.

Table 20 | Employment & Annual Average Wages in the Offshore Minerals sector, 2020

Industry	Jobs	Avg. Wages & Salaries	% of MA Wages & Salaries
Oil/Gas Exploration & Production	11	Insf. Data	Insf. Data
Limestone, Sand, & Gravel	5	Insf. Data	Insf. Data

Source: Emsi

Figure 35 | Historical employment in the Offshore Minerals sector, 2020



Source: Emsi

[68] Karl F. Seidman Consulting Services and UrbanFocus LLC, Massachusetts State Piers: A Business and Economic Assessment. Report to MassDevelopment and the Massachusetts Executive Office of Housing and Economic Development. May 2016.

[69] Martin Associates and Apex Companies, Economic Impact Study of New Bedford/Fairhaven Harbor. September, 2016.

[70] This is often the largest employment sector in other areas of the country, particularly in states along the Gulf of Mexico, which have large oil and gas drilling operations.

6. MARINE SCIENCE & TECHNOLOGY

The Marine Science and Technology (MST) cluster spans a wide variety of fields, including robotics, oceanography, renewable and non-renewable energy, biotechnology, communications hardware, information technology, advanced materials and civil engineering. MST crosses many academic disciplines and as a result, any attempt to identify MST businesses and organizations cannot make use of the standard categories by which data collection agencies sort and report information (for example, the NAICS-based approach used in the previous section of this report).

Accordingly, the research team manually developed a list using multiple sources and refined it to create an inventory of core MST businesses. We identified 18 MST businesses in the North Shore, which span several industries, including marine equipment, advanced materials and offshore communications (see Table 21 and Figure 36). The smaller number of MST businesses than may be expected is partly attributable to the fact that the region is not home to any major research institutions, which typically serve as the hubs of the MST cluster by spinning off entrepreneurs and attracting new businesses in need of a highly educated workforce. However, close proximity to Boston (rail, highway) and local and regional colleges/universities (Northeastern University, Salem State University, UMass Amherst Gloucester Marine Station, Gordon College, Endicott College, North Shore Community College, UMass Boston, UMass Lowell, MIT, Tufts, Harvard) and a growing suite of MST businesses, all present resources to form a strategic hub around regional MST strengths and needs.

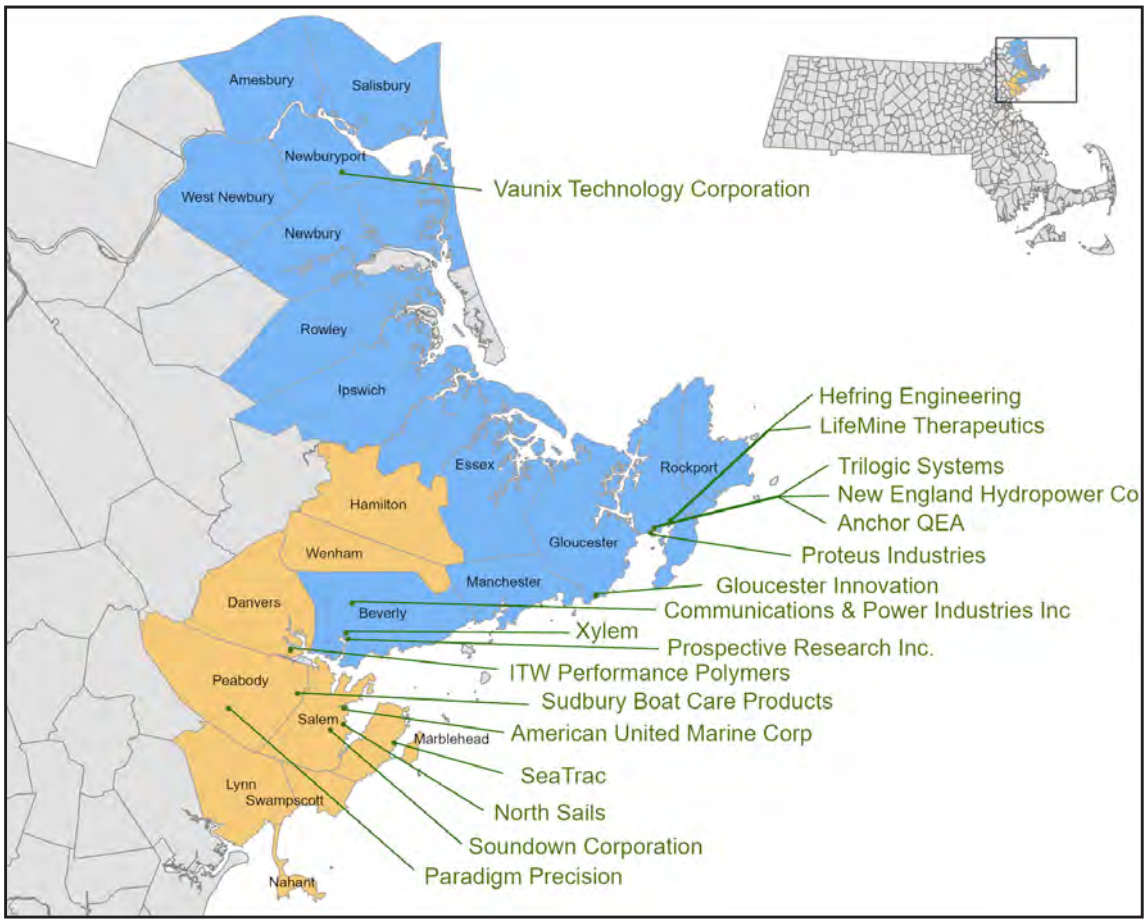
Table 21 | Number of Marine Science and Technology Businesses by Category, North Shore, 2020

Category	Count
Marine Equipment	3
Advanced Materials	4
Offshore Communications	4
Renewable Energy	1
Scientific & Engineering Services	2
Marine Robotics	1
Seafood Processing	2
Scientific Instrumentation	1

Source: Public Policy Center

However, close proximity to Boston (rail, highway) and local and regional colleges/universities (Northeastern University, Salem State University, UMass Amherst Gloucester Marine Station, Gordon College, Endicott College, North Shore Community College, UMass Boston, UMass Lowell, MIT, Tufts, Harvard) and a growing suite of MST businesses, all present resources to form a strategic hub around regional MST strengths and needs.

Figure 36 | Marine Science & Technology Businesses, North Shore, 2020



Source: Public Policy Center

Table 22 provides examples of the products and services produced by MST companies. These include ocean instrumentation and sensors, mooring systems, marine hardware, cable assemblies and connectors, data loggers, systems engineering, software engineering, testing and evaluation and environmental services.

Table 22 | Examples of MST products and services

Products	Services
Advanced engine components	RF and microwave test equipment
Sails	Digital radio communications
Robotics	Unmanned surface vehicles
AI technology	Adhesives, grouting, and chocking compounds
Data analytics	Design, integration, and testing services
Sensors	Science and engineering services
Microwave vacuum electron devices	Hydropower
Noise reduction solutions	Elastomeric sealants
Digital radio communications	Smart technology water solutions
Ocean ecosystem monitoring	Ship systems engineering
Marine-derived biopharmaceuticals	Fisheries population genomics

Source: Public Policy Center

6.1 RESEARCH AND DEVELOPMENT ACTIVITY

The presence of research and development (R&D) activities in a region, whether undertaken by private businesses, research institutions or other organizations, can be a major source of the new ideas that fuel innovation. The PPC used two metrics to gain insight into the competitive position of the North Shore in terms of MST-related R&D. Data about business R&D was gleaned from a database of Small Business Innovation Research (SBIR) and Small Businesses Technology Transfer (STTR) awards[71]. Also examined were the number of MST patents to measure the R&D activity more broadly[72].

SBIR and STTR Grants

The SBIR and STTR programs are highly competitive federal grant programs that enable small companies to conduct proof-of-concept research on technical merit (Phase 1) and idea feasibility and prototype development (Phase 2), building on Phase I findings. Both programs aim to increase the number of small businesses engaged in federally funded R&D. Additionally, the STTR program aims to facilitate the transfer of technology developed by a research institution through small business entrepreneurship. Consequently, STTR funding requires a partnership with an institution that is a nonprofit college, university, research organization or a federally funded R&D center.

North Shore businesses received 23 SBIR and STTR grants between 2015 and 2018, which represents 0.99 percent of the 2,314 awarded statewide. Of these 23 grants, only three in the North Shore were in the MST field, which represents 1.3 percent of the 233 MST grants statewide (see Table 23)[73]. The MST grants received by the region over this period were valued at $0.645 million. The low number of awards reflects the low number of MST companies in the North Shore.

Table 23 | Number and Value of SBIR/STTR Grants, North Shore Compared to Massachusetts, 2015-2018

	Number		Value ($millions)	
	All SBIR/ STTR Grants	MST SBIR/ STTR Grants	All SBIR/ STTR Grants	MST SBIR/ STTR Grants
North Shore	0.99%	1.3%	$10.5	$0.645
Remainder of State	99.1%	98.7%	$1059.0	$102.7

Source: SBIR.gov, Awards List 2015-2018

6.2 PATENT ANALYSIS

The volume of MST patents held by North Shore organizations and inventors provides a proxy for the vitality of MST research being conducted, particularly as it relates to new inventions that could be the source of new business ideas and business development. From 2008 to 2018, the U.S. Patent Office approved 14 patents associated with businesses and/or inventors in the North Shore region, or an average of 1.3 patents per year[74]. Among these patents, there were 24 inventor credits in the North Shore region[75]. The inventors receiving these credits reside in seven different cities and towns in the region, with Gloucester topping the list (see Figure 37)[76].

[71] See Appendix E for more information on the SBIR/STTR methodology.

[72] See Appendix F for more information on the MST patent methodology.

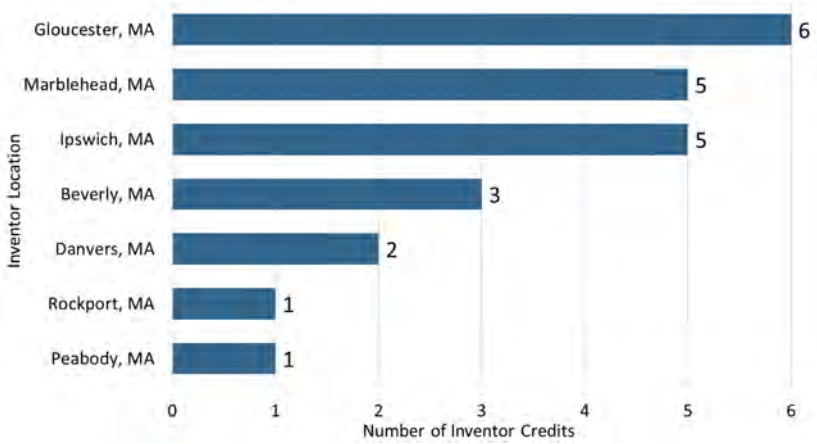
[73] Two of these grants were related to seaweed cultivation, which were granted by NOAA to C.A. Goudey & Associates in Newburyport, and the third was for the development of a foam composite for ocean use, which was granted by the Navy to Haddad Consulting in Peabody.

[74] The invention must have been developed by at least one inventor from the North Shore or assigned to an organization in the region in order to be counted here.

[75] An "inventor credit" is simply the listing of an inventor's name and location on the patent filing. Since the same inventor can be listed on more than one patent, these numbers should not be interpreted as unique individuals.

[76] As with most measures, MST patents cannot be accurately identified solely by using standard patent classifications. Consequently, PPC researchers developed and used a web scraping program to pull patents from the USPTO database that contained words included in an extensive list of MST-related terms developed by the research team. The PPC also searched for all patents owned by the businesses and organizations contained in our inventory of MST firms, organizations and institutions. The final list was then manually vetted to remove false positives.

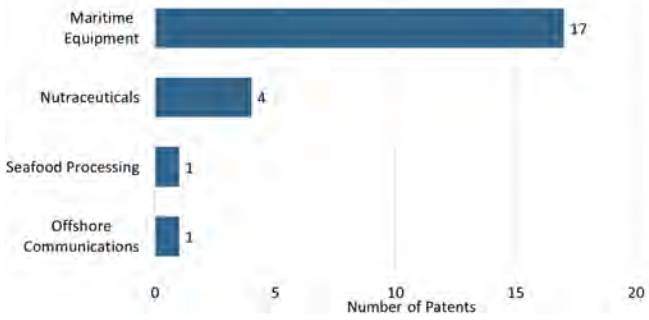
Figure 37 | Number of inventor credits by location, North Shore inventors, approved during 2008-2018



Source: USPTO Patent Full-Text and Image Database (PatFT)

The most common type of MST patent issued in the ten years from 2008 to 2018 was for various types of maritime equipment. This includes such items as diaphragm pumps, anchors and port infrastructure (see Figure 38). Most of these patents are held by Flow Control LLC which develops different types of water pumping systems[77]. The nutraceutical topic area consists of several patents related to a dietary formulation of omega-3 fatty acids that includes fish oils that was developed by Children's Medical Center and Beth Israel Deaconess Medical Center (see Figure 39).

Figure 38 | Number of MST patents by topic area, North Shore inventors or organizations, approved during 2008–2018



Source: USPTO Patent Full-Text and Image Database (PatFT)

Figure 39 | Number of MST patents by assignee, North Shore organizations or inventors, approved during 2008–2018

Source: USPTO Patent Full-Text and Image Database (PatFT)

[77] Flow Control is a division of Xylem, a water technology company presently located in Beverly, MA.

