

The Value of Rhode Island's Blue Economy

March 2020

A report by
Jennifer McCann, Sam Poli, Sue Kennedy,
Erin O'Neill, Don Robadue and Dawn Kotowicz

Edited by Monica Allard Cox

Coastal Resources Center and
Rhode Island Sea Grant College Program

Graduate School of Oceanography
University of Rhode Island
Narragansett, Rhode Island

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Introduction

It's easy to see how important and embedded Rhode Island's coastal and ocean natural and man-made resources and infrastructure are to the people of this state. From high-tech defense spurring innovation, to world-class marine trades and composites contributing to the state's reputation as the sailing capital of the world, to internationally respected oceanographic research and strategic military educational institutions tackling complex issues and training future leaders to solve local and global challenges, Rhode Island makes significant contributions to the blue economy here, nationally, and around the world. In fact, about 6-9%¹ of Rhode Islanders work within the state's ocean economy,² a sector with a direct impact of more than \$5 billion.³

Rhode Island's contributions to and successes in the blue economy are achieved due to long-term investments by government, industry, academic and research institutions, and communities. Crucial to this investment, however, are multiple local "enhancers" critical to ongoing growth, including our state's high quality of place and commitment to proactive planning and management, ensuring the protection of public access and working waterfronts as well as the well-being of our coastal and ocean resources.

In 2018 the Coastal Resources Center and Rhode Island Sea Grant at the University of Rhode Island (URI) were tasked with defining Rhode Island's blue economy and identifying strategies to nurture and grow this important sector. With support from the URI Graduate School of Oceanography (GSO) and Rhode Island Sea Grant, the research team interviewed more than 60 Rhode Island blue economy participants, attended and hosted blue economy-related events, and learned how other communities, states, and nations promote their maritime resources. They also analyzed what it is that significantly contributes to the innovation, enhancement, and evolution of the blue economy.

Although there are many interpretations of the term "blue economy," this report defines the blue economy as the economic sectors with a direct or indirect link to Rhode Island's coasts and ocean—defense, marine trades, tourism and recreation, fisheries, aquaculture, ports and shipping, and offshore renewable energy. Also included are higher education and research institutions, marine-focused advocacy and civic groups, and government agencies that contribute to building a strong blue economy workforce, invest in sustainable growth and innovation, and plan for the protection of our coasts and oceans.

This report describes the different blue economy sectors using both economic information and perspectives from sector leaders. We share these two distinct information sources

because the perspectives of the industry leaders demonstrate a value equal to if not greater than the economic value. In addition, to enhance the legitimacy and the uniqueness of the work, instead of applying a uniformed approach for describing each sector, different formats have been used. Defense therefore reads differently than tourism, for example (see more data in the Technical Report). A description of the four "enhancers"—components that increase or improve in value the quality, desirability, or sustainability of the blue economy as a whole—follow these sector descriptions as they serve as the foundational platform upon which the sectors thrive. A blue economy network analysis illustrates the connections among the blue economy sectors and how innovation can be nurtured. This report then offers strategies and actions for how Rhode Island can best respond to global and local opportunities while encouraging appropriate growth within the state.

One of the more important findings of this report is that most who were interviewed indicated that there is a clear recognition that moving forward, efforts to enhance the blue economy must honor the state's unique maritime character and mix of marine-based assets, and cultivate strategic, cross-sector innovations that multiply benefits across industries. In addition, the foundation of Rhode Island's blue economy requires the protection and wise management of coastal and ocean resources both within and alongside Narragansett Bay, the Salt Ponds, Block Island and Rhode Island Sounds, and the Atlantic Ocean.

This report recommends five strategies:

Strategy 1 — Intensify and expand collaborative leadership.

Establish systems jointly led by government, industry, and academia to engender a sense of shared responsibility and encourage cross-sector creative and marketable solutions that respond to both local and global blue economy issues.

Strategy 2 — Design policies and implement initiatives for Rhode Island's coasts and oceans that meet economic and social needs while doing no harm to the natural ecosystem.

Continue implementing plans and actions that consider the sustainable use and wise management of economic and recreational activities that result in a healthy coastal and ocean natural ecosystem. Prudent regulatory oversight to maintain the state's balance between economic growth and conservation, and private development and public good—particularly in a time of increased sea level rise and storms—must remain a priority.

¹ The 6% is author's calculation based on non-federal data. The 9% figure is from NOAA ENOW data.

² Only 3% of Massachusetts, Connecticut, California and Texas residents work within their state's blue economy according to NOAA ENOW data.

³ See the By the Numbers section for a more detailed explanation.

Strategy 3 — *Utilize pressing issues facing Rhode Island and Southern New England as opportunities to leverage the region’s technical and governance innovation capacity and approaches.*

Rhode Island’s public and private sectors should strategically invest in encouraging innovation, acceleration, and application of creative solutions to respond to natural and human-made issues, such as increased sea level rise, severe storms and related flooding, ocean and coastal pollution, resource-user conflicts, and food security. Industry clusters should be enhanced and prioritized for financial and technological opportunities that serve as effective strategies to bolster the economy.

Strategy 4 — *Prepare and integrate a diverse and increasingly capable cross-sector workforce to foster a growing and integrated blue economy.*

Rhode Island should expand its existing workforce development model to respond to industry needs. The blue economy workforce requires additional options, like certificate and increased-paid internship programs, professional master’s degrees, and continued learning

opportunities to develop the required skills and talent to meet growing industry demand, and continue contributing to the diversity and agility of the state’s blue economy. Increased coordination between all workforce and education skill building programs is needed to minimize redundancy and allow this in-demand workforce to respond to multiple sector needs at once. At the same time, workforce wages and benefits are necessary to provide an adequate quality of life.

Strategy 5 — *Continually engage and inform a broad constituency for stewarding our ocean resources and meeting the blue economy’s education, training, and infrastructure needs.*

Ensure Rhode Islanders have increased pride, ownership, understanding, and participation in the sustainable management and health of the state’s blue economy. Offer opportunities for Rhode Islanders to “experience” and tour different infrastructure within the sectors so they have better understanding of the value and the interconnectedness.

Moving Forward

By 2030, the world’s blue economy could outperform overall global economic growth as a whole in terms of value add and employment. This may appear surprising; however, the ocean economy’s contribution to national gross domestic product (GDP) in 2012 grew by 10.5%, growth four times higher than the United States (U.S.) economy as a whole (NOAA 2015). Rhode Island’s blue economy sectors are currently a highly integrated maritime economy with the capacity for strong deployment of advanced technologies in production activities, which with the right investment and leadership will continue to yield high-quality jobs and strong career prospects for Rhode Islanders. In addition, many of the state’s maritime sectors, including marine energy, coastal tourism (primarily cruise ships) and transport, and food production (mostly aquaculture), will offer unprecedented development and investment opportunities.

Rhode Island is the smallest yet second most densely populated state in the country, so space—especially along its coastline—is at a premium. Continuing to grow our blue economy will therefore require both planning and investment that recognizes this constraint as well as coordinated, diverse, and sustained leadership. GSO at URI is recognized globally

for its excellence in deep-water oceanographic research, coastal planning and management, sustainable fisheries and monitoring, and its training of future leaders. Results from this expertise and leadership have positioned Rhode Island as a leader in offshore renewable energy and led to 17,000 households being supplied with renewable energy from the first offshore wind farm in the country, located off the coast of Block Island.

URI and GSO have also enabled our communities to obtain the knowledge and tools to respond to increased sea level rise. With the future arrival of the state-of-the-art research vessel, the *R/V Narragansett Dawn*, and the 2018 state bond investment of \$45 million for the URI Narragansett Bay Campus enhancements, GSO will expand its leadership role and continue to improve the health of Narragansett Bay, serve as a driver of ocean and coastal education, K-12 outreach, and workforce development efforts; and act as an innovator in ocean exploration and new technologies. With this expertise and commitment to public service for Rhode Islanders, URI and GSO are committed to working with partners to implement the strategies and actions described in this report towards the development of a robust blue economy.



By the Numbers

Coming up with a definitive monetary value for Rhode Island's blue economy is challenging. Different reports on different sectors of the blue economy have been compiled using different methods at different times, sometimes incorporating overlapping data sources. In this section we present a defensible but conservative estimation: \$5 billion and over 36,500 jobs.

Information about Rhode Island's blue economy can be found in two distinct sources—federal and non-federal data. To comprehensively value Rhode Island's blue economy, this report utilizes both sources. The source that comes closest to providing a comprehensive view of Rhode Island's ocean economy is the Economics: National Ocean Watch (ENOW), which describes six economic sectors that are dependent upon the oceans and Great Lakes. ENOW's annual time-series data are gathered by the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management for about 400 coastal counties, 30 coastal states, eight regions, and the nation from 2005 and onward using data from the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA). This trends analysis offers a picture of the long-term growth or decline of different economic sectors. ENOW totals for business establishments, employment, and wages are based on the BLS Quarterly Census of Employment and Wages (QCEW) data (or ES-202 data). ENOW totals for gross domestic product (GDP) are based on the BEA GDP-by-state statistics. QCEW and GDP data are provided for industrial groups (ENOW 2017).

Based on this data source, in 2016, Rhode Island's ocean economy was valued at \$2.8 billion, employed 45,496 people, and ranked 20th out of the 30 coastal states (ENOW, 2019). In addition, although compared to other states the value of Rhode Island's blue economy is modest,⁴ a larger percentage of Rhode Islanders work within the blue economy. For example, while only 3% of California's, Massachusetts', and Connecticut's population works in the ocean economy, approximately 9% of Rhode Islanders do (ENOW 2019).

Although this source is extremely useful, it is important to review the state-derived or non-federal data in addition to the federal numbers to have a clearer and more comprehensive picture of Rhode Island's blue economy. In addition, the ENOW information does not present the blue economy as Rhode Islanders see it. For example, the Rhode Island Marine Trades Association (RIMTA) defines marine trades to include boat building, repair, and retail industries, diving and marine construction industries, and select tourism and recreation industries. The ENOW data for these activities are dispersed in marine transportation, marine construction, ship and boatbuilding, and tourism and recreation categories. Also, recreational fishing is reflected in non-federal marine trades, commercial fisheries, and recreation and tourism data. ENOW reports fisheries and aquaculture jointly under Living Resources, whereas Rhode Islanders view them as distinct sectors and therefore report them individually. Additionally,

The Value of Rhode Island's Blue Economy According to NOAA (ENOW 2019)

Sector	GDP	Jobs	Description
Living resources	\$128.9 million	1,670	Includes commercial fishing, fish hatcheries, aquaculture, seafood processing, and seafood markets; recreational fishing is excluded from this category (included in Tourism and Recreation).
Marine construction	\$22.4 million	152	Includes beach nourishment and harbor dredging.
Marine transportation	\$304.6 million	2,698	Includes deep sea freight, marine passenger transportation, pipeline transportation, marine transportation services, search and navigation equipment, and warehousing.
Offshore mineral extraction	\$40.6 million	176	Includes oil and gas exploration and production and sand and gravel mining.
Ship and boat building	\$591.0 million	4,432	Includes ship and boat building and repairs.
Tourism and recreation	\$1.7 billion	36,366	Includes eating and drinking establishments, hotels, marinas, boat dealers and charters, campsites and RV parks, scenic water tours, manufacturers of sporting goods, amusement and recreation services, recreational fishing, zoos, and aquariums.
TOTAL	\$2.8 billion	45,494	

⁴ The GDP for Texas and California (ranked 1 and 2 out of 30) are \$71.8 billion and \$45.8 billion respectively. The GDP for Massachusetts and Connecticut (ranked 11 and 15 out of 30) are \$7.4 billion and \$4.5 billion respectively.

ENOW merges ship building with ship repair, and boat building with boat repair. There are no ENOW data for defense or offshore renewable energy sectors.

During the past three years, many Rhode Island industry sectors—defense, fisheries, ports and shipping (Quonset Business Park),⁵ and marine trades and composites—produced their own detailed economic impact studies that applied a more thorough method of documenting economic impact compared to the ENOW method. As part of developing these reports, researchers counted the number of firms and spoke personally with business owners to ensure the information was as accurate and detailed as possible. In scoping these reports, researchers defined the sector based on its membership's interpretation. Some of these reports (e.g., defense) contribute directly to putting an economic value on the state's blue economy, while others (e.g., tourism and recreation) include non-blue economy activities (e.g., gaming and hunting) in their figures, making it hard to determine what percentage of this activity should be counted as blue economy. Some of these reports appropriately include the same entities. A significant example of information being included in more than one report is the defense industry report stating that the defense cluster supported \$4.3 billion in economic output in

Rhode Island in 2016, which at that time represented 7.6% of the state's economy (SENEDIA 2017). The Quonset Business Park report states that it alone supported \$4.3 billion in economic output in Rhode Island in 2018, which represents 7% of the state's economy (Bryant 2019). Although these numbers are impressive and accurate, they cannot be simply added up because in part the reports were completed during different times, possibly used different data collection methods, and included some of the same sources. For example, both reports appropriately include the value of General Dynamics Electric Boat, a major economic engine for both entities.

Even with these considerations, it is important to present this non-federal data because it provides an accurate picture of how Rhode Islanders view their different sectors and the impressive impact they have. It is not, however, prudent to add them all up to get a total for value or number of jobs due to the above-mentioned reasons.

Even without comprehensive economic impact studies documenting the value of Rhode Island's research and education community, it is clear these institutions strengthen the state's blue economy by contributing to workforce development, quality of place, resilience, and innovation. For example, over

The Value of Rhode Island's Blue Economy—Defined by Rhode Islanders Using Non-Federal Data

Sector	Value	Total Effect ⁶	Jobs	Description	Source
Aquaculture	\$5.77 million (farm gate ⁷)	\$6.03 million	194	Farm gate for shellfish aquaculture. Combined value—aquaculture products for consumption and seed sales.	CRMC 2018
Defense	\$3.16 billion (direct effect ⁸)	\$4.3 billion	16,011	Federally funded defense activities and industries.	SENEDIA 2017
Fisheries	\$164.58 million (direct effect)	\$268.59 million	3,147	Harvesting and processing capacity of the fishing industry, in addition to support businesses and organizations.	Sproul 2018a, 2018b, 2018c
Marine Trades	\$1.45 billion (direct effect)	\$2.64 billion	13,337	Boat building, repair, and retail industries, diving and marine construction industries, select tourism and recreation industries.	Sproul 2018a, 2018b, 2018c
Offshore Renewable Energy	—	—	300	Wind farm investment in Rhode Island has attracted \$20 million in capital investment to the state economy.	Utility Dive 2016; Deepwater Wind 2019
Ports					
Davisville —	n/a	\$333 million (business output)	1,500	Due to the difference of data sources, these figures are presented, but not added together.	Governor's Fact Sheet 2016; Quonset Pwprt. 2016; FXM Associates 2008; RIDEM 2019
Providence —	\$294 million (annual bus. sales)	n/a	372		
Other RI ⁹ —	\$100 million	n/a	n/a		
Tourism and Recreation	\$4.3 billion	\$6.5 billion	83,913	Includes all visitor spending, tourism-related construction, and supporting industries.	Oxford 2017

5 There is a 2008 Economic Effects of Allens Avenue Businesses study contracted by the Providence Working Waterfront Alliance.

6 Total Effect: The sum of the direct, induced, and indirect effect. See Appendix: Glossary for definitions.

7 Farm gate: The price of the product available at the farm, excluding any separately billed transport or delivery charge.

8 Direct effect: The changes in local business activity occurring as a direct consequence of public or private business decisions, or public policies and programs.

9 The Rhode Island Department of Environmental Management (RI DEM) Coastal Resources program is responsible for the development, management, and maintenance of the Port of Galilee, State Pier #9 (Newport), State Pier #4 (Jerusalem), and State Pier #5 (Narragansett). These properties comprise 41 piers and 24 lease holdings with an approximate combined value of over \$100 million (DEM 2019).

40% of the University of Rhode Island's 2018 \$100-million research portfolio was devoted to oceanographic research (Peter Snyder, personal communication, September 30, 2019). Specifically, URI Graduate School of Oceanography's (GSO) total revenue was valued at more than \$45 million in FY2019 (Bruce Corliss, State of GSO presentation, October 21, 2019). In addition, eight higher education institutions are currently collaborating in the \$23-million, multi-year National Science Foundation Rhode Island Coastal Ecology Assessment Innovation and Modeling effort (C-AIM) to position Rhode Island as a center of excellence for research on Narragansett Bay and beyond. Rhode Island's Endeavor Program, providing URI researchers and educators access to an ocean-going research vessel and its scientific research and educational capabilities, engaged more than 58 Rhode Island teachers and impacted approximately 3,500 students/year since FY2015. It also assisted in attracting almost \$10 million in additional oceanographic research funding since FY2014 (Bruce Corliss, State of GSO presentation, October 21, 2019). The U.S. Naval War College (NWC) educates more than 40,000 students annually with curricula tailored to the needs of sailors (NWC, 2019).

There are also no reports that document the economic contribution state agencies or civic organizations provide to the blue economy. An example however, is Rhode Island's Innovation Voucher Program that unlocks research and development capacity for Rhode Island small businesses. Led by Rhode Island Commerce Corporation, this program has committed about 25% of its funds towards blue-tech initiatives since 2016 (Christine Smith, personal communication, April 26, 2019). The Rhode Island Department of Environmental Management

and the Rhode Island Coastal Resources Management Council successfully manage, regulate, and guide appropriate development and conservation within our coastal and marine resources. In addition, civic organizations including the Salt Pond Coalition and Save The Bay are committed to educating and advocating for our coasts and oceans. Save The Bay alone connects approximately 15,000 students and more than 24,000 community members per year with the state's marine resources (Save The Bay 2019).

Considering this information, the value of Rhode Island's blue economy is significantly greater than \$2.8 billion (ENOW 2019). Even considering the direct value of five sectors that have no significant overlap—aquaculture, defense, fisheries, marine trades, and hotel and lodging—the economic direct impact is more than \$5 billion¹⁰ with the indirect value being potentially billions more (see Total Effect in table at left).¹¹

Although NOAA documents that 9% (45,494) of Rhode Islanders work within the state's blue economy, non-federal figures state that at least based on existing information, this figure is more like 6% (36,500). This difference is due in part to the different ways that NOAA and the authors define "blue economy," as well as the availability of data. Although this number may sound small, based on federal numbers, only 3% of Massachusetts, Connecticut, California, and Texas residents work within each state's blue economy (ENOW 2019). In addition, since the GDP share for the blue economy (8.8%) is higher than the employment share (5.7%), jobs are considered more productive than average because they produce higher value-add per employee than the economy as a whole (Tom Sproul, personal communication, November 5, 2019).¹²

The Value of Rhode Island's Blue Economy (Author's Calculations)

Sector	Value	Jobs	Description	Source
Aquaculture	\$5.77 million (farm gate ¹³)	194	Farm gate for shellfish aquaculture.	CRMC 2018
Defense	\$3.16 billion (direct effect ¹⁴)	16,011	Federally funded defense activities and industries.	SENEDIA 2017
Fisheries and Related (net of charter)	\$151.5 million (direct effect)	2,965	Harvesting and processing capacity of the fishing industry, in addition to support businesses and organizations. No charter.	Sproul, T., personal communication, Nov. 5, 2019
Marine Trades	\$1.45 billion (direct effect)	13,337	Boat building, repair, and retail industries, diving and marine construction industries, and select tourism and recreation industries, including charter.	Sproul 2018a, 2018b, 2018c
Hotels and Lodging (coastal communities)	\$428 million (direct effect)	3,999	Hotel and lodging establishments located in Rhode Island zip codes adjacent to the coast.	ENOW 2019
TOTAL	\$5.2 billion	36,506		

¹⁰ Due to insufficient data, this direct total does not include ports and shipping, or academic and research institutions or government entities that contribute to the blue economy.

¹¹ A more comprehensive study is required to calculate the exact indirect total value of Rhode Island's blue economy.

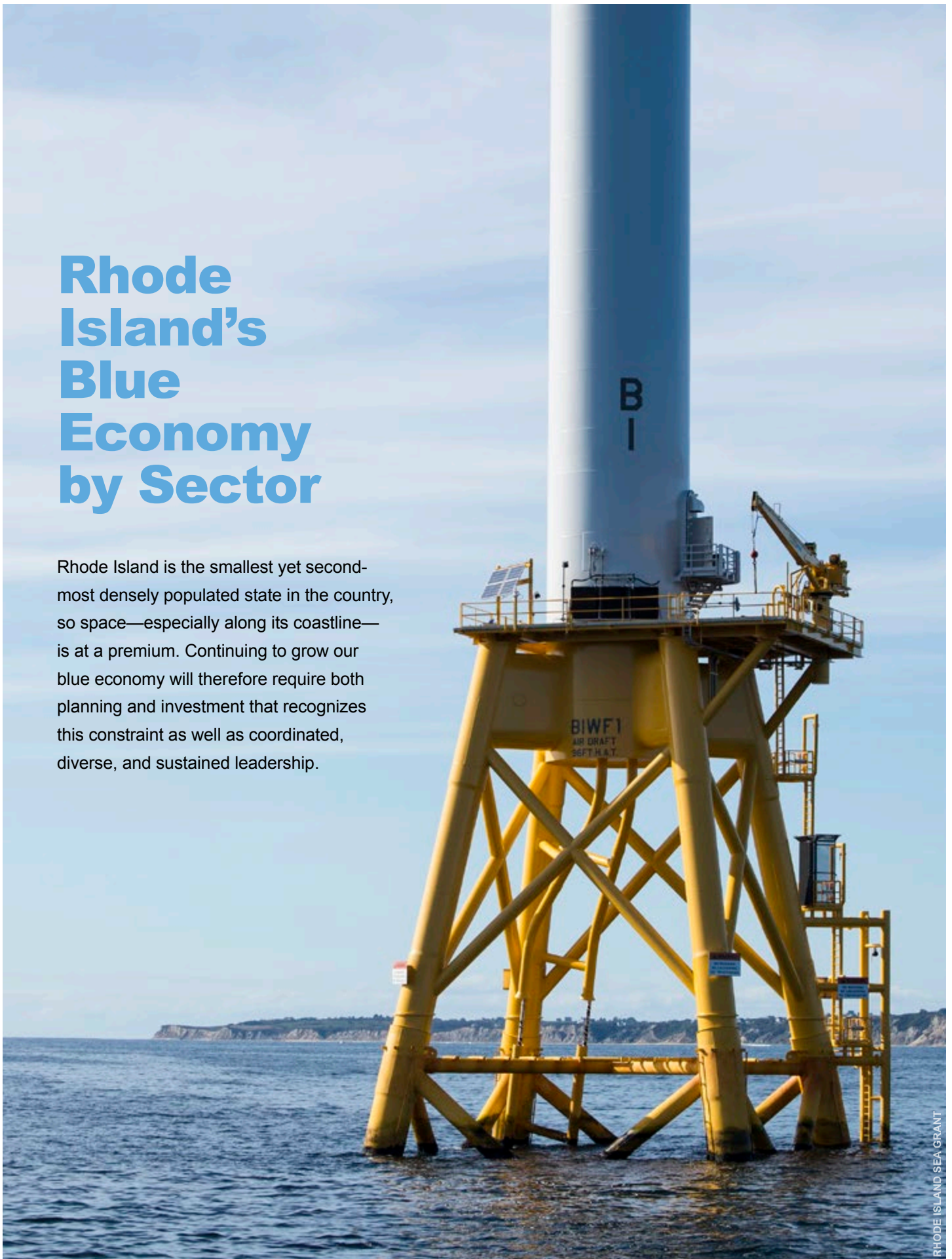
¹² In 2017 Rhode Island's employment was 639,244 (includes 565,758, private nonfarm; 1,461 agriculture; 72,025, government jobs) and its Gross State Product (GDP) was \$59.25 billion (Reserve 2019).

¹³ Farm gate: The price of the product available at the farm, excluding any separately billed transport or delivery charge.

¹⁴ Direct effect: The changes in local business activity occurring as a direct consequence of public or private business decisions, or public policies and programs.

Rhode Island's Blue Economy by Sector

Rhode Island is the smallest yet second-most densely populated state in the country, so space—especially along its coastline—is at a premium. Continuing to grow our blue economy will therefore require both planning and investment that recognizes this constraint as well as coordinated, diverse, and sustained leadership.



Sectors of the Blue Economy

DEFENSE



Direct effect value: \$3.16 billion and 16,011 jobs (SENEDIA 2017).

Accounting for indirect and induced effects, Rhode Island's defense sector supports 29,196 workers and produces \$4.3 billion in gross state product (GSP) (SENEDIA 2017).

Approximately 87% of defense contracts awarded to Rhode Island are tied to United States (U.S.) Navy/U.S. Marine Corps activities (DoD 2018).

Department of Defense (DoD) civilian jobs only increased by 4% from 2012 to 2016 as employment in the private defense industry increased by 18% in the same timeframe (85% of all new civilian jobs in this sector) (SENEDIA 2017).

Rhode Island companies have increased their market share for intrastate defense contracts from 48% in 2012, to 64% in 2017. In fact, of the \$1.5 billion in DoD contracts that were awarded in 2017, Rhode Island companies were awarded over \$900 million (SENEDIA 2017).

66% of Rhode Island companies doing business with the DoD see expansion opportunities (SENEDIA 2016).

When Amanda Costa and Stephanie Murphy, of Navatek—a technology firm specializing in naval engineering science and application—envision the future of ocean technology in Rhode Island, they speak with confidence and curiosity. “I’m excited both about what we’re doing in defense and what others in the industry are doing with ocean technology,” says Costa, who secured her master’s degree in Ocean Engineering from the University of Rhode Island (URI) before joining Navatek in 2013. “Rhode Island is definitely a great place for this kind of work because it is a collaborative, tight-

knit community—you literally can go into a coffee shop, bump into someone else working in the same field, and you learn from each other.”

Murphy, who also came on board Navatek in 2013 with a bachelor’s degree in ocean engineering from URI, is going back to secure a master’s degree in electrical engineering and says she’s planning a career in her current field, in which she focuses on cyber-physical systems security. “I’m staying in defense—I love it,” says Murphy. “A common phrase at Defense Innovation Days this summer is ‘Rhode Island is the Silicon Valley for undersea ocean technology.’”

Costa grew up in northern Massachusetts, playing soccer and retreating to the beach. As a self-

professed “Navy brat,” Murphy grew up in Sicily and the Netherlands. The Navy life eventually brought her to Rhode Island where she now calls home. Both excelled at sciences and established connections within URI engineering circles that led them to the doors of Navatek, which operates its company headquarters in Honolulu, Hawaii, and its east coast hub in South Kingstown, R.I.

And they both see immense value in the ocean technology work that their company, as well as many others in Rhode Island, are doing, both for the economy and public good. “I’ll stop and think, what I’m doing is helping protect and advance the needs of the war-fighter,” says Costa. Murphy agrees, adding that the combination of military presence in Rhode Island coupled with technology firm innovation is a major boon for the ocean science industry. “We’re able to solve real-life, complex problems, and that’s something that matters to me,” she says.

And for younger students who may be thinking about ocean technology as a future? “I think this is only going to grow in Rhode Island and globally,” says Costa. Murphy’s final comment for students interested in the field is as confident as her first: “Yes, do it!”



Amanda Costa
Director of Rhode Island Operations

Stephanie Murphy
Marine Engineer

NAVATEK

Our View of the Blue Economy: Defense



Molly Donahue Magee, *SENEIDIA* Executive Director, and Tom Carroll, Director of Undersea Technology Other Transaction Agreement (OTA)/Defense Commercialization for the Naval Undersea Warfare Center (NUWC) Division Newport

“We need to understand the oceans because they are the next frontier,” says Molly Donahue Magee of *SENEIDIA*. She and Tom Carroll of the Naval Undersea Warfare Center (NUWC), agree that the time is right for Rhode Island to take its marine innovation, with the bulk of it born from the United States (U.S.) Navy and its presence in Newport, and leverage it to create new economic opportunities and jobs in the state. “Until now, the process of being able to move ocean technology from the military to application in the larger economy could only move so fast,” says Carroll. “We now have the OTA – ‘Other Transaction Agreement’ – which is basically a vehicle for streamlining the process. This

is a major development and we’re excited about the possibilities.” Magee added that this evolution is advanced further as new effort is put towards developing the workforce for ocean technology industries in areas like undersea engineering, communications, and cybersecurity. “We provide opportunities now for college students to secure experience in ocean technology internships so they can prepare to enter the workforce, and this type of program is going to be even more important as the industry grows and strengthens,” says Magee. “This is Rhode Island’s opportunity to be the ‘Smart Ocean State’ based on its significant and growing contribution to ocean technology.”

Introduction

Since the end of the 17th century, Narragansett Bay has served as a strategic hub for military defense operations, training, and research. Correspondingly, a substantial sector of Rhode Island’s economy and population answers the research, development, and manufacturing needs of the United States (U.S.) Department of Defense (DoD). Defense—the highest paying industry sector in Rhode Island—has been instrumental in providing global military solutions and strategies as well as investment in applied research and innovation for other sectors of the community. This contribution strengthens the defense sector as well as contributes to solving technological issues within the other sectors. With its emphasis on boosting innovation and diversifying clients, products, and financial resources, the defense sector distinguishes itself as a major leader and growth sector for the state’s blue economy.

The defense cluster encompasses federally funded defense activities and industries. Major players within this cluster include the Naval Undersea Warfare Center (NUWC) Division Newport, the U.S. Naval War College, Naval Station Newport, the Rhode Island National Guard, and private defense industries, such as Raytheon and General Dynamics Electric Boat. As this sector is driven by the innovation, development, and manufacturing of products for the U.S. military and DoD, it continues to evolve to meet new defense and civilian challenges related to autonomous, undersea, and cybersecurity technologies, and to collaborate increasingly with the private sector and academia.

This report uses the Southeastern New England Defense Industry Alliance (*SENEIDIA* 2017) definition and economic information to analyze this sector from a Rhode Island perspective.

Defense in the Nation’s Blue Economy

Collaborations between the federal government and defense industries have recently encouraged the application of maritime-related defense technologies for use in academic

and commercial markets. The DoD spent \$378.5 billion on contracts and payroll nationwide in 2016; approximately 31% of these defense contract funds were awarded for Navy/Marines research, products, and services (DoD 2018).

Federal spending on naval defense is expected to increase in the next three decades (CBO 2018). DoD budgets indicate that the Navy plans to purchase 301 new ships between 2019 and 2048 at the average cost of \$26.7 billion per year. This includes the construction of underwater watercraft—submarines are expected to make up 44% of total shipbuilding expenditures between 2019 and 2048 (CBO 2018).

Defense in New England’s Blue Economy

As a significant hub for undersea warfare, southeastern New England—from Woods Hole, Massachusetts, to Groton, Connecticut—has been at the forefront of the research, design, and production of ocean-based national defense technology and products for decades (Chuck Hagel, presentation, 2014 and Molly Donahue Magee, personal communication, September 2019). These institutions work together and contribute to a collaborative and productive regional industry. The National Institute for Undersea Vehicle Technology (NIUVT) is a partnership between the University of Connecticut, the University of Rhode Island, and General Dynamics Electric Boat with the purpose of encouraging coordination and technology transfer and innovation regionally between the academic institutions and defense.

Rhode Island

Building upon Rhode Island’s strong defense legacy, the industry in 2016 organized the Undersea Technology Innovation Consortium (UTIC) to promote the rapid development, prototyping, and commercialization of innovative undersea and maritime technology and advanced learning in the undersea and maritime sector for commercial, academic, and defense organizations (UTIC 2019). This expertise and coordination led to NUWC awarding a competitive Other

Transaction Agreement (OTA) for undersea technology innovation to UTIC in 2018. The OTA allows NUWC to “engage with industry and academia, to develop and mature technologies to enable advanced approaches to maintaining maritime superiority” (UTIC 2019). Specifically, now NUWC can work with non-traditional organizations that have innovative solutions but would not normally participate in traditional federal acquisitions. This updated law is encouraging open communication and deeper collaboration between industry and government, and contributes to greater technology and prototype acquisition speed (UTIC 2019 and Tom Carroll, personal communications, September 5, 2019).

The defense cluster consists of a close network of military defense infrastructure and private defense industry institutions. This knowledge exchange requires high-level professional expertise and infrastructure, which results in the creation of high-paying jobs and revenue.

Table SD-1. The Rhode Island Defense Cluster

Defense Cluster = Military Defense Infrastructure + Private Defense Industry

Military Defense Infrastructure

- U.S. Department of Defense—Civilians
- U.S. Coast Guard
- Rhode Island National Guard
- Active Duty Military (U.S. Army/U.S. Navy/ U.S. Marine Corps/U.S. Air Force)

Private Defense Industry (Defense Contractors)

- All Other Fabricated Metal (includes small arms and ammunition) (NAICS 33299)
- Search Detection, Navigational, Guidance, Aeronautical and Nautical System and Instrument Manufacturing (NAICS 334511)
- Ship Building & Repair (NAICS 336611)
- Scientific Research (physical, engineering, and life sciences) (NAICS 54171)
- Engineering and Computer Systems Design Services (Part of NAICS 54151 and 54133)^a
- Other Defense-Related Activities

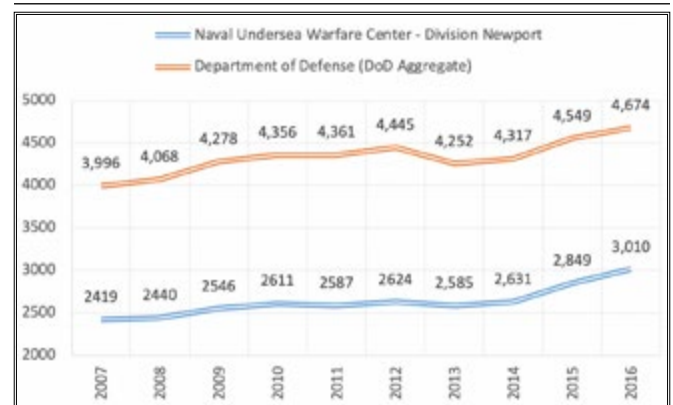
^a Only defense-related activities in computer, mathematical, architecture, and engineering are considered

Source: SENEDIA 2017

With NUWC serving as the major economic driver and General Dynamics Electric Boat and Raytheon serving as the economic engines in the Rhode Island private defense industry, this sector offers the highest paying jobs—with the average annual wage ranging from \$70,200 to \$101,400—and makes up a large portion of the state’s gross domestic product (GDP). Defense supports 29,196 jobs from both the private defense industry and civilian workers in 2016, which represents 6.2% of total employment in Rhode Island (SENEDIA 2017). In addition, every 100 jobs created in

the private defense industry supports another 119 jobs via the multiplier effect in other industries of the Rhode Island economy (SENEDIA 2017).

Figure SD-1. U.S. Department of Defense (DoD) Civilian Employees, Rhode Island 2007- 2016



Source: U.S. Office of Personnel Management (US OPM)

Note: The figures above do not include civilians working for the U.S. Coast Guard and Rhode Island National Guard. (SENEDIA 2017)

This industry supported \$4.3 billion in economic output in 2016, representing 7.6% of the state’s gross domestic product (SENEDIA 2017). The defense cluster supported the creation of an additional \$703.5 million in indirect and induced earnings throughout the state and \$146.9 million in tax revenues for state and local governments (SENEDIA 2017).

The state’s defense cluster has played an essential role in supporting the national ocean-based defense sector. As proof, Rhode Island companies have increased their market share for intrastate defense contracts from 48% in 2012, to 64% in 2017 (SENEDIA 2017). In fact, of the \$1.5 billion in Department of Defense (DoD) contracts that were awarded in 2017, Rhode Island companies were awarded over \$900 million. (SENEDIA 2017). These contracts have offered an opportunity for the cluster and the state to expand the capabilities of this workforce and increase their technical capability to conduct research and development work (SENEDIA 2017). In fiscal year 2017, 89% of the defense contracts awarded to Rhode Island were awarded by the U.S. Navy/U.S. Marines.

Figure SD-2. Naval Undersea Warfare Center (NUWC) Annual Contract Awards



Source: Rhode Island Commerce Corporation 2019

Major Players within the Rhode Island Defense Cluster

Naval Undersea Warfare Center (NUWC) Division Newport

NUWC provides the technical foundation that enables the conceptualization, research, development, fielding, modernization, and maintenance of critical U.S. Navy undersea systems. NUWC is engaged in efforts ranging from participation in fundamental research to the support of evolving operational capabilities in the U.S. Navy fleet. The major thrust of NUWC's activities is in applied research and systems development. Located just off the coast of Newport is a NUWC test and evaluation facility designed to support research and development work in advanced underwater weapons and weapons systems, weapon launchers, unmanned underwater vehicles (UUVs), and oceanographic equipment. The Narragansett Bay Test Facility offers a variety of unique shallow water ranges that allow government, academic, and industry partners to expose prototype systems to real environments with a minimal risk of loss. (NAVSEA, 2019).

Private Defense Industry (Defense Contractors)

More than 100 Rhode Island businesses and 6,829 workers substantially participate in the private defense industry (SENEDIA 2017). From 2010 through 2016, employment in the private defense industry increased by 18%. Ship building and repair accounts for the largest employment in the private defense cluster, employing 3,820 workers and representing 56% of the private defense employment in the state. Search detection, navigation, guidance, aeronautical and nautical systems, and instrument manufacturing employed 885 workers (13% of employment). Scientific research services employed 631 workers; other fabricated metal firms employed 420 workers. Firms engaged with other defense-related activities, including engineering and computer systems design services, employed 1,073 workers. Two private defense companies have significant economic impact for the Rhode Island defense industry (SENEDIA 2017).

General Dynamics Electric Boat (Electric Boat)

Electric Boat is the design yard and prime contractor for the Virginia-class submarine program. The Virginia class is the first major warship completely designed in a virtual environment, a capability pioneered by Electric Boat. With each Virginia-class submarine Electric Boat delivers, the company is shortening the construction schedule and reducing the cost, helping establish the program as a model for defense procurement. Electric Boat depends on a highly skilled workforce, including shipyard trades people, designers, engineers, and others required to produce this complex product (Electric Boat 2019).

Raytheon Company (Raytheon)

Raytheon is a technology and innovation leader specializing in defense, civil government and cybersecurity solutions in aerospace, defense, and civil government. Founded in 1922, Raytheon provides state-of-the-art electronics, mission systems integration, C5I™ products and services, sensing, effects, and mission support services. (Raytheon 2019).

Southeastern New England Defense Industry Alliance (SENEDIA)

SENEDIA is a membership organization for businesses and individuals that provide services to or have an interest in the defense industry. SENEDIA focuses on leadership and technical innovation in undersea technology, cybersecurity and other critical defense technologies; facilitates required workforce development; and provides information on defense and homeland security industry issues and initiatives (SENEDIA 2019).

Naval Sea Systems Command (NAVSEA)

NAVSEA is responsible for the design, construction, delivery, maintenance, and disposal of Navy ships and ship systems. The NAVSEA mission is to design, build, deliver, and maintain ships and systems on time and on cost for the U.S. Navy (NAVSEA 2019).

U.S. Naval War College (NWC)

The NWC has grown and transformed into the nation's premier professional military education institution, now educating more than 40,000 students annually with resident and nonresident curricula tailored to the educational needs of Navy sailors. NWC's mission is to educate and develop leaders, help define the future Navy and associated roles and missions, support combat readiness, and strengthen global maritime partnerships (NWC 2019).

Naval Station (NAVSTA) Newport

NAVSTA is a location in Newport that hosts many of the military entities mentioned in this document. In total, NAVSTA is home to 50 U.S. Navy, U.S. Marine Corps, U.S. Coast Guard, and U.S. Army Reserve commands and activities. Approximately 5,800 employees work at the 50 various commands located on NAVSTA with an additional 17,000 students annually passing through one of the many schools on base (NAVSTA 2019).

Rhode Island National Guard (The Guard)

The Rhode Island National Guard (RING) consists of 3,000 men and women who serve as military professionals within the state who hold civilian jobs or attend college while maintaining their military training part time. RING traces its history from the first colonial defensive force established in 1638 and has since served the state and nation in every major American

conflict. Rhode Island is the only state with a Special Forces unit, a Special Operations Detachment unit, an Airborne Infantry unit, and an Air Assault Capable Field Artillery Battalion (RING 2019). The RING employed 100 civilians in 2016 (SENEDIA 2017).

National Institute for Undersea Vehicle Technologies (NIUVT)

NIUVT is a partnership between the University of Connecticut, the University of Rhode Island, and General Dynamics Electric Boat to enhance performance and reduce costs of the ship-building process while ensuring that advanced technologies are implemented into the next generation and next platform of undersea vehicles. NIUVT engages in research, technology transition, and workforce development to enhance U.S. superiority in submarine and other undersea vehicle technologies (NIUVT 2019).

U.S. Coast Guard in Rhode Island

The U.S. Coast Guard presence in Rhode Island is responsible for more than 110 kilometers of coastline (U.S. Coast Guard 2019). In 2016 the Coast Guard employed 50 civilian personnel in Rhode Island (SENEDIA 2017).

Undersea Technology Innovation Consortium (UTIC)

UTIC, headquartered in Rhode Island, currently has over 250 member organizations from 35 states. The consortium makeup is 5% academic and nonprofit institutions, 70% small businesses, and 25% large businesses. UTIC was awarded an Other Transaction Agreement (OTA) in 2018, which represents a unique opportunity to work collaboratively and leverage industry, academia, and government capabilities to quickly deliver innovative solutions to the U.S. Navy. Prototypes developed through an OTA may include physical or virtual models to evaluate the technical or manufacturing feasibility or military utility of a technology, process, concept, end item, or system. Any commercial, nonprofit, or academic institution that is part of the consortium is eligible to receive an OTA. Barriers are minimized for non-traditional companies to participate.

Sectors of the Blue Economy

MARINE TRADES



Direct effect value is \$1.45 billion and 13,337 jobs (Sproul and Michaud 2018a).

The marine trades sector, with 1,712 firms, supports 13,337 jobs, with another 5,379 jobs connected to suppliers for marine trades. The sector grossed \$2.65 billion in sales in 2016 (Sproul and Michaud 2018a).

Rhode Island's marine manufacturing, services, and supply industries earn more than \$837 million in gross sales (31.5% of this sector) (Sproul and Michaud 2018a).

Composites firms earned more than \$295 million in gross sales in 2016 (11.2% of this sector) (Sproul and Michaud 2018d).

SIREN MARINE



Daniel Harper
Chief Executive Officer
Siren Marine

When he first started coming up with technological solutions for boating problems, Dan Harper did it for a very simple reason: "I'm a boater, so when I'd come across issues, I'd solve them to help myself," says Harper, founder and chief executive officer of Siren Marine, an innovation firm providing communication and security systems for boats. "I figured if I wanted things to work better, other people must be wanting the same."

Entrepreneurial in college, Harper found himself drawn to grappling with technological puzzles, developing medical and legal industry software tools. Upon graduation, he worked in accounting before his love of sailing ultimately led him to a career as a yachting captain.

That led him to recognize there would be a market for intuitive, web-based applications that would secure and alarm vessels, connect boaters to emergency assistance and to each other, and simplify boat connection to the internet. "I wanted these things, so I knew others would too," he said.

After his business plan won state innovation competition funds, Siren Marine launched in 2011 in the iconic sailing hub of Newport. Today, the company has more than 70 employees, a global customer roster, and strong connection to the Rhode Island marine economy.

"This is a great place for marine-based business, without a doubt," said Harper. "This is a place where people collaborate, get to know one another, and think things up together to make it happen. I am nothing but excited about it."

Introduction

Rhode Island’s marine trades form the backbone of the state’s blue economy. With a total effect of \$4.61 billion, this sector includes boat building, repair, and retail industries; diving and marine construction industries; and select tourism and recreation industries, including charter. It is also integrated into other blue economy sectors including tourism and recreation, ports and shipping, defense, and higher education. A key sector player is composites—firms that engage in and/or support the manufacturing, fabrication, and sale of composite goods and materials. Spanning four marine trades industries, composites alone is responsible for grossing more than \$295 million in 2016 (11.2% of all gross sales in this sector).

Marine Trades in the Nation’s Blue Economy

In the United States (U.S.), the marine trades sector contains more than 9,881 establishments that provide 118,916 jobs and produce \$11.44 billion in gross domestic product (GDP) (\$11.73 billion in real GDP). The marine trades sector experienced a decline between 2005 and 2015 as real GDP decreased from \$12.62 billion to \$11.73 billion (-7%). In addition, the number of establishments, wages, and average wages in this sector declined by 16%, 18%, and 2% respectively (NOAA 2015; Author’s Calculations).

Table SMT-1. Employment Growth in Marine Trades in the National Blue Economy (2005-2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair	49,325	21,230	26,126	-23,199	-47.03
Boat Dealers	18,162	12,531	13,343	-4,819	-26.53
Marinas	18,836	18,007	20,986	2,150	11.41
Scenic Water Tours	11,433	8,947	10,446	-887	-8.63
Marine-Related Construction	44,557	44,567	48,015	3,458	7.76

Source: NOAA 2015; Author’s Calculations

On the national scale, the boat building, repair, and dealers industry experienced massive layoffs during recession years (2007-2009). Employment in boat building and repair industries fell from 48,338 to 22,723 during this time as this industry’s real GDP plummeted by 52.6%. As of 2015, jobs in this industry are still 41.2% below pre-recession rates. Similarly, the boat dealer industry experienced significant declines in employment and real GDP during the recession, but employment in the industry has recovered to equal approximately 73.4% of pre-recession rates (NOAA 2015; Author’s Calculations). Other industries such as the marine-related construction industry and the marinas industry have rebounded and surpassed pre-recession levels of employment and real GDP growth.

Marine Trades in New England’s Blue Economy

New England’s industrial heritage has always been shaped by a vibrant marine trades sector. Boat building, dock construction, and manufacturing continue to shape the character of the region’s blue economy.

Table SMT-2. Employment Growth in Marine Trades in New England (2005-2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair (MA, RI)	1,514	829	798	-716	-47.29
Boat Dealers (CT, MA, ME, RI)	1,895	1,488	1,608	-287	-15.15
Marinas (CT, MA, ME, NH, RI)	3,525	3,889	4,204	679	19.26
Scenic Water Tours (RI, MA)	613	532	739	126	20.55
Marine-Related Construction (MA, RI, ME, NH)	1,223	1,224	2,444	1,221	99.84

Source: NOAA 2015; Author’s Calculations

Industries in New England’s marine trades sector experienced separate periods of growth and decline from 2005 to 2015. Notably, employment in the marine-related construction industry almost doubled from 1,229 to 2,444 (99.8%) between 2005 and 2015. Outside of the boat building, repair, and retail industries, New England’s marine trades sector experienced relatively consistent job growth between 2005 and 2015. Job growth in the marine-based construction, marinas, and scenic water tours industries outpaced the national average from 2005–2015. The recession hit employees in New England’s marine-related construction, marinas, and boat building and repair industries the hardest: employment in these industries declined by 22.5%, 9%, and 38.1% respectively. However, National Oceanic and Atmospheric Administration (NOAA) data indicates that the marine-related construction industry and the marinas industry recovered to reach previous levels of real GSP by 2014 (NOAA 2015; Author’s Calculations).

Rhode Island

Rhode Island’s marine trades sector plays a pivotal role in the state’s ocean economy. The sector is active in many economic, environmental, and social efforts, including an ongoing project with public and academic partners to develop opportunities to recycle fiberglass boats into building materials and keep them out of landfills. Elements of recreation, fisheries, manufacturing, and service industries are all linked to the economic activities in this sector.

Table SMT-3. Sources for the Marine Trades Sector

Industry	Source
Sproul and Michaud (2018a)	Boat Builders, Boat Repair, Charter & Cruise Services, Diving and Salvage, Marinas, Docks, and Yacht Clubs, Marine Related Construction, Marine Manufacturing, Marine Services & Supply, Professional Services (Marine Trades), Retail Boat Sales, Retail Sporting Goods
Sproul and Michaud (2018b)	Services & Supply, Tackle Shops, Charters, Service and Supply, Professional Services (Fishing)
NOAA (2015)	Boat Building and Repair, Boat Dealers, Marinas, Scenic Water Tours

Table SMT-4. Employment Growth in Marine Trades in Rhode Island’s Blue Economy (2005–2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair	1,282	639	565	-717	-55.93
Boat Dealers	347	337	324	-23	-6.63
Marinas	560	666	655	95	16.96
Scenic Water Tours	169	130	114	-55	-32.54
Marine-Related Construction	209	68	109	-100	-47.85

Source: NOAA 2015; Author’s Calculations

In Rhode Island in 2017, the marine trades sector directly produces \$1.44 billion in gross state product (GSP) and supports 1,712 jobs in the state. Accounting for the indirect and induced

My View of the Blue Economy: Marine Trades

Wendy Mackie, Chief Executive Officer, Rhode Island Marine Trades Association (RIMTA) and Composites Alliance



“When the recession hit in 2007, people in marine trades definitely saw they were in trouble—we saw that companies that were building or repairing extremely high-end custom jobs—one company would, say, work on building one yacht for five years—were going to have to do something different if they were going to stay in business. RIMTA and the state immediately got on it, and we were able to support retraining programs so they could do more with the specialized skills they were employing as builders and

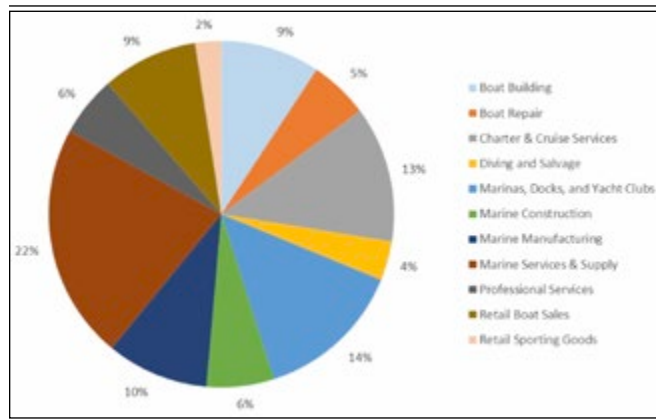
repairers. The effort worked; while the numbers show that, say, repair companies never recovered from the recession, in fact, they just were absorbed into other marine trades industries and efforts. So, for instance, people who only did custom boat jobs, now they're working at designing or creating components or composites for not only large boat manufacturers, but for other industries, like the defense industry. It's a great comeback story—yes, we did lose some jobs, but by and large, we were able to stabilize a lot of people working in marine trades locally. It's worthwhile to remember the role that Rhode Island's small size played when the recession hit; I honestly believe that because people in this state know one another, we were better able than other states to readily come up with a plan for retraining people through the state's job training programs. It took one phone call to the

state to get the wheels turning, once it was clear that we were going to be in a major downturn. Other states don't have that kind of public-private accessibility, and it really made a difference here.

Now, the goal is to continue the innovation, especially with the composites area, and look to solving additional issues for marine trades; for example, we need to continue to talk about resiliency and protecting these businesses. And it's very important to maintain a working waterfront and public access—we need to be thinking about what we want our waterfronts to be for the future. As the older generation of marine trades people and property owners retire, and potentially sell their properties, we need to be thinking about the future of waterfront areas, so everyone can continue to enjoy [them] in some form.”

effects of economic activity in the sector, this total increases to \$2.64 billion in GSP and 26,921 jobs supported (Sproul and Michaud 2018a).

Figure SMT-1. Rhode Island Marine Trades by Gross Revenue¹⁵



Source: Sproul and Michaud 2018a; Author's Calculations

Rhode Island's marine trades industry is relatively balanced—no one industry dominates more than 22% of the sector's gross sales. The marine services and supply industry, the marinas, docks, and yacht clubs industry, and the charter and cruise services industry are the three largest industries by employees, firms, and gross sales in this sector.

Included in these industries is the state's composites sector—firms that engage in and/or support the manufacturing, fabrication, and sale of composite goods and materials. Spanning four marine trades industries,¹⁶ the composites sector is responsible for grossing more than \$295 million in 2016 (11.2% of all gross sales in this sector) (Sproul and Michaud 2018d)

Overall Sector Trends

Altogether, the marine trades sector experienced a long-term decline in real GSP from 2005 to 2015. The recession contributed heavily to this decline as the real GSP produced by this sector decreased by 30.1%. Part of this overall decline can be attributed to the 58.4% decrease in GSP produced by the state's marine-related construction industry. Outside of marine-related construction, Rhode Island's marine trades industries experienced less severe declines than the national average. However, real GSP produced by the boat building and repair industry still declined sharply (-47.1%) as 9.3% of boat building and repair establishments closed or moved out of the state. According to NOAA data, the boat building and repair industry and scenic water tours industries are the only industries in this sector to not produce pre-recession levels of real GSP after 2009 (NOAA 2015, Author's Calculations).

Table SMT-5. Real Gross State Product (GSP) in the Marine Trades Sector in Rhode Island's Blue Economy (2005-2015)

Industry	Values			Change (2005-2015)	
	2005	2010	2015	\$	Percent
Boat Building and Repair	\$84,328,176	\$44,668,221	\$50,225,112	-\$34,103,064	-40.44
Boat Dealers	\$32,020,733	\$29,961,615	\$32,804,454	\$783,721	2.45
Marinas	\$44,996,456	\$55,482,526	\$58,280,032	\$13,283,576	29.52
Scenic Water Tours	\$6,730,126	\$5,970,930	\$3,873,664	-\$2,856,462	-42.44
Marine-Related Construction	\$49,216,683	\$14,264,209	\$15,099,855	-\$34,116,828	-69.32

Source: NOAA 2015; Author's Calculations

Other industries in the marine trades sector experienced growth since 2005. Real GSP created by Rhode Island's marinas industry grew by 29% from 2005 to 2015. The marinas industry has maintained relatively consistent growth in this time period: real GSP in this industry has only decreased in 2009, 2011, and 2015. Similarly, the boat dealer industry experienced a drop in real GSP (-16.8%) and employment

¹⁵ Values estimated by Sproul and Michaud (2018a) using data sources from 2014-2017.

¹⁶ The composites sector includes firms in the following industries: boating building and repair, marine manufacturing, services and supplies, and professional services industries (2018d).

(-17.8%) during the recession, but this industry has almost completely rebounded to pre-recession levels of real GSP (NOAA 2015; Author’s Calculations).

Sector Specific Data
(“Current Day” Snapshot)

Rhode Island’s marine trades sector is comprised of a variety of overlapping industries. For organizational purposes, this section will present the industries of Rhode Island’s marine trades referenced in Table SMT-1. Although these industries are presented separately, it should be noted that these industries often connect or overlap with other industries and/or sectors in and outside of Rhode Island’s blue economy.

Table SMT-6. Rhode Island’s Marine Trades Sector (2017)

Industry	Firms	Gross Sales (\$M)	Jobs
Boat Building, Retail, and Repair	203	393.0	2,456
Charters, Cruise Services, and Scenic Water Tours	306	336.2	1,965
Retail Sporting Goods	29	64.6	163
Marinas, Docks, and Yacht Clubs	269	367.4	2,743
Professional Services	145	148.1	1,005
Marine Manufacturing	113	252.9	767
Diving and Salvage	44	97.3	363
Marine Construction	41	167.1	407
Marine Services & Supply	431	583.6	2,757
Total	1,712	2,648.6	13,337

Source: Sproul and Michaud 2018a; Author’s Calculations

Boat Builders, Boat Repair and Retail Boat Sales

The boat building, retail, and repair industries are a substantial part of Rhode Island’s marine trades sector. Both in-state residents and out-of-state visitors purchase, use, or repair their own boats while they are in the state. Furthermore, small-scale tourist operators (such as charters) purchase boats and use repair services to support their businesses.

As of 2017, there are 104 firms in the state that engage in boat building activities. Rhode Island’s boat building industry supports 1,336 jobs and earns \$246.4 million in gross sales. Additionally, 99 boat repair firms generate 1,120 jobs and \$146.6 million in gross sales. At least 31 of these boat building and repair firms work exclusively manufacturing and fabricating carbon fiber and fiberglass for marine applications (Sproul and Michaud 2018d).

The retail of constructed boats also contributes to the economic output of this sector. Rhode Island’s retail boat sales industry includes 131 firms that support 712 jobs and generate \$238.32 million in gross sales. Altogether, the boat building, retail, and repair industries support 3,168 jobs and generate \$631.32 million in gross sales (Sproul and Michaud 2018a; Author’s Calculations).

Charters, Cruise Services, and Scenic Water Tours

The charter, cruise services, and scenic water tours industries support a sizable portion of Rhode Island’s ocean-based tourism and recreation sector. Most of the firms in these industries are sportfishing charters, small cruise operators, ferry services, fleet charter services, and other same-day scenic and sightseeing water transportation services. The charters and cruise services industry contains 306 firms that support 1,965 jobs and earn \$336.24 million in gross sales. At least 75 of these businesses operate as small fishing charters that support an average of 2.4 employees per firm (Sproul and Michaud 2018a). Despite its relatively small size, the small fishing charters industry supports 182 jobs and earns \$19.99 million in gross sales (Sproul and Michaud 2018b).

Diving and Salvage

The diving and salvage industry is predominantly composed of businesses that provide diving, salvage operations, and underwater surveying services to coastal and offshore facilities. Also included are dive shops and diving instructors. The diving and salvage industry includes 44 firms that support 363 jobs and earn \$97.28 million in gross sales (Sproul and Michaud 2018a).

Marinas, Docks, and Yacht Clubs

Marinas, docks, and yacht clubs support much of the recreational boating and sailing activities that occur in and around Rhode Island by providing storage, docking facilities, fuel, and supply sales. As of 2017, in Rhode Island, 269 marinas, docks, and/or yacht clubs support 2,743 jobs and earn \$367.43 million in gross sales (Sproul and Michaud 2018a).

Marine-Related Construction

The marine construction industry includes firms that construct waterfront infrastructure, run dredging operations, and/or provide specialty engineering or diving services that support construction and contracting firms. Firms in this sector are primarily mooring and dock builders, but several also engage in dredging operations and support specialty engineering. This industry includes 41 firms that support 407 jobs and earn \$167.07 million in gross sales (Sproul and Michaud 2018a).

Marine Manufacturing

The marine manufacturing industry includes manufacturers of boat parts, marine engines, and marine accessories. Approximately 10% of these firms are composites-only manufacturers—they account for 125 jobs and earn \$16.38 million in gross sales. Altogether, the marine manufacturing industry contains 113 firms that support 767 jobs and earn \$252.91 million in gross sales (Sproul and Michaud 2018a).

Professional Services (Marine Trades)

The professional services industry plays an important supporting role for many businesses in and outside of the marine trades sector. This industry includes contractors, designers, engineers, and surveyors, as well as marine real estate companies, developers, property managers, insurance agencies, and environmental services. At least 18 of these firms earn \$5.76 million in gross sales by operating as specialists in the fisheries and seafood industries (Sproul and Michaud 2018b). Altogether, the professional services industry contains 145 firms that support 1,005 jobs and earn \$148.13 million in gross sales (Sproul and Michaud 2018a).

Retail Sporting Goods

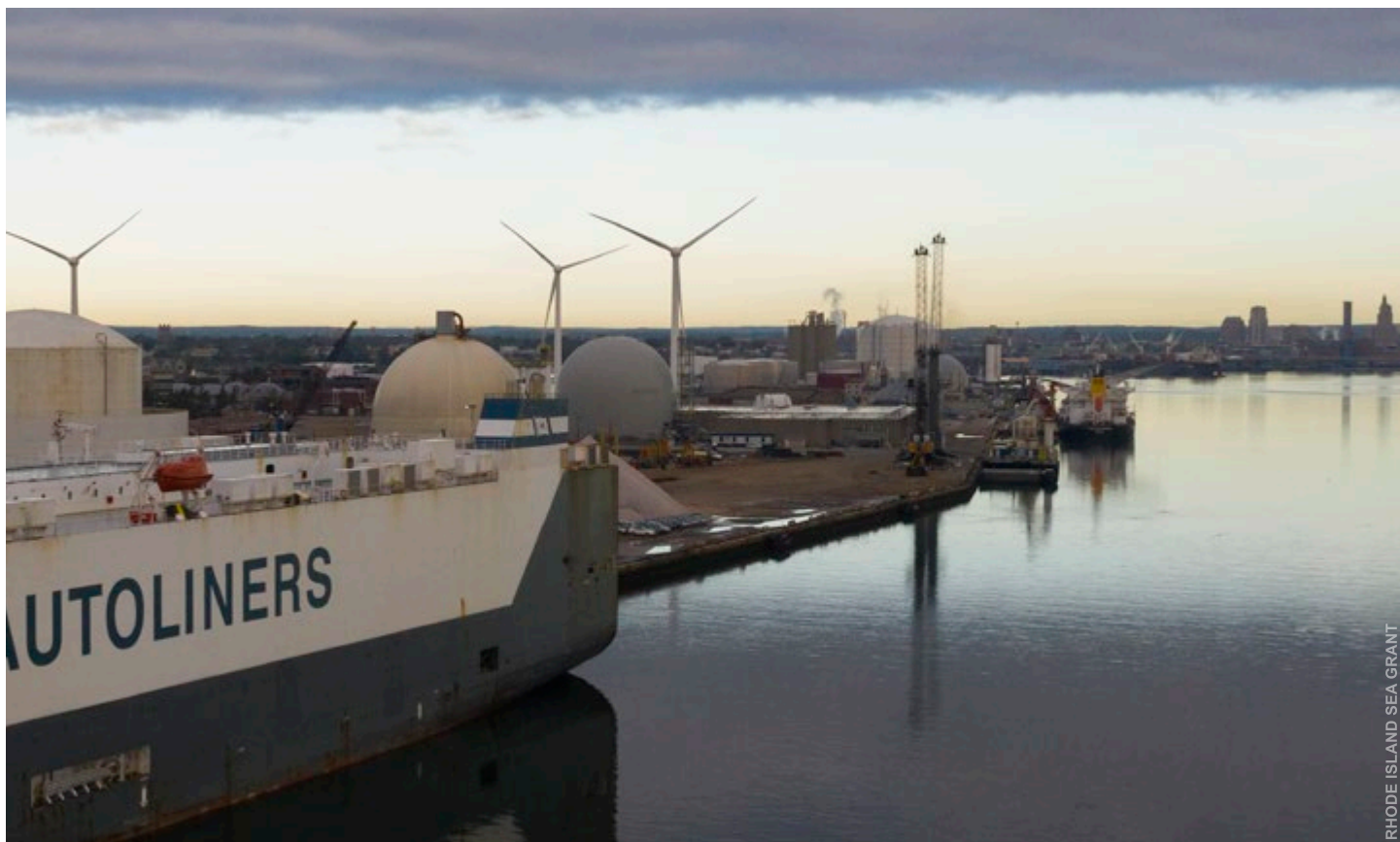
The retail sporting goods industry includes fishing and boating outfitters and sporting goods stores. These businesses support marine recreation for residents and visitors alike, especially those that engage in fishing and other water-based activities. Rhode Island's retail sporting goods industry includes 29 firms that support 163 jobs and earn \$64.64 million in gross sales (Sproul and Michaud 2018a). Of these firms, 25 are bait and tackle shops that support 62 jobs and earn \$14.71 million in gross sales (Sproul and Michaud 2018b).

Services and Supply

The marine services and supply industry includes wholesale suppliers of marine equipment and marine service firms. Included in this industry are the suppliers of wholesale marine equipment such as nets, bait, traps, and other gear used in the fishing sector. In Rhode Island, 27 fishing-related services and supply firms support 152 jobs and earn \$84.61 million in gross sales (Sproul and Michaud 2018b). Other firms in this industry generally supply components, parts, and technology for watercraft, or they provide painting, fuel, and lubricant services to watercraft or marine facilities. This includes composites suppliers that support 153 jobs and gross \$51.83 million in sales (Sproul and Michaud 2018c). Altogether, Rhode Island's marine services and supply industry includes 431 firms that support 2,757 jobs and earn \$583.60 million in gross sales (Sproul and Michaud 2018a).

Sectors of the Blue Economy

PORTS AND SHIPPING



Best estimates of direct effect value is \$727 million and of employment is 2,000 jobs.

In 2018, Rhode Island's Port of Davisville at the Quonset Business Park, a top 10 North American auto import location, processed 241,851 vehicle units from 225 ship calls. Vehicles are distributed from the Northeast to the Midwest (Quonset Development Corporation 2019).

Quonset Business Park generates nearly 7% of state gross domestic product (GDP) with \$4.3 billion in economic impact, \$1.28 billion generated in household income annually for Rhode Island families, and \$128.8 million in state and local taxes (Bryant University 2019).

Real gross state product (GSP) produced by the ship building and repair industry and the warehousing industry (the two largest industries in this sector) increased by 139.2% and 40.6% between 2005 and 2015 (NOAA 2015).

Newly announced offshore wind energy projects off Rhode Island and the rest of the East Coast present an opportunity for Rhode Island ports to cement their position as a significant part of the supply chain.

ERIN O'NEILL



Chris Waterson

General Manager
Waterson Terminal Services

Port of Providence/ProvPort

Some would call it tagging along, the hours that Chris Waterson, as a middle school kid, spent among the busy industrial yards and lots at Waterson Stevedoring, his father's company on the Port of Providence waterfront now called Waterson Terminal Services (WTS).

Waterson calls it an education—one that taught him that ships may be the most visible part of the marine economy, but they are supported by a host of other enterprises. “Energy, construction, equipment servicing—I was around these industries all the time,” says Waterson. “I could see that a marine-based economy is more than just what's on the water. So for me, the blue economy idea has always been real.”

For Waterson, WTS history reflects that understanding; father Bruce initially worked for a scrap metal recycling business at the port, and that experience over several decades inspired him to start his own multi-faceted port management firm. Security, vessel scheduling, and capital improvements are some of its services as ProvPort's terminal manager, and it also provides stevedoring services at the ports of Davisville (North Kingstown, RI) and New Bedford (MA).

Waterson studied business at Bentley University (“My dad's comment at graduation was that I'd basically been on vacation for four years, so he'd see me Monday morning,” he says,

wryly), and brought his new skills back to WTS and an entry-level management post. Today, with his father as chief operating officer, Waterson oversees day-to-day operations and business development activities, working alongside a staff that includes wife Lauren.

His vision for WTS is buoyed by the significant role that offshore renewable energy facilities—windfarms, specifically—could play in the region, and he's focused on integrating the industry into ProvPort, Davisville, and New Bedford. He thinks about the short-term potential for the company to serve as a storage area for turbine components; he ponders longer-term opportunities that could involve the manufacturing of such infrastructure.