6.3 MASSACHUSETTS SUPPORT FOR R&D AND ECONOMIC INNOVATION

An additional measure of innovation is the funding provided by Massachusetts agencies including the Mass Life Sciences Center (MLSC), which has awarded more than $3 Million to the Gloucester Marine Genomics Institute (GMGI) to fund capital projects to support R&D. The state also awarded GMGI a $940K Workforce Skills capital grant to develop a biomanufacturing training facility at their Gloucester Biotech Academy, an effort by the state to entwine economic innovation with education. The Life Sciences Consortium of the North Shore (LSCNS) was founded in 2012 as a public-private partnership to promote life sciences education and training in support of the region's life sciences industry cluster. The LSCNS is comprised of Endicott College, GMGI, Gordon College, North Shore Community College, North Shore InnoVentures and Salem State University. The MLSC has provided $6.4 Million in grants to the Consortium members since 2014, in addition to the GMGI award, which supports the economic innovation and education initiative.

The region is home to several university marine research laboratories and independent marine research institutes, including the UMass Amherst Gloucester Marine Station, Cat Cove Marine Laboratory and Northeastern Marine Science Center. Ocean Genome Legacy, founded by New England Biolabs of Ipswich and chaired by Nobel Laureate, Sir Richard Roberts, is co-located with the Northeastern Marine Science Center. The connection to Boston's life science, technology and investment communities is a critical factor in growing MST partnerships and supporting opportunities for homegrown MST workers within the region rather than having them commute outside the region. Together this broad capacity in MST can drive innovation in the North Shore's Blue Economy. With access to a diversity of laboratory, coastal and marine environments, relatively affordable and available office space and easy rail connections to and from Boston and Cambridge, the emerging MST sector is poised to launch.

7. STRENGTH-BASED OPPORTUNITIES ON THE NORTH SHORE

The strength of our North Shore Blue Economy is a combination of mature and emerging specialized industry clusters and opportunities in both traditional maritime industries and technology-based industries not always perceived as being connected to the ocean.

The Living Resources sector is a regional strength in terms of its size, history and specialization. However, employment in the sector declined 27 percent between 2004 and 2020. This is consistent with other available data regarding the decline of the fishing fleet on the North Shore. Moving forward, coordinated and sustainable seafood business strategies that harness the region's assets, experience, expertise and access to ocean resources are needed to revolutionize this sector, which is foundational to many other elements of the regional Blue Economy.

While Coastal Tourism and Recreation represents 87 percent of the employment, it also represents the lowest average annual wage ($24,979), with most employment based in service jobs with no direct connection to the sustainable use of ocean resources. In comparison, the average annual wage for Living Resources ($75,924), Marine Construction ($72,055) and Ship & Boat Building & Repair ($64,268) are two to three times the average salary for a worker in the Coastal Tourism & Recreation sector. It will be important going forward to tease out sustainable Blue Economy jobs within the Coastal Tourism & Recreation sector (e.g., boat dealers, marinas, marine supplies, restaurants promoting local seafood, eco tours) and focus regional strategies around leveraging opportunities in those sectors.

New areas, such as offshore wind or marine genomics, are only now being captured in employment and wage data, but are anticipated to be evolving opportunities moving forward. Climate change is a threat, but we have an opportunity to seize increased investments being made by state and federal government and to demonstrate leadership and innovation by incorporating climate resilient approaches into our Blue Economy strategies.

In addition to the comprehensive economic assessment to better understand the North Shore's competitive position in the sectors that make up the North Shore Blue Economy, nearly 300 businesses, nonprofits, community, state and federal government leaders and investors across the North Shore Blue Economy sectors revealed cross-cutting themes in the way that they discussed their perceptions of the region. Five sector-specific Industry Perspective Meetings (see Section 2 for further description) asked the following questions:

1. What are the strengths, or enabling conditions, on the North Shore for your sector to be successful?
2. What are the challenges, or limiting factors, for your sector on the North Shore?
3. What is the vision of success for your sector in a thriving North Shore Blue Economy?
4. What tangible actions or next steps are needed to achieve that vision?

Cross-cutting Themes From Five Industry Perspective Meeting Discussions

1. Strengths/Enabling Conditions

Across all sectors, participants noted that the North Shore is a great place to live and work given the balance of good jobs, high quality of life and natural beauty, easy rail commute to Boston and workforce development opportunities. In all but one group, fisheries and aquaculture research were discussed as enabling opportunities to leverage, given the regional talent and infrastructure at the intersection of human health, fisheries, climate change and marine disease.

2. Challenges/Limiting Factors

Across all sectors a theme around the need for a coordinated regional vision was highlighted as a way to define integrated sector advancement, coordinate strategies to make leading industries more profitable and to take advantage of local and regional assets. The high cost of living and lack of housing availability were also commonly noted as limiting factors for the region now and in drawing/retaining talent to Blue Economy jobs.

3. Regional Vision by Sector

Regional visions for a thriving North Shore Blue Economy varied by sector, but identification of interconnected opportunities to advance both ocean-related economic interests and environmental sustainability were a clear theme as was the idea of branding and/or marketing the region as a hub for research and development demonstration given our relatively high number of ocean access points. Also present in many discussions was the idea that a regional vision must include a unifying thread so that anyone who lives here would appreciate it, identify with it and be proud of it. Examples of vision statements include:

"The North Shore has a resilient Blue Economy with sustainable natural and built infrastructure approaches, diverse support and agreement among stakeholders."

"A sustainable seafood strategy is integrated with our strong tourism-based economy and other regional strength sectors to connect markets with industry and consumers – fish, lobster and shellfish."

"Consumer awareness is high. Local people and tourists want local seafood at grocery stores and restaurants."

"A sustainable seafood strategy is integrated with Blue Tech: greener fleet, robotics, ocean sensors (fishing boats, lobster - keep track of baits and trap locations and ocean climate)."

"Fishing is a sustainable industry 12 months of the year with a best-practices business model including a sound processing plan–freezing capabilities for high quality frozen fillets–guaranteed product to sell, high wages for fishermen year-round, updated infrastructure and financing strategy."

"We find a balance between positive economic impact of tourism and non-negative impact on the environment, traffic, natural and historic resources."

"The North Shore is the hub/destination for field testing ocean applications given diversity and number of ocean access points, docks, marinas, ports and three university marine labs."

"Develop a North Shore hub to market our Blue Economy strengths, our brand."

"The North Shore is a national model for coastal resiliency and broad education, showcasing 5-10 pilot projects."

4. Next Steps to Achieve a Thriving North Shore Blue Economy

Much of the discussion with stakeholders around the tangible steps we can take to achieve sector-specific visions of a vibrant Blue Economy revolved around doing a better job of:

- **Planning** by developing a coordinated plan for the region, mapping our assets and assessing business models;
- **Investing** in infrastructure (dockage, transportation, housing) while retaining our heritage;
- **Engaging** young people and attracting new workers by developing targeted workforce training in our strength sectors; and
- **Marketing** the region's successes, assets and vision forward, creating a regional brand that all can envision themselves being a part of.

The Economic Assessment and Stakeholder Engagement Efforts Offer Four Interconnected Opportunities to Grow the North Shore Blue Economy.

Four interconnected opportunities to grow the regional Blue Economy are tied to the North Shore's existing strengths and emerging growth prospects. These connections arose from the economic assessment taken along with robust stakeholder discussions. Opportunities are tied to the region's existing strengths (e.g., Living Resources, Coastal Tourism & Recreation), where the region's businesses and organizations already specialize, and to promising opportunities in new Blue Economy growth areas that have strong potential to be captured. Seizing these opportunities will require thinking in new interdisciplinary ways, building additional capacity and adopting new technologies informed by cross-sector collaboration.

7.1 AN EVOLVING LIVING RESOURCES SECTOR

The Living Resources sector around Cape Ann and on the North Shore have been the subject of many studies in past years[78]. While the North Shore has a well-earned reputation for its fishing communities and as a seafood destination, Gloucester's decline in influence, volume of fish harvested, processing capabilities, revenue and fleet are documented here. At the same time, data for lobstering on the North Shore shows substantial increase in fleet, workers and revenue.

The next chapter in the evolution of the Living Resources sector can be perceived with pessimism, seeing the many challenges on the horizon, or optimism in seeing the ample opportunities. It is clear from this report that the North Shore has assets, experience, expertise and access to ocean and coastal resources that can strengthen this sector, which is foundational to many other elements of the Blue Economy.

As described in Section 5.1, there may be many millions of dollars of groundfish left in the ocean as the fishing communities of the North Shore fail to harvest available quota for finfish like haddock and pollock. There are also opportunities to pursue new, sustainable fisheries approaches including new gear to minimize bycatch, hook and line fishing, better methods to improve quality and decrease waste. All of these could benefit local fisheries supply chain, and provide a steady source of fresh, wild caught and sustainable seafood for the region and for export, while supporting a reinvigorated workforce.

Growth in the lobster industry has provided an infusion of jobs and revenue in the last decade. Soft-shell clamming operations have offered a steady supply of mollusks for nearly a century. New

[78] University of Massachusetts Urban Harbors Institute. 2017. Building the Massachusetts Seafood System, www.mass.gov/files/documents/2018/05/09/Final%20Report%20Building%20the%20Massachusetts%20Seafood%20System.pdf

and burgeoning shellfish and kelp aquaculture ventures, found in other areas of Massachusetts, offer increased diversity for investors and harvest, and a hedge against potential future challenges to traditional Gulf of Maine species that may be threatened by climate change or other factors.

The Covid-19 pandemic shined a spotlight on key seafood vulnerabilities – complex and global supply chains, inadequate demand due to restaurant closures. It also revealed visible opportunities, such as direct boat-to-consumer seafood sales which provided increased revenue or margins to fishermen and shoreside businesses and great quality and price to consumers. The need for change to address vulnerabilities, seize opportunities and diversify the Living Resources sector is not limited to fishing. Additional areas for expansion and growth include, but are not limited to, food science research, marine biomaterials, fisheries management, value-added processing and the expansion of a local and regional food movement and culture.

As pointed out in a 2020 report "Groundfishing in New England: New Truths. New Rules: New Game,"[79] the North Shore needs to build markets to diversify culinary tastes just as we have witnessed for artisanal beer, cheese and distilled spirits, to purchase and prepare a much wider variety of seafood. The success of our re-emergent oyster industry in New England bodes well. With local high median incomes, high educational attainment and a reputation as a seafood destination for tourists, the North Shore is well-situated to develop a high-end, experimental seafood scene. Diversifying our tastes could include the development of new products from well branded species like lobster, haddock and clams and the promotion of "underutilized species," like dogfish or redfish, which could bring new growth and revenue for fish stocks that are abundant. It will not be easy, however. Challenges faced by species diversification efforts include the lower cost, low return on investment of underutilized species, high start-up and capital/infrastructure costs, potential for quota reductions and marketing of underutilized species. Possible solutions to these challenges may include cooperative models for processing facilities, marketing programs and capitalizing on the growth of the local and regional food movements. As noted in previous sections, direct-to-consumer marketing and innovative marketing initiatives can be leveraged. Existing programs include:

1. **Cape Ann Fresh Catch**, managed by the Fisherman's Wives Association, is a community supported fishery delivering sustainably caught local seafood to consumers. The organization enhances environmental stewardship and supports local economies on the North Shore by offering fixed seasonal prices per pound, helping to relieve areas impacted by market-driven forces and allowing ecosystems to recover.

2. **Gloucester Fresh Seafood** initiative supports local fish markets by fostering collaboration between fishermen, wholesalers and the restaurant service industry. The initiative brings attention to the value of consuming fresh, locally landed seafood.

3. **Fisherman's Wharf**, wholesale seafood dealer on Gloucester's historic waterfront. The direct offloader of community based fishing boats spurred new business in 2020 by working with the Northeast Atlantic Marine Alliance to offer direct sales to consumers through a drive-up food truck to sell fresh and prepared local seafood.

A more diverse and robust Living Resources economy would also further opportunities for the application of technology, including both hardware and software. Traceability software is now commonly used to connect a fishermen with his/her harvest, and the emergence of "blockchain" technology has the potential to further connect a fishermen to the supply chain. Ocean sensing technology is revolutionizing the aquaculture industry by expanding tools available for

[79] T Balf. 2020. Groundfishing in New England – New Truths. New Rules. New Game. Oceanvest, LLC. https://ocean-vest.com

proactively managing their assets. Fishery monitoring devices, from high-end AI coded video imaging equipment to smart phone apps, are being used to "count" fish. As an applied example, Gloucester Fresh Seafood and the Massachusetts Lobstermen's Association announced in 2019 the development of a smartphone application designed to promote, connect and trace Massachusetts lobster for global buyers. And the list goes on.

Business as usual will not suffice. According to the UMass Boston Urban Harbors Institute, "public sector engagement is heavily tilted toward the harvesting end of the value chain[80]." In order to expand the Living Resources sector, more research dollars and a focus on new product development need to exist. Unfortunately, traditional sources of funds (e.g., SBIR) are often very limited since most money for new product development is geared towards the defense and medical industries. Many stakeholders in Massachusetts envision the possibility for "seafood innovation centers" which include makerspace-like facilities for contract processing the development of specialized value-added products. A "sustainable seafood center of excellence" model that also engages seafood researchers, business planning and marketing and that could partner with an incubator to coach start-up business ventures is also desirable.

Fishing Permit Bank Helps to Preserve Gloucester's Groundfish Community

SPOTLIGHT

The Gloucester Fishing Community Preservation Fund (GFCPF) was founded in 2008 to establish a permit bank, benefitting the local groundfishing community. Due to increased regulation and rising costs, some fishermen in Gloucester sold their boats and permits to out-of-town interests. The fund's permit bank buys fishing permits from small and medium-sized local vessels and leases days at sea to local fishermen and other boats landing their catch in Gloucester. According to the GFCPF's executive director, the permit program is responsible for adding an average of three to five million pounds of groundfish landings annually in Gloucester, leading to additional revenue and working to drive economic activity.