It's exploration—the schoolboy tagalong coming full circle. “It's funny, but really, I've been thinking this way for a long time, way before it was called ‘blue economy,’” laughs Waterson. “And I'm absolutely convinced that ProvPort, Rhode Island, and the Northeast have a big role to play in it.”

My View of the Blue Economy: Ports and Shipping

Jason Kelly, Executive Vice President, Moran Shipping Agencies, Inc., Co-Founder and Board Chair of SeaAhead—an organization supporting ocean-based venture development



“I am passionate about the future of ports and shipping in Rhode Island; it actually keeps me up at night. We are part of a regional cluster, and a world industry—on any one point of any given day, there are 60,000 vessels on the ocean worldwide—either crossing the seas or in port. It’s fascinating to think about the scope and importance of international port trade in Rhode Island: The Port of Providence, for example, has traditionally supported a wide range of diverse cargos which provide energy security such as home heating oil, coal, jet fuel, and reformulated gasoline for our vehicles. Additionally, it supports a wide range of project cargos, scrap metal, and used car exports along with salt and chemical

shipments like caustic soda, cement, and various bulk building material cargoes. The Port of Davisville is one of the largest car import ports in North America and is positioned well for short sea shipping. But perhaps most exciting is to think about the future and how we can trade in the goods and services of the new emerging advanced blue economy, all the while innovatively building the smart and green ports of the future. Many other port communities have chosen condos over their working waterfronts at high cost. In Rhode Island, having protected our port assets, we’re still in the energy security game, except now in the new renewable energy economy through offshore wind projects supported by Rhode Island ports and the working waterfront stakeholders who serve them—I’m so excited to be working every day on figuring out what we’re going to do as an industry to support and take part in offshore renewable energy and the greater blue tech ocean economy. And in my mind, when we talk about the blue economy, I’m actually thinking much more broadly, beyond the

robust commercialization aspect itself. I’m thinking about the environment, about what we need to do as an industry to foster ocean sustainability. I think how through innovation we build off of what we have in our maritime cluster, including the marine and ocean science knowledge from our colleges, the access we have to Naval and other defense technology, our marine trades, and the bay’s living ocean resources that we have in Rhode Island. I see several big challenges and opportunities associated with shipping within the blue economy—eliminating carbon and sulfur emissions, reducing ship strikes to right whales, ballast water management for invasive species—and I can tell you there are a lot of thought leaders in Rhode Island who share my passion and want to solve these intractable problems. Blue economy, green ports, smart ports—it’s all part of the vision many of us have for Rhode Island thought leadership in this industry, and we’re working to make it happen. It is a triple bottom line proposition: profitability, economic development, and ocean sustainability.”

Introduction

Ports and Shipping are critical links to the national and global movement and exchange of goods and services. With its proximity to Europe, Rhode Island has been associated with the offloading of bulk commodities, project cargoes (large, complex, or high-value pieces of equipment) and cars, and with the overseas transport of exports such as seafood products, scrap metal, automobile and project equipment, and materials. More than nine million tons of waterborne cargo passed through Rhode Island ports in 2017. In 2018, Rhode Island’s Port of Davisville at the Quonset Business Park, a top 10 North American auto import location, processed 241,851 vehicle units from 225 ship calls. Today, port businesses are serving as staging, storage, manufacturing, and transport sites for offshore renewable energy components like wind turbine blades. The continued growth of the Port of Davisville is partially due to its naturally deep channel. The port’s 29-foot channel is not a federally maintained navigation channel, so vessels are not required to pay a harbor maintenance tax at the port. Efforts to further leverage this competitive advantage are being explored by the Quonset Development Corporation. However, the channel is growing increasingly shallow, so the issue of dredging it has arisen. Ports are also looking at opportunities to participate in newer kinds of transport: Short sea shipping, for instance—replacing larger vessels with smaller, less fuel-intensive ones involving multiple port stops to move cargo—could offer economic and environmental benefits; some of the equipment necessary for this system is

already in place. At the same time, ports and shipping leaders are increasingly engaged in understanding and protecting the ocean and coastal environments upon which they depend, participating in efforts that examine the roles that shipping industries can play in issues such as marine mammal conservation, air and water quality, and coastal resiliency building.

Rhode Island’s ports and shipping sector includes port-dependent businesses, port-related businesses, and businesses that provide services and supplies to these industries. At least 17 of Rhode Island’s 21 coastal municipalities have a commercial port or harbor (Becker 2010). The majority of these commercial ports and harbors contain parcels dedicated to water-dependent uses (uses that require direct access to marine and tidal waters), water-related uses (uses that do not require direct access to the water, but provide goods or services associated with water-dependent uses), and water-enhanced uses (uses that do not require access to the water for viable operation, but are enhanced by a waterfront location). Although port access is essential to many fisheries industries, these industries are mostly discussed in the Fisheries section.

Industries involved in the transport, receiving, processing, and storage of goods in and around port facilities support Rhode Island’s ports and shipping sector. Other businesses transport passengers to destinations throughout Narragansett Bay and New England. Additionally, supporting industries provide services and supplies for businesses and workers in this sector. For further detail of the industries that are included in this sector, please see Table SPS-1 and the Technical Report.

Table SPS-1. Sources for the Ports and Shipping Sector

Source	Industry
Sproul and Michaud (2018a)	Diving and Salvage, Marine Construction, Marine Services and Supply, Professional Services
Sproul and Michaud (2018b)	Service and Supply, Processors
NOAA (2015)	Ship Building and Repair, Marine Passenger Transportation, Warehousing, Marine Transportation Services, Marine Related Construction, Seafood Processing

Ports and Shipping in the Nation's Blue Economy

In the United States (U.S.), the ports and shipping sector contains over 13,000 establishments that provide 547,000 jobs and produce \$58 billion in gross domestic product (GDP) (\$55 billion in real GDP). The ports and shipping sector experienced an increase in real GDP from 2005 to 2015 as real GDP grew from \$45 billion to \$55 billion (22%). In addition, wages and average wages in this sector grew by 37% and 23% respectively (NOAA 2015; Author's Calculations).

Table SPS-2. Employment Growth in Ports and Shipping Industries in the National Blue Economy (2005-2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Ship Building and Repair	115,568	122,836	134,486	18,918	16.37
Marine Passenger Transportation	16,844	169,62	17,969	1,125	6.68
Warehousing	179,018	179,266	211,409	32,391	18.09
Marine Transportation Services	96,022	89,591	98,681	2,659	2.77
Marine-Related Construction	3,080	3,015	3,213	133	4.32
Seafood Processing	965	854	836	-129	-13.37

Source: NOAA 2015; Author's Calculations

As globalization and shipping innovations transformed the world economy, industries in the U.S. grew to accommodate increased demand in port and shipping industries. The warehousing industry was a beneficiary of increased water-trade: employment, wages, and real GDP produced by this industry grew by 18.1%, 47.6%, and 35.3% respectively from 2005 to 2015. Much of this growth occurred in 2015 as employment wages and real GDP increased by more than 10% (NOAA 2015; Author's Calculations).

The marine transportation services industry, marine passenger transportation industry, and ship building and repair industries also experienced growth in jobs and total wages paid between 2005 and 2015. Of these three, only the marine transportation services industry experienced a decline in real GDP in the same 10-year period.

In terms of jobs in the maritime industry, the majority of job openings are for operational occupations serving on vessels, such as sailors and machinery oilers, laborers and movers, and pilots, and the Northeast is one area of concentration for these jobs (U.S. Departments of Education, Transportation, and Labor 2015).

Longer-term growth of the country's maritime industry has been linked to the effect of the Jones Act of 1917. The law permits only American ships—built, owned, and crewed vessels—to move product when both the leaving and destination points are on U.S. soil, and this activity is tied to contributing \$150 billion annually to the U.S. economy and to supporting 650,000 American jobs (Seafarers International Union 2019).

Therefore, any regulations, policies, or technological advances can have tremendous economic impacts. For example, recent ballast water treatment system requirements, on both the international and national stages, have created a new \$200 billion blue technology market.

Ports and Shipping in New England's Blue Economy

Many of the sectors within New England's ports and shipping industries are often associated with the history of the region's ocean economy. The movement of goods and people between mainland ports and island stopovers supported much of the economic energy that the region experienced from the late 17th century through the 19th century. Today, ports and shipping industries still play a key role in the region's economy.

Table SPS-3. Employment Growth in New England Ports and Shipping Industries (2005-2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Ship Building and Repair (RI, MA)	2,612	2,705	4,366	1,754	71.84
Marine Passenger Transportation (NH, MA)	323	329	254	-69	-21.36
Warehousing (CT, MA, ME, NH, RI)	11,314	10,860	13,172	1,858	18.84
Marine Transportation Services (CT, MA, ME, RI)	1,295	1,030	1,016	-279	-49.48
Marine-Related Construction (MA, ME, NH, RI)	1,223	1,224	2,444	1,221	99.84
Seafood Processing (MA, ME, RI)	3,527	3,779	3,375	-152	-10.94

Source: NOAA 2015; Author's Calculations

Overall, New England's ports and shipping industries experienced mixed job growth from 2005 to 2015. Some industries observed substantial growth in employment, wages, average wages, and real GDP. The ship and boat building industry and the warehousing industry both experienced sizable growth: Real gross state product (GSP) produced by the New England warehousing industry increased from \$825.6 million to \$1.23 billion (49%) between 2005 and 2015. This economic growth also created 1,858 jobs that pay an average wage of \$57,200. Additionally, the region's ship building and repair industry also experienced impressive growth between 2005 and 2015. Job numbers, wages, and real GSP in this industry outpaced the national average by 30.8%, 98.7%, and 92.5% respectively (NOAA 2015; Author's Calculations).

Conversely, New England's marine passenger transportation and marine transportation services industries experienced declines in employment over time. Employment in the marine passenger transportation industry shrank by 22.8% between 2010 and 2015 as real GSP decreased by 7.8%. In this same time, the marine transportation services industry experienced a similar decline as real GSP produced by this industry decreased by 23.1%, even as employment numbers remained relatively consistent (NOAA 2015; Author's Calculations).

Rhode Island

Rhode Island possesses port services and infrastructure that connect it with other regional and global shipping hubs. The municipalities of East Providence, North Kingstown, Providence, and Tiverton host ports that handle liquid

cargo, dry bulk cargo, and roll-on/roll-off cargo (Becker et al. 2010). Vessels also access the Port of Fall River (MA) via Narragansett Bay (CRMC 2010).

Table SPS-4. Employment Growth in Ports and Shipping Industries in Rhode Island's Blue Economy (2005-2015)¹⁷

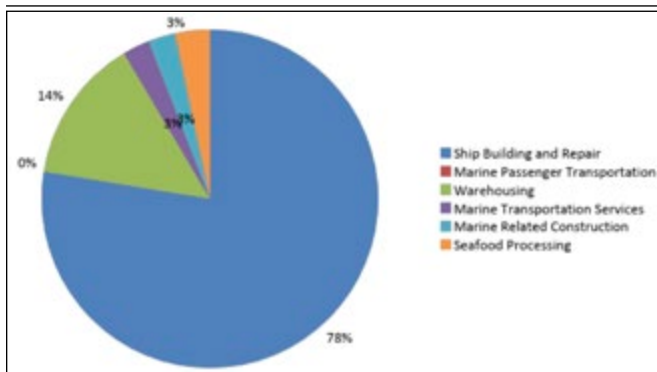
Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Ship Building and Repair	2,397	2,437	4,119	1,722	71.84
Marine Passenger Transportation	107	-	-	-	-
Warehousing	913	863	1,085	172	18.84
Marine Transportation Services	194	262	290	96	49.48
Marine-Related Construction	209	68	109	-100	-47.85
Seafood Processing	265	258	236	-29	-10.94

Source: NOAA 2015; Author's Calculations

The state's largest ports—the Port of Providence and the Port of Davisville at the Quonset Business Park—are deep harbors that handle the majority of the cargo that is transported in and out of the state. More than nine million tons of waterborne cargo passed through Rhode Island ports in 2017. Approximately eight million tons of this cargo were foreign and domestic imports (USACE 2017). In comparison, cargo exiting Rhode Island ports totaled 988,000 tons (USACE 2017). These figures do not include cargo passing through the Port of Davisville as that port's shipping channel is not maintained by the U.S. Army Corps of Engineers (USACE) (Becker et al. 2010). The continued growth of the Port of Davisville at the Quonset Business Park is partially due to its naturally deep channel. The port's 29-foot channel is not a federally maintained navigation channel, so vessels are not required to pay a harbor maintenance tax at the port. Efforts to further leverage this competitive advantage are being explored by the Quonset Development Corporation. However, as noted, the channel is growing increasingly shallow, so the issue of dredging it has arisen.

For both ports, potential is also being discussed for short sea shipping, or transport that moves goods over multiple short distances instead of via a single long trip. Both ports have some equipment already for this purpose, but more would be needed. Both the Port of Davisville and the Port of Providence are situated within, and are supported by, business and industrial park settings that are expected to play roles in hosting and leveraging activities related to the construction of future offshore wind farms.

Figure SPS-1. Rhode Island Ports and Shipping Industries by real GSP (2015)¹⁸



Source: NOAA 2015; Author's Calculations

Much of the real GSP produced by Rhode Island's ports and shipping sector (77.5%) comes from the ship building and repair industry. Industries that can be considered contributions to the operation of port infrastructure (warehousing, seafood processing, and marine-related construction industries) produce \$115 million in real GSP (19.8% of the sector total) (NOAA 2015; Author's Calculations).

Overall Sector Trends

Various industries in Rhode Island's ports and shipping sector experienced sustained economic growth from 2005 to 2015. Real GSP produced by the ship building and repair industry and the warehousing industry (the two largest industries in this sector) increased by 139.2% and 40.6% respectively (NOAA 2015). Conversely, the marine construction, marine transportation services, and seafood processing industries experienced varying declines during the same time period. Of the industries that experienced declines in real GSP between 2005 and 2015, only the marine transportation services industry experienced a positive employment trend. Interestingly, much of the marine transportation services industry's real GSP and employment growth occurred during recession years (2007-2009) (NOAA 2015; Author's Calculations).

Table SPS-5: Real Gross State Product (GSP) in Ports and Shipping Industries in Rhode Island's Blue Economy (2005-2015)¹⁹

Industry	Real Gross State Product (GSP)			Change (2005-2015)	
	2005	2010	2015	Real GSP	Percent
Ship Building and Repair	\$188,240,038	\$212,172,346	\$450,371,543	\$262,131,505	139.25
Marine Passenger Transportation	\$4,686,490	-	-	-	-
Warehousing	\$57,375,450	\$61,331,923	\$80,696,568	\$23,321,118	40.65
Marine Transportation Services	\$15,223,257	\$18,539,067	\$15,066,614	-\$156,643	-1.03
Marine-Related Construction	\$49,216,683	\$14,264,209	\$15,099,855	-\$34,116,828	-69.32
Seafood Processing	\$23,292,693	\$21,582,080	\$19,359,384	-\$3,933,309	-16.89

Source: NOAA 2015; Author's Calculations

Rhode Island's marine-related construction industry experienced the most intense decline from 2005 to 2015 as real GSP produced by this industry decreased from \$49.2 million to \$15 million. The seafood processing industry also experienced decreases in employment (-10.9%) and real GSP (-16.8%) between 2005 and 2015 (NOAA 2015; Author's Calculations).

The warehousing industry includes establishments that operate warehousing and storage facilities. This includes establishments that operate refrigerated warehouses and other cold-storage facilities. Rhode Island's warehousing industry has 18 establishments that provide 1,085 jobs and produce \$80.6 million in real GSP (NOAA 2015).

17 * - denotes unknown values due to data suppression.

18 The marine passenger transportation industry is excluded from this calculation because of data suppression.

19 * - denotes unknown values due to data suppression.

Descriptions of Major Rhode Island Ports

Port of Davisville

The port is located on Narragansett Bay and offers four berths and five terminals with over 60 acres of terminal storage and area for placing down, or laying down, containers. The two main piers combined offer 6,800 linear feet of berthing space, and have an on-dock rail service, ideal for import and export. The port can accommodate deep-draft oceangoing vessels of 10m or less. There is also a carrier pier at the southern part of the business park. The Port of Davisville is primarily used as an auto import facility, with ancillary warehousing, processing, and auto storage areas. Smaller areas are used for commercial boating, aquaculture, and frozen fish distribution. It is one of the top auto and frozen seafood ports along the East Coast supporting regional shippers and major ocean carrier services. In total, Quonset Business Park generates nearly 7% of state GDP with \$4.3 billion in economic impact, \$1.28 billion generated in household income annually for Rhode Island families and \$128.8 million in state and local taxes. (Bryant University 2019).

Port of Galilee/Point Judith

The Rhode Island Department of Environmental Management (RI DEM) Coastal Resources program is responsible for the development, management, and maintenance of the Port of Galilee, State Pier #9 (Newport), State Pier #4 (Jerusalem), and State Pier #5 (Narragansett). These properties comprise 41 piers and 24 lease holdings with an approximate combined value of over \$100 million. The Port of Galilee is one of the largest commercial fishing ports on the East Coast and is home port to over 250 commercial fishing vessels. State pier #9 is the only state owned facility supporting commercial fishing vessels in Newport Harbor and provides dockage for approximately 50 vessels. (RI DEM 2019). Support for fishing operations includes gear and supply shops, open space to work on gear, fueling facilities, ice plants, cold storage facilities, fish buyers/dealers, fish processors, mooring space, facilities to maintain and repair vessels, transportation for fish and fish products, and U.S. Coast Guard/port security. Besides commercial fishing, the port supports ferry transportation to Block Island. Ferry service transports people, fuel, and supplies, runs year round, and requires extensive parking facilities in Point Judith for customers. Narragansett's Point Judith Harbor of Refuge, formed by a man-made breakwater, is a critical resource for vessels needing to escape inclement weather.

Port of Providence

The Port of Providence is New England's second-biggest deepwater port. It covers over 115 acres and contains 4,200 feet of berthing space, 130,000 square feet of covered storage, and more than 20 acres of open laydown area. The

port offers on-dock rail service and 40-foot-alongside water depth, and is near the interstate highway network. Ships from around the world utilize the deepwater federal channel, bringing products in from Central and South America, Europe, East Asia, Russia, Africa, Australia, and New Zealand. Petroleum, asphalt, cement, liquified petroleum gas, coal, aluminum oxide, project cargoes, and road salt are a few of the primary imports. Primary exports are scrap metals, automobile and project equipment, and materials. Various other bulk products pass through the port as well. Water dependent, water enhanced, and industrial businesses in the area of Allens Avenue, Providence, represent \$294 million in annual business sales and 372 workers; direct, indirect, and induced effects combined totaling \$324 million in business output within the state; more than 700 jobs; and nearly \$30 million in household incomes (Providence Working Waterfront Alliance 2008).

Sector Specific Data **("Current Day" Snapshot)**

Rhode Island's ports and shipping sector is comprised of a variety of overlapping industries. For organizational purposes, this section will present the industries of Rhode Island's ports and shipping sector referenced in Table SPS-1. Although these industries are presented separately, it should be noted that these industries often connect or overlap with other industries and/or sectors in and outside of Rhode Island's blue economy.

Marine Construction

The marine construction industry includes firms that build waterfront infrastructure, run dredging operations, and/or provide specialty engineering or diving services that support construction and contracting firms. Firms in this sector are primarily mooring and dock builders, but several also engage in dredging operations and support specialty engineering. This industry contains 41 firms that support 407 jobs and bring in \$167.07 million in gross sales (Sproul and Michaud 2018a).

Marine Services and Supply

The marine services and supply industry includes wholesale suppliers of marine equipment and marine services firms. Included in this industry are the suppliers of wholesale marine equipment such as nets, bait, traps, and other gear fishermen purchase in port areas. In Rhode Island, 27 fishing-related services and supply firms support 152 jobs and earn \$84.61 million in gross sales (Sproul and Michaud 2018b). Other firms in this industry generally supply components, parts, and technology for watercraft, or they provide painting, fuel, and lubricant services to watercraft or marine facilities. This includes composites suppliers that support 153 jobs and gross \$51.83 million in sales (Sproul and Michaud 2018c). Altogether,

Rhode Island's marine services and supply industry includes 431 firms that support 2,757 jobs and \$583.60 million in gross sales (Sproul and Michaud 2018a).

Marine Passenger Transportation

The marine passenger transportation industry includes establishments that provide water transportation for passengers in coastal waters and between deep-sea ports. Ferry boats give both in-state and out-of-state travelers easy access to ports in and around Rhode Island.

Ferry services transport passengers in-state between Block Island, Newport, Point Judith, and Quonset (CRMC 2010). Interstate passenger destinations include New London (CT), Montauk (NY), and Martha's Vineyard (MA) (CRMC 2010). In 2015 alone, Rhode Island ferries transported 201,634 passengers (McFadden et al. 2017). As of 2009, Rhode Island's marine passenger transportation industry provided 91 jobs and produced \$9.64 million in real GDP (NOAA 2015).

Marine Transportation Services, and Diving and Salvage

The marine transportation services industry includes establishments that operate ports, harbors, and other docking and pier facilities. This includes establishments that primarily provide stevedoring and other marine cargo handling services (outside of warehousing). Also included in this industry are establishments that support navigational services for vessels. Combined, the businesses in Rhode Island's marine transportation services industry include 20 establishments that provide 290 jobs and produce \$15 million in real GSP (NOAA 2015).

The majority of shipping vessels that enter Narragansett Bay handle automobiles, dry bulk, and liquid bulk (petroleum products) (Chris Waterson, personal communication, August 13, 2019). The Port of Providence plays an essential role in supplying energy products such as home heating oil and other petroleum products to southern New England (CRMC 2010). Additionally, the port's 40-foot-deep navigational channel makes Providence one of a few New England ports that can directly connect large ocean-going vessels with major interstate highways (I-95 and I-195) (CRMC 2010). Providence Port tenants include: Sea-3 Providence, Grimaldi/ACL, McInnis Cement, Lehigh Cement, New England Petroleum Terminal, Schnitzer Northeast, Univar USA, Liberty Global Logistics, Morton Salt, and Mid-American Salt (Waterson 2019).

Rhode Island's other major shipping port, the Port of Davisville at the Quonset Business Park, is a large automobile importing, processing, and distribution center. In 2017, the port processed 222,521 vehicle units from 202 ship calls (Quonset Development Corporation 2017). These vessels accounted for 43% of all cargo vessels arriving at ports and terminals in Narragansett Bay (Quonset Development Corporation 2017).

The next year saw imports and ship calls increase as the port processed 241,851 vehicle units from 225 ship calls (Quonset Development Corporation 2019).

Marine salvage operations are also a part of the larger marine transportation services industry (NOAA 2015). Rhode Island's diving and salvage industry is predominantly composed of businesses that provide diving, salvage operations, and underwater surveying services to coastal and off-shore facilities. Also included are dive shops and diving instructors. The diving and salvage industry contains 44 firms that support 363 jobs and earn \$97.28 million in gross sales (Sproul and Michaud 2018a).

Professional Services

The professional services industry plays an important supporting role for many businesses in and outside of the ports and shipping sector. This industry includes contractors, designers, engineers, and surveyors, as well as marine real estate companies, developers, property managers, insurance agencies, and environmental services. Altogether, the professional services industry comprises 145 firms that support 1,005 jobs and earn \$148.13 million in gross sales (Sproul and Michaud 2018a).

Processors

Seafood processors handle virtually all commercial landings in Rhode Island's fishing industry. As water-related businesses, processors play a key role in cleaning and packaging landed fish in port and harbor areas (Becker et al. 2010). Rhode Island's processing industry is highly specialized: most of the processors handle finfish and squid, and the rest specialize in shellfish like lobster, mussels, and clams. Overall, the processing industry includes 11 firms that support 215 jobs and earn \$67.05 million in gross sales (Sproul and Michaud 2018b).

Shipbuilding and Repair

The shipbuilding and repair industry includes establishments that construct, repair, convert, or alter ships²⁰ in a fixed drydock or other facilities. This includes the production and repair of defense-related watercraft (see Defense section for additional detail). Establishments in this industry also produce and/or repair ferries, tugboats, barges, and other commercial vessels (J. Goodison 2019). Rhode Island's shipbuilding and repair industry includes approximately 10 establishments that employ 3,820 workers and produce roughly \$450 million in real GSP (NOAA 2015; SENEDIA 2017).

Warehousing

The warehousing industry includes establishments that operate warehousing and storage facilities. This includes establishments that operate refrigerated warehouses and other cold-storage facilities. Rhode Island's warehousing industry has 18 establishments that provide 1,085 jobs and produce \$80.6 million in real GSP (NOAA 2015).

²⁰ Ships are defined as watercraft typically suitable or intended for uses other than personal or recreational use.



Jessica Willi
Executive Director
Block Island Tourism Council

Talk tourism with Jessica Willi, and a theme of balance quickly emerges. “Destination marketing is very important to the island—it’s a reason why so many of us can live here year-round,” says Willi, executive director of the Block Island Tourism Council. “At the same time, it’s so critical that we don’t overwhelm our resources here and compromise our ability to maintain a sense of place.”

She views herself as lucky; her parents were teachers, so summers growing up were spent on the island. Today, she lives there with husband Chris, a fisherman with a bait and tackle operation, and their two children. It’s her perspectives both as a resident and as a business leader that she has brought over the years to her work at the tourism council.

You can’t get more “Blue,” economy-wise, than on Block Island, Willi says, referring to the plentiful marine-based amenities—the beaches, sailing regattas, and fishing tournaments, for example—that draw staggering numbers of summer visitors to the New Shoreham community. But, she indicates, the goal is to find a prosperous balance, so summer business isn’t overwhelming, while off-season opportunities are encouraged. “The shoulder seasons are increasingly important,” says Willi, referring to off-peak months. “We do education with the business community so they can think about longer term planning.”

Education is also key as the community is learning to interact with the Block Island Wind Farm. The island is exploring how best to integrate offshore renewable energy—another “blue” sector—with tourism and business while still maintaining a quality of life deeply resonant of its coastal character.

“Tough tightrope, no doubt,” says Willi. “But we’re committed to doing this as best and as balanced as we can. We need tourism and business—but we are always aware that the reason Block Island is so special is that it looks the way it looks and it feels like it feels.”

Sectors of the Blue Economy

TOURISM AND RECREATION



Direct-effect value (not already counted by other sectors) is \$428 million and 3,999 jobs.

As the largest constituent of Rhode Island's tourism and recreation sector, the eating, drinking, hotels, and lodging industries employ 32,078 workers (NOAA 2015).

Combined, Rhode Island's charter, cruise services, marinas, docks, and yacht clubs industries earn \$703.6 million in gross sales (Sproul 2018a).

Real gross state product (GSP) produced by Rhode Island's tourism and recreation sector declined by 3% between 2005 and 2015 despite growth in sector employment and wages (NOAA 2015).

Recreational saltwater fishermen spent \$103 million in 2016 in the Narragansett Bay Watershed in 2011 (Uchida 2019).

Our View of the Blue Economy: Tourism and Recreation

Louise Bishop, President and CEO and Alan Horenstein, Financial Officer, South County Tourism Council

“For us, what’s increasingly important is this focus on providing people with attractions and experiences that can really build on the activities of going to a beach or a waterfront, and make people’s visits more meaningful, more distinctly Rhode Island,” says Bishop. “We’re very much looking to ecotourism experiences—say a farm experience or

tour—to enhance people’s visits to Rhode Island, and their connection to the state, as well as to offer more businesses and workers the opportunity to participate in, and prosper in, the tourism economy. To do this well, added Horenstein, the industry needs accurate, detailed, and consistent data so opportunities and challenges can be better understood. “While we work with the data available, it’s difficult to forecast exactly where we should be going as an industry,

and it’s hard to know what kinds of impacts our efforts are making, both in the region, the state—and within the visitor audience themselves,” says Horenstein. “I’m a numbers guy, so it makes sense that I want as much sound data as I can get, but many people in the industry—Louise and the board say it, too—are really seeing a need for more information gathering and analysis, so we can ultimately know how to shape the industry for the future.”

Introduction

Over time, Rhode Island’s hospitality industry has worked with blue businesses to create new economic opportunities in tourism and recreation; for example, developing shoulder seasons (spring and fall, even into winter) to encourage visits beyond the summer months. This creates a more stable earning cycle for companies, enabling them to pay employees more over a longer time period. Blue economy businesses in this sector face a balancing act—serving as large a customer base as possible, while protecting the sensitive environmental resources on which the industry depends. As the Ocean State, Rhode Island’s connection to the water is one of its greatest economic, environmental, and cultural assets, and the recreational use of coastal resources not only provides enjoyment but also generates major economic benefits for the state. Rhode Island’s large coastline given its size means much of the economic value that should be attributed to Rhode Island’s tourism and recreation sector is included in marine trades and fisheries data. For example, values from marinas, tackle shops, charter boats, and seafood restaurants are claimed and counted by these two sectors. State economic information documents that tourism and recreation overall is valued at \$4.3 billion (direct effect) with 83,913 jobs, making it the state’s largest sector for jobs (although jobs in recreation and tourism are generally the lowest paying). These overall numbers include coastal tourism and recreation, but also include non-blue economy tourism such as gaming and hunting.

The tourism and recreation sector includes shore-based activities in which residents and tourists alike enjoy Rhode Island’s ocean-based resources. In Rhode Island, lodging, attractions, shopping, dining, recreation, transportation, and special event activities characterize the tourism industry. As both National Oceanic and Atmospheric Administration (NOAA) and Rhode Island tourism experts group tourism and recreation together, these two industries are presented as a joint sector.

A broad assortment of businesses support or attract ocean-based tourism and recreation. Many of these businesses directly provide recreation and tourism services: Charter boat cruises, scenic water tours, hotels, restaurants, and other amusement and recreation services all provide marine-based

or marine-enhanced services to residents and visitors alike. Boat building, boat repair, boat retail, sporting goods stores, and other supporting industries can also provide the means for people to enjoy the water, in addition to supporting recreation and tourism services.

Table STR-1. Sources for the Recreation and Tourism Sector

Source	Industry
Sproul and Michaud (2018a)	Charter & Cruise Services, Diving and Salvage, Marine Services & Supply, Professional Services (Marine Trades), Retail Boat Sales, Retail Sporting Goods
Sproul and Michaud (2018b)	Charters, Professional Services (Fishing and Seafood), Retail Dealers, Tackle Shops, Wholesalers
Sproul (2017)	Beaches, Bikeways, Parks
NOAA (2015)	Boat Building and Repair, Marine Passenger Transportation, Amusement and Recreation Services, Boat Dealers, Eating and Drinking Places, Hotels and Lodging Places, Marinas, Scenic Water Tours, Zoos and Aquaria

Tourism and Recreation in the Nation’s Blue Economy

In the United States (U.S.), the tourism and recreation sector includes 125,603 establishments that provide 2.32 million jobs and produce \$122.18 billion in gross domestic product (GDP) (\$106.35 billion in real GDP). Adjusted for inflation, the tourism and recreation sector experienced moderate GDP growth from 2005 to 2015 as real GDP grew 14% from \$93.25 billion to \$106.35 billion. In addition, the number of establishments, wages, and average wages in this sector grew by 17.3%, 21.8%, and 27.7% respectively (NOAA 2015; Author’s Calculations).

Table STR-2. Employment Growth in Coastal Tourism and Recreation Industries in the National Blue Economy (2005-2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair	49,325	21,230	26,126	-23,199	-47.03
Marine Passenger Transportation	16,844	16,962	17,969	1,125	6.68
Amusement and Recreation Services	43,845	47,102	63,286	19,441	44.34
Boat Dealers	18,162	12,531	13,343	-4,819	-26.53
Eating and Drinking Places	1,346,467	1,433,207	1,731,040	384,573	28.56
Hotels and Lodging Places	388,510	378,448	424,629	36,119	9.30
Marinas	18,836	18,007	20,986	2,150	11.41
Scenic Water Tours	11,433	8,947	10,446	-987	-8.63
Zoos and Aquaria	17,452	19,304	19,924	2,472	14.16

Source: NOAA 2015; Author’s Calculations

Much of the economic activity associated with tourism and recreation is tied to hotels, lodging, and food service establishments like restaurants and bars. At the national level, jobs supported by the eating and drinking places industry grew from 25,155 in 2005 to 28,077 in 2015, an increase of 11.62%. Eating and drinking places produce 55.3% of this sector's real GDP and employ 74.4% of this sector's workforce. Comparatively, hotels and lodging places produce 31.6% of this sector's real GDP and provide 18.2% of all jobs in this sector. Combined, these two industries provide 92.6% of all employment in tourism and recreation industries and produce 86.9% of all real GDP for this sector (NOAA 2015; Author's Calculations).

Tourism and Recreation in New England's Blue Economy

Since the mid-1800s, New England has been a hub for tourism and recreation activities. Today, visitors travel to the region to experience its unique shorelines, historical character, and fresh seafood.

Table STR-3. Employment Growth in Coastal Tourism and Recreation in New England (2005-2015)²¹

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair (MA, RI)	1,514	829	798	-716	-47.29
Marine Passenger Transportation (MA, ME, NH, RI)	9,569	19,655	19,744	10,175	*
Amusement and Recreation Services (CT, MA, ME, NH, RI)	4,622	4,779	6,383	-1,762	38.10
Boat Dealers (CT, MA, ME, RI)	1,895	1,468	1,608	-287	-15.15
Eating and Drinking Places (CT, MA, ME, NH, RI)	114,378	121,652	142,315	27,937	24.43
Hotels and Lodging Places (CT, MA, ME, NH, RI)	23,410	23,240	26,206	2,796	11.94
Marinas (MA, ME, NH, RI)	2,545	2,922	3,151	606	23.81
Scenic Water Tours (MA, RI)	613	532	739	126	20.55
Zoos and Aquaria (CT, MA, RI)	*	1,362	1,452	*	*

Source: NOAA 2015; Author's Calculations

Outside of the boat building, repair, and retail industries, New England's tourism and recreation sectors experienced relatively consistent job growth between 2005 and 2015. Notably, employment in the amusement and recreation services industry grew from 4,622 workers to 6,383 workers (38.1%) from 2005 to 2015. Despite this growth, employment in the amusement and recreation services industry grew more slowly than the national average. At a growth rate of 24.4% between 2005 and 2015, employment in the eating and drinking places industry also grew less than the national average. Conversely, job growth in the scenic water tours, marinas, and hotels and lodging places industries outpaced the national average from 2005–2015. The boat building and repair industry was the only regional industry to experience a greater decrease in employment than the national average (NOAA 2015; Author's Calculations).

Rhode Island

As the Ocean State, Rhode Island's connection to the water is one of its greatest economic, environmental, and cultural assets. The recreational use of coastal resources not only provides enjoyment, but also generates major economic benefits for the state. Since the mid-19th century, tourists have traveled to Rhode Island to enjoy the natural beauty of Narragansett Bay and popular seaside resorts towns, such as Newport and Narragansett.

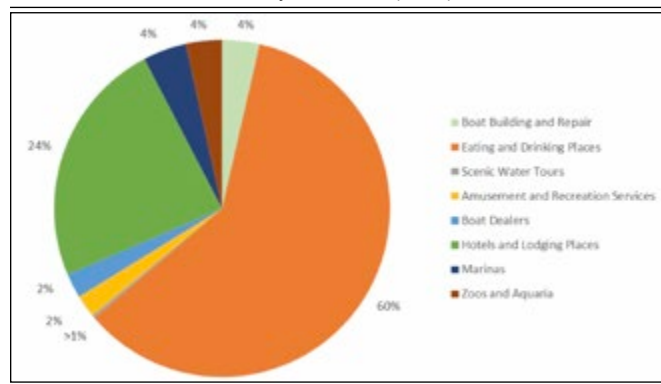
Table STR-4. Employment Growth in Coastal Tourism and Recreation Industries in Rhode Island's Blue Economy (2005-2015)²²

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Boat Building and Repair	1282	639	565	-717	-55.93
Marine Passenger Transportation	105	*	*	*	*
Amusement and Recreation Services	769	803	914	145	18.86
Boat Dealers	347	337	324	-23	-6.63
Eating and Drinking Places	25,155	24,939	28,077	2,922	11.62
Hotels and Lodging Places	3,341	3,543	4,001	660	19.75
Marinas	560	666	655	95	16.96
Scenic Water Tours	169	130	114	-55	-32.54
Zoos and Aquaria	758	726	723	-35	-4.62

Source: NOAA 2015; Author's Calculations

According to NOAA data, Rhode Island's tourism and recreation sector produces more than \$1.59 billion gross state product (GSP) (\$1.41 billion real GSP) and employs approximately 35,373 workers who earn an average of \$20,802 annually (NOAA 2015; Author's Calculations). It should be noted that annual wages are relatively low due to the seasonal nature of work in this sector (Rhode Island Department of Labor 2012). Rhode Island does not tax boat purchases for residents or for residents of other states as long as a purchased boat is moored in the state 90 days each year (RI DEM 2019).

Figure STR-1. Rhode Island Coastal Tourism and Recreation Industries by Real GDP (2015)²³



Source: NOAA 2015; Author's Calculations

21 * - denotes unknown values due to data suppression. For more information on data details, see the Tourism and Recreation sector tables in the Technical Report.

22 * - denotes unknown values due to data suppression.

23 The marine passenger transportation industry is excluded from this calculation because of data suppression.

Much of the real GSP produced by Rhode Island's tourism and recreation sector (83.9%) comes from the eating and drinking places industry and the hotels and lodging places industry. On a smaller scale, businesses associated with amusement and recreation services, marinas, zoos and aquaria, and scenic water tours often provide the means of attracting residents and visitors alike to eating, drinking, and lodging establishments.

Overall Sector Trends

The tourism and recreation sector experienced a slight reduction in GSP from 2005 to 2015 as real GSP dropped from \$1.46 billion to \$1.41 billion (3.3%). Despite this loss in real GSP, the establishments, wages, and average wages grew by 5.6%, 8.8%, and 20% respectively. Notably, the tourism and recreation sector surpassed pre-recession levels of real GSP in 2013 before shrinking more than 4.8% the following year (NOAA 2015).

Table STR-5. Real Gross State Product (GSP) in Coastal Tourism and Recreation Industries in Rhode Island's Blue Economy (2005-2015)²⁴

Industry	Real Gross State Product (\$)			Change (2005-2015)	
	2005	2010	2015	\$	Percent
Boat Building and Repair	\$84,326,176	\$44,668,221	\$50,225,112	-\$34,103,043	-40.44
Marine Passenger Transportation	\$4,686,490	*	*	*	*
Amusement and Recreation Services	\$35,151,386	\$30,885,787	\$30,732,306	-\$4,428,080	-12.57
Boat Dealers	\$32,020,733	\$29,961,615	\$32,804,454	\$783,721	2.45
Eating and Drinking Places	\$859,493,146	\$759,554,129	\$840,920,141	-\$18,573,005	-2.16
Hotels and Lodging Places	\$344,144,791	\$373,109,235	\$332,064,218	-\$12,080,573	-3.51
Marinas	\$44,996,456	\$55,482,926	\$58,280,032	\$13,283,576	29.52
Scenic Water Tours	\$6,730,126	\$5,970,930	\$3,873,664	-\$2,856,462	-42.44
Zoos and Aquaria	\$48,655,371	\$51,847,596	\$62,876,827	\$14,221,456	29.23

Source: NOAA 2015; Author's Calculations

Rhode Island's two largest GSP-producing industries in this sector, eating and drinking places and hotels and lodging places, experienced slight decreases in real GSP (-2.2% and -3.5% respectively) from 2005 to 2015. Other tourism and recreation industries such as scenic water tours and amusement and recreation services experienced more significant decreases in real GSP over the same 10-year period, decreasing by 42% and 13% respectively (NOAA 2015).

Although the recession had a significant impact on many tourism and recreation industries, the boat building and repair industry experienced a significant decline: Employment in this industry dropped by 42%, and real GSP plummeted by more than 47% during this period. As of 2015, Rhode Island's boat building and repair industry is still producing 40% less real GSP than pre-recession levels. Similarly, the boat dealers industry experienced a drop in real GSP (-16.8%) and

employment (-17.8%) during the recession, but this industry has almost completely rebounded to pre-recession levels of real GSP (NOAA 2015). The industry everywhere is also adjusting to a changing customer base. Financially secure older adults remain a consistent portion of the boat-buying and marina usage market, but younger adults are also participating more by trying new, more economical options: boat rental, group ownership, or even taking up residence solely on boats. These younger customers, when they do purchase boats, buy smaller vessels that are versatile and generally cheaper to dock and repair (BoatUS 2017).

Other industries in the tourism and recreation sector experienced substantial growth since 2005. Real GSP created by Rhode Island's marinas industry grew by 29% from 2005 to 2015 and the industry has maintained relatively consistent growth in this time period: real GSP in this industry has only decreased in 2009, 2011, and 2015. Rhode Island's zoos and aquaria also experienced growth during the study period, with real GSP growing by 29% from 2005 to 2015. Much of this growth occurred from 2013 to 2015 as real GSP in this industry increased by more than 47%. Rhode Island's zoos and aquaria comprise the only industry in this sector to experience real GSP growth during the recession (NOAA 2015).

Sector Specific Data ("Current Day" Snapshot)

In Rhode Island's blue economy, the tourism and recreation sector is comprised of a variety of overlapping industries. For organizational purposes, this section will present the industries of Rhode Island's tourism and recreation sector referenced in Table STR-1. Although these industries are presented separately, it should be noted that they often connect or overlap with other industries and/or sectors in and outside of the blue economy.

Boat Building, Retail, and Repair

Rhode Island hosts a significant degree of boating, with 39,685 boats registered via the state (MarineTitle.com 2019). Boating is a substantial part of Rhode Island's tourism and recreation sector, as residents and visitors alike purchase, use, or repair boats using Rhode Island vendors and services. Furthermore, small-scale tourist operators (such as charters) purchase boats and use repair services to support their businesses. Boat sales are especially supportive to recreational fishing in Rhode Island, as past studies of recreational fishing in the state found that boat sales make up approximately 22.5% of all spending by recreational saltwater anglers (Rhode Island Saltwater Anglers Association (RISAA) 2007).

There are 104 firms in the state that engage in boat building activities. Rhode Island's boat building industry supports 1,336 jobs and earns \$246.4 million in gross sales. Additionally, 99

²⁴ * - denotes unknown values due to data suppression.

boat repair firms generate 1,120 jobs and \$146.6 million in gross sales. The retail of constructed boats also contributes to the economic output of this sector. Rhode Island's retail boat sales industry contains 131 firms that support 712 jobs and generate \$238.32 million in gross sales (Sproul and Michaud 2018a). Altogether, the boat building, retail, and repair industries support 3,168 jobs and generate \$631.32 million in gross sales (Sproul and Michaud 2018a; Author's Calculations).

Charters, Cruise Services, and Scenic Water Tours

The charter, cruise services, and scenic water tours industries support a sizable portion of Rhode Island's ocean-based tourism and recreation sector. Most of the firms in these industries are sportfishing charters, small cruise operators, ferry services, fleet charter services, and other same-day scenic and sightseeing water transportation. The charters and cruise services industry includes 306 firms that support 1,965 jobs and earn \$336.24 million in gross sales (Sproul and Michaud 2018a).

At least 75 of these businesses operate as small fishing charters that support an average of 2.4 employees per firm (Sproul and Michaud 2018a). Despite the relatively small size of many charter firms, the industry supports 182 jobs and earns \$20 million in gross sales (Sproul and Michaud 2018b). Recreational saltwater fishing has generated in the past \$160 million in total value, \$24 million in wages, and supports approximately 1,030 jobs. (RISAA 2007). Saltwater recreational fishing alone is the state's eighth largest tourist attraction with over half of saltwater anglers coming from out of state. With 38 percent of these anglers staying overnight, these visitors generally also engage with the golfing industry, restaurant/bar industry, beaches, and other cultural amenities (RISAA 2007).

Retail Sporting Goods

The retail sporting goods industry includes fishing- and boating-related outfitters and sporting goods stores with a customer base that includes residents and visitors. Rhode Island's retail sporting goods industry includes 29 firms that support 163 jobs and earn \$64.64 million in gross sales (Sproul and Michaud 2018a). Of these firms, 25 are bait and tackle shops that support 62 jobs and earn \$14.71 million in gross sales (Sproul and Michaud 2018b).

Marinas, Docks, and Yacht Clubs

Marinas, docks, and yacht clubs support much of the recreational boating and sailing activities that occur in and around Rhode Island by providing storage, docking facilities, fuel, and supply sales. In Rhode Island, 269 marinas, docks, and/or yacht clubs support 2,743 jobs and earn \$367.43 million in gross sales. The marine services and supply industry also supports the operations of marinas, docks, and yacht clubs by providing facility maintenance such as painting, fuel, and

lubricant services or by providing marine supplies. Rhode Island's marine services and supply industry included 431 firms that support 2,757 jobs and \$583.60 million in gross sales (Sproul and Michaud 2018a).

Professional Services

The professional services industry plays an important supporting role for many tourism and recreation businesses. This industry includes contractors, designers, engineers, and surveyors, as well as marine real estate companies, developers, property managers, insurance agencies, and environmental services. The professional services industry contains 145 firms that support 1,005 jobs and earn \$148.13 million in gross sales (Sproul and Michaud 2018a).

Diving and Salvage

The diving and salvage industry interacts both directly and indirectly with other tourism and recreation industries in Rhode Island's blue economy. This industry includes dive shops and diving instructors, but it is predominantly composed of businesses that provide diving, salvage operations, and underwater surveying services to coastal and off-shore facilities. The diving and salvage industry includes 44 firms that support 363 jobs and earn \$97.28 million in gross sales (Sproul 2018a and Michaud).

Amusement and Recreation Services

Amusement and recreation services industries include a variety of recreational providers in Rhode Island. This includes businesses that provide scenic and sightseeing transportation or the ability to rent recreational goods such as bicycles, canoes, sailboats, and beach chairs and umbrellas. Also included are businesses that more generally provide recreation and amusement services (such as miniature golf facilities).

Rhode Island's beaches, bikeways, and coastal parks play a key role in supporting the amusement and recreation services industries. Much of the tourism in Rhode Island is based on attraction to its sandy beaches and rocky shoreline (Rhode Island Department of Labor 2012). State beaches alone attract over 1.17 million people who spend an estimated \$115.01 million annually. Rhode Island's system of coastal bike paths also contributes to amusement and recreation service businesses. Most notably, the scenic East Bay Bike Path attracts 836,699 people who spend an estimated \$12.4 million (Sproul 2017).

Coastal parks also attract people from Rhode Island and beyond. Some parks, such as Fort Adams and Colt State Park, provide historical attractions, outdoor events like music festivals, and sailing opportunities. Combined, coastal parks in Rhode Island host 5.24 million people who spend an estimated \$154.55 million (Sproul 2017).²⁵

²⁵ Coastal parks are defined as parks with boundaries that touch the ocean: Beavertail, Brenton Point, Colt State Park, Fort Adams, Fort Wetherill, and Goddard Park.

Zoos and Aquaria

The zoos and aquaria industry includes businesses that preserve and exhibit live plant and animal life. Zoos and aquaria are an attraction for residents and visitors who participate in experiences involving exhibits, educational programs, and tours. Rhode Island's zoos and aquaria include 21 establishments that support 723 jobs and produce \$62.87 million in real GDP (NOAA 2015).

Eating and Drinking Places

Eating and drinking places include businesses that primarily provide food services to patrons, seafood wholesalers, and some seafood retailers. People at Rhode Island's state beaches and parks spend over \$89.06 million (29.2% of visitor spending) at restaurants and bars (Sproul 2017). In Rhode Island, restaurants, grills, bars, and specialty snack bars/shacks are enhanced by coastal areas that provide patrons with scenic views and access to freshly prepared seafood.

Rhode Island's eating and drinking places industry contains 1,671 establishments that support 28,077 jobs and produce \$840.92 million in real GDP (NOAA 2015) and are supplied by seafood wholesalers. Rhode Island's seafood wholesalers industry includes 96 firms that support 617 jobs and \$246.26 million in gross sales. Of these wholesalers, 39 are exclusively shellfish dealers. In several cases, community supported fisheries, such as those operated at farmers markets and retail "lobster shacks," will sell live and/or cooked lobster for patrons for takeout or delivery. The retail seafood dealers industry contains 26 firms that support 136 jobs and \$11.57 million in gross sales (Sproul & Michaud 2018b).

Hotels and Lodging

The hotel and lodging industry provides short-term lodging to visitors in hotels, motels, resorts, and other lodging places (such as bed-and-breakfast inns). Visitors to Rhode Island's

state beaches and parks spent over \$49.48 million (16.2% of visitor spending) at hotels and motels (Sproul 2017). In Rhode Island, lodging is often enhanced by scenic views of coastal areas or access to coastal attractions. Rhode Island's hotels and lodging places industry contains 141 establishments that support 4,001 jobs and produce \$332.06 million in real GDP (NOAA 2015).

Marine Passenger Transportation

The marine passenger transportation industry includes establishments that provide water transportation for passengers in coastal waters and between deep sea ports. Ferry boats give both in-state and out-of-state customers easy access to Rhode Island destinations such as Block Island. Cruise ship activities also play an important role in bringing visitors to Rhode Island's shores.

Ferry services transport passengers in-state between Block Island, Newport, Point Judith, and Quonset (CRMC 2010). Interstate passenger destinations include New London (CT), Montauk (NY), and Martha's Vineyard (MA) (CRMC 2010). As of 2009, Rhode Island's marine passenger transportation industry provided 91 jobs and produced \$9.64 million in real GDP (NOAA 2015). In 2015 alone, Rhode Island ferries transported 201,634 passengers (McFadden et al. 2017).

Cruise ship activities also contribute to Rhode Island's tourism and recreation sector. In 2018, 47 cruise ships carrying 58,945 passengers supported \$353,670 in revenue (Discover Newport 2018). As the majority of these vessels visit Rhode Island in September and November, these cruise ship activities assist in extending the tourism season beyond Labor Day. Cruise ships represent economic activity, but there is increasing focus on the pollution the ships create, and efforts to make the activity more environmentally conscious.

Sectors of the Blue Economy

FISHERIES



Direct effect value is \$164.58 million and 3,147 jobs (Sproul and Michaud 2018b).

The total effect for the Rhode Island Fisheries Sector is valued at \$268.5 million in Gross State Product (GSP) and accounts for 4,381 jobs (Sproul and Michaud 2018b).

In 2017, commercial fishermen in Rhode Island landed 84,108 pounds of fish valued at \$93.8 million (National Marine Fisheries Service 2018).



Dave Monti (left)
Captain, No Fluke Charter
Fishing & Tours
Officer, Rhode Island Saltwater
Anglers Association

Dave Monti sees his livelihood as three equal parts: “One third my charter fishing business, one third writing about issues related to recreational fishing, and one third advocacy work for these same issues.”

It’s a good balance, says Monti, a Rhode Islander who has been in the recreational fishing business for more than 40 years. His enterprises provide him a unique perspective on a variety of industries within Rhode Island’s blue economy. Many of the issues he thinks about as a fisherman, businessman, writer and industry advocate are shared, he says, by people in commercial fisheries, marine trades, and tourism and recreation, among other sectors.

“Climate change is, of course, the main issue for anyone in the blue economy,” says Monti, who operates No Fluke Charter Fishing & Tours and serves as second vice president of the Rhode Island Saltwater Anglers Association. “We see the warmer-water fish like scup, black sea bass and summer flounder moving up the coast into our area in greater abundance, as the cooler-water fish like American lobster, winter flounder and cod head north or out to deeper water. We’re going to have to do more to address the climate change problem, rather than just continually adjust to the changes in fish species.”

Because fishing, boating, and tourism are so closely entwined, a collaborative approach is needed to solve pressing problems, Monti indicates. “The blue economy is a good opportunity to bring people and industries together to work on these issues in partnership.”

Doing so would help Rhode Island focus its strengths while differentiate itself from other states. Monti points out that both recreational and commercial fishing are important to Rhode Island’s economy. According to Fisheries Economics of the U.S., published by the National Oceanic and Atmospheric Administration (NOAA), Rhode Island’s commercial fishing industry, excluding imports, has an annual sales economic impact of \$333 million, and recreational fishing has an even greater annual sales impact of \$412 million.

“We are a very strong recreational fishing state,” he says.

And regarding the commercial fishing arena, while he acknowledges that offshore renewable energy (ORE) projects, like windfarms, continue to spark frustration, Monti thinks that a blue economy partnership could be a forum for solutions. “The Block Island Wind Farm shows how fish treat the structures like reefs, and we’re seeing more fish, enough to support increased fishing pressure from both the recreational and commercial sectors that are there fishing. Ocean wind and fishing are getting along and thriving out at Block Island.”

Hopefully, he says, Rhode Island’s fishing sectors can change with the environment and work alongside other ocean industries. “The ocean belongs to all of us, and we need to figure out ways to make sure we can all continue to benefit from the resources. And yes, I’m optimistic that we can.”

My View of the Blue Economy: Fisheries

Jason McNamee, Chief, Division of Marine Fisheries, Rhode Island Department of Environmental Management (RIDEM)



“When I talk to people about why fisheries is so tough to figure out, I like to point out a couple things, because it adds perspective to the issues. First, fishing is difficult. I always say

that. Right off, you’re talking about work which is inherently hard, not only to do, but also to access, understand, and quantify—and yet, that’s our starting point. Second, it’s only very recently that we have started to implement metrics to describe changing fisheries; because of that, it can seem as though things were great before, and are only heading downhill now, but the reality is we just didn’t have the information years ago that

we have now, and we’re paying more attention. Third—I did say this was complicated—while stocks do often show consistent, if gradual, rebounds, some of the growth has to do simply with the fact that we have an aging fishery—many of these guys just aren’t able to do today what they did 30 or 40 years ago, and their kids often aren’t following in their footsteps. Fewer fishermen, and not many stepping in to replace them, can lead to more fish in the water.

Given the restrictions—stock declines, the increasing pressures of climate change, the regulatory framework, the older workforce, the changing ocean landscape—we can still do a lot to improve the picture. We need to keep investing in good science, so we know what’s out there. We need to engage younger people in a collective effort to visualize what fisheries are going to look like over the next decades, and offer them exciting new versions of this industry. Maybe we do it via training programs, like

the one quahoggers offer to new members of their workforce, or maybe it’s something else. I do feel that enough younger people are coming into the science end of fisheries really wanting to be part of the effort to bring data and analytics forward to help shape and improve the resources and the workforce. And we need to reimagine how the industry functions. ‘Boutique’ fisheries, which would focus on building flexibility into fishermen’s work so they can make a living from catching a variety of different species, some that aren’t normally caught, is something we should explore collectively. We have the windfarm situation. Can we think about smaller vessels, and different gear types, so navigation and fishing within these structures is possible? If we do these things, we may be better able to rework the regulatory framework to increase flexibility for fishermen, and to start a conversation about changing how our fisheries operate.”

Introduction

The data offered here illustrate a story that is fairly common to fishing communities: Some fish stocks have suffered declines, and climate change is impacting ocean animals and their habitats, making it hard for fishing industries to plan for the future. Nonetheless, average wages in the fishing industry have rebounded and surpassed pre-recession wages between 2010 and 2015 (NOAA 2015). Jason McNamee, chief of the Division of Marine Fisheries at the Rhode Island Department of Environmental Management, states that declines are largely the result of very long term and persistent conditions, that rebounds and recoveries are often solid, if not strong, and that Rhode Island has plenty of opportunity to think creatively about big fisheries issues. This would bode well both for ocean resources and the people who depend on those resources.

Like many coastal states, Rhode Island possesses a rich fishing heritage that contributes to the unique character of the state and its ocean economy. Commercial fisheries contribute to sustaining Rhode Island coastal communities by providing jobs to fishermen and supporting businesses and industries, as well as food for local consumption or export throughout the United States (U.S.) and overseas. Additionally, the state’s recreational fisheries play a key role in supporting businesses that enable residents and visitors to enjoy fishing trips aboard their private vessels or on for-hire party and charter boats.

Rhode Island’s fisheries sector includes businesses that engage in or support the commercial and recreational harvest of fish and shellfish. This sector includes the harvesting and processing capacity of the fishing industry, in addition to support businesses and organizations (Sproul and Michaud

2018b). Although aquaculture is related to fisheries, it is mostly discussed in a separate section.

Several industries support Rhode Island’s fisheries sector. Many of these businesses are involved in the direct harvest, processing, or sale of fishing resources. Other industries provide services and supplies for workers in this sector. Table SF-1 shows the components of Rhode Island’s fishing sector as identified by Sproul and Michaud (2018b). For further detail of the industries that are included in this sector, please see Table SA-1 and the Technical Report.

Table SF-1: Sources for the Fisheries Sector

Source	Industry
Sproul and Michaud (2018b)	Commercial Fishing, Charters, Services and Supply, Professional Services, Seafood Markets, Tackle Shops, Seafood Processing, Wholesalers
NOAA (2015)	Fishing, Seafood Markets, Seafood Processing

Fisheries in the Nation’s Blue Economy

In the U.S., the fisheries sector includes 5,290 establishments that provide 56,167 jobs and produce \$6.720 billion in GDP (\$5.76 billion in real GDP). The fisheries sector experienced an increase in GDP from 2005 to 2015 as real GDP grew from \$5.43 billion to \$5.76 billion (6%). In addition, wages in this sector grew by 21.6% and 30.7% respectively (NOAA 2015).

Table SF-2: Employment Growth in Fisheries Industries Nationally (2005–2015)

Industry	Jobs			Change (2005-2015)	
	2005	2010	2015	Job Growth	Percent
Fishing	6,961	6,207	5,635	-1,326	-19.05
Seafood Markets	13,318	12,248	14,314	996	7.48
Seafood Processing	40,160	35,570	36,218	-3,942	-9.82

Source: NOAA 2015; Author’s Calculation

At 88%, finfish make up most of species landed in the U.S. (NMFS 2018). Nationally, growing seafood demands and stagnant domestic production have increased seafood imports (NMFS 2018). Between 1997 and 2013, imported seafood increased by more than 80% in weight and 70% in value (NOEP 2016).

Despite this trend, processing in the U.S. continues to be productive: In 2017, the production of raw fish fillets and steaks exceeded 798 million pounds. This includes the increased processing of groundfish fillets and steaks that total 606 million pounds. Altogether, processed fishery products total over \$10.8 billion (National Marine Fisheries Service 2018).

Fisheries in New England's Blue Economy

New England's historically productive fisheries are home to many high-value, commercially harvested species. Between 2010 and 2014, the commercial landing of seafood increased from 577.8 million pounds to 643.1 million pounds, which represents an 11.3% increase in New England (National Ocean Economics Program 2016) The total value of these commercial landings for New England grew from \$942.8 million to \$1.088 billion (15.4%) in the same time period (NOEP 2016).

Table SF-3. Employment Growth in New England Fisheries Industries (2005–2015)²⁶

Industry	Jobs			Change (2005–2015)	
	2005	2010	2015	Job Growth	Percent
Fishing (CT, MA, ME, RI)	2,198	2,119	1,851	-347	-15.79
Seafood Markets (ME, MA, NH)	*	1,430	1,372	*	*
Seafood Processing (MA, ME, RI)	3,527	3,779	3,375	-152	-4.31

Source: NOAA 2015; Author's Calculations

New England's fishing industries experienced relatively consistent job losses between 2005 and 2015. Long-term decreases in employment generally fell in line with the national average. The regional seafood industry lost jobs despite this industry's steady job growth nationally. Employment in the regional seafood processing industry also decreased from 2005 to 2015, but this industry rebounded to outperform the national average between 2012 and 2015 (NOAA 2015; Author's Calculations).

Rhode Island

Fishing has always been a staple of Rhode Island's ocean economy. The harvest, processing, and retail of shellfish, crustaceans, and groundfish continues to employ workers in the state. In 2017, commercial fishermen in Rhode Island landed 84,108 pounds of fish valued at \$93.8 million (NMFS 2018).

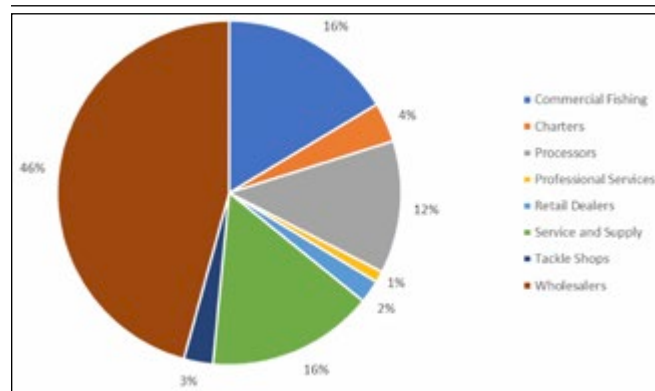
Table SF-4. Employment Growth in Fisheries Industries in Rhode Island's Blue Economy (2005–2015)²⁷

Industry	Jobs			Change (2005–2015)	
	2005	2010	2015	Job Growth	Percent
Fishing	98	53	78	-20	-20.41
Seafood Markets	*	*	*	*	*
Seafood Processing	265	258	236	-29	-9.82

Source: Sproul and Michaud 2018b; Author's Calculations

In Rhode Island, the fisheries sector includes 428 firms that support 3,147 jobs and earn a combined \$538.3 million in gross sales (Sproul and Michaud 2018b).

Figure SF-1. Rhode Island Fisheries Industries by Gross Sales (2016)



Source: Sproul and Michaud 2018b; Author's Calculations

Interestingly, industries that directly harvest fish resources (commercial fishing and charters) only earn 20.1% of this sector's gross sales: Direct fishing activity from commercial fishing and charters earned \$108.3 million in gross sales. Processors and wholesalers dominate much of the gross sales (58.2%), earning \$313.3 million. Industries most closely associated with recreational fishing (charters and tackle shops) earn \$34.7 million (6.4%) in gross sales.

Overall Sector Trends

National Oceanic and Atmospheric Administration (NOAA) economic data indicates that Rhode Island's fisheries sector declined as real gross state product (GSP) dropped from \$117.8 million to \$83.7 million (-28.9%) from 2005 to 2015. Despite this loss in real GSP, wages and average wages grew by 16.6% and 33.2% respectively.

Table SF-5 Real Gross State Product (GSP) in Fisheries Industries in Rhode Island's Blue Economy (2005-2015)²⁸

Industry	Values			Change (2005-2015)	
	2005	2010	2015	Real GSP	Percent
Fishing	\$71,236,277	\$49,284,506	\$45,074,016	-\$26,162,261	-36.73
Seafood Markets	*	*	*	*	*
Seafood Processing	\$23,292,693	\$21,582,080	\$19,359,384	-\$3,933,309	-16.89

Source: NOAA 2015; Author's Calculations

Rhode Island's fishing industry experienced large losses in real GSP between 2005 and 2015. Real GSP decreased from \$71.2 million to \$45.0 million (-36.7%) in this time. Much of this GSP loss occurred during 2007: Between 2006 and 2007, employment decreased by 26.2%, wages dropped by 44.3%, and real GSP dropped by 26.7%. Despite these decreases, average wages in the fishing industry rebounded and surpassed pre-recession wages between 2010 and 2015 (NOAA 2015).

26 * - denotes unknown values due to data suppression. For more information on data details, see the Fisheries sector tables in the Technical Report.

27 * - denotes unknown values due to data suppression.

28 * - denotes unknown values due to data suppression.

Sector Specific Data

("Current Day" Snapshot)

The Rhode Island's fisheries sector comprises a variety of overlapping industries. For organizational purposes, this section will present the industries of Rhode Island's fisheries sector referenced in Table SF-1. Although these industries are presented separately, it should be noted that these industries often connect or overlap with other industries and/or sectors in and outside of Rhode Island's blue economy.

Commercial Fishing

Commercial fishing is one of the cornerstones of Rhode Island's fisheries sector. Businesses in this industry tend to specialize in either finfish/squid or shellfish, including lobster, crab, scallops, and clams. Rhode Island's squid fishery is the second most productive in the nation; state fishermen landed 16.1 million pounds (almost 14% of the national total) in 2014 alone (NMFS 2015). Altogether, the state's commercial fishing industry is made up of 150 firms that support 1,711 jobs and earn \$88.39 million in gross sales (Sproul and Michaud 2018b).

Charters

The charter boat industry represents an important part of Rhode Island's recreational fishing industry. This industry contains 75 businesses that support 182 jobs and earn \$19.99 million in gross sales. Most businesses in this industry are relatively small (2.4 employees per firm), but this industry boasts some of the highest gross sales per employee at \$109,840 (Sproul and Michaud 2018b). A 2007 study funded by the Rhode Island Saltwater Anglers Association (RISAA) found that recreational saltwater fishing generated \$160 million in total value, \$24 million in wages, and supported approximately 1,030 jobs (RISAA 2007). (See Tourism and Recreation section for additional detail about the value of recreational fishing.)

Services and Supply

The service and supply industry supports other fishing industries by providing wholesale supplies such as nets, commercial tackle, bait, traps, and other gear for fishing and shellfishing operations. This industry also includes businesses that provide welding, engine repair, fuel, and other maintenance and repair services to commercial fishing boats and equipment. In this sector, the services and supply industry comprises 27 firms that support 152 jobs and earn \$84.61 million in gross sales (Sproul and Michaud 2018b).

Professional Services

The professional services industry plays an important supporting role for other industries in the fisheries sector. This industry supports the financial management, accounting, insurance, and consulting and logistics needs of fisheries-related businesses. Quota management, fisheries research, marine safety

training, and other fisheries-specific management services are also included in this industry. The professional services industry includes 18 firms that support 73 jobs and earn \$5.76 million in gross sales (Sproul and Michaud 2018b).

Seafood Markets / Retail Dealers

Retail seafood dealers are businesses that primarily sell fresh and frozen fish at seafood markets, community supported markets (like farmers markets), and retail "lobster shacks" that sell live and/or cooked lobsters for takeout or delivery. This industry does not include restaurants and bars, even those that are explicitly seafood-themed (See Tourism and Recreation section for information on eating and drinking businesses.) The retail seafood dealers industry includes 26 firms that support 136 jobs and earn \$11.57 million in gross sales (Sproul and Michaud 2018b).