[80] Urban Harbors Institute at UMass Boston. (2017). Building the Massachusetts Seafood System. (p. 3)

There are also opportunities to think beyond the filet, which is typically only 40 percent of a fish by weight. Rather than just focusing on standard seafood products, there are a range of marine biomaterials that could be cultivated and/or harvested to support the development of nutritional supplements, cosmetics, liquid fuels and medical devices. For example, chitin from crustacean shells, seaweed and microalgae have all shown exciting promise in their ability to be transformed into a wide range of valuable products. Other opportunities for innovation include finding feed substitutes, environmental toxicology, assays to detect marine disease, ways of preventing or treating infection and the use of selective breeding or biotechnology to cultivate economically important traits, such as body shape and size or disease resistance[81].

7.2 A DEVELOPING MARINE SCIENCE & TECHNOLOGY CLUSTER

Innovation often occurs at the intersection of existing clusters. For example, the colocation of major teaching hospitals and a vibrant information technology industry made Massachusetts a natural place for many medical health records companies to take root. Something similar could happen in the North Shore at the intersection of the Blue Economy and Massachusetts' world-renowned life sciences sector. There are many Marine Science and Technology (MST) businesses that are located in and around the North Shore comprised of life sciences, marine sensing and robotics. According to the Massachusetts Biotechnology Council, in 2019 there were over 50 biotech companies in the Northeast region of the state[82]. The life sciences industry in the region, more broadly defined, includes more than 250 companies, according to the Life Sciences Consortium of the North Shore[83]. In Beverly, at Cummings Center alone there are at least 60 life sciences companies, many of them in the North Shore InnoVentures incubator. In the nearby Boston-Cambridge region, there are over 500 biotech companies to explore for potential Blue Economy partnerships. The connection to Boston's life science, technology and investment communities is a critical factor in growing MST partnerships and supporting opportunities for homegrown MST workers within the region rather than having them commute outside the region. The life sciences space is large and the opportunity to innovate marine life sciences with the present capacity is vast given the foundation of talent.

The region has been home to New England Biolabs since 1970 and to Cell Signaling Technology since 1999, both leaders in life sciences and molecular biology applications. Newer to the region is the Gloucester Marine Genomics Institute (GMGI). Founded in 2013, the nonprofit Institute conducts marine biotechnology research with the goal of expanding the regional economy. GMGI hosts an annual marine biotech scientific meeting that draws more than 100 scientists from around the world. It also runs the Gloucester Biotechnology Academy, which hosts a Biotechnology Certificate Program and a Summer STEM Program.

Since 2020, GMGI's new building on the Gloucester waterfront has also become home to both LifeMine, a marine biotech firm with the goal of creating new drugs and medicines, which also has a presence in Cambridge, and to Hefring Engineering, developing a new generation of ocean gliders for ocean observation and research.

The development of a MST cluster in the region could have multiple benefits, including providing new opportunities to the fishing industry where livelihoods have been impacted by the dwindling groundfish stocks as well as providing local employment opportunities to biotech scientists and technicians who currently commute to Boston.

[81] Borges, et al. (2019). Charting the Course: An Assessment of Southeastern New England's Marine Science & Technology Sector. The Public Policy Center at UMass Dartmouth. Dartmouth, MA.

[82] Massachusetts Biotechnology Council (2019). 2019 Industry Snapshot. Retrieved from: https://files.massbio.org/file/MassBio-2018-Industry-Snapshot-FINAL-8-29-18.pdf

[83] https://lscns.wordpress.com/

Marine bioresources can be used to produce a wide range of products, including pharmaceuticals, medical devices, cosmetics, nutraceuticals and replacements for many different petroleum-based products. Furthermore, they can provide a host of services, including water treatment, de-acidification, carbon capture and biosensing.

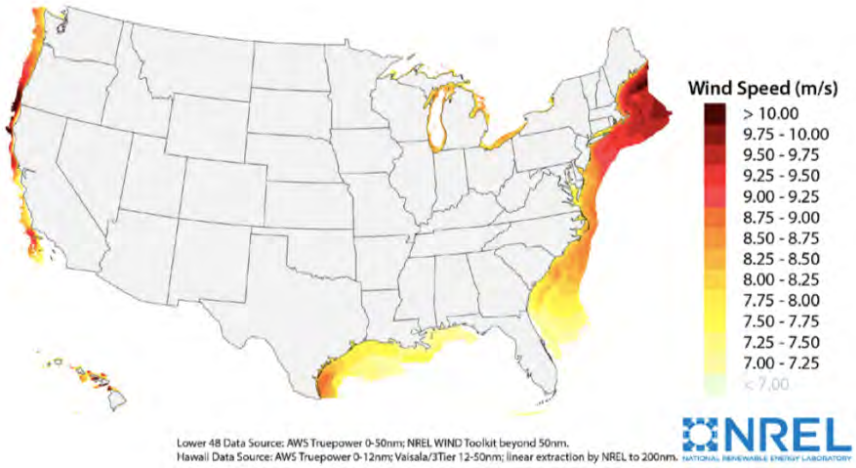
7.3 THE POTENTIAL FOR OFFSHORE WIND IN THE GULF OF MAINE

Offshore wind will soon be a major new industry in the United States. State-level incentives and mandates have created a market of over 30 gigawatts of nameplate capacity at the time of this report. The Block Island Wind Project, by comparison, was just 30 megawatts (MW), which is 1/1,000th of a conservative estimate of the total market. Northeast states are exceptionally well-positioned to benefit from offshore wind, since they have the most offshore wind potential, the cheapest costs of deployment, and the potential for substantial economic benefits (see Figure 40)[84,85]. Contracted MW goals by state at the time of this report place Massachusetts in a competitive position (see Table 24).

[84] Beiter, P., Musial, W., Kilcher, L., Maness, M., & Smith, A. (2017). An Assessment of the Economic Potential of Offshore Wind in the United States from 2015 to 2030 (No. NREL/TP-6A20-67675). National Renewable Energy Lab. (NREL), Golden, CO (United States).

[85] Musial, W., Heimiller, D., Beiter, P., Scott, G., & Draxl, C. (2016). 2016 Offshore Wind Energy Resource Assessment for the United States (No. NREL/TP-5000-66599). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

Figure 40 | Wind speed map for the U.S. offshore wind energy technical resource area



Source: The National Renewable Energy Laboratory

Table 24 | Contracted Megawatts (MW) vs. State Wind Targets and Goal Year

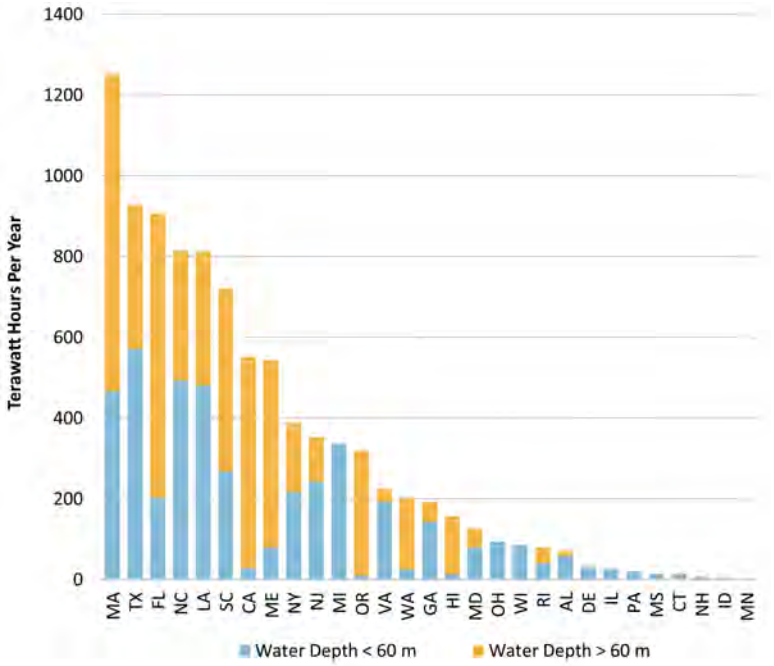
State	Goal Year	Goal (MW)	*MWs w/ Offtake Pathway
Connecticut	2030	2000	1108
Maine	2030	132	12
Maryland	2030	1568	390
Massachusetts	2035	5600	1604
New Jersey	2035	7500	1100
New York	2035	9000	4316
Rhode Island	-	2030	430
Virginia	2034	5200	2652
Federal	2030	30,000	

Source: Business Network for Offshore Wind.
*MWs w/Offtake Pathway = operational projects, pilot projects, projects awarded Power Purchase Agreements (PPA), projects awarded Offshore Renewable Energy Credits (OREC)

Presently, there are no offshore wind projects slated to be built north of Cape Cod. This is mostly due to technical limitations. As a rule of thumb, 60 meters is considered the maximum water depth for fixed-bottom foundations. Floating foundations are a relatively immature technology compared to fixed-bottom foundations, which partially accounts for the fact that they are also more expensive. Since most of the wind resources in the nearby Gulf of Maine are located where water depths exceed 60 meters, there are not yet any nearby wind farms presently under development. This is demonstrated by Figure 41, which shows that a relatively low percentage of the offshore wind resource is easily captured in Maine's waters in comparison to Massachusetts.

However, while lagging fixed-bottom offshore wind, floating offshore wind has already reached the point of technical feasibility. In 2013, the University of Maine and its partners successfully deployed the VolturnUS 1:8, a 1/8th scale, 65-foot-tall prototype that was the first grid-connected floating wind turbine in the Americas. A full-scale demonstration project, New England Aqua Ventus I, is now under development in the Gulf of Maine. Two 6 MW wind turbines will be mounted to patented floating semisubmersible concrete hulls designed by the Advanced Structures and Composites Center at the University of Maine. The floating units will be held in position in the ocean by three marine mooring lines securely anchored to the seabed, and connected by subsea cable to the Maine power grid by subsea cable. The New England Aqua Ventus I demonstration project will likely be the first full-scale floating wind project in the Americas.

Figure 41 | Technical Offshore Wind Potential by State and Water Depth



Source: National Renewable Energy Laboratory, 2016

Recognizing the imminent commercial viability of floating offshore wind, "In January of 2019, Governor Christopher Sununu of the State of New Hampshire requested the establishment of an intergovernmental offshore wind renewable energy Task Force for the state. Given the regional nature of offshore wind energy development, BOEM has decided to establish a Gulf of Maine Task Force – including representation from New Hampshire, Massachusetts, Maine and federally recognized Tribes in the area[86]." This regional, rather than state-by-state, Task Force construction is a valuable opportunity to understand how a series of ports might work together in the Gulf of Maine to consider efficiencies in the market including energy transmission. This regional approach opens opportunity for innovation.

The massive size of modern offshore wind turbines limits the transport of finished products over land. As a result, the manufacturing of the primary, finished components must occur at waterfront locations with a large amount of acreage and a quay that has been reinforced to withstand heavy loads. In addition, the height of some components limits the locations (e.g., routes with bridges). A detailed assessment of potential sites in Massachusetts is provided by the Massachusetts Clean Energy Center. Massachusetts has laid the groundwork for private investment in secondary locations for future turbine and foundation component manufacturing through Mass Clean Energy Center's *2017 Massachusetts Offshore Wind Ports & Infrastructure Assessment*. A North Shore ports assessment is expected in 2021 from Massachusetts Clean Energy Center.

Presently, no sites have been formally identified on the North Shore that can support the manufacturing or assembly of the primary, large scale components. Most of the coastal land in the North Shore is privately held residential land and industrial sites tend to be smaller than is required for offshore wind. However, strong potential exists in Salem Harbor for a 40 acre parcel of undeveloped land owned by New Jersey-based Footprint Power. There are opportunities for the North Shore to participate in the offshore wind supply chain, since there are a wide range of products and services that are required to build a windfarm that could be procured in the region.

[86] https://www.boem.gov/Gulf-of-Maine

For example, there are many specialized contract manufacturers in the region that could supply parts during the operations and maintenance phase of the wind farm.

The opportunity for the North Shore to establish a voice, ask questions and be a part of working through efforts at every level in the development of the Gulf of Maine offshore wind industry is now, if the region is to benefit in the future when siting takes place. We know from previous offshore wind development efforts that communication across state lines and communication across sectors is important. The time is now to become integrated in those conversations. The region has an opportunity to frame questions around marine science and technology innovation, job creation and training, planning, prototype development and how this progress toward clean energy takes place in concert with supporting a sustainable, lucrative seafood supply chain. Asking questions now, starting the research to answer those questions now, and being a part of the conversation now will provide a solid foundation to understand the North Shore's potential role in the emerging offshore wind market. It will also ensure a seat at the table for decision-making moving forward.

7.4 INCREASED INVESTMENT IN COASTAL RESILIENCE SCIENCE, PLANNING AND PREPARATION

In a statewide 2017 report focused on the Massachusetts maritime economy, a survey of Blue Economy business owners revealed that "preserving and protecting our ocean resources" is the second most important policy area to the success of their businesses, preceded only by "reducing business costs related to taxes[87]." In addition, a majority of key informant interviews and stakeholder meetings revealed an interest in promoting science and technology that helps to improve the ocean and coastal environments. The extent to which preserving and protecting ocean resources presents a market opportunity is important to explore. The economic value of the harm that could be averted is immense, whether it is to maintain the idyllic nature of our coastlines—which supports a tourism industry valued at over $3 billion in Massachusetts—maintain an ocean environment that is hospitable to valuable seafood species such as clams, lobsters and groundfish, or prevent the catastrophic loss of property due to storm surge and sea level rise.

Understanding North Shore Coastal Vulnerability Informs Resilience Strategies

The 21 North Shore coastal communities assessed in this report are home to an estimated 435,065 people, comprising 56 percent of Essex County and 6.4 percent of the Commonwealth[88]. Rising sea level represents a significant threat to coastal ecosystems, communities and infrastructure through land loss, altered habitats and increased vulnerability to coastal storms, nuisance flooding and damaging wave actions such as erosion.

While state and federal projections for sea level rise and flood projections are available, regions and individual coastal communities often require finer-scale data on the projected impacts to feel confident making informed short- and long-term community development and planning decisions that will result in ecological and socionomic resilience.