Tackle Shops

Tackle shops are retailers that provide fishing gear, including specialty lures, fishing apparel, and custom-designed equipment (such as custom rods and reels) to fishermen. Tackle shops that also sell canoes, kayaks, and similar recreational supplies are excluded from this industry (See Tourism and Recreation section for information on sporting goods stores.) This industry comprises 25 firms that support 62 jobs and earn \$14.71 million in gross sales (Sproul and Michaud 2018b).

Seafood Processing

Processors handle virtually all commercial landings in Rhode Island's fishing industry. Seafood processors clean and package landed fish for sale. Rhode Island's processing industry is highly specialized: most of the processors handle finfish and squid, and the rest specialize in shellfish like lobster, mussels, and clams. Overall, the processing industry includes 11 firms that support 215 jobs and earn \$67.05 million in gross sales (Sproul and Michaud 2018b).

Wholesalers

Wholesalers include businesses that operate as fish dealers, importers, exporters, and seafood traders. This industry also includes wholesalers that provide retailers and restaurants with salted, smoked, and prepared seafood. The wholesale industry includes 96 firms that support 617 jobs and earn \$246.26 million in gross sales. At least 39 of these wholesalers are exclusively shellfish dealers (Sproul and Michaud 2018b).



Catherine Puckett
"Oyster Wench" Kelp Farmer

Catherine Puckett, owner of the Block Island "Oyster Wench" shellfish and kelp farm, doesn't mind the chill of an early spring day—the sky is blue, birds swoop, the ocean is clear—and it's just about time to harvest her golden sugar kelp. "Isn't it just gorgeous?" she marvels, pulling a seaweed swathed line alongside her boat for inspection. She's the island's first farmer to try her hand at kelp production, but she also grows oysters and hard clams, and experiments with selling invasive crabs for bait.

A single mom of two little girls, Puckett remembers herself as a youngster in her family's boat, island bound—and she's never really been away from the sea since. These days, her vessel boasts spirited hues of pink and blue, her daughters join her for harvest, and she's a vocal spokesperson for women-owned and operated water-based businesses.

Kelp growing's the easy part; the hurdle is selling it, she says. She's got a buyer this year, but next year could be different—so she's always thinking

ahead. "What we need is a hub in South County, a place where we can send our kelp, and other local seafood from the island," she says. "A type of co-op so industry can work together, pool our resources, and get the biggest return for our products." She's also interested in exploring how farming can be intertwined with other aspects of the island's marine economy; tourism—welcoming visitors to her farm—offers, for example, a natural overlap.

And she's thankful for the ocean farming life she's now living with her daughters as part of a coastal community. "I'm so grateful to the fishermen and island families who help me each and every day," she says. "They support what I'm doing, they give me advice, and they're sharing their years on the water so I can be a better business owner."

Sectors of the Blue Economy

AQUACULTURE



In 2017, farm gate value is \$5.77 million with 194 jobs (CRMC 2018).

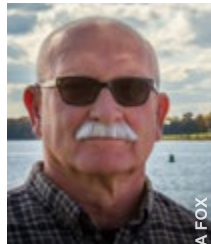
In 2018, the aquaculture industry grew by 23.2 acres and three farms for a total of 76 farms and 319.3 acres (CRMC 2019).

The 2018 farmgate value of Rhode Island grown products was \$5.85 million (CRMC 2019).

Aquaculture products for consumption and seed sales equated to \$6.09 million dollars (CRMC 2019).

My View of the Blue Economy: Aquaculture

David Beutel, Aquaculture Coordinator, R.I. Coastal Resources Management Council (CRMC)



and Virginia, are heading if certain conditions continue here. In the Salt Ponds, aquaculture takes place, but it is a complicated relationship between the industry and the

“Rhode Island aquaculture is doing well within the existing regulations. However, aquaculture in Rhode Island will not have the potential to be where other states, like Maryland

public. There are portions of the public that are not accepting of aquaculture, and no, I do not think that you will ever see an expansion of the activity in the Salt Ponds beyond the 5% rule. Pretty soon, unless there is substantial legislative support for aquaculture, and unless the user conflicts are resolved or improved, we are going to hit the saturation point for aquaculture in Rhode Island. Other states have somewhat similar issues, but not to this extent. This will have the impact of keeping aquaculture at a level below its potential. There are discussions about

examining how aquaculture could be applied more often within Narragansett Bay, and were that to happen, that could enhance the industry. There are other obstacles to aquaculture in Rhode Island; for example, while we do have a developed oyster raw bar market, other crops, such as kelp, do not have well developed marketing chains. This is a problem encountered by other states, too. But no, we are not positioned right now for the type of projected growth that other states with more supportive community arenas are looking towards.”

Introduction

Aquaculture is one of the state's fastest growing enterprises, reflecting a trend in shellfish aquaculture regionally. The nearly \$5.4 million in 2016 oyster sales in Rhode Island (Rhode Island Coastal Resources Management Council Aquaculture Report, 2016) is driving an increased interest in lease opportunities, and the state is encouraging growth, citing “green jobs” (Gov. Raimondo, remarks, April 2017) and contributions to the state's cultural and culinary arenas. Although the numbers and trends indicate that marine farming in Rhode Island has made significant strides in recent years, the data do not fully illustrate the complex environmental and social issues shaping the industry in Rhode Island. Most aquaculture in Rhode Island takes place in the Salt Ponds, located in the southern part of the state, and farmers and community members often disagree about whether and how the industry should operate in these pristine waters, and what farms should look like above and below the surface. The state has adopted a “5% rule,” limiting aquaculture in the Salt Ponds to no more than 5% of the surface area of each pond. At the same time, the state has identified aquaculture as an economic growth area, is investing in job training programs to ensure qualified workers for local farms, and is exploring potential for more farming in the open waters of Narragansett Bay.

Aquaculture in the Nation's Blue Economy

While the United States (U.S.) experienced a significant boom in marine farming in the last portion of the 20th century—production rose by about 400 percent, to a value of almost \$1 billion in the 1980s and 1990s (U.S. Commission on Ocean Policy 2004)—and grew 3.3 percent annually from 2009-2014, its rate still lags in contrast to the rest of the world (National Oceanic and Atmospheric Administration Aquaculture 2019)²⁹. The trend of growth continues, as in 2015, the U.S. was ranked 16th globally in aquaculture production with a valuation of \$1.4 billion (NOAA Aquaculture 2019).

Most of the aquaculture production in the U.S. involves bivalves such as clams, mussels, and oysters (NOAA Aquaculture 2019). The rest is largely shrimp and salmon (NOAA Aquaculture 2019). Oysters are valued at \$173 million, shrimp at \$11 million, mussels at \$10 million, salmon at \$88 million, and clams at \$112 million (NOAA Aquaculture 2019). NOAA has also estimated that 40 percent of the salmon caught in Alaska and 80 to 90 percent caught in the Pacific Northwest starts in hatcheries (NOAA Aquaculture 2019).

While sales of domestic marine aquaculture increased from 2007–2011 by 13 percent due largely to oyster and salmon production (NOAA Aquaculture 2019), the U.S. remains a minor aquaculture player worldwide. Half of the aquaculture products consumed in the U.S. come from abroad (NOAA Aquaculture 2019), and due to the importation of aquaculture, the U.S. seafood trade deficit grew to \$14 billion in 2016 (NOAA Aquaculture 2019). Today, the public and private sectors examine opportunities to grow the U.S. aquaculture industry so it can answer the country's food needs as well as increase economic health and job opportunities.

National annual wages within the aquaculture industry range significantly, with a biological technician earning an average median salary of \$41,650, aquaculture managers earning an average of \$64,170 (for all farmers, ranchers, and other agricultural managers), and aquaculture farmhands earning roughly \$34,153 per year, or \$11.50 per hour (“Aquaculture Salaries” 2019).

Aquaculture in New England's Blue Economy

The New England aquaculture industry is comprised of small, often family-owned companies with many workers originating from the fishing industry (Lapointe 2013). There are over 1,500 leases, permits, and licenses for aquaculture in New England (Lapointe 2013). Species include European oyster, American oyster, quahog, blue mussel, softshell clam, Atlantic sea scallop, bay scallop, and green sea urchin (Lapointe 2013). In the Northeast/Mid-Atlantic region, marine aquaculture totaled approximately \$219 million in 2013. Per this

²⁹ Globally, aquaculture production has been estimated at a valuation of USD \$243.5 billion and 110.2 million metric tons produced in 2016 (FAO). Annual growth between 2001-2016 has a moderate pace of 5.8 percent (FAO). An increase by 172 million metric tons is expected by 2021 which represents an increase by 15 percent over 2009-2011 levels (Lapointe). Some of the key organizations in this field are the National Aquaculture Association (NAA), World Aquaculture Society, Global Aquaculture Society, Aquaculture Stewardship Council (ASC), Northeast Aquaculture Research Farm Network (NARF-Net), and NOAA National Sea Grant.

evaluation, aquaculture is the third most valuable fishery in the region in terms of economic revenue, behind American lobster and scallops (NOAA Aquaculture). New England shellfish aquaculture has roughly \$50 million in dockside value at point of first sale (also called farm gate value) (Lapointe 2013). Cultured oyster harvest in the Northeast tripled in the past six years; it's now \$143 million (Rheault 2016).

Rhode Island

In Rhode Island, the aquaculture arena is narrower, due to permitting and market limitations. The state permits shellfish and kelp harvesting in its waters, and also cultures fish for stocking freshwater fisheries and restoring coastal habitats (CRMC 2019). The Rhode Island Coastal Resources Management Council (CRMC) is the lead state agency for aquaculture and coordinates with the Rhode Island Department of Environmental Management and the Rhode Island Department of Health on regulating this industry. There are nearly 80 farms operating on 300 acres at the ponds and Narragansett Bay; the farms are regulated by the state through 15-year maximum leases that are renewable (CRMC 2019). Growth is consistently strong, with the total number of farms and acreage dedicated to shellfish aquaculture rising at an average of 2.8 new farms and 12 acres per year since 1997 (more than doubling to over 70 farms and 240+ acres since 2006) (Leavitt 2016).

Aquaculture is among the state's fastest growing enterprises, reflecting the regional trend. Oyster sales topped more than \$6 million in Rhode Island in 2018 (CRMC 2019), and there is increased interest in lease opportunities. Still, there are challenges: Aquaculture business owners struggle to find and retain skilled entry-level workers seeking long-term career paths in the industry, there is uncertainty about locating aquaculture beyond the Salt Ponds and in other areas of Narragansett Bay (Rhode Island Shellfish Initiative 2019), and questions remain about how to bring to market other kinds of farmed seafood, like kelp.

The aquaculture industry in Rhode Island is expected to grow further and provide jobs (CRMC 2019) as there is a high demand for these products locally, nationally, and internationally. From 2005-2018, Rhode Island aquaculture increased in value per farm acre, total acreage leased, total acreage cultivated, and workforce numbers.

Aquaculture Leases (CRMC 2019)

Location	Acres	Location	Acres	Location	Acres
Pt. Judith and		Quonochontaug	7.9	Wickford	3.0
Pt. Judith Pond	75.9	Potters Pond	6.9	Harbor of Refuge	2.8
Ninigret	64.4	Sakonnet River	6.4	Warwick	2.8
Middletown	46.9	RI Sound	6.0	Allen's Harbor	2.0
Portsmouth	24.2	Trims Pond	5.3	Harbor Pond	1.0
Rome Point	22.1	Hog Island	5.1	Bristol	0.3
Winipaug	13.4	Great Salt Pond	4.9	Harbor Pond	0.3
Jamestown	13.1	North Kingstown	4.2		
Dutch Harbor	10.9	Fox Island	4.2		
		Total Acres	333.6		
		Total Farms	81		

Total acreage of aquaculture (includes shellfish and kelp) in Rhode Island by water body/ geographic area. Numbers based on personal communication with David Beutel, August 2019, and reflect 2019 totals.

Furthermore, between 1996–2018, total acreage cultivated and leased increased from nine to over 319 acres, and the value also increased from \$83,518 to over \$6 million. In 2018, the aquaculture industry grew by 23 acres and three farms from the previous year. Although oysters, quahogs, and blue mussels are the primary products, there are a few local farmers growing sugar kelp, many of whom also farm oysters. There is also growing interest in exploring opportunities to farm soft shell clams, surf clams, and bay scallops, with several farms growing these products (CRMC 2019).

Table SA-1. Acreage in Shellfish Aquaculture Industries in the Rhode Island Blue Economy (2005-2018)

Shellfish Aquaculture Farms	Values				Change (2005-2018)	
	2005	2010	2015	2018	Growth	Percent
Value per Acre	\$8,757	\$16,503	\$23,183	\$19,086	\$10,329	118
Total Acreage Leased and Cultivated	85	141	241.4	319.3	234	276

Source: CRMC 2005-2018; Author's Calculations

Table SA-2. Yield of Shellfish Aquaculture Industries in the Rhode Island Blue Economy (2005-2018)

Shellfish Aquaculture Farms	Individual Units				Change (2005-2018)	
	2005	2010	2015	2018	Growth	Percent
Oysters	1,530,815	3,652,414	8,272,172	8,515,950	6,985,135	456
Quahogs	32,745	62,000	47,325	41,995	9,250	28
Blue Mussels ³⁰	*	*	*	*	*	*

Source: CRMC 2005-2018; Author's Calculations

Employment in the shellfish aquaculture industry, including full-time, part-time, seasonal full-time, and seasonal part-time, grew from 2005–2017, with total employment growing by 385%. In addition, the total number of aquaculture farms and overall gate value increased, growing from 24 farms in 2005 to 73 farms in 2017, a spike of 204.17%. The gate value grew from \$744,319 to \$ 5,771,436, equating to a 675.40% increase. During 2017, there was a strong growth of 9.6 percent in aquaculture farm workers for a total of 194 workers (CRMC 2018).

Table SA-3. Employment Growth in Shellfish Aquaculture Industries in the Rhode Island Blue Economy (2005-2017)

Shellfish Aquaculture Farms	Jobs				Change (2005-2017)	
	2005	2010	2015	2017	Job Growth	Percent
Full Time Employees	13	17	47	62	49	376.92
Part-Time Employees	13	30	39	41	28	215.38
Full Time Seasonal Employees	2	4	26	27	25	1250
Part-Time Seasonal Employees	12	28	59	64	52	433.33
Total Employees	40	79	171	194	154	385

Source: CRMC 2005-2017; Author's Calculations

Table SA-4. Farm Value in Shellfish Aquaculture Industries in the Rhode Island Blue Economy (2005-2017)

Shellfish Aquaculture Farms	Values				Change (2005-2017)	
	2005	2010	2015	2017	Growth	Percent
Total Farms	24	38	61	73	49	204.17
Farm Gate Value	\$744,319	\$2,326,948	\$5,596,448	\$5,771,436	\$5,027,117	675.40

Source: CRMC 2005-2017; Author's Calculations

30 No information available due to proprietary nature of the data.

As they prepare to graduate and join the workforce, Samantha Montella and Sarah O'Neil, University of Rhode Island (URI) Energy Fellows, share their excitement about their career choices. "I think there is more going on with the environment and the economy than ever before," says Montella.

O'Neil agrees. "We will have opportunities, because this is an area that is growing. Jobs that we may have [in the future] don't even exist yet. When environmental concern and economic issues that arise when keeping the lights on are taken into consideration, renewables become a viable solution."



The Energy Fellows program provides its students with hands-on learning opportunities in the field of sustainable energy. Montella and O'Neil, both seniors, are completing internships at Green Development, LLC, a North Kingstown renewable energy developer, where they are participating in the growth of solar and wind power. The Fellows program, along with other URI courses and programs, has given them the education and experience to succeed in the renewable energy field, and Rhode Island has served as a fitting location for them to launch their careers.

"Rhode Island has the first offshore wind, which is impressive," says O'Neil, a Massachusetts resident.

**Samantha Montella
and Sarah O'Neil**

Energy Fellows

University of Rhode Island

Montella, of New York, adds that the more people recognize the need for renewables, the more the workforce will expand. "It's being seen more now as a necessary choice for energy, so change is happening."

While both Environmental & Natural Resource Economics majors are looking forward to returning to their own home states eventually and becoming part of the renewable energy workforces there, they value their time in Rhode Island. "My experience has been so useful. I plan to stay in Rhode Island for a while after graduation to continue learning," says O'Neil.

"I would advise younger students to find programs, like the Energy Fellows program, so you can fit your education to what you want to do," says Montella, adding that she knew going into college that she wanted to focus on the environment, and she turned to opportunities, like the Fellows program, to home in on a specific career path.

Renewable energy is a career field that is changing every day, say Montella and O'Neil, and they hope to be in it for the long haul.

"The development of renewable energy is taking place quickly, and we're able, through the experience we're getting, to stay ahead of the curve," says O'Neil. "We're learning things you're not necessarily able to get from a classroom."

Sectors of the Blue Economy

OFFSHORE RENEWABLE ENERGY



Direct effect value to be determined and 300 jobs.

In December of 2016, the Block Island Wind Farm became the first such North American facility, with its five turbines and 30 megawatt (MW) capacity generating enough energy to power 17,000 Rhode Island homes and support a large portion of the island's energy needs

(Deepwater Wind/Ørsted 2019).

Deepwater Wind directly involved 300 local workers in the construction, installation, and operation of the Block Island Wind Farm

(Deepwater Wind/Ørsted 2019).

The procurement of 400MW of energy from the proposed Revolution Wind wind farm, slated for an area roughly 15 miles south of the Rhode Island coast, would be able to generate about one-quarter of all the electricity used by the state annually (Governor Gina Raimondo, press release, Feb. 7, 2019).

My View of the Blue Economy: Offshore Renewable Energy (ORE)

Hilary Fagan, Executive Vice President of Business Development, Rhode Island Commerce Corporation



RICOMM. CORP.

"We're at a dramatic moment in time for offshore wind in Rhode Island and the Northeast U.S. High wind speeds off the Northeast shoreline, a large buildable continental shelf, and

high energy demand make this region desirable for offshore wind development. The growth of offshore wind presents a unique opportunity for the state and region, and we're well positioned to benefit. We have two deep-water ports, 11 institutions of higher education, and an existing supply chain due to the work on the Block Island Wind Farm. And we have flexible, demand-driven workforce training programs to train people for jobs in ORE. We have a window of time to solidify Rhode Island as a leader in

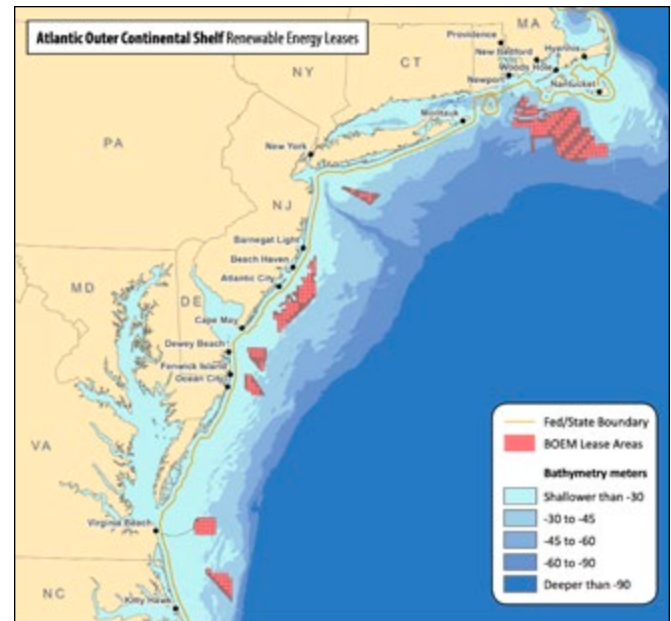
offshore wind energy technology and development—we're working to support the existing supply chain and to attract new companies to the state. We're committed to supporting the growth of this exciting new clean energy source."

Introduction

A growth sector for the blue economy is offshore renewable energy (ORE), an industry focused on securing electricity from clean, ocean-based resources such as wind, waves, and tides, rather than fossil fuels. Rhode Island, as the first state to host an offshore wind facility, the Block Island Wind Farm, is focused on building its ORE sector so it can play a significant role in the region's and country's offshore wind arena. In the United States (U.S.), the ORE sector includes industries that provide windfarm projects with a spectrum of services: design (e.g., feasibility studies, financial services), turbine manufacture (e.g., casting, rotor components, blades), non-turbine offshore wind farm facilities (e.g., towers, cable, foundations, access platforms), construction (e.g., vessels, divers, lighting), and operation and maintenance (e.g., inspection, monitoring, safety) (Business Network for Offshore Renewable Energy 2019). Such industries form the ORE economic backbone, or supply chain, and Rhode Island is focused on developing a robust local structure.

Although ORE is expected to contribute to the mitigation of climate change and expand the local and global economy, the potential cumulative impact and aggressive growth of this new industry on existing human uses and natural resources and wildlife remain unclear and require additional research (Willstead et al 2018). In addition, other marine resources users, including coastal communities, government, and civic and environmental organizations, and existing maritime uses, such as commercial and recreational fishing, shipping, and aquaculture, seek answers about potential impacts, minimizing conflict with this new industry, and better understanding the economic and workforce opportunities.

The U.S. is positioning itself to rapidly become a world producer of electricity from offshore wind, which will potentially result in attracting a \$300 billion investment (Business Network for Offshore Wind 2019) and revitalizing ports and coastal communities (AWEA 2019). This investment has the potential of producing energy for 6.5 million homes primarily along the coast (BOEM 2019) and job demands reaching



Source: U.S. Department of Interior, Bureau of Ocean Energy Management 2019

34,000 by 2020, 80,000 by 2030, and 181,000 by 2050 (NREL 2019). With Europe also setting an aggressive goal of producing 100 gigawatts (GW) of offshore wind by 2020, the market potential and workforce demand is significant (Wind Europe 2019). The U.S. federal government is leasing 1.7 million acres of the ocean bottom specifically for the development and siting of offshore renewable energy (ORE) facilities and projects. Currently there are 15 federal lease blocks, with the potential of producing 21GW just off the East Coast (Burdock 2019). This aggressive commitment presents a potential \$70 billion capital expenditure revenue opportunity to businesses within the industry supply chain over the next decade, not to mention the local economic activity development that operation and maintenance will stimulate (McClellan 2019).

The Northeast states and beyond are coordinating and competing for the economic and carbon reduction benefits of this new industry. The East Coast is a prime spot to develop this new industry because of the large populations living along the coast (e.g., Boston, Providence, New York), high energy

demand, significant wind speeds relatively close to shore, and a shallow outer continental shelf. The offshore wind industry is expected to create between 8,300 and 16,700 full time equivalent jobs in the Northeast by 2028 (BVG Associates Limited 2017). Research indicates there is significant wind potential and demand to invest in this new industry.

According to a recent study, seven states will be able to procure more than 18,000 megawatts (MW) of energy by 2030. Currently, the amounts of offshore renewable energy slated for east coast states is: New Jersey (3,500 MW), New York (7,730 MW), Massachusetts (3,2000 MW), Connecticut (2,000 MW), Rhode Island (1,000 MW), Maryland (1,200 MW), and Virginia (12 MW) (McClellan, 2019). Cumulatively, these state commitments are equivalent to the electrical capacity of 18 large nuclear power plants, and could drive the creation of an estimated 36,000 jobs in as many as 74 occupations over the decade (AWEA 2019). Overall, this sector will build in capacity by supporting more than 1,700 offshore wind turbines and towers, in addition to over 1,750 offshore turbine and substation foundations (McClellan 2019).

Rhode Island's prime location, high wind speeds, and proactive commitment to renewable energy have generated significant economic interest and activity in this industry. Wind farm investment in Rhode Island has attracted \$20 million in capital investment to the state economy, with entities, such as the Wind Energy Foundation, projecting that growing wind power in Rhode Island could result in \$240 million in electricity bill savings by 2050 and up to \$744 million in savings through lower gas prices (Utility Dive 2019). Building on this momentum, the state is implementing strategies to strengthen its offshore renewable energy supply chain and build its workforce, while considering, primarily through its coastal management administration, the potential impacts of industry development upon existing coastal and ocean uses, resources, and wildlife.

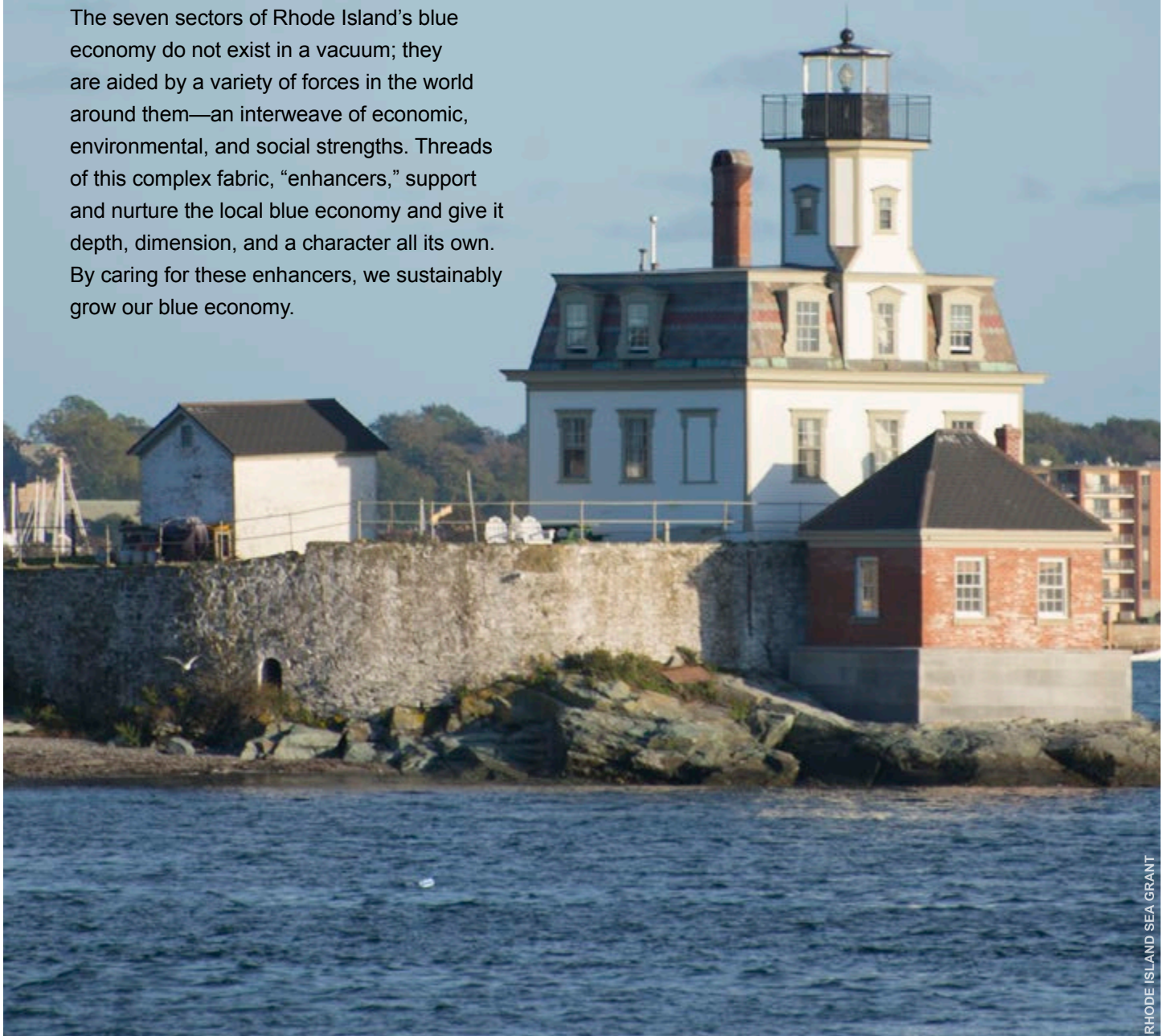
In addition to procuring 30MW from the Block Island Wind Farm, the state approved a 20-year power purchase agreement with Ørsted and Eversource for the offshore wind energy that the Revolution Wind project will deliver to the state (Froese 2019). This wind farm, with about 50 turbines, will be located about 15 miles from the Rhode Island coast—roughly midway between Block Island, R.I., and Martha's Vineyard, Massachusetts (CRMC 2019). Revolution Wind will generate enough clean energy to power more than 270,000 average Ocean State homes each year, about a quarter of the total electricity used by Rhode Islanders annually. Ørsted and Eversource are committed to investing \$40 million in Rhode Island for local port improvements. The Port of Providence will serve as a major construction hub, and Quonset Port will likely serve as the long-term operations center. The project is estimated to create 800 construction jobs and 50 permanent operations and maintenance jobs. It is slated to be operational circa 2023 (CRMC 2019).

Northeast Renewable Energy Standards and Goals

Maine	<i>Set goal to have 2,000 megawatts (MW) of wind power installed by 2015 and 3,000 MW by 2020 (State Legislatures 2019). A later report set a renewable ocean energy goal of five gigawatts (GW) of offshore wind by 2030 (State Legislatures 2019).</i>
Vermont	<i>Does not have any offshore renewable standards, but it aims to be 75% renewable by 2032 and seeks to have 90% of energy from renewable sources by 2050 (State Legislatures 2019).</i>
New Hampshire	<i>Does not have any offshore renewable standards, but seeks to be 25.2% renewable by 2025 and 100% renewable by 2050 (State Legislatures 2019).</i>
Massachusetts	<i>Seeks to utilize 35% renewable sources by 2030 and aims to reduce greenhouse gas emissions by 25% by 2020 (State Legislatures 2019). The state also has a goal to obtain 2,000 MW of wind energy by 2020 and harness 1.6 GW of offshore renewable energy by 2027 (State Legislatures 2019).</i>
Rhode Island	<i>As part of the state's Grow Green Jobs RI Action Plan, Rhode Island has set its renewable energy standard target to 14.5% of renewable energy by 2019 and increasing 1.5% per year until reaching 38.5% by 2035. Although not adopted by the State Legislature, the Governor signed an Executive Order to procure 1,000 MW of clean energy by 2020 (Chris Kearns, personal communication, June 17, 2019). To date, Rhode Island has procured 430 MW of offshore renewable energy through the Block Island and Revolution Wind wind farms.</i>
Connecticut	<i>Aims to have 2,000 MW by 2030. (State Legislatures 2019).</i>
New Jersey	<i>Aims to harness 7,500 MW of offshore wind energy by 2035 (State of New Jersey website 2019).</i>
New York	<i>Goal includes becoming 50% renewable by 2030 and aims to have 9,000 MW of offshore renewable wind energy by 2035 (State Legislatures 2019).</i>

The Complex Fabric Supporting Rhode Island's Blue Economy

The seven sectors of Rhode Island's blue economy do not exist in a vacuum; they are aided by a variety of forces in the world around them—an interweave of economic, environmental, and social strengths. Threads of this complex fabric, “enhancers,” support and nurture the local blue economy and give it depth, dimension, and a character all its own. By caring for these enhancers, we sustainably grow our blue economy.



Enhancers



This section begins to describe four enhancers—Quality of Place, Workforce, Innovation, Resiliency—and offer insights from those engaged in, or thinking about, the nuances of Rhode Island’s ocean-based economy and its opportunities and challenges. The enhancers can be described as follows:

Quality of Place

This is the degree to which a place’s natural and built environments resonate, both with residents and visitors, as authentic, unique, and meaningful. This section provides glimpses into history’s shaping of the local landscape and the assets Rhode Island should bank on to preserve its place value.

Workforce

A blue economy is necessarily dependent on plentiful jobs for skilled employees. Rhode Island has integrated workforce development resources from public, private, community, and academic spheres, bridging the gap between education and employment and improving opportunities for local graduates to find work in their home state.

Innovation

Innovation is doing something in a new or different way; the section provides a snapshot of Rhode Island’s long history of being innovative, presents information about the culture of innovation in Rhode Island, and explores Rhode Island’s potential to expand its participation in the regional economy.

Resiliency

The ability to return to life-as-normal following an emergency is the heart of resiliency; this section considers the work Rhode Island has undertaken to help coastal communities prepare for strong storms and sea level rise, identifies key obstacles, and asks what shoreline change means for a heavily coastal blue economy.

Quality of Place

Unique and Meaningful Natural Assets and Environment

Quality of Place Defined

Rhode Island is, in many ways, defined by its physical relationship to the ocean. From the Narragansett Indians, whose masterful harvesting of quahogs helped support tribes for millennia, to 18th-century colonists who embraced water power as the conduit to modern industrialism, and to yachters worldwide whose homage to Newport's waters is legendary, ocean tides might well be Rhode Island's pulse. Look no further than Interstate 95; the government's general issue license honors the "Ocean State" and depicts a cresting, grey-blue wave. And regularly, travel media lauds this coastal landscape, admiring the "less crowded and underdeveloped beaches, ones that families have returned to for generations (New York Times 2019). The ocean and coast are the physical underpinnings for the industries that comprise Rhode Island's blue economy.

So quality of place can be understood, broadly, as the measure of benefit provided to people by the natural landscape. Rhode Island, overall, stacks up well, data-wise: significant public land, such as beaches and parks, is managed by the government; amenities such as public access points, boat and kayak launches, fishing piers, and hike and bike trails are plentiful; and voter approval is strong for open space bond issues to support government efforts to maintain lands for conservation and recreational purposes.



Rhode Island's Quality of Place: A Talk with Ken (Frazier) Payne

Ken Payne, a revered Rhode Island statesman and self-declared lifelong student, has served in many roles, including policy

advisor to the state Senate, moderator for the Rhode Island Ocean Special Area Management Plan (Ocean SAMP) public process, and member of numerous boards of organizations such as the Rhode Island Food Policy Council. Somehow, he still manages to spend significant time reading, writing, and re-writing—he was, at the time of this talk, 10 drafts into his policy piece on Rhode Island's "green economy"—and deliberating on a variety of issues, including the differences between "quality of life" and "quality of place."

Quality of Life vs. Quality of Place

In Payne's view, the terms differ in scope. Quality of life, he says, referring to a definition developed for the United Nations, measures for health, literacy, and income, with adequacy in each "enabling you to have a full life and family and the ability to go into public with no shame," he says. Quality of place, on the other hand, measures the extent to which the environment—Payne focused here on the natural environment, building off his "green economy" work—is recognized by people for providing them with a wide range of value, including economic prosperity, health, comfort, pride, and enjoyment.

"In terms of quality of place attributes, Rhode Island does very well," says Payne. "We have a vibrant quality of place."

Knowing the state's history is a key in part to understanding what gave rise to this quality in the first place. "Why is it that we have had, here in Rhode Island, wonderful open space and public access for a solid three-hundred-year period?" asked Payne. "It's because we weren't overwhelmed with suburbanization, as other places have been. We have, to a great degree, held on to the formative physical characteristics of our communities. There is a presence of layers of time; Rhode Island has a very high density of historic structures. Therefore, we did not lose the authenticity and identity of our landscapes—natural, working, and otherwise."

Opportunity

Payne points to several ways in which Rhode Island's natural landscape looms large in terms of quality of place:

High Points for Land Preservation

With 45 local land trusts and dedicated government, non governmental organizations, and community-driven land and historical preservation offices and efforts, Rhode Island possesses active and advanced resources and technical expertise necessary for protecting and enhancing land deemed critical to either maintaining character, or supporting environmental, cultural, and recreational goals. "It is often through these entities that awareness of the need to protect and provide public access is cultivated," says Payne.

Exceptional Open Space and Public Access

So used to this degree of access are we in Rhode Island, indicates Payne, that we fail to recognize its uncommonness. "When one considers the acres of land that are being held and maintained for public benefit, for public good, and when the related assets are factored in—think of the public access to beaches that we have—we are unlike many other places," says Payne.

Plentiful Hiking and Biking Trails

Because Rhode Island government has operated for a long time with specific agencies targeted at management for particular portions of the environment—the state Department

of Environmental Management oversees, for example, parks and beaches, while the state Coastal Resources Management Council administers the coastal public access program—Rhode Island now, quite flexibly, coordinates the provision and maintenance of an array of supportive services, such as hiking and biking trails, often in tandem with community and business interests. “These can happen once the larger public access needs are answered,” says Payne.

Nature’s Benefits for All

As most of Rhode Island’s public and open space can be enjoyed for free—some fees, such as parking costs, apply to amenities like state beaches—the natural landscape provides opportunity for people to experience nature, a high-quality life enhancer, at little to no cost. “Yes, the outdoors is an equalizer,” says Payne. “If we want people to participate in blue and green economies, we must ensure that they have the means to develop appreciation for the outdoors, and from there, expand this so they, too, can expand their opportunities and participate in the economies.”

Challenges

Where Rhode Island’s landscape fails—and it’s a problem shared by many states, is not in nature, says Payne, but in development—especially residential development. Payne moves away from his emphasis on the natural environment to talk about a key challenge in housing that, in his estimate, mars Rhode Island’s quality of place.

The Fundamental Flaw in How We Create Residential Places

“We fail the diversity test, and the divide in Rhode Island is very sharp,” says Payne. The failure, he continues, is deeply rooted in the basic principle of home ownership against which Americans, by and large, measure economic wealth and prosperity. “For most households, the primary asset is the home, and the homeowner thus wants the home to appreciate in value.”

Payne says the problem is not in home appreciation itself. “The problem is that the values of appreciation are, more than ever, dependent upon exclusion, rather than upon diversity. Due to the values we now attach to home appreciation, we fail, in terms of quality of place, the diversity test. While our

natural landscape provides opportunity for equality across economic and social standings, our residential landscape is increasingly an obstacle to such.”

And if the natural landscape already supports some connection to equality, reasons Payne, does it not make sense to consider its value as an arena for understanding and examining new economic opportunities, be they “blue” or “green,” for Rhode Island?

The Future

“Optimizing,” rather than “maximizing,” is central to Payne’s thinking, when it comes to taking Rhode Island’s economy

in a new direction that aligns it with “green” (farms and forests) and “blue” (fisheries and water supplies) resources. While economics traditionally isolates a target commodity, such as lobsters or lumber, and tries to maximize its yield and price, Payne envisions a local economy that takes a more holistic approach, seeking optimal results on a playing field where the conditions and needs of many resources and uses are wisely weighed, and choices are based on sound science.

It means, perhaps, a loss of some value for prime commodities, like lobsters, but it could provide a competitive bump up for other catches, and ultimately ensure longevity for them all. “We can choose to want all of our resources, and not make it an either/or decision. It’s very doable,” says Payne. If it seems far-fetched, think again. Rhode Island, in many ways, is already doing it. Payne notes that the state already has:

A Healthy Natural Based Resources Economy

Seven industries—marine trades, tourism and leisure activities, fisheries, forestry, water supply, agriculture, and

renewable energy—employ many. “One job out of every nine here is natural resources based,” says Payne.

Good Stewardship Always Aligns with Optimization

Consider the work of a land trust, Payne says, which often examines a wide range of economic, environmental, and social assets when developing a care plan for a portion of land. The more successful efforts are those that focus on overall quality of resources, rather than the quantity or size

Ocean State, Open Space

Since 1900, the State of Rhode Island has so far conserved 90,482 acres—about an eighth of the Ocean State. Of those conserved acres, 38,775 are state bond fund acres (*Rhode Island Department of Environmental Management 2019*).

In the six state elections held from 2006-2018, a majority of Rhode Island voters (60-74%) backed environmental bonds issues (*The Providence Journal 2018*).

The first of Rhode Island’s 45 land trusts launched in 1972 (*Rhode Island Land Trust Council 2019*).

Rhode Island oversees 222 coastal access points, all of which are open to the public (*Rhode Island Coastal Resources Management Council 2019*).

Rhode Island’s natural public recreational resources include eight saltwater beaches, 8,200 acres of parkland, 1,000 campsites, 400 miles of hiking and biking trails, 200 fishing spots, and 25 park and nature preserves. They draw more than 9 million Rhode Islanders and tourists a year (*Rhode Island Department of Environmental Management 2019*).

of the property. “Optimization is inherently a function of stewardship, and we need to start thinking about the economy in those terms.”

The Public Has Always Invested in Infrastructure

As Rhode Island voters are traditionally generous with supporting bond issues that pay for open space purchases and for the creation of public buildings, facilities, roads, and bridges—why not extend this thinking? “Within the blue and green economies, we have many opportunities to invest in infrastructure. We have fishermen who are going to require vessels that can navigate through windfarms. Our public water supplies are stored in reservoirs or infrastructure. Our marinas are infrastructure unto themselves,” Payne says. “We have a legitimate tradition of supporting and designing public infrastructure, and every one of our natural resources industries are infrastructure dependent.”

No Choice But to Be Agile

“Fortuitously, Rhode Island is a place with limited space,” says Payne. We are eight times the population density of the U.S. as a whole. That means that within a 1,000 square-mile area, we have one million people, which would thus mean, that space is at a premium, and we have the opportunity now to figure out ways to make multiple uses of this space.” Rhode Islanders, he said, have already proven themselves willing to take part in space-planning work, as evidenced by their participation in the creation of the Ocean SAMP, which carved out room for a wind farm, among competing uses, in state waters bordering Block Island.

Workforce

Integrated Workforce Development Opportunities

Workforce Defined

While the term, strictly speaking, isn't difficult to define—a “workforce” consists of jobholders—understanding how they can perform optimally in a rapidly changing economy—be it “blue,” “high-tech,” “global,” or “21st century”—can be both a challenge and an opportunity.

From Farmland, to Factories, to the Future

Farmers were among the first “workforce” in Rhode Island; Native Americans raised corn and shared their expertise in subsistence growing with European colonists who expanded farming commercially and made Rhode Island a solid agrarian economy for more than 200 years (Rhode Island Farm Bureau 2019). That economy would shift to industrialism by the 19th century, as Rhode Island entrepreneurs harnessed rushing river waters to power factories and mills, and built the first modern system to treat wastewater (Blackstone Heritage Corridor 2019). A “golden age” of manufacturing would enable several generations of Rhode Island families to work lifetimes within iconic single companies—Brown and Sharpe and the Gorham Manufacturing Company, for instance (Small State Big History 2019)—through the Depression and both World Wars. Through changing economies, higher education options expanded; public and private colleges maintained a variety of education tracks—from academic, to technical, to military training—with college-educated workers moving into government and the private sector in business, healthcare, education, and service industry jobs.

But by the end of the 20th century, Rhode Island's economy stuttered. Traditional manufacturing faltered, as the costs of utilities increased and it became cheaper for companies to operate in other parts of the country or overseas. Colleges graduated students who would move elsewhere in search of available jobs. And while Rhode Island's popularity for its coastal tourism remained high, wages associated with often seasonal work remained low, and other “blue” industries met with hard times. As a decade-long national recession hit Rhode Island in 2007, marinas and boat builders feared they'd have to close doors (Wendy Mackie, personal communication, June 27, 2019), while the commercial fishing industry faced a triple threat: stock declines, climate change, and an aging workforce (Jason McNamee, personal communication, July 19, 2019).

Some of the steps taken to solve those problems became the building blocks for today's blue economy in Rhode Island. A public-private effort undertaken to retrain boat builders so they could apply their skills in the composites industry (Wendy Mackie, personal communication, June 27, 2019) has become a textbook example of a "blue-tech" success, and commercial fishermen engage in government and academic efforts so they can be informed and be leading voices in navigating issues such as offshore wind farms, warming waters, and workforce recruitment (Jason McNamee, personal communication, July 19, 2019). Rhode Island's evolving economy, one that includes "blue" business, may not be marked, as in past ages, by a specific type of work, such as farming or manufacturing, but it is emerging as a collaborative, problem-solving arena—one that cuts across sectors, reflects learning innovations at both the college and workplace levels, and provides in-state job opportunities, even as it proves itself regionally relevant.



It's a tall order, but totally doable, says Scott Jensen, director of the Rhode Island Department of Labor and Training. He says it's all about

integration, which turns the old model of workforce building on its head.

Take a Deep Breath— and a Trip Back to the '50s

"Telling people to 'Take a deep breath, we can do this,'—that's a lot of what I do, because people are often just kind of overwhelmed, and aren't really sure about how Rhode Island is going to be able to serve the workforce needs of the future," says Jensen, who served as Maryland's workforce development czar prior to his current appointment. "But I tell them, there's a great amount that has been done, and is being done here, to get us to that point. My job is to make the workforce work great, and I can do that, in great part, because of what we have going here, and what we're doing to connect it all together. I really believe integration is the key."

To describe what he means by "integration," Jensen first goes back in time, to the 1950s—a heyday, in Rhode Island and elsewhere, for behemoth businesses and corporations backboned by "in-house" resources and support. "Think of that time. Think about how these businesses trained their workforces," says Jensen. "The era was marked by enormous, less-than-lean conglomerates who faced little

foreign competition. They were able to spend significant time and money on training workers, not only in the specifics of their jobs, but in understanding the ethos and principles of their places of employment. It was possible to get hired at a General Electric of old straight out of high school to sweep floors, and 30 or 40 years later, if you were talented and worked hard, to retire a vice president."

And he mentions that era, says Jensen, because "it's that post-World-War business context which truly shaped the government workforce programs that came into being during that time, and are largely, in many ways, with us today." Not needing to train workers for jobs—businesses were doing that on

their own—state programs addressed very practical issues that were best dealt with by direct government programs, such as unemployment insurance and the enforcement of workplace safety and wage and hour laws. On top of that, says Jensen, because the technology driving innovation has stabilized since the upheavals of the industrial revolution more than a hundred years prior, the education model had basically striated into two workforce pipelines—"you either went to college for a 'white collar' job at one of those businesses, or you were 'blue collar' and were trained on the job in a manufacturing plant."

Fast forward to today, says Jensen, and "you're looking at a whole different world," one that's emerged somewhat transfigured from the last recession, with lean and decentralized businesses, entrepreneurial agility, and global and technological competition. The weakness of this new model is that training and mentoring budgets for developing human talent are not factored in. Making this more challenging is that each day, transformative technologies emerge

that as of yet are not taught in school or applied in business. It's no wonder, Jensen says, why there would be a disconnect between today's workforce stakeholders, be they jobseekers or employers, and the resources typically available to support them. The gap created here is more than just a skills gap.

"Deep breath," he repeats, because this is where the good news—the integration—comes in.

Integration is the Key to Workforce Training

With the shift in the economy away from the all-inclusive corporate structure toward a more fluid and spare entrepreneurial model, an evolution has taken place in the provision of

Workforce Development by the Numbers

Real Jobs Rhode Island—the state's platform for workforce development—created the following three-year impact across both industry and workers. (data: 3/1/16–4/1/19)

44 Sector Partnerships developed across 16 industry sectors (at least six of these sectors are significant to the blue economy)

855 Employers Served (hired new worker, secured intern, or trained current worker)

167 New Hire Training Activities

125 Incumbent Worker Training Activities

12 Pipeline Development Activities

3,132 New Hires Placed

3,119 Incumbent Workers Upskilled & Entrepreneurs Served

10 New Career and Technical High School Programs Created

(Source: *Real Jobs Rhode Island Program Report*, 7/1/19)

support to workforce needs. “So what changed? Who stepped in when the corporations weren’t doing the R&D, job and tech training, and mentoring anymore? The colleges did. Non profits did,” says Jensen. “We started being imaginative, and now government needs to keep up too.”

This new mode of workforce development stressed career over job, skill building to serve the needs of evolving employees and employers, and education and technical training for a spectrum of a science-informed industries. “Government and the private sector saw this, and said, “We’re in,”” says Jensen.

And because so many different players were bringing workforce development and job training opportunities to the forefront on their own, the need emerged for an across-the-board integration of these valuable services. “What we have now isn’t a system as much as it’s a network,” says Jensen, “and what I see this office doing is being the integrator, the platform or mechanism, for resources, the programs, the people we have to share with this developing network.”

Opportunities

Integration of workforce programming across government, business, and education arenas leverages economic opportunity, as a wider range of learners, from students to workers, plan potential entries into varied industries seeking skilled workers of all levels:

Pipeline Training is Targeted

Rhode Island’s workforce development model is in keeping with the national and often the international mode of thinking: government and the private sector work together and are supported by academia in identifying key industries that represent economic growth areas, and then these areas become pipelines, as an education-to-workforce-to-continued-training path is created and enhanced. In Rhode Island, “pipelining” has been established for a number of local industries, with several of them key for the blue economy: aquaculture farmer and farmhand training, submarine construction, windfarm servicing, and marine trades building and design, for example, with technology and innovation training being offered to support the breadth of industries within the local economy.

Schools and Colleges are Key

Schools—primarily, as of now, from high school up through college and graduate school, but with increasing inclusion of younger grades—are pivotal alongside government and private sector efforts to develop workforce training. High school and college represent for many students the first introduction to potential careers. Higher education works alongside government and business to craft and offer programming, often targeted to pipelines, that provides classroom learning in concert with worksite skill building, and then supports continued training with professional development opportunities.

Examples of Real Jobs Rhode Island workforce training efforts with strong school engagement include a Wind Energy Career Pathway Initiative (WindWinRI), with the North Kingstown Chamber of Commerce partnering with North Kingstown High School and the University of Rhode Island on windfarm education programming for students and teachers, and a submarine trades program that brings Electric Boat together with the New England Institute of Technology and the Community College of Rhode Island (Real Jobs Rhode Island 2019).

Challenges

Employment Opportunities Lag

While the local economy is improving and workforce development efforts are making inroads, many Rhode Island college graduates still need to secure work outside of the state (Forbes 2019).

Housing Is Tight, Business Costs Are High

It’s not easy to buy single family homes in Rhode Island, as inventory is low (RI Realtors 2019), nor are costs of business operation, such as those related to utilities, as affordable as those in other states. (RIPEC 2019).

The Future

Jensen sees Rhode Island workforce development building on its current successes with some positive changes: “I think we’ve got a good balance between what we’re doing with pipelines, and what we’re doing to be flexible, to answer needs by integrating across the resources—I really see that as the focus,” he says. “But what I would love to see if we could move ourselves toward some real and new kinds of support for our workforce—I would love to see us provide programming, perhaps a voucher type of program, so people would have the wiggle room they need to secure transportation, to secure childcare. More and more often, I’m talking to people, and these are the things that are standing in their way to stable, solid places in the workplace.”

Innovation

History and Culture of Supporting New Ventures and Cross-Sector Collaborations

Innovation Defined

Innovating means doing things in a new or different way. In terms of business and the economy, innovation is an activity often associated with problem solving, and “achieving new levels of technological prowess, productivity, and ultimately prosperity” (Kerr 2015). By disrupting old or tired modes of thinking and breaking out of ruts and silos, issues can be recast, and new collaborations can decide how to answer them in better ways. Innovation can refer to improvements in products, in the processes applied to create them, and in the partnerships supporting them. Technology firms, entrepreneurial companies, and startup businesses born of collaboration between the private sector and academia or the military are commonly described as being innovative and pioneering.

Innovation also exists outside the boundaries of the technology strata; it percolates throughout Rhode Island, and plays out not only in advances in the economy, but in strides made in education, the environment, and in social and cultural arenas.

Seeing Differently

When it comes to innovation, seeing differently is part of doing differently. This is something that Tom Carroll, a director of innovation programs for both the state of Rhode Island, via Rhode Island Commerce Corporation, and the Naval Undersea Warfare Center (NUWC), encourages people to do. “It’s going to become increasingly possible for us to work in the oceans and explore opportunities for communication improvements, security improvements, and medical and health advances, just for starters,” says Carroll. “We need to be visualizing innovation and where we want to go with it.”

Many are doing just that. “Former Defense Secretary Chuck Hagel once called southeastern New England ‘the Silicon Valley of undersea warfare.’ I like to believe that Rhode Island is the heart of that ‘Silicon Valley,’” says Stephanie Murphy, marine engineer at local defense innovation firm Navatek LLC. For Brendan Breen, who grows cultured pearls in quahogs via

his startup company, Mercenaria LLC, innovation starts with the entrepreneur’s ability to “see what can be,” and strengthens through supportive collaboration.

For others, like Scott Jensen, director of Rhode Island’s Department of Labor and Training, and Deedee Chatham, program director of Entrepreneurship & Innovation at the University of Rhode Island Business Engagement Center, innovation conjures an increasingly seamless, iterative, and two-way connection between education and tomorrow’s workplace. Jensen sees an integrated array of training resources supporting job seekers and employers; Chatham emphasizes connection as well, with “team-based programming across all disciplines” and problem-solving in which cross-sector collaboration helps “democratize” innovation, and opens it to a larger audience.

Still others—take Jason Kelly, executive vice president of Moran Shipping Agencies, Inc. and co-founder and board

Glossary for Innovation

Some terms used in innovation circles include:

Design thinking — Applying design methods and principles (like empathy, observation, and experimentation) to solve problems or develop new offerings.

Hackathon — A time-limited work session often focused on solving a specific problem or addressing an issue, held over the course of a day, weekend, or month. Teams form with members that have different skill-sets. Often, there is a pitch-off or presentation at the end of the hackathon, and prizes are awarded to the best projects that emerge.

Angel investor — An individual investor who offers funding, mentoring, introductions, and other help with the eventual goal of a return on investment. Angels usually

invest at the earliest, or seed stage, before venture capitalists get involved with a company.

Startup accelerator — Fixed-term programs that allow a startup to receive mentorship, education, and other services needed to get it to its next stage. The best-known of the accelerator programs are Y Combinator, Techstars, and MassChallenge. Most accelerator programs conclude with an investor pitch event.

Startup incubator — Physical spaces often run by non profit organizations, which aim to help entrepreneurs develop a new business. There is often an application process which can be just as selective as an accelerator program.

(Excerpted from “A Glossary of Innovation Terms and Strategies” by Pamela Bump, 1/2/18, *Innovation Leader*.)

chair of SeaAhead, an ocean focused venture development, and Curt Spalding, a professor of the practice at Brown University’s Institute for Environment & Society—see innovation as a collaborative opportunity for reframing economic, environmental, and social problems and testing potential solutions. Kelly says that Rhode Island, with its “living ocean assets” and a “biodiverse Narragansett Bay,” can play a leadership role in driving innovation in the New England ocean cluster and blue economy, and Spalding says the state has a proven track record in problem solving in many areas, including life sciences, and this can be applied to “blue” issues. And for Ken “Frazier” Payne, an author and advisor of Rhode

Island policy initiatives, innovation takes place when we move beyond “maximizing” the value of one resource, and choose instead to more broadly “optimize” the potential of many.

Community and Connection are the Core of Innovation

Physical clusters of companies within a similar industry have spurred innovation through working together as well as competing with one another. This can be seen from the corporate campuses of Silicon Valley to the “technology highway” of Route 128 outside of Boston. And Rhode Island, to a degree, claims its own places for entrepreneurship and business innovation: Aquidneck Island, with its Naval presence, hosts defense industry and ocean technology clusters; Bristol is home to companies known for advances in boat design and composites applications; and Providence, with several hospitals and Brown University’s medical school, has attracted pharmaceutical laboratories and the healthcare industry.

Still, innovation doesn’t necessarily hinge on the ability of companies to inhabit physical communities in proximity to each other. The advancement of global, web-based communication and commerce, coupled with the costs associated with traditional brick-and-mortar development, increase the potential for virtual innovation communities. Regardless of form, innovation communities often share characteristics that emphasize:

Cross Sector Learning and Collaborative Problem Solving

Coming up with something new makes the most sense when lots of stakeholders representing varied interests and views are driven to seek change. “It’s about focusing on problem solving to respond to societal needs,” says Spaulding. When there is real need, innovation occurs authentically, with a logical flow, a process described by Carroll, of NUWC and Rhode Island Commerce Corporation, in simple terms: “Communicate, collaborate, innovate, demonstrate.”

Openness to Trying Incentives and Taking Risks

Innovation companies are considered more likely than traditional business to test the boundaries of economic survival. Although Rhode Island’s experience with venture capital investment for the private sector is minimal when compared to neighboring Massachusetts, efforts are being made to introduce potential and burgeoning startups to opportunities for growth. Kelly, of Moran Shipping and SeaAhead, notes “the untapped potential of our regional cluster synergies,” and his colleague, Alissa Peterson, co-founder and executive director of venture developer SeaAhead, says that sometimes, launch becomes possible when the kernel of a company receives mentoring, networking introductions, and other support services. “Providing this support enables the company to fully focus on what they’re trying to create,” says Peterson. A variety of support entities for the innovation sector now exist.

Private sector entities CIC (Cambridge Innovation Center) and Venture Café operate in Providence offices at the Wexford Science & Technology building. A business and community organization, the Social Enterprise Greenhouse, also of Providence, guides and supports entrepreneurs working on social issues. Innovate Newport represents the city’s efforts to provide collaboration space to support innovation, and Hope & Main in Bristol is a private sector culinary incubator and offers kitchen space and marketing services. And on the government side, support services and economic incentives are available, with the Rhode Island Commerce Corporation providing assistance via business attraction, expansion, and retention programs.

Opportunities

What’s Old is New Again

Scan a primer of Rhode Island history, and the state’s early innovation figures clearly. State founder Roger Williams was recognized even in his own time for a streak of unorthodox creativity and independence bordering on the eccentric. The depth and breadth of Samuel Slater’s collaboration with other thought leaders of the time launched his legendary mill and Rhode Island’s emergence as the birthplace of American industrialism. The state would go on to revolutionize wastewater treatment, create the country’s first comprehensive coastal and ocean management policies, and establish itself as an essential haven and knowledge center for the world’s expert sailing community. Payne says “Rhode Island has always been innovative” and that often, the most compelling examples of positive change are those that “embrace history’s lessons—its successes as well as its failures. And Rhode Island’s greatest innovation? Why, religious tolerance! Roger Williams had the idea, but Rhode Islanders, Quakers, Jews, Episcopalians, and Baptists achieved a proof of concept. Puritan Massachusetts hated what was happening here, yet we wouldn’t have modern culture without it.”

The Ocean State’s Regional Advantages

Rhode Island’s regional proximity to Boston has been identified as an opportunity for cultivating connections to the Bay State’s robust innovation sector known for its rich collaborations with numerous colleges, including the Massachusetts Institute of Technology and Harvard University. Rhode Island is also centrally located in a Northeast economy, from Maine to New York, which “produces a combined economic output of \$2.1 trillion and a combined innovation output of 16,000 patents (Brookings Institute 2016). Kelly, of Moran Shipping and SeaAhead, illustrates this further: “Rhode Island’s location between Boston’s global leadership in tech and innovation and New York’s legacy maritime and financial ecosystems presents an exciting strategic opportunity for the country’s smallest state,” Kelly says. “And while Silicon Valley still leads

in venture capital dollars, innovation in the Northeast is newly attracting capital to both Boston and New York—now second and third in venture money.”

Challenges

Separated by Sector “Silos”

More innovation could take place in Rhode Island’s blue economy if sectors collaborated on problem solving and opportunities for economic enhancement. While some collaboration does take place—for example, the ports and shipping industry is engaged with the offshore renewable energy industry in determining business roles that ports can play in wind farm construction, such as serving as staging or storage locales—other kinds of interaction are possible: Tourism and recreation businesses could further explore the potential to develop visitor activities, like aquaculture farm tours, with marine farmers, while defense and ocean technology interests could work with marine trades to examine resiliency approaches for coastal business. “I do see the opportunity for defense technology to have wider application to other areas of the economy in Rhode Island,” says Amanda Costa, director of Rhode Island Operations at Navatek LLC. “These technology advances are usually built on fundamental engineering approaches that have endless applications. Advances in the defense industry are usually inspired by other commercial developments and vice versa.”

Graduate Migration and Other Economic Challenges Persist

Rhode Island has made some economic progress by investing in its public college system, transportation infrastructure, and workforce training programs, but obstacles remain, including lack of jobs and housing for college graduates, and a business environment hampered by costs tied to utilities and property taxes (Brookings Institute 2016). In terms of the problem of college graduates leaving the state for work, more focus is being paid to how Rhode Island’s public college system, with a concentration of local residents largely seeking in-state work, can more closely engage with economic and workforce planning efforts to create skilled jobs for skilled workers (Leazes et al 2016).

The Future

Carroll, of NUWC and Rhode Island Commerce Corporation, sees no reason why Rhode Island can’t be the Paris Air Show for defense sector innovation, and for ocean technology writ large. Crediting United States (U.S.) Senator Sheldon Whitehouse with the allusion to the world’s largest celebration and display of aircraft, Carroll says Rhode Island has a significant opportunity to be a premier global center for ocean technology, but that there is work to do. “We need to recognize the considerable value of the innovation we already have happening here, and we need to then work together

to leverage it further,” he says. “And then, we really need to promote it, promote it, promote it. Why shouldn’t we be the Paris Air Show?”

More broadly, the vision of Rhode Island being a leader, on a larger scale, in blue economy and ocean based business, would also mean a cascade of exciting and vibrant changes in the way that people live, work, and learn in Rhode Island: students of all age levels would participate in education programs that enable them to experiment with innovation, and startup companies would make use of recognized and proven incubator and accelerator facilities and resources until they achieved stability. Compelling careers would be available to college graduates wanting to live and work in their home state, and out-of-staters would seek to move here, as housing and jobs would be more plentiful than in decades. Quality of place would be a prime consideration for all residents, and Rhode Island’s coastal and ocean environment, and its assets, like fresh and local seafood, would be prized and central to economic, environmental, and social goals and opportunities.

For Kelly, part of this vision is already in place. “New England’s ocean cluster has one of the most robust blue economies in the world, anchored by unrivaled ocean research and development capabilities, a blossoming bluetech startup ecosystem, and a legacy ocean cluster community which includes dozens of blue economy subsectors,” he says. “Of particular note is Rhode Island’s blue economy ecosystem, a uniquely diverse and robust ocean cluster, which includes defense, the marine trades, offshore wind, the marine sciences, ports and shipping, aquaculture and fisheries, logistics, maritime AI and cyber, undersea tech, smart bay and most importantly our living ocean assets—our 400-mile-plus coastline, deep water ports, and biodiverse Narragansett Bay.”

Resiliency

Helping Rhode Island's Blue Economy Thrive in the Face of Climate Change

Resilience Defined

Resilience, in a basic sense, means bouncing back to normal after disruption. Coastal resiliency refers to two kinds of endurance—one involves a place's ability to adapt so it can withstand storm flooding and erosion, while the other involves withstanding, over time, the encroachment of water as sea level rises. Projected increases in both storms and sea level rise are tied to climate change (National Climate Assessment 2018).

Tabulations of losses, existing and potential, point to the growing problem that rising water poses for Rhode Island and other coastal states. For example, it's estimated that by 2100, \$3.6 billion in Rhode Island property could be compromised by flooding (The Union of Concerned Scientists 2018). Similarly, it's estimated that Rhode Island's coastal housing market lost \$44.7 million in appreciation between 2005 and 2017 due to an increased risk of tidal flooding (Columbia University, First Street Foundation 2018), and by 2050, a staggering \$106 billion worth of United States (U.S.) real estate could be under water (National Climate Assessment 2018).

For Rhode Island and its blue economy, resilience has emerged as an important enhancer—the more adaptive the state is to storm and sea level rise impacts, the more sustainable its blue economy can be. Resilient coastal communities are better prepared to endure short- and long-term physical shoreline changes, while residents and businesses are better able to resume daily life at home and work following a disaster such as a hurricane.



Teresa Crean, a coastal manager at the University of Rhode Island Coastal Resources Center and an extension agent for Rhode Island Sea Grant, focuses on coastal resilience as part of her work. Crean assisted the state's coastal regulator, the Rhode

Island Coastal Resources Management Council (CRMC), in the development of comprehensive coastal resilience guidance and recommendations—the Rhode Island Shoreline Change Special Area Management Plan (SAMP), or, as it's familiarly known, the "Beach SAMP"—that was adopted by the council in 2018.

Reflecting on the work that she, alongside numerous government, community, private sector, and academic partners

undertook to develop and test a wide suite of Beach SAMP policies and tools, Crean says that, "Rhode Island has a number of success stories illustrating coastal adaptation in municipal projects, and the state is committed to ensuring that stakeholders and decision makers at all levels have access to decision-support tools to assess risk so they are empowered to make a plan and take action for reducing future damage and losses from coastal hazards."

Rhode Island's Blue Economy is Vulnerable

Rhode Island's coastal infrastructure, including buildings, roadways and bridges, telecommunication systems, ports and marinas, and energy facilities may be vulnerable to flooding, erosion, or other impacts from natural hazards, such as wind damage from storms. It is also important to remember that the natural environment is also critical to the success of the blue economy—beaches, estuaries, and other "soft" landscapes are important to many businesses, including those in the tourism and recreation, fisheries, and aquaculture sectors. Information on the vulnerability of municipal transportation assets from sea level rise and storm surge is available at http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

Community and Business Resiliency Building Takes Shape

In the past decade, Rhode Island has committed to understanding climate change and its impacts, and is collecting the science necessary for substantiating the problems and risks, educating the public, and forming collaborative efforts to plan for protecting coastal communities from flooding and erosion. These efforts include:

State Government Recognizes Resilience as a Goal

The Resilient Rhode Island Act established the Executive Climate Change Coordinating Council (EC4) in 2014. It also set specific greenhouse gas reduction targets and incorporated consideration of climate change impacts into the powers and duties of all state agencies. Rhode Island also hired its first Director of Stormwater and Resiliency at the Rhode Island Infrastructure Bank, and created the "Resilient Rhody" climate change strategy. In addition, the state now mandates that certain volunteer boards at the municipal level, such as planning boards, receive basic resiliency education.

Coastal Communities Gain State's Most Comprehensive Resilience Guidance to Date

Full guidance and recommendations are available for helping coastal communities incorporate policies and practices into municipal plans and codes so they can prepare for the impacts of storms and sea level rise. CRMC administers the Beach SAMP, with a supportive array of coastal mapping applications (STORMTOOLS) and policy guidance so decision

makers, planners, asset managers, and property owners can make science-informed choices about coastal development.

Rhode Island's Small Size Creates a Workshop or Laboratory Atmosphere

State decision makers and staff can engage regularly with local coastal communities on place-specific flooding and erosion issues, and community concerns can be relayed to state officials quickly and efficiently.

Infrastructure Success Stories

Accomplishments include the efforts of 19 state and municipal wastewater treatment facilities to begin incorporating climate resilience into their management plans and to implement actions to protect plants from flooding. For example, the Warwick, R.I., facility is now protected from floodwater by an engineered berm made largely of natural materials, and the Warren wastewater plant features elevated machinery that can remain operational during floods. Also, the Rhode Island Statewide Planning Program identified and prioritized the roads and bridges in the state that are most prone to impacts from projected sea level rise as the first step in a process toward building resiliency into these structures.