Recent sea level rise and flood assessments for the Greater Boston area find that relative sea level (RSL) in Boston Harbor is rising at an accelerating pace. The average rate of RSL rise between 2001-2019 was 5.4 mm/yr (0.21 inches/yr), about twice the rate averaged over the last century and faster than the global average[89].

[87] Borges et al. (2017), Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy, The Public Policy Center at UMass Dartmouth.

[88] U.S. Census Bureau, 2015–2019 ACS 5-year estimates.

[89] DeConto et al. 2021. Greater Boston Research Advisory Group: Sea Level Rise. https://www.umb.edu/gbrag/about

Under the most optimistic (RCP2.6) climate change scenario, RSL rise in 2100 relative to a 2000 baseline is 35-78 cm, versus 72-146 cm for the more extreme (RCP8.5) scenario. Multimeter RSL rise in Boston Harbor is possible by 2100 under RCP8.5 and within the likely range of projections by 2200 (184-378 cm). Bottom line, sea level will continue to rise and will not stop or reverse in Greater Boston for centuries, regardless of which emissions trajectory is followed. Any sea level rise that does occur should be considered permanent from a planning perspective[89].

While this rising trend is expected to continue, state-of-the-art research is pointing to a lot of uncertainty around exactly "how much", which makes planning difficult. Therefore, we need adaptive engineering solutions where the water meets the land now, under a range of higher-sea level futures and flooding and storm scenarios.

The Commonwealth is Taking Action

In 2016, Governor Baker filed Executive Order 569: Establishing an integrated strategy for climate change adaptation across the Commonwealth, instructing state government to provide assistance to cities and towns to complete climate change vulnerability assessments and resiliency planning.

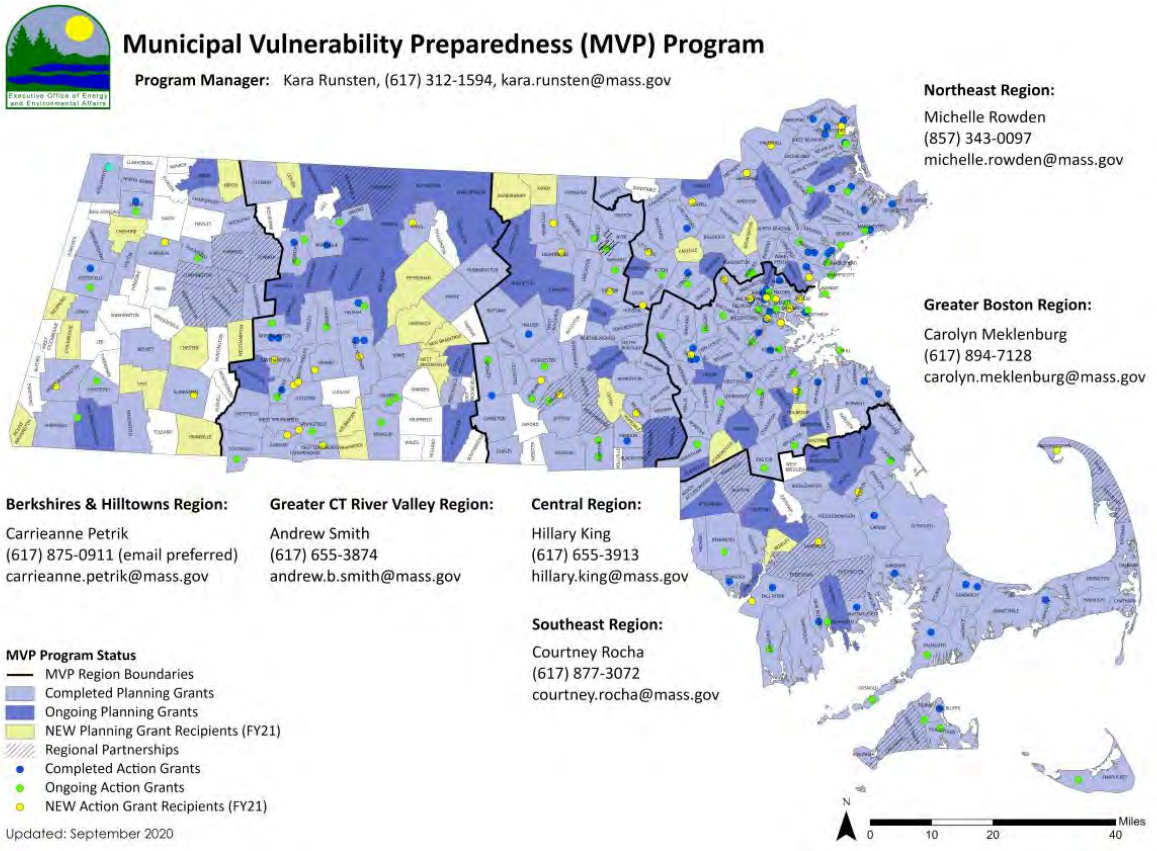
In 2018, the Governor allocated over $2.4 billion in capital allocations for investments in safeguarding residents, municipalities and businesses from the impacts of climate change,

[89] DeConto et al. 2021. Greater Boston Research Advisory Group: Sea Level Rise. https://www.umb.edu/gbrag/about

protecting environmental resources and improving recreational opportunities. The funds are enabling critical environmental investments at the state and local levels and put into law essential components of EO 569, including the Municipal Vulnerability Preparedness grant program (MVP)[90] and the Statewide Hazard Mitigation and Adaptation Plan[91].

In the first four years of the MVP Program (2017-2020), 100% of North Shore communities completed municipal climate vulnerability assessments and became designated as MVP Communities (see Figure 42). They conducted municipal vulnerability assessments with their community decision-makers, identifying priority actions for their safety, economy and ecological well-being. On the North Shore, seven Planning Grant projects have been completed, one is ongoing. Completion of the Planning Grants designates MVP Communities as eligible for Action Grants. Action Grants invest in municipal priorities that build climate resilience through proactive climate adaptation projects that utilize best available climate data, employ nature based solutions and center environmental justice and equity. Eight North Shore communities have completed Action Grants and 11 are in progress. In total, over $5.6 million in Planning and Action Grants have been awarded to North Shore communities to date.

Figure 42 | Massachusetts Municipal Vulnerability Preparedness (MVP) Program



The Federal Government is Taking Action

The Biden administration has proposed $14 billion in spending on initiatives to fight climate change in the 2022 budget, including allocation for environmental regulation and science research. The proposal underscores the administration's ambitions to decarbonizing the economy by 2050 to stem global warming.

[90] https://www.mass.gov/municipal-vulnerability-preparedness-mvp-program

[91] https://resilientma.org/shmcap-portal/index.html#/

Competitive federal coastal resilience grant programs to advance research and application include opportunities such as the NOAA Effects of Sea Level Rise Program[92], National Fish & Wildlife Foundation Coastal Resilience Fund[93], National Science Foundation Coastlines and People program[94] and NOAA SeaGrant[95]. Opportunities through DOE's Northeast Climate Adaptation Science Center[96], headquartered at UMass Amherst, offers broad coordination across multiple institutions for researchers and partners to seek funding as well.

While proposals for regional projects in the context of multi-state geographies often produces a more competitive grant application for many of these federal funds, local and regional information is often what is needed to inform local and regional decision-making and to shape sound investment strategies that safeguard ports, properties and people. This issue of scale can present a challenge, but with increased regional coordination among stakeholders, is achievable and can have far-reaching impact.

The North Shore Is Taking Action

As described in Section 2, the UMass Amherst Gloucester Marine Station and Essex County Community Foundation partnered to hold a Think Lab entitled *Exploring the North Shore Blue Economy* in October 2019 (Appendix B)[97]. The 78 participants met to learn about the Blue Economy concept, lend their local expertise in exploring stengths and challenges and offer their visions for a thriving North Shore Blue Economy. Through hundreds of bold ideas collected from participants, "Coastal Resilience" and "Climate Change Solutions" emerged as two prominent common themes.

Through hundreds of bold ideas collected from participants, "Coastal Resilience" and "Climate Change Solutions" emerged as two prominent common themes.

Coastal resilience continued to emerge as a theme in the five Industry Perspective Meetings. In all cases, coastal resilience was identified as an issue that, if not addressed as a part of a regional vision forward, would be a roadblock to regional success. This suggests that higher levels of assurance at finer geographic scales would aid communities, businesses and homeowners in understanding their vulnerabilities, thus their urgency to plan for climate resilience into the future.

The North Shore has the opportunity to seek creative ways to live with water, innovate around resilient best practices in coastal design, architecture, engineering and construction; and be aware of and compete for robust funding strategies to both safeguard and enrich our communities.

The region has a tremendous set of coastal resilience knowledge and land management assets in its colleges, universities, nonprofits and state and federal agency offices (see Figure 26). We have an opportunity shape a North Shore resilience strategy as a part of a Blue Economy strategy.

[92] https://coastalscience.noaa.gov/research/coastal-change/ecological-effects-sea-level-rise-program/

[93] https://www.nfwf.org/programs/national-coastal-resilience-fund

[94] https://www.nsf.gov/pubs/2020/nsf20567/nsf20567.htm

[95] https://seagrant.noaa.gov/

[96] https://necsc.umass.edu/

[97] https://www.umass.edu/ses/sites/default/files/North%20Shore%20Blue%20Economy_ThinkLabReport_2Oct2019.pdf

7.5 VISION FORWARD: RESILIENT, SUSTAINABLE & EQUITABLE NORTH SHORE BLUE ECONOMY

Regional blue economies are successful when they understand their strengths and competitive advantage. With this report, the Phase I North Shore Blue Economy initiative offers a comprehensive baseline assessment that quantifies the regional economic base, identifies leading and emerging industry clusters, provides a profile of the current regional population and workforce and describes the composition, size and growth opportunities for Blue Economy businesses. The Project Team also engaged over 300 stakeholders to assess their perceptions of regional strengths and challenges, their visions for developing a vibrant Blue Economy and the steps needed to achieve those visions.

This information offers a foundation upon which to build resilient, sustainable and equitable economic development and community engagement strategies. These strategies can both advance ocean-related economic interests while also addressing and improving ecosystem health that supports long-term opportunities for the region.

Over the next three years, Phase II of the North Shore Blue Economy initiative will advance strategy development, raise funds, drive priority analysis to inform regional and sustainable decision-making, develop a financing strategy for programs that emerge from this work and put findings into practice. The anticipated outcomes of this work include a more sustainable and diverse set of living wage jobs and new and expanded business growth across our interconnected Blue Economy areas of strength and opportunity. Moving forward, Phase II will focus on how to apply Phase I findings to advance four broad targets:

1. **Grow the North Shore Blue Economy Network.** A Network of diverse, regionally-representative thought leaders across Blue Economy sectors will provide coordinated thought leadership, inclusive community engagement and serve as a hub for creative economic development and engagement strategies. The Network will collaboratively design, guide and inform: (a) strategy development, (b) funding opportunities and (c) research needs.

2. **Develop workforce training and education to drive Blue Economy job creation.** Integrated partnerships between regional research and higher education institutions, government and nonprofit enterprises and workforce incubators will be designed and catalyzed to shape and meet these new employment opportunities. By coordinating workforce development with economic development, we aim to open career pathways with a strong living wage that supports a high quality of life and serves to retain the talent we train.

3. **Brand and market the North Shore's vision of a resilient, sustainable and equitable Blue Economy.** Promote the region's successes and demonstrate Blue Economy activities and assets to attract new businesses, entrepreneurs, investors, scientists and engineers to areas of opportunity, as well as help the existing and traditional working waterfront enterprises succeed and expand in this larger market.

4. **Fundraise and increase access to capital that will foster entrepreneurship and incubate Blue Economy enterprises and initiatives.** Develop a cross-sector coordinated and targeted portfolio of state, federal and private funding opportunities to advance the North Shore Blue Economy and the infrastructure that supports its growth.

The goal of the North Shore Blue Economy initiative over the next 10 years is to grow and implement a resilient, sustainable, equitable and integrated Blue Economy network that builds upon North Shore strengths and positions the region to capitalize on emerging opportunities in the Blue Economy. Join us!

Appendix A:

GEOGRAPHIC DEFINITION METHODOLOGY

Many key decisions were made with regards to how best to group cities and towns into commuting zones—also sometimes referred to as labor market areas. Most labor market areas that analysts work with on a daily basis are nodal or core-based. Nodal regions are built starting with a major center, which is then connected to other smaller communities. Depending on the degree of inter-dependence, nodal regions may have multiple nodes. For example, the Greater Boston labor market area includes the city of Boston, as well as surrounding economic centers along the Route 128/95 corridor, many of which are economically tied to industry based in Boston, as well as their surrounding suburbs. In the U.S., Metropolitan Statistical Areas (MSAs), as defined by the Office of Management and Budget (OMB), and the Bureau of Economic Analysis' Economic Areas are both core-based. The only exception is the Department of Agriculture's (USDA) Commuting Zones, which takes a non-core-based, non-metropolitan approach in order to allow for a unique identity for the country's more rural areas. Believing that different types of areas (e.g. rural vs. non-rural) require different economic strategies, and finding that the core-based approach often produces regions that are too large for many practical purposes, the commuting zones and economic regions defined in this analysis are non-core-based.

Consistent with the approach used by the USDA, an agglomerative hierarchical clustering approach was used to combine cities and towns into commuting zones. Agglomerative clustering is a bottom-up approach, in which each city and town starts off as its own cluster. During each iteration of the algorithm, clusters merge with the cluster with which they have the strongest commuting relationships. However, this analysis deviates from the USDA's approach in a couple of ways. First, it incorporates a different measure of commuting interchange to determine which cities and towns are most highly connected and, second, a custom algorithm that was developed to improve on existing clustering techniques.

Within the methodologies used by the federal government, there are two different measurements of commuting interchange: the Proportional Flow Measure used by the USDA and the Employment Interchange Measure (EIM) used by the OMB. Conceptually, the EIM appears to be superior to the Proportional Flow Measure, since unlike proportional flow, it includes both the number of residents and the number of jobs in the smaller community, thereby limiting the confounding influence of bedroom communities on the data. Both measures were tested and the EIM resulted in more coherent regions. Given these results and the better conceptual match, the EIM was selected as a better approach for measuring the strength of commuting relationships between regions.

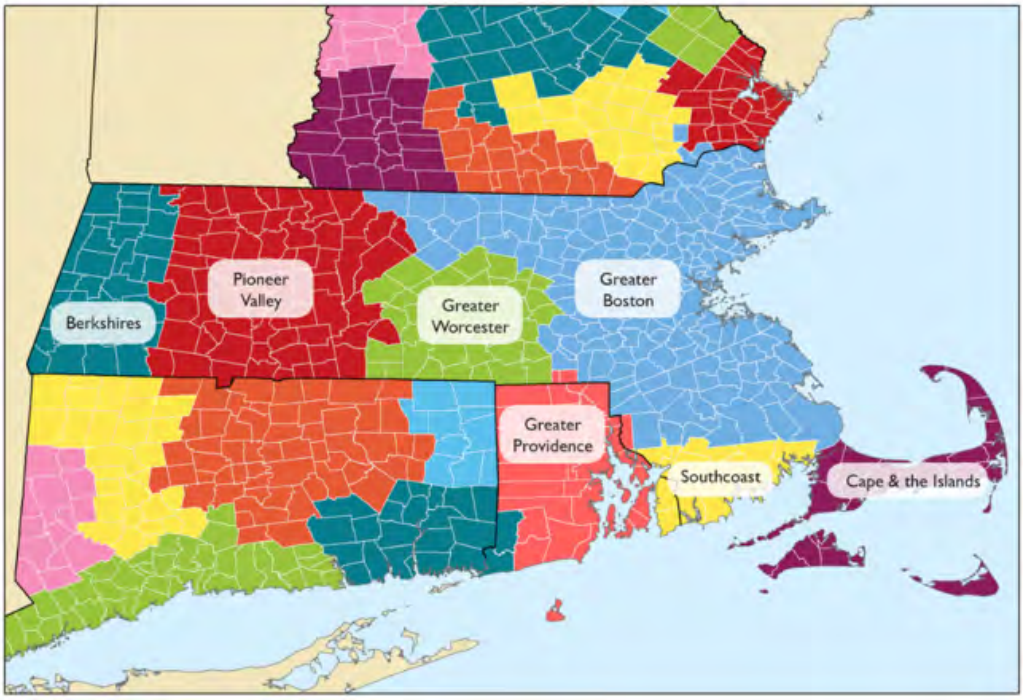
In the jargon of cluster analysis, the EIM is a measure of the "distance" or "similarity" between clusters. The most common clustering algorithms use pairwise comparisons between individual cluster members. So, for example, the distance between clusters might be determined by the pair of towns, one from each cluster, that have the weakest or the strongest commuting linkage. Another common option is to look at the average distance, but this is not possible for relational data like the EIM. The custom algorithm used for this analysis improves on these methods by aggregating the data up to the cluster level during each iteration. This enabled assessments of the relationship between clusters, rather than between cluster members. In addition to being arguably valid, this approach has the added benefit of smoothing out the effect of outliers. Additional information about the grouping process can be found in the PPC Working Paper *The Economic Geography of South Coastal New England*.

Agglomerative clustering is a bottom-up approach, in which each city and town begins as its own cluster. During each iteration of the algorithm, clusters merge with the cluster with which they have the strongest commuting relationships. Our analysis deviated from the USDA approach in that the strength of commuting relationships was measured using the Employment Interchange Measure (EIM) applied by the U.S. Office of Management and Budget.

RESULTS

A full analysis of the commuting zones in Massachusetts yields six commuting zones: the Berkshires, the Pioneer Valley, Greater Worcester, Greater Boston, the Southcoast and Cape Cod & the Islands. Using the custom algorithm, the North Shore very quickly becomes part of Greater Boston and never develops a coherent identity (see Figure 1).

Figure 1 | Commuting zones in and around Massachusetts

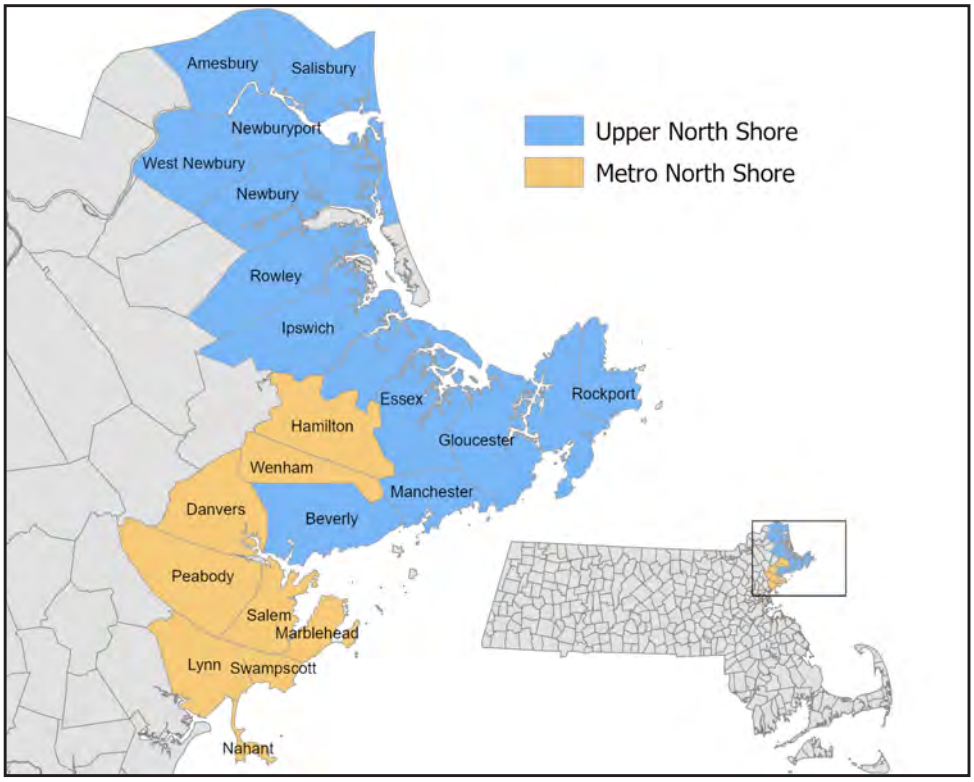


Source: Public Policy Center

Stopping the algorithm just shy of when the North Shore communities merge with Greater Boston, we find that Danvers and Peabody become part of Greater Boston before any other communities in the North Shore region. This suggests that Beverly is the southern-most town in the North Shore.

Overall, the North Shore region as a whole is strongly tied to the Greater Boston area economically. However, applying the methodology described above and taking into account regional commuting patterns, we find that the North Shore can be defined as 21 communities that primarily run along the coastline of northeast Massachusetts (see Figure 2).

Figure 2 | North Shore communities



Source: Public Policy Center

The region is divided into "Metro North Shore" communities and "Upper North Shore" communities, with the Upper North Shore communities having more inter-commuting relationships within the region than with Greater Boston. Conversely, the commuting relationships of the Metro North Shore communities closer to Boston show the substantial influence of the Greater Boston economy. Workers who live in Upper North Shore communities are more likely to work within the region than commute to Greater Boston, while the reverse is true for residents of Metro North Shore communities. Simply put, there will always be economic opportunities in and around Boston that draw in workers from other parts of Massachusetts, although the Metro North Shore communities also have commuting, economic and other relationships with the Upper North Shore communities. In addition, the Metro North Shore communities are in some ways the "front door" or the "bridge" to the Greater Boston economy and are most strongly attached to future economic opportunities in the North Shore, particularly in terms of developing technologies that spin-out from Greater Boston.

Appendix B:


EXPLORING THE NORTH SHORE BLUE ECONOMY
An Essex County Think Lab, part of ECCF's Empowering Economic Opportunity initiative
Strategy Session Report
Wednesday, October 2, 2019
Endicott College, Gloucester, MA
The World Bank defines Blue Economy as "the sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health."
University of Massachusetts Amherst
E C C F
Essex County Community Foundation
The North Shore Blue Economy initiative is led by the UMass Amherst Gloucester Marine Station in research partnership with the Public Policy Center at UMass Dartmouth, and with the collaboration and funding support of the Cape Ann Chamber of Commerce, City of Gloucester, Gloucester Economic Development and Industrial Corporation, and the Essex County Community Foundation.
Other supporters include the North Shore Technology Council and North Shore InnoVentures. We look forward to broadening this partnership throughout the North Shore as the initiative advances.

Essex County Community Foundation

Think Lab Overview

EDUCATE. IDEATE. INCUBATE.

On October 2, UMass Gloucester Marine Station partnered with Essex County Community Foundation (ECCF) to convene more than 75 community leaders to learn about the North Shore Blue Economy (NSBE) initiative, a new project focused on sustaining and growing the North Shore's Blue Economy.

As part of the NSBE's strategy to build enthusiasm and engage community leaders, participants were invited to lend their local expertise in exploring the strengths and challenges currently impacting the sector. Their feedback will be used to help inform the vision and strategy for next steps of the initiative.

WHAT IS A THINK LAB?

A facet of ECCF's Empowering Economic Opportunity (EEO) initiative to increase economic opportunity for Essex County residents living below the living wage, Think Labs harness local expertise around special areas of focus to inspire creative thinking that can impact the economic landscape. Learn more at eccf.org/EEO.

Attendee Snapshot

More than 75 cross-sector leaders spanning the North Shore participated, providing a diverse set of perspectives.

Business leaders: 31%
Nonprofit organizations: 22%
Municipal and Community leaders: 19%
Academic and Researchers: 18%
Investors and Philanthropists: 10%

**This invitation only event welcomed attendees from across regional Blue Economy sectors and North Shore geographies. Invitees were selected based on their personal expertise for this particular session/topic to gain a diverse set of perspectives. Future sessions and topics will target other appropriate sectors as necessary.*

Essex County Community Foundation

Presentation Summary

"Exploring the North Shore Blue Economy" participants were welcomed by Stratton Lloyd, ECCF's COO and vice president for community leadership. Lloyd spoke of the Foundation's Systems Philanthropy approach to social change of which collaboration, cross-sector partnerships and regional convenings like Think Labs are major components. He emphasized the importance of these meetings as opportunities to harness local knowledge, open dialogue around complex issues, build relationships and inspire creative thinking that can impact the future economic landscape.

GOALS FOR THE DAY:

Share the NSBE concept and early data framework with Think Lab participants

Learn from one another

Gather the group's feedback on the strengths, challenges and opportunities of the North Shore Blue Economy to inform analysis and next steps

Dr. Katie Kahl, assistant extension professor of sustainable fisheries and coastal resilience at the UMass Amherst Gloucester Marine Station, is leading the North Shore Blue Economy (NSBE) initiative. She provided research and data defining the project including Phase 1 learning and outputs, and next steps for Phase II. Dr. Kahl also provided broad definitions of the Blue Economy including key themes and learnings that could be leveraged from state, national and global examples of similar initiatives to support the upcoming strategy session.

Dr. Katie Kahl and Dr. Michael Goodman

Keynote speaker Mike Kennealy, Massachusetts Secretary of Housing and Economic Development, addressed the group, providing statewide context for the importance of the Blue Economy, citing the state's $41 million investment in 87 projects to improve infrastructure in coastal communities (including several strategic investment on the North Shore). He added that while the state's Blue Economy is strong - with a total economic impact of more than $17 billion - it has lacked a comprehensive regional strategy and applauded the morning's event as an important step in working together to support the sector.

Dr. Michael Goodman, executive director of the Public Policy Center at UMass Dartmouth presented his research highlighting how much North Shore coastal communities rely on a healthy ocean for economic security. Goodman was clear that the Blue Economy is a central and integral part of the Massachusetts economy – yet it is a sector under pressure. He concluded that threats to the Blue Economy like climate change, ocean pollution, depleting fish stocks and others also present opportunities to innovate and grow.

More from the Think Lab:

- Read ECCF's press release: Essex County Think Lab Focuses on North Shore Blue Economy HERE.
- View Dr. Michael Goodman's full presentation HERE

Essex County Community Foundation

Exploring the North Shore Blue Economy
October 2 | Think Lab Report

Think Lab Activity Summary and Key Themes

In small groups, participants were led through a series of design thinking activities to brainstorm and discuss the North Shore's strengths, challenges, and their visions for the future of the regional Blue Economy. Attendees were encouraged to think boldly and to use their personal experience as a unique lens throughout the strategy session.