Next Steps

While significant progress has been made to make resiliency a reality in Rhode Island, much more work is necessary to ensure that communities and their infrastructure—the basis upon which the blue economy relies—are better able to withstand the increasing pressures of climate change impacts. Work continues in these areas:

Putting the Pieces Together

While data, policy guidance, and planning and mapping tools are widely available now, municipalities lack the staff, resources, and capacity to fully carry out the work necessary to move into practical implementation of solutions. Similarly, the state has taken great strides to document and prioritize areas of concern—such as those roads or bridges that stand to be compromised by climate change impacts—but lacks the resources for putting the plans into action.

Testing the Beach SAMP is Still Underway

The Beach SAMP contains detailed guidance to assist municipalities in their resiliency planning, and CRMC now requires that coastal property owners seeking a permit complete a



Segments of Rhode Island's road network are exposed to high tides and storm surge flooding; they will be further compromised by rising seas in 2050.

risk assessment worksheet before the permit is issued. It remains unclear, however, what larger effect the recommendations will have upon coastal development, especially in terms of where and how homes and businesses can be built or rebuilt close to the water.

Resiliency is a Community Issue

Efforts are ongoing to ensure that people from many walks of life in coastal communities understand climate change and its impacts, and the blue economy business arena is included. As more marine-based businesses acknowledge the need for resiliency building, they, too, can become leaders who educate others.

The Future: A Blue Economy Powered by Resiliency Innovations

Rhode Island is already well positioned on its path to a resilient future, making its blue economy better prepared to maintain stable routines in the face of shoreline change and the impacts of flooding and erosion. Advances include:

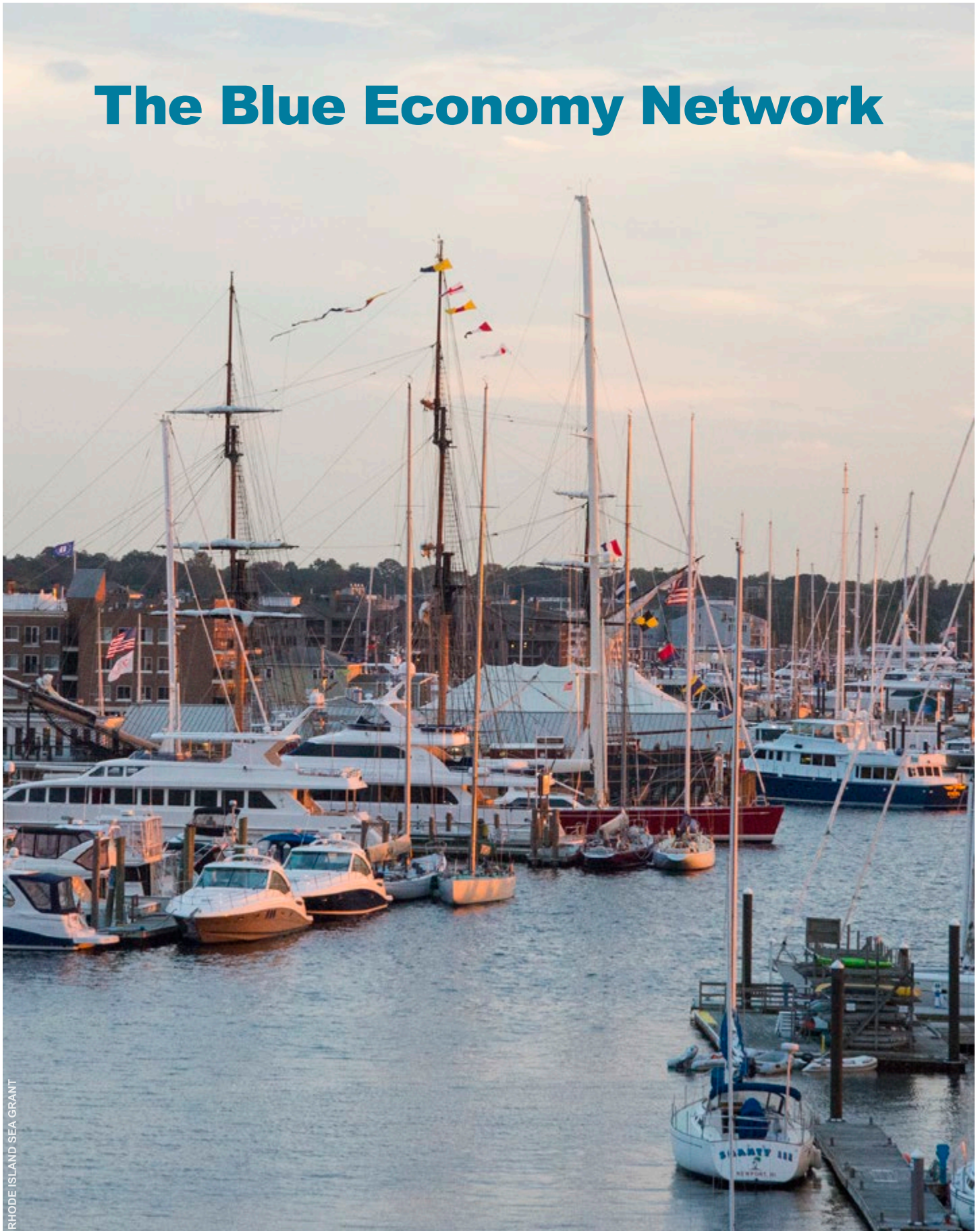
Practical Actions to Protect Property and Habitat

Solutions are being implemented at state and municipal levels. For example, the city of Newport has raised the height of harbor pilings. This infrastructure improvement now keeps floating docks and tethered boats secured even if they are lifted by rising water. Around the state's shoreline, stabilization projects are protecting both coastal development and habitats important for fish nurseries and other wildlife. These efforts can now be monitored and evaluated for their adaptation effectiveness, and potentially replicated elsewhere.

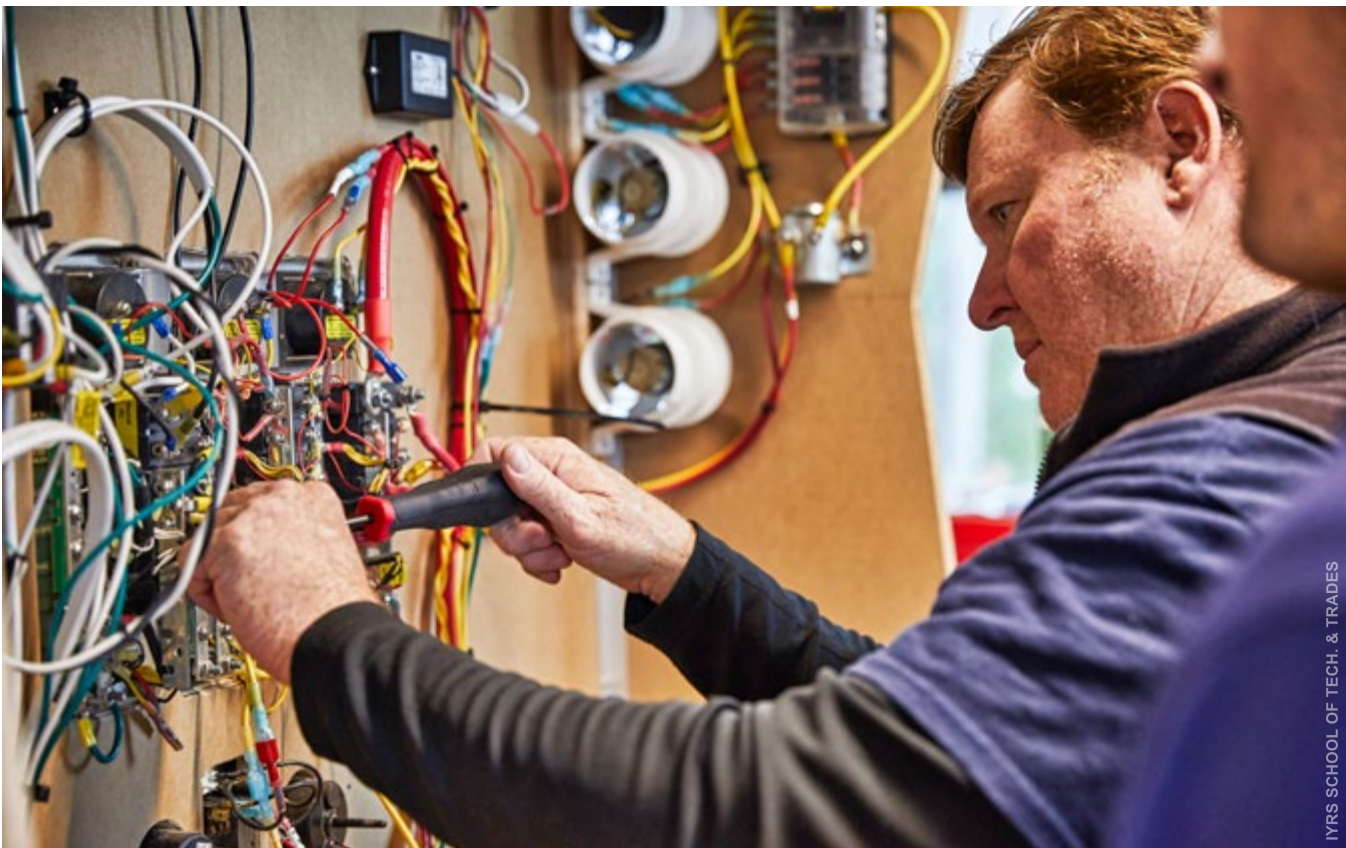
Navigating Difficult Dialogues to Improve Policy

As Rhode Island tests new resiliency policies and practices, and as climate change impacts continue, coastal communities will increasingly encounter challenging questions: Where and how should people and their homes and businesses locate on a diminishing shoreline—or should they at all? How limiting should development recommendations or regulations be? What will happen if marine-dependent business finds it difficult and expensive to continue in place either on or near the coast? These complicated issues encompass the public, private, legal, academic, and community spheres, and will require continuing partner efforts to evolve policy and resolve problems.

The Blue Economy Network



RHODE ISLAND SEA GRANT



Rhode Island’s blue economy combines traditional industries such as marine trades, ports and shipping, fisheries, and tourism and recreation with emerging industries such as composites, undersea defense, aquaculture, and offshore renewable energy. Integral to the success of this industry are higher education and research institutions, marine-focused advocacy and civic groups, and government agencies that contribute to building a strong workforce within the blue economy, invest in blue economy sustainable growth and innovation, and/or plan for and protect coasts and oceans.

This social network analysis, called affiliation network or two-mode analysis (Borgatti 2013), reveals the connections among Rhode Island’s blue economy sub-sectors. The first mode is the list of individuals who have been identified as having at least one tie to the overall network of interest. The second mode represents the sources of information—event attendees, organization leaders and members, databases, industry directories, or documents—where individuals likely to be affiliated with a sub-sector of the blue economy as defined in this report could be identified (Borgatti 2014). The present analysis is a first sketch based solely on publicly available information sources as described and not personal contacts or interviews. The basic idea is that an initial overall picture of likely connections among actors in Rhode Island’s blue economy can guide further analysis, which could involve interviews or further examination of affiliations. Individuals who

have met each other or are involved in some way in a blue economy project, company, event, research project, or public policy effort can be identified. Those who appear especially well-connected might be important leaders, communicators or influencers whose insights are valuable in understanding how a sub-sector with only weak ties to the current blue economy could better engage with it.

In the present blue economy overview network analysis, lists of businesses and organizations related to the Rhode Island blue economy were provided by Rhode Island Commerce Corporation, covering defense, hotels, restaurants, and seafood. Information on firms involved in marine trades comes from the Rhode Island Marine Trades Association (RIMTA) online membership (RIMTA 2019), and the composites industry from the Composites Alliance of Rhode Island (CARI 2019). Additional information on the defense industry based in Rhode Island is available from the Southeastern New England Defense Industry Alliance (SENEDIA 2019) as well as participants in the Undersea Technology Innovation Consortium (UTIC) (UTIC 2019). Information on the ports and shipping subsector is taken from the membership or staff listings of organizations including the Providence Working Waterfront Alliance, ProvPort, Quonset Development Corporation, and Moran Shipping Agencies, Inc.

Fin fisheries and shellfisheries firms and key actors were identified through several association membership lists online, including the Rhode Island Commercial Fishermen's Association, the Responsible Offshore Development Alliance (RODA), advisory committees to the Rhode Island Department of Environmental Management (RIDEM) and the Rhode Island Coastal Resources Management Council (CRMC), participants in the Rhode Island Shellfish Management Plan (SMP), the Rhode Island Ocean Special Area Management Plan (Ocean SAMP), the Commercial Fisheries Research Foundation (CFRF), and the Commercial Fisheries Center for Rhode Island. The renewable energy sub-sector centers on the activities of Deepwater Wind/Ørsted including newspaper coverage and press releases from the company announcing its engagement with local firms, as well as connections with the Business Network for Offshore Wind.

The Diagram

The following are the data sources of affiliations and individuals for the specific Rhode Island-centric network diagram that has 'bubbles' circling the main subsectors. It is NOT a comprehensive list of sources, since names and affiliations may have incidentally appeared in news articles or websites that are indirectly tied to the key actors or have been included in a broader category or association in the matrix that includes non-Rhode Island entities or individuals. Some nodes were deleted after the diagram was created but still remain in the data. In addition, this is NOT a full representation of all the nodes within Rhode Island blue economy sub-sectors, rather it only includes the first few expansions of the network data from the starting point of a small number of groupings of Rhode Island entities.

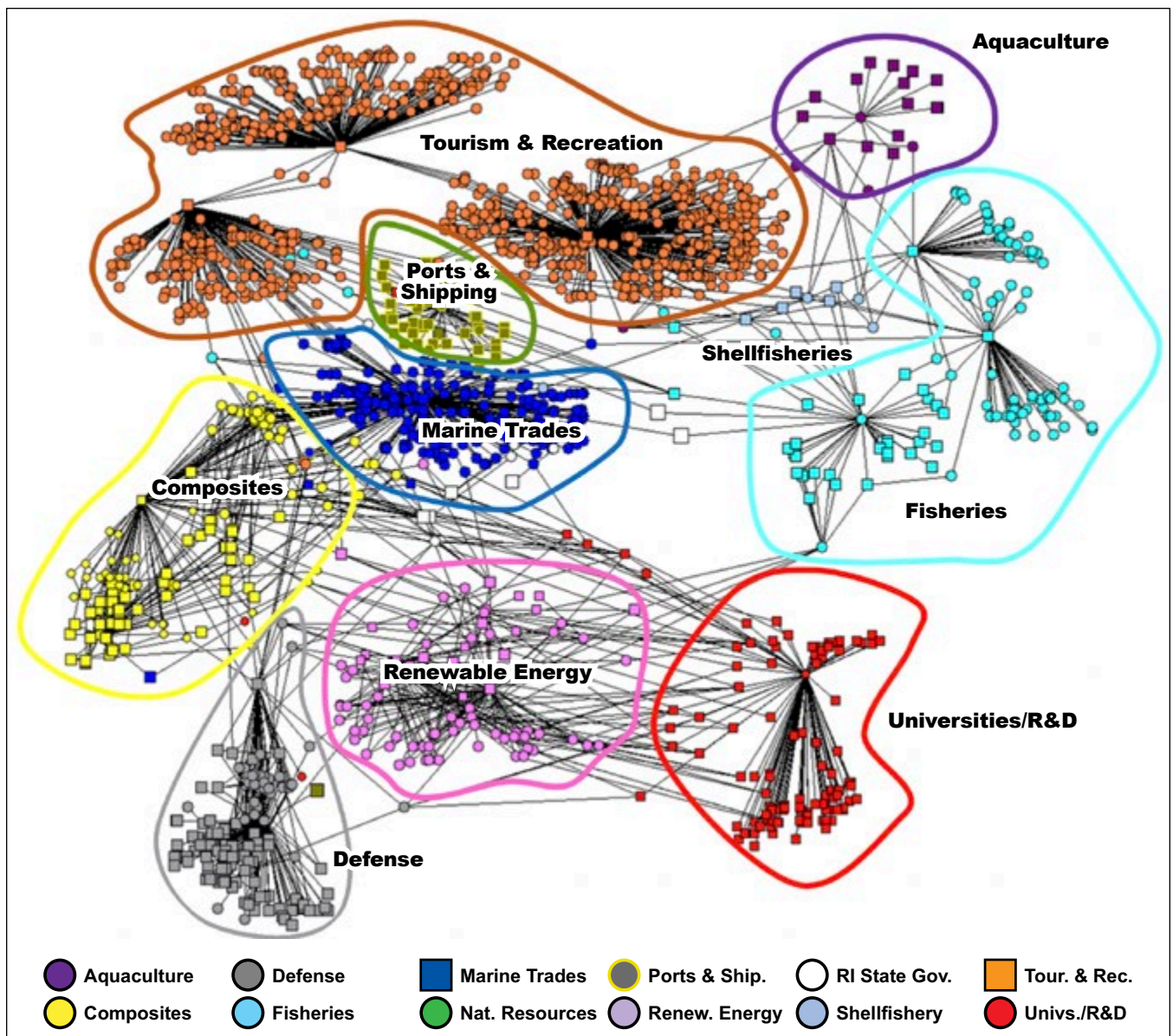


Figure 1. An Overview of the Relationships Among Firms and Individuals Involved in Rhode Island's Blue Economy Sub-Sectors.

Major Trade Leads by Sector

Defense

Southern New England Defense Industries Association (SENEDIA) with the Undersea Technology Innovation Consortium (UTIC), Naval Undersea Warfare Center (NUWC)

Marine Trades

Rhode Island Marine Trades Association (RIMTA) with a strong link to Composites Alliance of Rhode Island (CARI)

Aquaculture

Ocean State Aquaculture Association, East Coast Aquaculture Growers Association

Ports and Shipping

Propeller Club Port of Narragansett Bay, and the Providence Working Waterfront Alliance

Commercial Fishing

Commercial Fisheries Research Foundation (CFRF) and Commercial Fisheries Center for Rhode Island, Rhode Island Commercial Fishermen's Association, Rhode Island Shellfisherman's Association, Rhode Island Lobsterman's Association, Responsible Offshore Development Alliance (RODA), and Responsible Offshore Science Alliance (ROSA)

Tourism and Recreation

Tourism Councils (Block Island, Blackstone Valley, Newport County, Providence/Warwick, South County) Rhode Island Saltwater Angler's Association, Rhode Island Party and Charter Boat Association

The overview sociogram in Figure 1 consists of 211 events, organizations, or entities that generated 1,466 named individuals (or a business name only when an individual associated with the business or event was not easily identified). The following is a summary of some of the major findings from this analysis. In addition, Figure 1 is a highly compressed version of the more complex diagram not shared in this report due to its extensive detail. By simplifying the diagram so as to develop one that is understandable, many of the university research and development (R&D) affiliations and individuals were deleted. Some of this is reflected in the section below concerning the University of Rhode Island's (URI) involvement in the blue economy.

Rhode Island trade associations are the glue that hold this network together.

Many of Rhode Island's blue economy sector trade associations work to respond to the needs and demands of their membership. They offer, for example, educational and workforce development programs, public relations assistance, networking opportunities, and representation at state, national, and global levels. The marine trades, defense, and composites industries have numerous close ties among firms and actively engage with policy makers and educational institutions. RIMTA and SENEDIA have established "sister" organizations to respond to the specific needs of sub-sectors within these growing entities. For example, the purpose of

CARI is to grow this sub-sector by marketing Rhode Island's strength in this technology globally and serving as a forum for Rhode Island composites companies to share expertise and respond to shared issues, like growing a skilled labor pool (CARI 2019). CARI builds upon a century-old tradition of excellence in boat building in Rhode Island and has expanded its reach into areas including aerospace and marine energy. Wendy Mackie is the CEO for both RIMTA and CARI, which keeps the link strong between the two entities, and provides the composites industry members with the non-marine focused services they need to expand to other sectors. RIMTA organized the 2019 Southern New England Marine Industry Environmental Conference (<http://rimta.org/index.php/agenda/>), featuring speakers from the tourism and recreation industry, researchers, as well as composites and marine trades representatives who introduced innovations both to reduce the environmental impact as well as increase the productivity of the marine industry.

The defense industry in Rhode Island is similarly structured around the well-established Naval Underwater Warfare Center (NUWC) and its continuing role in fostering innovation and managing from Rhode Island a network of innovative firms based here and throughout the United States (U.S.). SENEDIA works to identify, champion, and coordinate issues that contribute to national security and provide benefit to members' communities, the departments of Defense and Homeland Security, and other federal government agencies. Meanwhile, "sister" organization UTIC is able to focus on rapidly growing undersea and maritime technology and facilitate collaborative, rapid development testing and commercialization of innovative undersea and maritime technology for commercial, academic, and nonprofit organizations contributing to the defense and security of the U.S. (UTIC 2019). Like Mackie, Molly Donohue Magee holds dual roles; she is the executive director for both UTIC and SENEDIA, allowing for seamless synergies between the two entities.

According to this analysis, although the other key sectors—tourism and recreation, fishing, aquaculture, offshore renewable energy, and ports and shipping—have strong leaders, they may not yet be as strategically or integrally networked into the blue economy as they could be. For example, Rhode Island has many strong tourism councils that effectively promote their counties and businesses; however, their involvement in strategically connecting with the aquaculture or shellfish industries to promote existing activities, such as the Rhode Island Oyster Trail, and to also build the capacity to diversify services such as co-developing aquaculture farm tours or clamming classes, is not strong. However, seafood festivals are promoted.

The Propeller Club and the inactive Providence Waterfront Alliance could be forums to proactively establish increased coordination within the ports and service industries. They

could—if positioned correctly—serve to coordinate and identify future development opportunities within the blue economy. Currently, for example, each Southern New England port and potential service provider is establishing its own relationships with the offshore wind industry. Although there is a great interest by many to establish some structure that would increase coordination and communication among the ports, especially with Port of Providence and Quonset, not much progress

blue economy sectors to bolster the research agenda and identify innovative solutions to respond to some of the issues identified in the Strategies and Actions section. These include responding to climate change impacts, and implementing techniques to ensure commercial fishing access within proposed offshore wind farms. Stronger connections between marine trades (e.g., naval architects) and defense (e.g., undersea technology) could identify solutions that would

benefit not only Rhode Islanders, but service a much larger marketplace of resource users around the world. It is possible that RODA and Responsible Offshore Science Alliance (ROSA) could act as platforms to help make this work for some blue economy sectors.

Universities play a key role in bringing these different sectors together.

Many URI departments and programs are involved in providing education, training, research, and advisory services to blue economy firms. URI has been especially engaged in providing the scientific and technical basis for renewable energy, fisheries and aquaculture, environmental quality, marine and coastal conservation, and management efforts in conjunction with stakeholders and Rhode Island government agencies. In addition, URI's key role in bringing diverse sectors to the table to build an understanding and identify solutions to difficult issues has been instrumental in strengthening the blue economy network and represents a unique strength in the Northeast region. State

and private funded efforts including the Ocean SAMP and the SMP brought together many sectors from within and beyond the blue economy to inform the siting of the Block Island Wind Farm and establish a comprehensive blueprint for the management of our state's shellfish resources. URI departments also assist with workforce development and innovation efforts, that encompass and go beyond the blue economy arena alone. For example, the composites industry is engaged with the textiles industry in part through a URI Textiles Innovation Network. Engineering and science departments are active in nano-technology innovations, which touch upon but are not limited to blue economy businesses. This network analysis focused primarily on URI's involvement and not that of other universities. Although others are engaged in the different aspects of the blue economy as well.

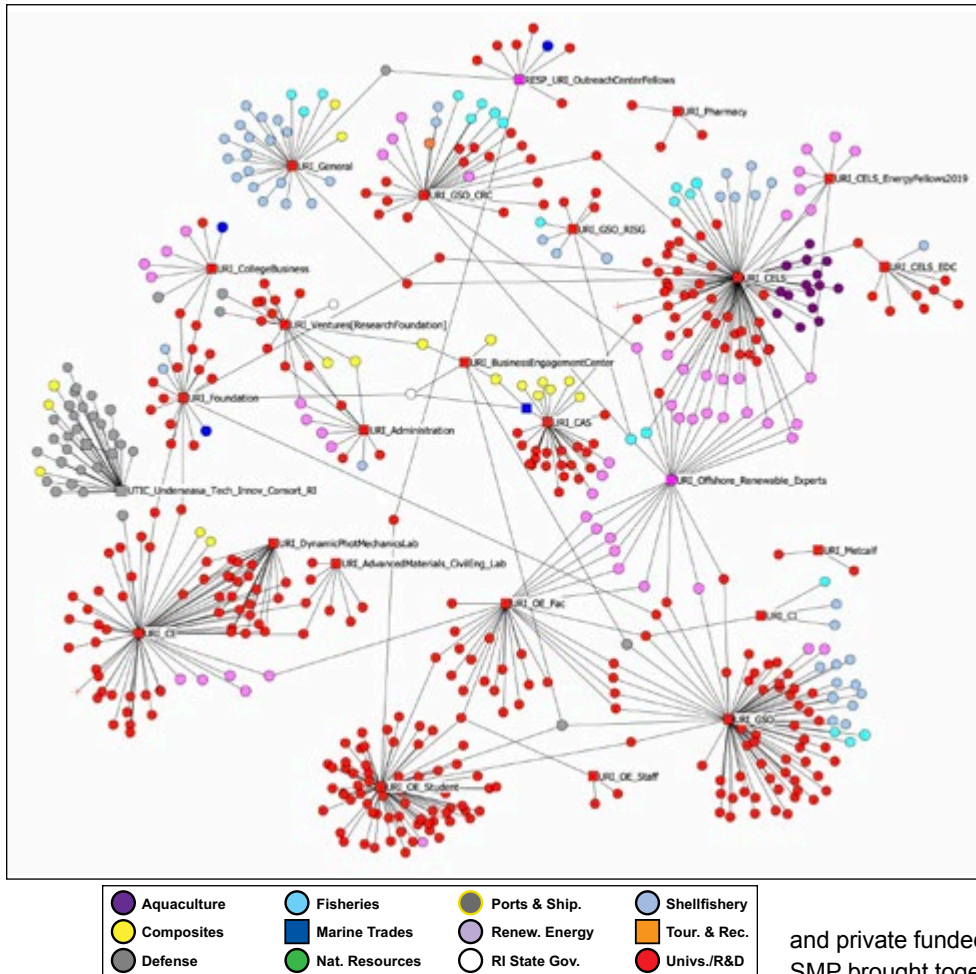


Figure 2. Overview of University of Rhode Island Interactions with Blue Economy Sub-Sectors.

has been made. A traditional port authority would not be an effective model to coordinate the state ports or participate in regional coordination, in part due to the fact that they are not all owned by the same entity.

Due in part to the leadership of the East Coast Aquaculture Growers Association and the CFRF, federal funding has been directed to increase aquaculture and fisheries applied research, frequently with researchers and members of the industry partnering to find real solutions. These connections and this strategy should be expanded to the other

Offshore Renewable Energy (ORE) is bringing different blue economy sectors to the table.

For more than 10 years, offshore wind energy has stirred the blood of Rhode Islanders. Some have seen it as a threat to their traditional way of life, while others have seen it as a job generator and a solution to reducing carbon emissions. No matter what “camp” a person has been in, ORE is spurring many new connections among firms and other actors within the blue economy. The desire to initiate projects and strengthen U.S. capabilities in ORE has allowed URI and others to secure millions of dollars of federal, state, and private funds for research, education, and workforce solutions. Through the Ocean SAMP process, resource users, federal and state entities, community members, and industry learned and worked together to find solutions and a place for newcomer ORE, while minimizing the impact on the existing resource users and the natural environment. The emergence of ORE has created additional business opportunities for ports and shipping, marine trades/composites, and tourism and recreation. It could serve as a driver for innovation to implement new techniques for commercial fishers to adapt to the changing ocean landscape. The state is putting great emphasis on attracting new businesses and bolstering existing Rhode Island businesses to respond to the demand of this growing industry. What appears to be lacking is coordinated leadership between government, industry, and academia to survey the landscape and make those connections in a more strategic fashion. The Rhode Island based but regionally engaged approach taken to foster undersea innovation in the defense industry via SENEDIA and UTIC might provide a network model that could respond more effectively to some of these issues. This approach appears to be successful as demonstrated by other entities, for example, the National Renewable Energy Laboratory via New York State Energy Research and Development Authority and Stony Brook’s Advanced Energy Research and Technology Center.

Tourism and Outdoor Recreation could play a stronger connector role.

Tourism and outdoor recreation alone serves as a strong sector within the state’s economy and also contributes to quality of place, which helps all sectors of the blue economy. The sector could serve as an overall connector for the blue economy, marketing and promoting the unique aspects of each blue economy entity. For example, encouraging

research tourism within both the undersea technology and the ORE sectors is something that other states are considering. Continuing to strengthen the connections between the different tourism councils and the industries is a valuable activity to enhance collaborative economic purposes.

Government serves as a strong connector within the blue economy.

The representation in Figure 3 mainly focuses on Rhode Island based sub-sector activities. Fisheries (light blue), renewable energy (magenta), and natural resources (lime green) are particularly important areas where Rhode Island government departments are especially important. This par-

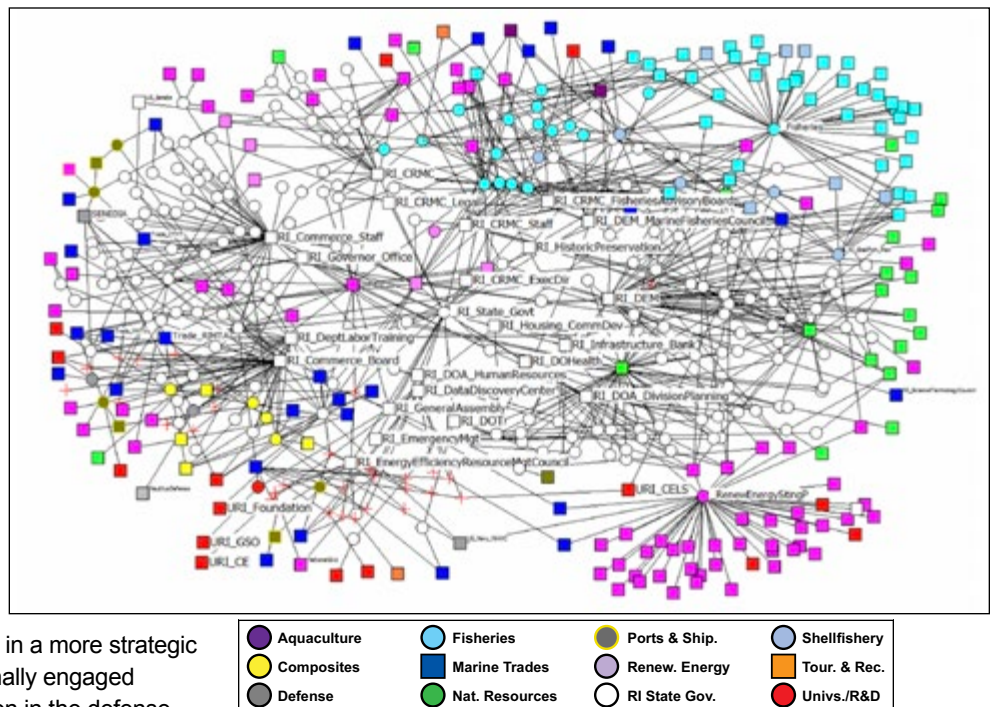


Figure 3. Rhode Island Government Interactions with Entities Involved in the Blue Economy.

ticular network view probably underrepresents the state’s role in working with the defense sector, as well as its extensive efforts to enhance the Rhode Island workforce, since these efforts address many sub-sectors, not just marine-related businesses. It also should be recognized that some Rhode Island leaders in the blue economy are also engaged in regional, national, and international meetings and maintain contact with the broader global blue economy. Based on this analysis, the unique roles that each relevant state agency plays connect and enhance the sectors.



Networks in Action

A CASE STUDY

The Composites Industry: Reinvention as Innovation

Industries contributing to the blue economy in Rhode Island must continually innovate to stay relevant in a constantly changing economic, political, and environmental landscape. The composites industry presents a valuable illustration of an industry that has been successful at using innovation to maintain success over time. Drawing on a long history of boat building and yacht racing in Rhode Island, individuals and organizations working composites have continually designed creative solutions for boats, and have overcome economic challenges by expanding into other industries. This examination of the composites network in Rhode Island shows the actors and organizations that sustain, support, and inspire one another to continually innovate in their industry and contribute to the blue economy in Rhode Island.

Composites Defined

“Composite materials are broadly defined as those in which a binder is reinforced with a strengthening material. In modern terms, the binder is usually a resin, and the reinforcing material consists of glass strands (fiberglass), carbon fibers or aramid fibers” (ThoughtCo 2018). Advantages of composites are that they are very lightweight and that their mechanical properties—strength and stiffness can be set in different ways—can be customized (Fornaro 2019). Composites are stronger than wood or steel traditionally used on hulls (ThoughtCo 2018).

Composites have been used for boats since the first half of the 20th century; since the 1950s, various types of composites have been used in boatbuilding and shipbuilding. Composites are likely to play a larger part in boat construction in the future because of their lightness, strength, durability, and ease of production (ThoughtCo 2019).