Activity 1: Building on our Strengths

Individuals were asked to spend several minutes writing down the strengths we have as a community in relation to the North Shore Blue Economy. Ideas were shared and grouped into major themes, summarized below:

Examples of individual responses related to **access** as a strength of the North Shore Blue Economy:

- Proximity to ports and top research facilities
- Proximity to Boston, Cambridge and the region's top universities and diverse educational opportunities
- Proximity to a diverse coastal ecosystem
- Access to regional and national transportation

Examples of individual responses related to **innovation** as a strength of the North Shore Blue Economy:

- Emerging blue and sustainable technologies including off-shore wind
- Regional coastal resilience efforts and research
- Innovative work culture and mindset
- Proximity to related current growth industries including life sciences, robotics and clean tech

Examples of individual responses related to **culture/heritage** as a strength of the North Shore Blue Economy:

- Strong maritime and fishing history
- Diversity in perspectives from different communities
- Pride of Place
- Healthy tourism industry

Examples of individual responses related to **workforce** as a strength of the North Shore Blue Economy:

- Talented workforce with local experience
- High education levels and access to research
- Historical track record of innovation
- Diversity of workforce including age, skill level, race and interest

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Essex County Community Foundation

Exploring the North Shore Blue Economy
October 2 | Think Lab Report

Activity 2: Awareness of our Challenges

Individuals were asked to spend several minutes writing down the challenges we have as a community in relation to the North Shore Blue Economy. Ideas were shared and grouped into major themes, summarized below:

CHALLENGE
CULTURE

Examples of individual responses mentioning **culture** as a challenge facing the North Shore Blue Economy:

- North Shore communities can be provincial (34 cities and towns)
- Collaboration and strategic vision is lacking
- Competing priorities and visions

CHALLENGE
ATTRACTING TALENT

Examples of individual responses related to **attracting and retaining talent** as a challenge facing the North Shore Blue Economy:

- Current North Shore career opportunities offer low wages
- Limited cultural and social opportunities for young professionals
- More innovative/exciting career opportunities in Boston
- High cost of living vs. low sector wages

CHALLENGE
ANTIQUATED POLICIES

Examples of individual responses related to **antiquated policies** as a challenge facing the North Shore Blue Economy:

- Government policies regulating the Blue Economy are out of date
- Regional permits, requirements and fishing moratoriums challenge innovation
- Federal/State/local land use regulations are complex and impact waterfront investment

CHALLENGE
INFRASTRUCTURE

Examples of individual responses related to **infrastructure** as a challenge facing the North Shore Blue Economy:

- Aging infrastructure and decaying port facilities
- Transportation regionally is limited / commute inequality
- Inadequate broadband quality regionally

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Next Steps

Part of the NSBE's comprehensive engagement strategy, Think Lab participants provided valuable input to better understand the strengths, opportunities and challenges facing the North Shore Blue Economy. The initiative will continue these efforts through targeted focus groups and meetings over the next several months.

This report is a high level overview of the Think Lab session including key themes that emerged from the group activities. Report data and takeaways from key discussions will be used to help inform the NSBE initiative Phase I analysis, outputs and vision for next steps in our region.

NSBE will release a comprehensive report, including the full economic analysis by Dr. Michael Goodman, and the data culled from the Think Lab and other engagement events this winter. The Phase II launch of the NSBE Initiative is expected in the spring of 2020.

Stay Connected:

- SIGN UP for ECCF's Impact Essex County information and newsletter
- VISIT for more information about the UMass Amherst Gloucester Marine Station
- READ UMass Dartmouth's Public Policy Center report: Navigating the Global Economy: A Comprehensive Analysis of the Massachusetts Maritime Economy
- READ White Paper, Catching the Next Wave: Building the Blue Economy Through Innovation and Collaboration

What Could Be?

Building off the strengths and challenges recognized earlier in the session, teams participated in an ideation process to discover bolder, bigger ideas of possibility. Common in design thinking, this activity was meant to build enthusiasm and engagement by allowing participants to reflect on the potential and possibility of *what could be*. While the NSBE initiative is not committed to enacting each vision, they are an important part of the engagement strategy and identify the potential for the Blue Economy in our region.

Through hundreds of bold ideas collected from participants, several common themes emerged:

- Blue technology
- Coastal resilience
- Climate change solutions
- Improved legislation
- Integrated workforce development
- Local capital investment in the area

Exemplars of the **BOLD VISIONS** participants found particularly interesting:

Essex County Community Foundation
175 Andover Street | Danvers, MA 01923
www.eccf.org | @eccfgives | follow us on

THINK LAB: EXPLORING THE NORTH SHORE BLUE ECONOMY PARTICIPANTS

Thank you to the leaders from business, nonprofits, academic and research institutions, philanthropy, investment institutions and municipal, state and federal government who shared their insights at the October 2019 *Think Lab: Exploring the North Shore Blue Economy*.

The *Think Lab*, hosted by Essex County Community Foundation (ECCF) in partnership with the University of Massachusetts Amherst Gloucester Marine Station, would like to extend special thanks to Massachusetts Secretary of Housing and Economic Development, Michael Kennealy for providing opening remarks and to Massachusetts Senator Bruce Tarr for his closing remarks.

Thank you to the following for facilitating breakout sessions: Crystal Bates, Karen Ristuben and Hehershe Busuego from ECCF; Ken Riehl from Cape Ann Chamber of Commerce and Tom Balf from Gloucester Economic Development and Industrial Corporation.

Stratton Lloyd (ECCF) and Katie Kahl (UMass Amherst Gloucester Marine Station) were the meeting facilitators.

Meeting attendees (in alphabetical order):

1. Mike Armstrong, Massachusetts Division of Marine Fisheries
2. Tom Balf, Gloucester Economic Development and Industrial Corporation
3. Alessandra Bianchi, SeaTrac Systems, Inc.
4. Bill Bochnak, EDIC-Lynn
5. Chris Bolzan, Gloucester Marine Genomics Institute
6. Kelly Bovio, Office of Congressman Seth Moulton
7. Kate Bowditch, Essex County Greenbelt
8. Joan Brooks, Garbrook, Inc.
9. Harold Burnham, Schooners Ardelle and Sylvina Beal/Burnham Boat Building
10. Mollie Byrnes, Tower Foundation
11. John Byrnes, Tower Foundation
12. Jill Cahill, City of Gloucester
13. Elizabeth Carey, Discover Gloucester
14. Michael P. Carvalho, Carvalho & Associates, P.C.
15. Ann Marie Casey, North of Boston Convention & Visitors Bureau
16. Tom Chmura, North Shore Technology Council Board; UMass President's Office, retired
17. Karen Conard, Merrimack Valley Planning Commission
18. Al Cottone, Gloucester Fisheries Commission

19. Beth Debski, The Salem Partnership
20. Denise Deschamps, City of Beverly
21. Salvatore Di Stefano, City of Gloucester
22. Chris Dunn, UMass Amherst Government Relations
23. Jynessa Dutka-Gianelli, UMass Amherst Gloucester Marine Station
24. Martha Farmer, North Shore Tech Council, Board; North Shore InnoVentures, Founder & Board
25. Kate Fox, Destination Salem
26. Beth Francis, ECCF President & CEO
27. Mark Fregeau, Salem State University
28. Marzie Galazka, Town of Swampscott
29. Michael Goodman, UMass Dartmouth Public Policy Center
30. Julie Gerschick, Surren, LLC
31. Raul Gonzalez, Metropolitan Area Planning Council
32. Jim Goriou, Cape Seafoods
33. Peter Gourdeau, Windover Construction
34. Karen Hynick, North Shore Community College
35. Chris Ilsley, North Shore InnoVentures
36. Adrian Jordaan, UMass Amherst Gloucester Marine Station
37. Steve Kelleher, Proteus Industries
38. Michael Kennealy, MA Office of Housing and Economic Development
39. Iain Kerr, Ocean Alliance
40. Amanda Kinchla, UMass Amherst Food Science
41. Steve Kirk, The Nature Conservancy
42. Lorri Krebs, Salem State University Center for Economic Development & Sustainability
43. Natasha Lamb, Arjuna Capital
44. Alex Lamb, New Summit Investments
45. Seth Lattrell, City of Salem
46. Carol Lavoie Schuster, Essex County Community Foundation
47. Abbott Lowell, Microsoft
48. Donald Lynch, Gorton's
49. Joe McEvoy, Action Inc.

50. Sandy McGrath, Candescent Partners, LLC
51. Derek Mitchell, Lawrence Partnership
52. Ann Marie Molloy, Neptune's Harvest Organic Fertilizers / Ocean Crest Seafoods, Inc.
53. Betsy Nicholson, NOAA Office for Coastal Management
54. Gerry O'Neill, Cape Seafoods
55. Andrea O'Donnell, Ipswich Shellfish Company
56. Steve Parkes, Mass Oyster Project
57. Jon Payson, ECCF Board of Directors
58. Alicia Pensarosa, Ocean Alliance
59. Alissa Peterson, SeaAhead
60. Antonio Raciti, UMass Boston
61. Gautam Ramchandani, Global Source
62. Chat Reynders, Reynders, McVeigh Capital Management
63. Ken Riehl, Cape Ann Chamber of Commerce
64. Rebecca Riff, Senor Communications and Strategy Consultant
65. Bud Ris, Boston Green Ribbon Commission
66. Shannon Rogers, University of New Hampshire
67. James Rullo, ECCF Board; retired, Senior VP and Partner Wellington Management
68. Stephen Sacca, Board Member at Maritime Gloucester; retired, MIT Sloan School
69. Mary Sarris, MassHire North Shore Workforce Board
70. Krish Sharman, UMass Amherst Engineering & Wind Energy Center
71. Dougan Sherwood, Greater Haverhill Chamber
72. Laura Swanson, Salem Enterprise Center/ North Shore Alliance for Economic Development
73. Bruce Tarr, Massachusetts State Senate
74. Ric Upton, Gloucester Innovation
75. Marc Vidal, Dana-Farber Cancer Institute
76. Loren Walker, UMass Amherst Office of Research Development
77. Joel Whitman, Global Marine
78. James Worden, LightSpeed Energy

Appendix C:

INDUSTRY PERSPECTIVE MEETING PARTICIPANTS

Thank you to all of the participants from North Shore businesses: nonprofits, academic and research institutions, public institutions and coalitions and municipal and state government who shared their insights at the five North Shore Blue Economy Industry Perspective meetings held 2019-2020.

Katie Kahl, facilitated all Industry Perspective meetings

Marine Sciences & Technology: Life Sciences

(Thank you to North Shore InnoVentures for providing conference space for this meeting.)

1. Salvatore Russello, Director, OEM & Customized Solutions, New England Biolabs
2. Christine Bolzan, Director, Gloucester Marine Genomics Institute
3. Dan Distel, Ocean Genome Legacy Project, Northeastern Marine Science Center
4. Chris Ilsley, President & CEO, North Shore InnoVentures
5. Martha Farmer, Board Member and Founder, North Shore InnoVentures
6. Thomas Chmura, Board Member, North Shore Technology Council

Invited, unable to attend:

- Carla Reimold, Director of Industry Programs, Massachusetts Life Sciences Center

Marine Sciences & Technology: Marine Robotics and Sensing Technologies

(Thank you to North Shore InnoVentures for providing conference space for this meeting.)

7. Dave Bertoni, CEO & Co-Founder, LeviSense Medical, Inc.
8. Mark Huang, Co-founder & Managing Director, SeaAhead
9. Chris Ilsley, President & CEO North Shore InnoVentures
10. Adam Cantor, Robots in Service to the Environment
11. James Byrnes, Mass Tech Collaborative
12. Julie Chen, Vice Chancellor for Research & Innovation, University of Massachusetts Lowell
13. Rob Vincent, Assistant Director for Advisory Services, MIT Sea Grant College Program
14. Mike Sacarny, Research Engineer, MIT Autonomous Underwater Vehicles Lab
15. Karen Utgoff, Venture Development, UMass Amherst Institute for Applied Life Sciences
16. Pascal Mittermaier, Green Cities Expert & Executive Coach, Board Member at Nature Sacred
17. Tom Balf, Founder & President, OceanVest LLC

Invited, unable to attend:

- Ric Upton, Gloucester Innovation
- James Herman, SeaTrac

Living Resources (held at UMass Amherst Gloucester Marine Station)

18. Al Cottone, Gloucester Fisheries Commission
19. Vito Giacalone, Gloucester Fishing Community Preservation Fund
20. Mark Ring, Gloucester Lobster Foundation
21. Jim Goriou, Cape Seafood, Vice President & General Manager
22. Don Lynch, Gortons, Vice President R&D and Quality Assurance
23. Ted Maney, Salem State Cat Cove Lab
24. Pete Seminara, Gloucester Shellfish Constable
25. TJ Ciarametaro, Gloucester Harbormaster
26. Paul Movalli, Sales, Ipswich Shellfish
27. Andrea O'Donnell, Sustainability Coordinator, Ipswich Shellfish
28. Tom Balf, Gloucester Economic Development & Industrial Corporation

Invited but unable to attend:

- Nick Giacalone, Gloucester Fisherman's Wharf
- Kristian Kristensen, Cape Ann Seafood Exchange
- Jim Turner, Turners Seafood
- Monte Rome, Intershell
- Tessa Brown, Cape Ann Lobstermen
- Scott Soarse, MA Shellfish Initiative

Coastal Tourism & Recreation
(Thanks to Annie Harris for hosting the meeting at Essex National Heritage.)

29. Annie Harris, Essex National Heritage Area
30. Kate Fox, Destination Salem
31. Ann Marie Casey, North of Boston Convention & Visitors Bureau
32. Jill Cahill, Community Development Director
33. Ken Riehl, CEO, Cape Ann Chamber of Commerce

Coastal Resilience: hosted via zoom
(Thank you to UMass Amherst Office of Research Development (Mary Green and Loren Walker) and Office of Faculty Development (Karen Whelan-Berry) for helping to facilitate Zoom breakout groups.)

34. Abbie Goodman, American Council of Engineering Companies of Massachusetts
35. John Nunnari, American Institute of Architects, Massachusetts, Executive Director

36. Eric Kelly, Environmental Partners (Engineering), Project Manager
37. Natalie Pommersheim, Environmental Partners, Project Manager
38. Anders Bjarngard, GZA, Principal
39. Courtney Lewis, Metropolitan Area Planning Commission, Regional Land Use Planner
40. Greg Federspiel, Manchester-by-the-Sea, Town Administrator
41. Brendhan Zubricki, Essex, Town Administrator
42. Darlene Wynne, City of Beverly, Planning Director
43. Gregg Cademartori, City of Gloucester, Planning Director
44. Aaron Clausen, City of Lynn, Planning Director
45. Kristin Grubbs, Ipswich, Town Planner
46. Betsy Nicholson, NOAA Office for Coastal Management, North Regional Director
47. Peter Phippen, Mass Bays National Estuary Partnership, Upper North Shore Regional Coordinator
48. Kathryn Glenn, Coastal Zone Management Program, North Shore Regional Coordinator
49. Tom O'Shea, Trustees, Director Coast & Natural Resources
50. David Moon, Mass Audubon, Community Science and Coastal Resilience Manager
51. Bud Ris, Boston Green Ribbon Commission, Senior Advisor
52. Jack Clark, MA Ocean Advisory Commission
53. Pascal Mittermaier, Green Cities Expert & Executive Coach, Board member at Nature Sacred
54. Stratton Lloyd, Essex County Community Foundation, NSBE Steering Committee

Invited but unable to attend:

- Anthony Marino, Ipswich, Town Manager
- Tom Daniel, City of Salem, Community Development and Planning
- Matt Hillman/Nancy Pau, US Fish & Wildlife Service, Parker River National Wildlife Refuge, Director
- Barbara Warren, Mass Bays National Estuary Partnership, Lower North Shore Regional Coordinator & Salem Sound Coast Watch
- Kate Bowdich, Essex County Greenbelt, Executive Director
- Mary Skelton Roberts, Barr Foundation, Co-Director of Climate
- Steve Kirk, The Nature Conservancy, Coastal Program Manager
- Mia Mansfield, MA EEA, Director of Climate Adaptation & Resilience

Appendix D:

MARITIME ECONOMY SECTORS AND INDUSTRIES

SECTOR	INDUSTRY	NAICS INDUSTRY	DESCRIPTION
Marine Construction	Marine Related Construction	237120 - Oil and Gas Pipeline and Related Structures	This industry comprises establishments primarily engaged in the construction of oil and gas lines, mains, refineries and storage tanks. The work performed may include new work, reconstruction, rehabilitation and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to oil and gas pipeline and related structures construction. All structures (including buildings) that are integral parts of oil and gas networks (e.g., storage tanks, pumping stations and refineries) are included in this industry.
		237990 - Other Heavy and Civil Engineering Construction	This industry comprises establishments primarily engaged in heavy and engineering construction projects (excluding highway, street, bridge and distribution line construction). The work performed may include new work, reconstruction, rehabilitation and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to engineering construction projects (excluding highway, street, bridge, distribution line, oil and gas structure and utilities building and structure construction). Construction projects involving water resources (e.g., dredging and land drainage), development of marine facilities and projects involving open space improvement (e.g., parks and trails) are included in this industry.
Living Resources	Fish Hatcheries & Aquaculture	112511 - Finfish Farming and Fish Hatcheries	This U.S. industry comprises establishments primarily engaged in (1) farm raising finfish (e.g., catfish, trout, goldfish, tropical fish, minnows) and/or (2) hatching fish of any kind.
		112512 - Shellfish Farming	This U.S. industry comprises establishments primarily engaged in farm raising shellfish (e.g., crayfish, shrimp, oysters, clams, mollusks).
	Fishing	114111 - Finfish Fishing	This U.S. industry comprises establishments primarily engaged in the commercial catching or taking of finfish (e.g., bluefish, salmon, trout, tuna) from their natural habitat.
		114112 - Shellfish Fishing	This U.S. industry comprises establishments primarily engaged in the commercial catching or taking of shellfish (e.g., clams, crabs, lobsters, mussels, oysters, sea urchins, shrimp) from their natural habitat.
	Seafood Processing	311711 - Seafood Canning	This U.S. industry comprises establishments primarily engaged in (1) canning seafood (including soup) and marine fats and oils and/or (2) smoking, salting and drying seafood. Establishments known as "floating factory ships" that are engaged in the gathering and processing of seafood into canned seafood products are included in this industry.
		311712 - Fresh and Frozen Seafood Processing	This U.S. industry comprises establishments primarily engaged in one or more of the following: (1) eviscerating fresh fish by removing heads, fins, scales, bones and entrails; (2) shucking and packing fresh shellfish; (3) manufacturing frozen seafood and (4) processing fresh and frozen marine fats and oils.
	Seafood Markets	445220 - Fish and Seafood Markets	This industry comprises establishments primarily engaged in retailing fresh, frozen or cured fish and seafood products.
Offshore Minerals	Limestone, Sand & Gravel	212321 - Construction Sand and Gravel Mining	This U.S. industry comprises establishments primarily engaged in one or more of the following: (1) operating commercial grade (i.e., construction) sand and gravel pits; (2) dredging for commercial grade sand and gravel and (3) washing, screening or otherwise preparing commercial grade sand and gravel.
		212322 - Industrial Sand Mining	This U.S. industry comprises establishments primarily engaged in one or more of the following: (1) operating industrial grade sand pits; (2) dredging for industrial grade sand and (3) washing, screening or otherwise preparing industrial grade sand.

SECTOR	INDUSTRY	NAICS INDUSTRY	DESCRIPTION
Offshore Minerals	Oil & Gas Exploration and Production	211111 - Crude Petroleum and Natural Gas Extraction	This U.S. industry comprises establishments primarily engaged in (1) the exploration, development and/or the production of petroleum or natural gas from wells in which the hydrocarbons will initially flow or can be produced using normal pumping techniques or (2) the production of crude petroleum from surface shales or tar sands or from reservoirs in which the hydrocarbons are semisolids. Establishments in this industry operate oil and gas wells on their own account or for others on a contract or fee basis.
		213111 - Drilling Oil and Gas Wells	This U.S. industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling and directional drilling.
		213112 - Support Activates for Oil and Gas Operations	This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars; well surveying; running, cutting and pulling casings, tubes and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells and cleaning out, bailing and swabbing wells.
		541360 - Geophysical Exploration and Mapping Services	This industry comprises establishments primarily engaged in gathering, interpreting and mapping geophysical data. Establishments in this industry often specialize in locating and measuring the extent of subsurface resources, such as oil, gas and minerals, but they may also conduct surveys for engineering purposes. Establishments in this industry use a variety of surveying techniques depending on the purpose of the survey, including magnetic surveys, gravity surveys, seismic surveys or electrical and electromagnetic surveys.
Ship & Boat Building & Repair	Boat Building & Repair	336612 - Boat Building & Repair	This U.S. industry comprises establishments primarily engaged in building boats. Boats are defined as watercraft not built in shipyards and typically of the type suitable or intended for personal use.
	Ship Building & Repair	336611 - Ship Building & Repair	This U.S. industry comprises establishments primarily engaged in operating a shipyard. Shipyards are fixed facilities with drydocks and fabrication equipment capable of building a ship, defined as watercraft typically suitable or intended for other than personal or recreational use. Activities of shipyards include the construction of ships, their repair, conversion and alteration, the production of prefabricated ship and barge sections and specialized services, such as ship scaling.
Tourism & Recreation	Boat Dealers	441222 - Boat Dealers	This U.S. industry comprises establishments primarily engaged in (1) retailing new and/or used boats or retailing new boats in combination with activities, such as repair services and selling replacement parts and accessories and/or (2) retailing new and/or used outboard motors, boat trailers, marine supplies, parts and accessories.
	Eating & Drinking Places	722110 - Full Service Restaurants	This industry comprises establishments primarily engaged in providing food services to patrons who order and are served while seated (i.e. waiter/waitress service) and pay after eating. These establishments may provide this type of food services to patrons in combination with selling alcoholic beverages, providing carry out services or presenting live nontheatrical entertainment.
		722211 - Limited Service Eating Places	This U.S. industry comprises establishments primarily engaged in providing food services (except snack and nonalcoholic beverage bars) where patrons generally order or select items and pay before eating. Food and drink may be consumed on premises, taken out or delivered to the customer's location. Some establishments in this industry may provide these food services in combination with selling alcoholic beverages.
		722212 – Cafeterias	This U.S. industry comprises establishments, known as cafeterias, primarily engaged in preparing and serving meals for immediate consumption using cafeteria-style serving equipment, such as steam tables, a refrigerated area and self-service nonalcoholic beverage dispensing equipment. Patrons select from food and drink items on display in a continuous cafeteria line.

SECTOR	INDUSTRY	NAICS INDUSTRY	DESCRIPTION
Tourism & Recreation	Eating & Drinking Places	722213 - Snack and Nonalcoholic Beverage Bars	This U.S. industry comprises establishments primarily engaged in (1) preparing and/or serving a specialty snack, such as ice cream, frozen yogurt, cookies or popcorn or (2) serving nonalcoholic beverages, such as coffee, juices or sodas for consumption on or near the premises. These establishments may carry and sell a combination of snack, nonalcoholic beverage and other related products (e.g., coffee beans, mugs, coffee makers) but generally promote and sell a unique snack or nonalcoholic beverage.
	Hotels & Lodging Places	721110 - Hotels (Except Casino Hotels) and Motels	This industry comprises establishments primarily engaged in providing short-term lodging in facilities known as hotels, motor hotels, resort hotels and motels. The establishments in this industry may offer food and beverage services, recreational services, conference rooms and convention services, laundry services, parking and other services.
		721191 - Bed and Breakfast Inns	This U.S. industry comprises establishments primarily engaged in providing short-term lodging in facilities known as bed-and-breakfast inns. These establishments provide short-term lodging in private homes or small buildings converted for this purpose. Bed and breakfast inns are characterized by a highly personalized service and inclusion of a full breakfast in a room rate.
	Marinas	713930 – Marinas	This industry comprises establishments, commonly known as marinas, engaged in operating docking and/or storage facilities for pleasure craft owners, with or without one or more related activities, such as retailing fuel and marine supplies; and repairing, maintaining or renting pleasure boats.
	Recreational Vehicle Parks & Campsites	721211 - RV Parks and Recreational Camps	This U.S. industry comprises establishments primarily engaged in operating sites to accommodate campers and their equipment, including tents, tent trailers, travel trailers and RVs (recreational vehicles). These establishments may provide access to facilities, such as washrooms, laundry rooms, recreation halls and playgrounds, stores and snack bars.
	Scenic Water Tours	487210 - Scenic and Sightseeing Transportation, Water	This industry comprises establishments primarily engaged in providing scenic and sightseeing transportation on water. The services provided are usually local and involve same-day return to place of origin.
	Sporting Goods	339920 - Sporting and Athletic Goods Manufacturing	This industry comprises establishments primarily engaged in manufacturing sporting and athletic goods (except apparel and footwear).
	Amusement & Recreation Services	487990 - Scenic and Sightseeing Transportation, Other	This industry comprises establishments primarily engaged in providing scenic and sightseeing transportation (except on land and water). The services provided are usually local and involve same-day return to place of departure.
		611620 - Sports and Recreation Instruction	This industry comprises establishments, such as camps and schools, primarily engaged in offering instruction in athletic activities to groups of individuals. Overnight and day sports instruction camps are included in this industry.
		532292 - Recreation Goods Rental	This U.S. industry comprises establishments primarily engaged in renting recreational goods, such as bicycles, canoes, motorcycles, skis, sailboats, beach chairs and beach umbrellas.
		713990 - Amusement and Recreation Services Not Elsewhere Classified	This industry comprises establishments (except amusement parks and arcades,; gambling industries, golf courses and country clubs, skiing facilities, marinas, fitness and recreational sports centers and bowling centers) primarily engaged in providing recreational and amusement services.
	Zoos, Aquaria	712130 - Zoos and Botanical Gardens	This industry comprises establishments primarily engaged in the preservation and exhibition of live plant and animal life displays.
		712190 - Nature Parks and Other Similar Institutions	This industry comprises establishments primarily engaged in the preservation and exhibition of natural areas or settings.

SECTOR	INDUSTRY	NAICS INDUSTRY	DESCRIPTION
Transportation	Deep Sea Freight	483111 - Deep Sea Freight Transportation	This U.S. industry comprises establishments primarily engaged in providing deep sea transportation of cargo to or from foreign ports.
		483113 - Coastal and Great Lakes Freight Transportation	This U.S. industry comprises establishments primarily engaged in providing water transportation of cargo in coastal waters, on the Great Lakes System, or deep seas between ports of the United States, Puerto Rico and United States island possessions or protectorates. Marine transportation establishments using the facilities of the St. Lawrence Seaway Authority Commission are considered to be using the Great Lakes Water Transportation System. Establishments primarily engaged in providing coastal and/or Great Lakes barge transportation services are included in this industry.
	Marine Passenger Transportation	483112 - Deep Sea Passenger Transportation	This U.S. industry comprises establishments primarily engaged in providing deep sea transportation of passengers to or from foreign ports.
		483114 - Coastal and Great Lakes Passenger Transportation	This U.S. industry comprises establishments primarily engaged in providing water transportation of passengers in coastal waters, the Great Lakes System or deep seas between ports of the United States, Puerto Rico and United States island possessions and protectorates.
	Marine Transportation Services	488310 - Port and Harbor Operations	This industry comprises establishments primarily engaged in operating ports, harbors (including docking and pier facilities) or canals.
		488320 - Marine Cargo Handling	This industry comprises establishments primarily engaged in providing stevedoring and other marine cargo handling services (except warehousing).
		488330 - Navigational Services to Shipping	This industry comprises establishments primarily engaged in providing navigational services to shipping. Marine salvage establishments are included in this industry.
		488390 - Other Support Activities for Water Transportation	This industry comprises establishments primarily engaged in providing services to water transportation (except port and harbor operations, marine cargo handling services and navigational services to shipping).
	Search and Navigation Equipment	334511 - Search, Detection, Navigation, Guidance, Aeronautical and Nautical System and Instrument Manufacturing	This U.S. industry comprises establishments primarily engaged in manufacturing search, detection, navigation, guidance, aeronautical and nautical systems and instruments. Examples of products made by these establishments are aircraft instruments (except engine), flight recorders, navigational instruments and systems, radar systems and equipment and sonar systems and equipment.
	Warehousing	493110 - General Warehousing and Storage	This industry comprises establishments primarily engaged in operating merchandise warehousing and storage facilities. These establishments generally handle goods in containers, such as boxes, barrels and/or drums, using equipment, such as forklifts, pallets and racks. They are not specialized in handling bulk products of any particular type, size or quantity of goods or products.
		493120 - Refrigerated Warehousing and Storage	This industry comprises establishments primarily engaged in operating refrigerated warehousing and storage facilities. Establishments primarily engaged in the storage of furs for the trade are included in this industry. The services provided by these establishments include blast freezing, tempering and modified atmosphere storage services.
		493130 - Farm Product Warehousing and Storage	This industry comprises establishments primarily engaged in operating bulk farm product warehousing and storage facilities (except refrigerated). Grain elevators primarily engaged in storage are included in this industry.

Appendix E:

SBIR & STTR METHODOLOGY

Metadata on all SBIR/STTR awards by state were collected from the U.S. Small Business Administration for the time period 2011 through 2015. For Massachusetts, awards involving maritime-related technologies were identified by hand. In order to facilitate identification, all SBIR/STTR awards for Massachusetts were divided into two groups: (1) those awarded by the U.S. Navy and (2) all other. All Navy awards were included, with the exception of those that were clearly aerospace-related. For all other awards, PPC kept only those that are clearly maritime-related. The first group is likely to slightly overstate the true number of maritime awards, while the second group is likely to slightly understate the true number of maritime awards. Thus, the number and dollar amount of maritime-related SBIR/STTR awards should be treated as estimates.

Appendix F:

MARINE PATENT IDENTIFICATION METHODOLOGY

The method used to identify marine patents employed dictionary matching. An algorithm containing an initial list of strings considered likely to be related to marine patents was developed and matched against each patent's title and abstract. The algorithm was then further improved by adding effective marine terms found in search results. Results were then manually screened to remove patents deemed to be non-marine related and remaining matches were marked as marine patents.

Data Harvesting

A simple but highly parallelized script and wrapper were written to generate local patent databases containing pertinent USPTO fields for a number of U.S. states over a period of 2010-2015. Fields included the CLCP groupings, title, abstract, date and year. 227,164 patents from New England and California were available for analysis, as well as additional patents from other states such as New York. The number of patents available for analysis were increased following the preliminary analysis with the study expanded to include all coastal US states, representing 451,231 patents across 22 states.

Analysis Accuracy

Examination of the dictionary matching results suggested an initial false-positive rate of approximately 15 percent, although this rate varied between states. False positives were reduced from this rate by manual screening following the dictionary matching. The accuracy of the manual screening process is limited by the complexity associated with correctly classifying highly technical patents as marine or otherwise. Applying a constant threshold across states and years is also important for the accuracy of the count.

Manual checking was undertaken in order to identify marine patents that were missed by the dictionary matching. While manual corroboration across a small 230 observation sample - RI, 2011 - indicated a 3/3 hit rate and another 300 observation sample - from MA, 2015 - also indicated a 3/3 hit rate, the false-negative rate is ultimately unknown and certainly greater than zero. Accurate evaluation of the false-negative rate is limited by the low prevalence of marine patents observed in both the dictionary matching and manual sampling. The observed marine patents accounted for approximately 1 in 282 patents for Massachusetts between 2010 and 2015, while marine patents accounted for only 1 in 750 patents in California over the same time period.

For comparisons across years or states, the false-negative rate is assumed in this analysis to be constant. However, if the unobserved false-negative rate varies between sectors within the marine industry – such as between the fishing sector and the telecommunications sector - any interstate variation in the marine industry composition will likely result in variations in the unobserved rate between states and potentially years.

Patents were associated with the assignee's state. In cases where there we co-assignees from different states, the same marine patent was represented in both states. The inherent issue with using this method is that it depends on the contractual arrangements of the organizations submitting the patent. These contractual arrangements are unknowable. Furthermore, this method cannot identify the exact locations where the actual research took place.

Investigation of Advanced Search Methods

Due to the low prevalence of marine patents to non-marine patents, the use of advanced search methods such as Machine Learning (ML) was assessed to be impractical. The process of manually screening patents was found to be particularly slow, with the differentiation of marine and non-marine patents frequently requiring a thorough and careful reading of the title and/or abstract. As a result, developing, training and validating datasets of an adequate size would be particularly labor intensive.

Preliminary Results

415 marine patents were identified from the 227,164 patents analyzed, for an effective rate of 1 marine patent per 547 patents. This rate was heavily skewed by California's large number of patents relative to the smaller New England states. The proportion of marine patents to total patents varied between the six states examined, ranging from 1 marine patent per 66 patents in Vermont to 1 marine patent per 750 patents in California. The ratio of marine patents in Massachusetts was 1 per 283 patents.

On a population basis, Massachusetts generated the highest rate of marine patents in 2015, at a ratio of 1 patent per 226,481 residents. Due to fluctuations in the annual number of marine patents over the observed period, other states, such as New Hampshire in 2014, generated higher population/patent rates than Massachusetts in earlier years.

Limited Analysis from the Full Survey Results

Following the preliminary results, all coastal states were included for analysis, increasing the number of scanned patents to 451,231. 1,846 marine patents were identified from this population, for an overall effective rate of 1 marine patent per 244 patents. The proportion of marine patents to total patents varied between the 22 states examined. With 1 marine patent per 14 patents, Alaska had the highest ratio. At the other extreme, California had the lowest ratio, at 1 marine patent per 750 patents. California's low ratio is likely due to the high proportion of information technology related patents.

The state with the highest number of marine patents over the 2010-2015 period was Texas, with 816, representing nearly half of all marine patents identified. Offshore oil and gas patents accounted for a significant proportion of Texas' marine patents. On a population basis, Texas was the only state to have a higher rate of patents per population than Massachusetts in 2015. The calculated ratio of 1 marine patent per 183,127 residents in Texas represented a decrease from previous years, possibly attributable to the downturn in oil prices reducing investment in oil and gas R&D.

SQL Code Library

Create the Host Table

CREATE TABLE `MA` (id INT, patent_no VARCHAR(12), date VARCHAR(255), title text, cpcl text, inventors text, company text, abstract text, state VARCHAR(5), marine tinyint null, pkey INT auto_increment, PRIMARY KEY (pkey));

Add Data by Year

LOAD DATA INFILE '/var/lib/mysql-files/output_MA.201x.csv' INTO TABLE `MA` FIELDS TERMINATED BY ',' ENCLOSED BY '"' LINES TERMINATED BY '\n';

Identify Possible Marine Targets

SELECT * FROM `MA` WHERE (title REGEXP 'phytoplankton|deep water|marine|ocean| sea |seafloor|seabed|subsea|offshore|shoreline|seafood| tide |seawater| fish| boat |mooring|salt water|submarine|aquatic|hull|submersible|shellfish|underwater|sonar|yacht| ship | wave energy' OR abstract REGEXP 'phytoplankton|deep water|deepsea|marine|ocean| sea | sea[.]| seafloor| seabed | seabed[.]|subsea |subsea[.]|offshore|shoreline|seafood| tide | tide[.]|seawater| fish| boat | boat[.]|mooring|salt water|submarine|shellfish|underwater|sonar|submersible| hull | hull[.]|aquatic|yacht| ship | ship[.]| wave energy');

Update Marine Based on Screening

UPDATE `MA` SET marine = 1 WHERE date LIKE '%2015%' AND (title REGEXP 'phytoplankton|deep water|marine|ocean| sea |seafloor|seabed|subsea|offshore|shoreline|seafood| tide |seawater| fish| boat |mooring|salt water|submarine|aquatic|hull|submersible|shellfish|underwater|sonar|yacht| ship | wave energy' OR abstract REGEXP 'phytoplankton|deep water|deepsea|marine|ocean| sea | sea[.]| seafloor| seabed | seabed[.]|subsea |subsea[.]|offshore|shoreline|seafood| tide | tide[.]|seawater| fish| boat | boat[.]|mooring|salt water|submarine|shellfish|underwater|sonar|submersible| hull | hull[.]|aquatic|yacht| ship | ship[.]| wave energy') AND (pkey NOT IN ( ))

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https://www.umass.edu/nsblueeconomy

North Shore Blue Economy Phase I: Findings & Vision Forward | Fact Sheet

Blue Economy:
the sustainable use of ocean resources for economic growth, improved livelihoods and jobs and ocean ecosystem health.

UMass Amherst
Gloucester Marine Station

UMass | Dartmouth

WHO

- UMass Amherst Gloucester Marine Station
- Gloucester EDIC
- Cape Ann Chamber of Commerce
- City of Gloucester
- North Shore Technology Council
- North Shore InnoVentures
- Essex County Community Foundation
- Commonwealth of Massachusetts
- Economic analysis: UMass Dartmouth Public Policy Center & Springline Research Group

WHAT

- Assessed regional economic base.
- Engaged nearly 300 North Shore business, municipal, NGO, research, philanthropy & government stakeholders.

WHY

While the North Shore has a longstanding connection to the maritime economy (i.e., fisheries, tourism, boat building), it lacks a comprehensive regional economic development strategy that builds on these strengths and positions the region to capitalize on new and emerging opportunities in the Blue Economy.

Stakeholder Engagement

- Life Sciences
- Marine Sensing & Robotics
- Living Resources
- Tourism & Recreation
- Coastal Resilience
- North Shore Alliance for Economic Development, Planners
- North Shore Coalition of Mayors, MAPC
- North Shore Chamber of Commerce

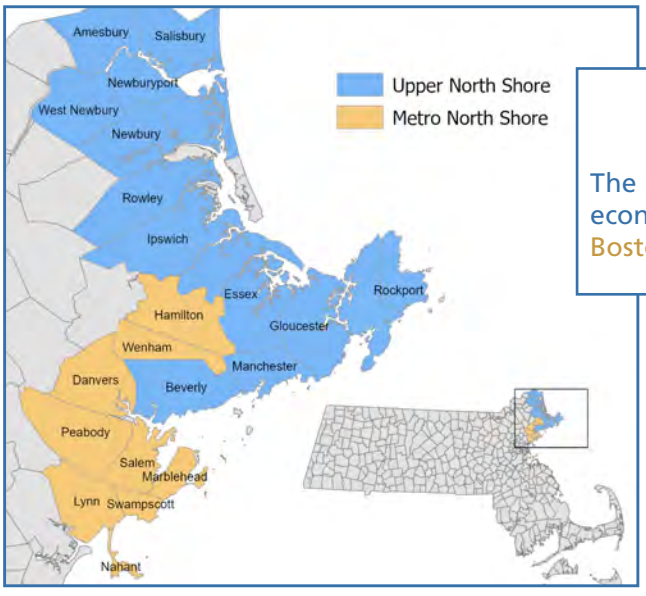
2019 — **Think Lab**

2020

2021 — **Report: Phase I Findings**

Phase II Vision Forward

- **Grow** the North Shore Blue Economy Network
- **Develop** Workforce Training and Education
- **Brand & Market** the North Shore's Vision of a Resilient, Sustainable and Equitable Blue Economy
- **Fundraise** and Increase Access to Capital that will Foster Entrepreneurship and Incubate Blue Economy Enterprises and Initiatives



NORTH SHORE

The North Shore has both a strong coastal "self-sufficient" economy, as well as communities with a "front door" to Greater Boston's finance, life science and technology innovation economy.

For more information, contact:
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STAKEHOLDERS TELL US THAT A THRIVING BLUE ECONOMY NEEDS:

✓ **Planning** a coordinated plan for the region, mapping our assets and assessing business models

✓ **Investing** in infrastructure (dockage, transportation, housing) while retaining our unique culture

✓ **Engaging** young people and attracting new workers by developing targeted workforce training in our strength sectors

✓ **Marketing** and promoting the region's successes, assets and vision forward, while creating a regional brand that all can see themselves being a part of

The strength of our North Shore Blue Economy is a combination of mature and emerging specialized industry clusters and opportunities in both traditional maritime industries and technology-based industries not always perceived as being connected to the ocean.

JOBS, WORKFORCE AND EARNINGS

- An average of **209,711 jobs were located within the North Shore** in 2020, with the number of jobs increasing by 10% since 2001
- **16,485 Blue Economy jobs** on the North Shore represent 8% of the regional employment (2020)
- Blue Economy jobs grew faster than the regional economy as a whole; from 2004 to 2020, **the number of people working in the Blue Economy grew by 19.5%** on the North Shore (+2,644 jobs)

BUILDING ON REGIONAL STRENGTHS & EMERGING OPPORTUNITIES TO GROW OUR BLUE ECONOMY

Industry Cluster	LQ	Employment
Fishing/Fishing Products	11.2	900
Aerospace Vehicles & Defense	8.4	6,921
Biopharmaceuticals	4.7	1,782
Medical Devices	4.7	1,762
IT & Analytics	2.9	4,861
Education/Knowledge Creation	1.9	8,181
Marketing, Design, Publishing	1.6	3,631
Food Processing and Mfg.	1.5	2,281
Performing Arts	1.2	980
Lighting & Elec. Equipment	1.2	483
Downstream Chemical Products	1.1	400
Financial Services	1.1	2,851

Source: EMSI, 2020

LQ > 1 means the region is more specialized in the industry than the nation as a whole

Living Resources is a regional strength sector in terms of its size, history and specialization. However, employment in the sector declined 27% between 2004 and 2020.

Coastal Tourism & Recreation represents 87% of Blue Economy employment, but the lowest average annual wage ($24,979), with most employment based in service jobs with no direct connection to the sustainable use of ocean resources.

New Marine Science & Technology areas, such as offshore wind or marine genomics, are only now being captured in employment and wage data, but are anticipated to be evolving opportunities moving forward.

Climate Change is a threat, but we have an opportunity to seize increased investments being made by state and federal government and to demonstrate leadership and innovation by incorporating climate resilient approaches into our Blue Economy strategies to safeguard people, properties and ports.

Nonprofit and Public Institutions play a crucial role for work ahead in our regional Blue Economy. They produce research that drives innovation, implements and manages marine and coastal regulation, educates our children and the public, convenes dialogues and supports action.