Composites in Rhode Island

The composites sector is a significant contributor to the Rhode Island and United States (U.S.) economies. The composites industry generates \$22.2 billion to the overall economy with applications in the automotive, aerospace, infrastructure, and sports and recreation industries (ACMA 2019). In 2018, a study of the composites sector of the Rhode Island economy found that it generated \$295.74 million in gross sales from 81 firms employing 1,545 people (Sproul and Michaud 2018). These firms provide a valuable source of employment for Rhode Island residents, with 29% higher labor income per firm and 66% higher employment per firm (Sproul and Michaud 2018). Within the composites sector—boat building and repair firms that work in manufacturing carbon fiber and fiberglass for marine applications—is the largest composites subsector in the state, with 31 firms employing 679 jobs and generating \$129.68 million (Sproul and Michaud 2019).

The composites industry in Rhode Island began in the 1980s with roots in Rhode Island’s storied legacy of boat building innovation and repair services. The focus on competitive boat racing at all levels, from the America’s Cup to rowing shells, has produced a generation of innovators with the ability to take on new challenges.

Beginning around 2005, the economic recession in Rhode Island impacted not only the composites industry, but the larger boat building, repair, and marine-related construction industries. Between 2005 and 2015, employment in boat building and repair decreased by 56%, jobs in boat dealers decreased by 7%, and the value of boat building and repair and marine-related construction decreased by 40% and 69% respectively (NOAA 2015).

However, in 2005, the Rhode Island Marine Trades Association (RIMTA), an industry group supporting the recreational boating industry throughout the state, recognized the potential impacts of the recession on its members and initiated a public-private effort to retrain workers to utilize their specialized skills for more diverse industries with a focus on composites (Mackie 2019). Certain companies, such as those working in high-end customized boat building and repairs, were highly susceptible to the economic downturn, but this initiative allowed many of these workers to continue their jobs. It enabled companies to diversify their businesses, provide composites applications to other industries, and build support for continued success. Wendy Mackie, chief executive officer of RIMTA attributes the success in part to public-private coordination that enabled her to call, for instance, the Governor’s office directly to begin discussing her concerns and the industry’s needs (Mackie 2019).

The Composites Alliance of Rhode Island (CARI), formed in 2014

“after an industry roundtable that drew a hundred thought leaders from government and industry who together determined a clear need for a unified approach to exploring the capabilities of the state’s composites industry, its needs, and its ability to create jobs” (CARI 2018).

CARI is an industry group that prioritizes economic development to continue growing the composites industry in Rhode Island and to meet composites employers’ workforce needs. The group is a strong advocate for the industry, representing Rhode Island at industry shows internationally and providing a venue for individuals to showcase their work as well (Fornaro 2019). CARI functions as an intermediary for creating relationships and facilitating connections, for example, with new industries and markets to increase members’ potential to diversify their businesses. CARI is also responsible for

supporting workforce development by informing students about job opportunities in this field (Daly 2019). It is also closely tied to RIMTA, whose goal is enabling continued success through networking among firms, work force development, and marketing and attracting a new generation of innovators and workers to the field.

Innovation

Innovation in the composites industry comes from the forward-thinking nature of the people and organizations that make up this network. The organizations that form the industry contribute to the blue economy but their use of composites is not constrained to applications connected to the marine environment; these range from those specializing in boat repair, to unique market niches, and to some that are pushing the frontier of composites.

In fact, CARI notes that composites companies located in Rhode Island contribute to at least nine different industries including the aerospace, automotive, construction, marine, military, transportation and wind energy arenas (CARI 2018).

Building upon the tradition of competitive yachting and boat racing, composites have been used to develop materials and high-end finishes that are used for the luxury market of the boating industry.

Composites companies produce a wide variety of advanced materials, composite-based products, and a continuous flow of new ideas and designs for application of composites. Success has been achieved with an increasingly diverse array of maritime products, including boat hulls and components, furnishings, masts, booms, rigging, propellers, and rudders. Rhode Island-based firms are also exporting blades for wind energy systems to manufacturers based in Japan, China, and Mexico. Local companies are developing military applications, stringed instruments, solar-powered houseboats, and offshore aquaculture installations.

The structure of the Rhode Island composites industry includes multi-generational companies whose elder, more experienced founders and business owners are now training a second generation of specialists in composites production and application through informal and formal apprenticeships. This younger generation comes to the

industry with new ideas and some have started new companies, in part with the aid of CARI, RIMTA, state government, and academic support.

In an effort to bolster the entrance of a new generation into the workforce in this industry and to attract and retain skilled workers through training programs, the Rhode Island Department of Labor and Training awarded RIMTA funding to support a workforce development collaboration called the Marine Trades and Composites Partnership (MTCP) (Pearson-Merkowitz et al. 2018). The MTCP linked employers with training partners to deliver targeted training necessary for employees to succeed in the industry. In turn, the employer partners provided feedback about the training to ensure the programs addressed the appropriate skills. RIMTA coordinated industry trainings and subcontracted with its employers and training partners to establish an effective route for trainees to enter the industry. As part of the MTCP, Goetz Composites hosted an apprenticeship program to support the industry in cooperation with the International Yacht Restoration School School of Technology & Trades (IYRS) and RIMTA (IYRS 2017; Composites World 2016).

The local industry gains an important benefit from the fact that several global composite companies have offices located in Rhode Island. This situation allows the interaction of the newer

Spotlight on Innovation

Ariston Technologies, Wakefield, RI



David Fornaro is the owner of Ariston Technologies, based in South Kingstown, RI. He is an engineer who began his career in the automotive industry working for Ford Motor Company, then practiced at Farr Yacht Design for 10 years before founding Ariston in 2008. His experience includes contribution to design teams for four America's Cups, three Volvo Ocean Races, and two Vendee Globe Races.

Fornaro provides advanced composites engineering services to marine, wind energy, automotive, architectural, and aerospace industries. He doesn't consider himself an innovator but admits he works with others to make their "Big Ideas" materialize, thus exemplifying innovation in the degree of creativity he brings to each challenge.

Currently, Fornaro is primarily working in boats, but he has worked in other industries with composites. He has experience in

wind turbine composites engineering; aerospace turbine engine structural analysis; steel ship structural engineering and analysis, automotive engineering in composite body engineering, and structural engine component design.

Fornaro regularly competes on many high performance racing yachts. He mentions that Rhode Island is a great place for a sailor, noting "It's a great feeling to be off Beavertail with the sea breeze blowing in your face and waves crashing on the rocks" (Fornaro 2019). He loves living in Rhode Island because Narragansett Bay is clean and good for a variety of recreational activities.

As the social network maps illustrate, Ariston Technologies is linked to many other actors in the composites industry in Rhode Island (Figure 1). The tight collaboration of the network of composites companies and individuals has allowed Fornaro to work almost exclusively with companies in Rhode Island. He also noted that he has worked with about one-quarter of the organizations in the industry since beginning the business in Rhode Island in 2008.

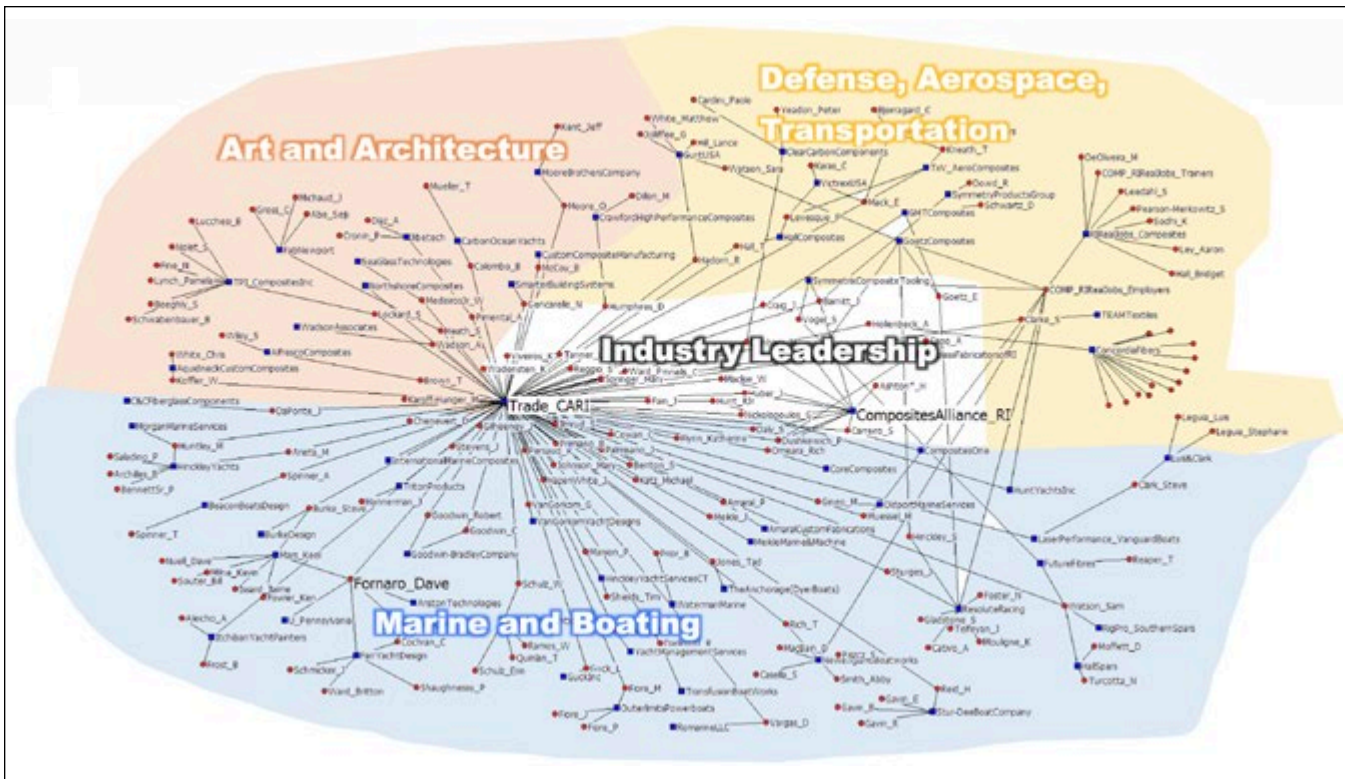


Figure 1. Network Map of Composites Organizations in Rhode Island

and often smaller companies to gain easier access to the supply chains, markets, and experience of larger organizations.

Composites have been used in boat building for decades, but the market which the boat building industry in Rhode Island serves has been largely stable over time. The future of this industry will continue to rely upon the ingenuity of the actors in this network to find new and innovative applications for composites.

Supporting Network

The network of individuals and organizations involved in the composites industry provides a valuable contribution to the blue economy in Rhode Island. A social network diagram illustrates the highly integrated nature of the individuals and organizations making up the composites industry in Rhode Island (Figure 1). This depiction groups the companies by general area of activity (e.g., Art and Architecture). The companies within the marine and boating related area are most accurate because firms are often listed with a wide range of products and areas of expertise on the CARI website.

CARI, at the center of the diagram, connects many of the actors within the composites industry. As described earlier, CARI is an outgrowth of RIMTA with, therefore, highly overlapping membership between the two industry groups. Within this network, actors specialize in a wide range of capabilities, some of which are unrelated to the marine

environment. These capabilities range from performance powerboat producers (Outerlimits Powerboats) to a specialist in composites repairs investigating composite structural failures for insurance and legal cases (Burke Design). Actors within this network think beyond the confines of traditional economic sectors to bring composites to a wide range of applications in different industries, like those involving race cars, orthotics, and prosthetics (Custom Composite Manufacturing).

However, they benefit from a concentration of composites expertise in Rhode Island, upon which to creatively build, with companies such as TEAM, Inc. specializing in textile engineering and manufacturing and “conceiving novel engineering and manufacturing solutions to meet [their] customer’s textile based design problems” (TEAM, Inc. 2019). This concentration of supporting companies provides local expertise that can assist composites experts in realizing innovative applications of composites.

Figure 2 [next page] illustrates the location of the individuals and organizations that are members of CARI. The members are largely concentrated in Bristol, Newport, and Portsmouth. These areas correspond with centers of boating and boat building in the state with Bristol, the home of Herreshoff boats, hosting the largest number of CARI members.

This clustering of the composites industry provides individuals and organizations in composites with hubs of industry knowledge, relationships, and motivation. This provides a

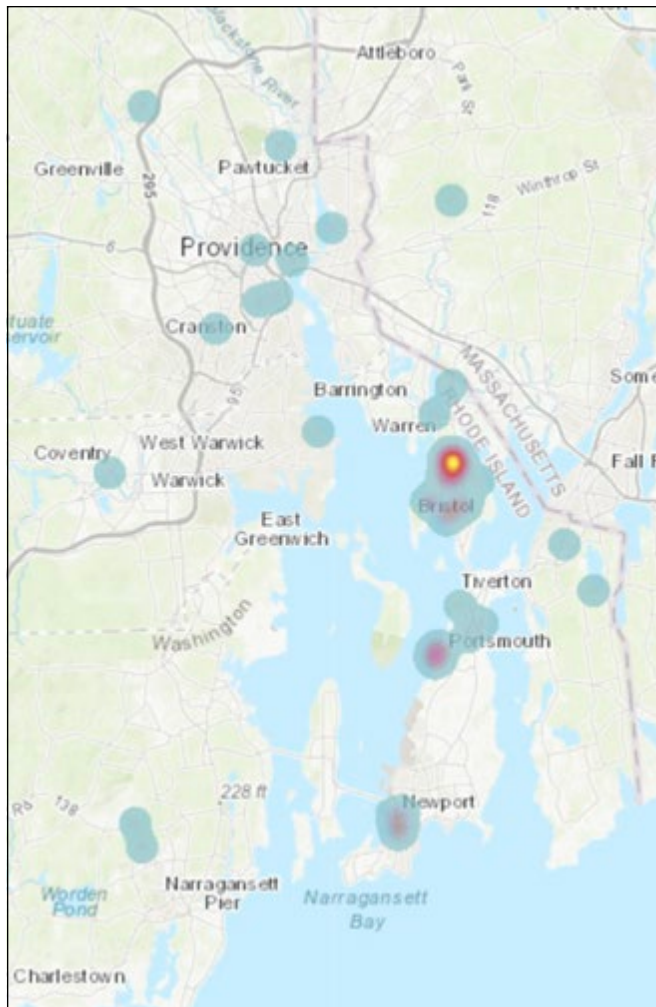


Figure 2. “Heat” Map of CARI Members; colors closer to red represent higher concentrations of CARI members.

competitive advantage due to the close proximity of organizations with experience in composites and in boat building, more generally (Porter 1998). Companies specializing in yacht design, naval architecture, and boat engineering provide a network of expertise to support actors in the composites industry and foster innovation. The companies in these areas interact often, sharing resources and ideas, which increases productivity and drives innovation and growth (Porter 1998).

Quality of Place

The composites industry began as a connection to Rhode Island's history of sailing. Rhode Island's vast coastal access and ample wind contributed to the establishment of competitive boat racing in this state and these factors remain a draw for boating participants and boat building companies. With America's Cup races located in Newport for many years, competitive sailing and boat building has strong roots in Rhode Island, and composites have been a vital component of that

success. Herreshoff boats, dating back to 1878, constructed eight consecutive successful defenders of the America's Cup from 1893 to 1934 (Herreshoff 2019). This and other boat building companies have provided a strong foundation of boat building and naval architecture in Rhode Island. Expertise, supply chains, and economic and intellectual capital related to boat building continue to gravitate to these historic areas of boat building in a “self-fulfilling prophesy,” which supports and inspires the composites industry to continually and creatively adapt to changing needs and opportunities for composites in boat building (Fornaro 2019).

Research and Education

There are numerous examples of the strong connection of composites companies to Rhode Island based universities. A 1977 national dinghy sailing champion from the University of Rhode Island (URI), Ed Adams, went on to be the face of a composites boat company, Jibetech, that produced his favorite boat, the McLaughlin Snipe, with which he continued to win national competitions. (Jibetech 2019; Wikipedia 2019). Professors from different departments in URI's College of Engineering advised doctoral students on materials engineering projects with the goal of developing composites applications for Rhode Island bridges (URI 2018b). URI is also supporting the Rhode Island Textile Innovation Network, which fosters the growth of firms using composites, nanotechnology, and other advanced approaches to create fabrics and membranes applied in a wide range of applications in construction, personal protection, military, energy conservation, patient care, sports, recreational boating, and space exploration arenas (URI 2018a).

URI, Roger Williams University, Brown University and the Rhode Island School of Design are among the Rhode Island based academic institutions that have trained individuals who have brought their backgrounds to the composites industry, for example, through collaborations with IYRS.

Individuals engaged in the composites industries also have expected backgrounds such as naval architecture or engineering, but many are self-taught or apprenticed under established companies since many of the existing training programs do not cover all of the skills needed to design and engineer advanced composites to meet current industry needs (Fornaro 2019).

Workforce

The industry has access to several schools located within or near to Rhode Island. These programs train skilled workers to meet the needs of the industry including, IYRS in Newport, R.I.; New England Institute of Technology in East Greenwich, R.I.; and Motoring Technical Training Institute in Seekonk, Mass.

Beginning in 2015, Rhode Island’s Real Jobs RI program has worked with the RIMTA and CARI on the Composites Pre-Apprenticeship Training Program to prepare individuals for entry-level positions at companies involved in applying composites technology and in the marine trades. A recent evaluation found this collaboration to be successful and sustainable (Pearson-Merkowitz et al. 2018). IYRS currently hosts students for a six-month program in composites technology, advertising its use in a wide variety of industries involving aviation, aerospace, marine, medical, automotive, and athletics arenas (IYRS 2018).

Regarding the professional workforce, the composites industry is very well-developed in Rhode Island, but the industry’s connection with nearby universities could be strengthened. Universities would benefit from connection to industry members who have developed this expertise and innovative uses of composites in a wide variety of industries. The composites industry would benefit from well-trained designers and engineers graduating from nearby universities who could become employees at established composites companies in the state.

For example, Figure 3 depicts the network of the composites industry and URI, illustrating relatively few direct contacts. The exceptions are URI graduates working in local companies and efforts by URI in workforce and business engagement.

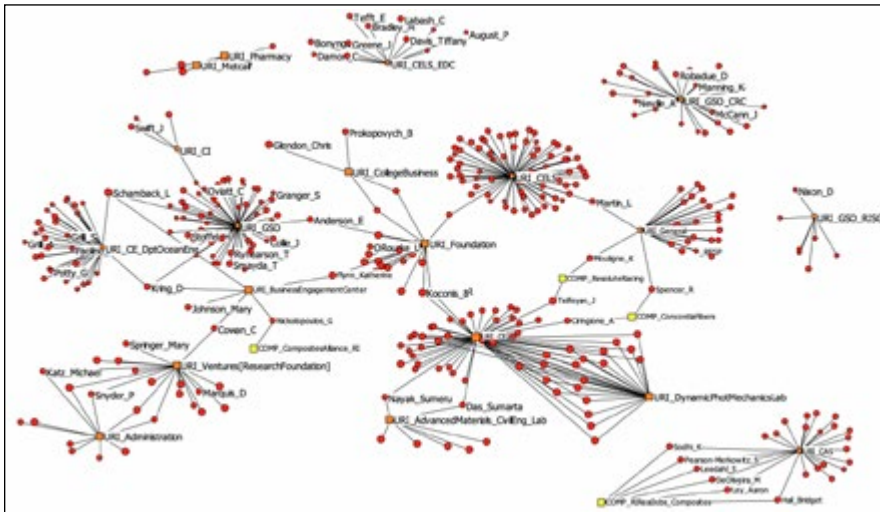


Figure 3. Network Map of Composites Industry Organizations and Individuals and Ties to the University of Rhode Island.

Resilience

The composites industry has benefited from access to the marine environment that is ubiquitous in Rhode Island. Water-dependent infrastructure is a vital component of many of these companies and many facets are heavily dependent on access to the coast, which could present high vulnerability to rising sea levels and storm surge associated with climate change.

However, the impacts of climate change present both challenges and opportunities for this industry’s ability to contribute to the blue economy. Composites have taken advantage of the move to alternative energy sources in marine infrastructure with marine-based composites currently supporting solar panels on boats, including house boats. Offshore renewable energy projects in the planning stages in southern New England could provide the composites industry in Rhode Island with an additional market for service boats, turbine blades, and potentially new products.

Prior to offshore wind development in Rhode Island, the composites industry produced both boats with the capability to service offshore wind infrastructure and wind turbines. These companies are poised to capitalize on offshore wind development in the southern New England region as well as expand their offerings to the global marketplace.

Future of Composites

Employment in composites-related businesses serving the boating industry has been stable over time, with little room for growth. Therefore, most companies have expanded into other industries. Their willingness to think beyond boat building is an important aspect of this industry that contributes to its ability to continually innovate. Aerospace, architecture, and infrastructure

are three sectors into which the composites industry has made inroads and could possibly expand to in the near future.

A significant development for the Rhode Island composites industry is the initiation of its innovation campus, a joint collaboration between RIMTA and Polaris MEP with URI. In the post-recession era, the innovation campus is positioned as a way to showcase Rhode Island’s expertise, network, and infrastructure in the advanced materials (composites and textiles) and to facilitate diversification to new industries. The campus will be a Center of Excellence, providing support and a collaborative space for members of the industry to connect with each other and with potential future clients,

such as the U.S. Navy, with which negotiations are currently underway (Daly 2019).

Related to the blue economy, two additional areas of future potential for the composites industry are underwater and wind energy applications. The former is a natural extension of a history of naval capabilities and water defense that has been an area of significant expertise for Rhode Island. Additionally, the developing partnership between the industry and the U.S. Navy associated with the innovation campus has presented

new opportunities for composites in underwater defense applications. For example, a rust-free material could be used to rapidly develop prototypes for testing new technology underwater (Daly 2019). Wind energy applications also present a future opportunity for this industry and its creative design capabilities. The local expertise in design and engineering is well-positioned to contribute to offshore renewable energy construction, and operations and maintenance (Daly 2019).

Lessons Learned

Composites in Rhode Island has a history of working at the leading edge of projects, beginning with Goetz Composites contributing to the first composite boat to win the America's Cup (Goetz Composites 2019). The individuals and organizations continue to work at the cutting edge to find competitive advantages for composites in design and weight applications for many industries (Daly 2019).

The composites industry is made up of a network of people accustomed to thinking creatively about new applications of their skills, both in boat building and in applications for other industries. Many of the businesses are small and nimble, able to meet the needs of changing economic conditions, just as they meet the needs of small, high-end custom projects.

There is a strong connection between this industry and state-level representatives, as evidenced by the retraining program put into place at the first signs of the last recession.

CARI provides valuable support for this industry to continue to innovate through its inclusive and cooperative approach. This group provides networking, relationship building and advocacy for members of the composites industry in Rhode Island. This organization acts as an intermediary to support succession planning through its workforce development initiatives targeting the next generation of composites workers. It also regularly communicates with the congressional delegation, which supports development of the policy side of composites in standards and codes. And, it provides representation to

national level industry groups, bringing up issues of concern and communicating opportunities for local companies from the national level.

Based on this examination of the composites network in Rhode Island and discussions with industry members, the following are recommendations to support and grow this industry in the future:

There is a growing need for composites engineering education at a level between the skills of building with composites and high-level academic research to create new materials and applications. There appears to be several composite-related research activities within engineering disciplines but there is a lack of a unified program which could be met by creating a concentration in composites engineering within the mechanical engineering program at URI to train people in the design and engineering aspects of composites work (URI 2019).

There is a lack of programs training naval architects in boat building and interlacing with composites, and with southern New England's ocean focus, this could be a future program to establish at an area university or training school.

Conclusions

Industries need certain things to rise to the challenge of innovation. This investigation of the network supporting and surrounding this industry illustrates how it has met that challenge. As described above, the composites industry network and actors illustrate how many of those criteria are met: the existence of a supportive network, multi-disciplinary and creative approaches to problem solving, cooperation and inclusiveness, succession planning, quality of place, supporting workforce, and resilience planning. Other industries working in the blue economy in Rhode Island could benefit from supporting ways to establish similar criteria to cultivate innovation in their networks.

Strategies and Actions

2020—2025



1975 SCHOOL OF TECH. & TRADES

From the Author



Rhode Island's blue economy—the jobs it creates, the markets it supplies, and the quality of place and resilience it offers—instills the state with a character all its own. With Rhode Island being the smallest and second most densely populated state in the country, space—especially along the coastline—is at a premium.

There is a need, therefore, to implement thoughtful planning of our coastal and ocean resources. The Rhode Island Ocean Special Area Management Plan (Ocean SAMP) process used to site the Block Island Wind Farm is an excellent example of proactive planning and one our state is known for internationally. Although we boast about our strong networks of people who can “get things done quickly,” we are somewhat siloed within our sectors. Our accelerating aquaculture and budding

offshore renewable energy industries could potentially benefit from even more strategically developed connections with the marine trades and defense industries, and with the academic community to solve some of their technological and social conflict issues. In order to encourage diversification and innovation to solve societal problems and make money, our community must increase its efforts to integrate these networks. We also need to understand that we must appropriately connect to the broader region in order to strengthen our own core. For example, Rhode Island is stronger in defense because of its connections with Woods Hole, Mass., and Groton, Conn., and many believe a regional port strategy would allow us to more effectively respond to the needs of the offshore renewable energy industry.

There is a need to invest in our blue economy infrastructure, including our commercial fishing, marine trades, tourism and recreation, aquaculture, defense, and ports and shipping industries, as they are the backbone of our economy and what makes us unique and strong. In turn, this investment will expand our blue economy, bolster public support, and nurture our abilities to envision another way of problem solving with intention. By investing in our blue economy infrastructure, we will build stronger local and regional integrated networks and more informed and empowered stewards to ensure the health of the foundation of our blue economy—our coastal and ocean resources within and alongside Narragansett Bay, the Salt Ponds, Block Island and Rhode Island Sounds, and the Atlantic Ocean. This long-term commitment to our blue economy is what the people of our state need to undertake in order to maintain, sustain, and grow.

Although our ocean economy may look very different in the future—with smaller commercial fishing vessels powering through offshore wind farms and underwater technology prototypes being tested in our Narragansett Smart Bay “plug and play” facility—it is necessary for us to also uphold the maritime values and traditions that have gotten us where we are today. This story of our maritime past and present must be told with honor and passion as we begin to write the next chapter.

—Jennifer McCann, Director, U.S. Coastal Programs,
URI Coastal Resources Center, and Extension Leader,
Rhode Island Sea Grant

Moving Forward

Although synthesized and elaborated on by the author, the following strategies and actions have been identified by Rhode Islanders who work, live, and play in our blue economy and are supported by other experts and technical reports. The Enhancers—Research that leads to Innovation; skills and talent that bolster a sustainable Workforce; design and planning that preserve and enhance our Quality of Place and Resilience—underlie all of these strategies and actions.

Strategy 1: Intensify and expand collaborative leadership.

Recommendation

Establish systems jointly led by government, industry, and academia to engender a sense of shared responsibility and encourage cross-sector creative and marketable solutions that respond to both local and global blue economy issues.

Rationale

A high-level vision and cross-sector leadership will bolster blue economy infrastructure, building on existing overlap within the blue economy trades workforce. Some sectors have strong trade associations and are aggressively innovating in response to local and global demand, while others lag (due to sector maturity and/or organization) and will benefit from information and energy exchange. While universities play a role in offering education, training, research, and advisory services within the blue economy, their role is currently opportunistic versus strategic, minimizing potential impact. Additionally, several significant leadership gaps in key blue economy sectors, including aquaculture and coastal management, are anticipated in the near future. New leadership can drive positive change and alternative approaches; however, care must be taken to allow for information exchange between successors to ensure continued growth.

Actions

Leadership Coordination

Establish a state level blue economy Innovation Advisory Council (Council) made up of industry, academia, and government that champions blue economy initiatives towards achieving innovative economic growth, healthy ecosystems, and thriving communities. In addition to spearheading the development of a blue economy vision, the Council will uphold the five blue economy strategies and implement the following recommendations, while minimizing redundancies, and encouraging cross-cutting creative participation and synergies amongst sectors.

Create a Blue Economy Director

Similar to the Governor’s Director of Food Strategy and Chief Resilience Officer, the state should appoint a Blue Economy Director with the purpose of guiding and assisting the Council with its responsibilities. This position would foster platforms and synergies amongst the Rhode Island blue economy sectors so innovative solutions can be developed and applied within these markets. It would also assist the sectors to develop and implement interconnected strategies that respond to these markets and civic opportunities and connect with other state priorities. This Director would also ensure that the Council and industry are provided opportunities to continually understand and communicate regional and global blue economy existing and future markets, needs, and opportunities.

Succession Leadership

Invest in leadership development for the next generation of blue economy industry, academic, and government leaders. This leadership should be at mid-career and upcoming career levels. This succession planning will strengthen the connections and commitment within Rhode Island’s overall economy and minimize the significant leadership gaps, which may occur particularly in the aquaculture and coastal management areas.

University Investment

Provide incentives for the university community to strategically incorporate its science, innovation, policy, and education abilities to strengthen the players and the products of the state’s blue economy. Establish a university consortium that includes, at a minimum, the University of Rhode Island (URI), Brown University, Salve Regina University, and Roger Williams University, with the purpose of coordinating this expertise.

Diversify Tourism and Recreation, Aquaculture, and Offshore Renewable Energy (ORE) Sectors

Use the bolstering of these three sectors as opportunities to create connections with other blue economy sectors. For example, establish research tourism and the product diversification of aquaculture with assistance from academic institutions, and the undersea technology and offshore renewable energy sectors. Continue to strengthen workforce and technological synergies between defense, marine trades, and ORE.

Strategy 2:**Design policies and implement initiatives for Rhode Island’s coasts and oceans that meet economic and social needs while doing no harm to the natural ecosystem.*****Recommendation***

Continue implementing plans and actions that consider the sustainable use and wise management of economic and recreational activities that result in a healthy coastal and ocean natural ecosystem. A prudent regulatory framework to maintain the state’s balance between economic growth and conservation, and private development and public good—particularly in a time of increased sea level rise and storms—must remain a priority.

Rationale

The health of our coasts and ocean directly impacts the well-being of our economy and communities, and also directly contributes to our quality of place. Recreation and tourism, commercial and recreational fishing, marine trades, and aquaculture all depend on a healthy environment. A strong regulatory entity will provide additional support and direction, build on our state’s current initiatives, and contribute to the sustainable growth and environmental awareness needed to advance Rhode Island economically, socially, and environmentally.

Actions***Design our Coasts and Oceans***

Continue to encourage the wise use of our coasts and oceans and minimize the growing tensions between maritime resource users and uses by continuing to invest in proactive planning of our coasts and oceans. The periodic process of developing and updating existing plans with the best available science, resource-user input, and best management practices serves as a tool for balancing growth and preserving the natural resources upon which it all depends. By developing these plans, the state’s regulations and regulatory processes will be increasingly streamlined and public shoreline access and working waterfronts will be preserved.

Narragansett Smart Bay

Building upon URI and Naval Undersea Warfare Center (NUWC) efforts, establish a Smart Bay Initiative that would assist industry, government, and academia to coordinate in the testing of new maritime and defense products and better monitor the changes in the bay. The opportunity to model this ecosystem as well as understand potential natural and human caused disasters will fuel a think-tank setting that assists Rhode Island in caring for our natural resources and

promoting innovation. The federally funded and university led Coastal Ecology Assessment & Modeling (C-AIM) Consortium, in addition to the ongoing expertise about the bay developed by research institutions and the defense industry would serve as the basis for this effort.

Digital Governance for Aquaculture and Fisheries

Building upon the multi-state-agency Rhode Island Shellfish Management Plan effort (Rhode Island Department of Environmental Management, Rhode Island Coastal Resources Management Council, URI), develop an online aquaculture permitting system to allow the aquaculture industry to expand in an informed and efficient way, help state agencies make informed decisions for siting future aquaculture activities, and ensure that new entrants to aquaculture are informed and utilizing best management practices. Develop electronic data reporting (eVTR) for commercial fishermen to reduce data processing time and effort and allow data to be analyzed more quickly by managers.

Prepare for Climate Change

Building upon the state's "Resilient Rhody" effort and the Rhode Island Executive Climate Change Coordinating Council, implement actions identified in the Resilient Rhody: Municipal Resilience Program to ensure that blue economy industries, and the people who depend on it, are prepared for increased flooding and storms. Government, insurance companies, and academia should collaborate to promote the application of cost-effective solutions to make Rhode Island more resilient.

Promote the Appropriate Growth of Offshore Renewable Energy

Build upon the state's commitment to develop a robust supply chain for offshore wind energy and promote the appropriate development of offshore wind.

Strategy 3: Utilize pressing issues facing Rhode Island and Southern New England as opportunities to leverage the region's technical and govern- ance innovation capacity and approaches.

Recommendation

Rhode Island's public and private sector should strategically invest in entities that encourage innovation, acceleration, and application of creative solutions to respond to natural and human-made issues, such as increased sea level rise, severe storms and related flooding, ocean and coastal pollution, resource user conflicts, and food security. Industry clusters should be enhanced and prioritized for financial and technological opportunities that serve as effective strategies to bolster the economy.

Rationale

Despite strong relationships between some blue economy sectors, academia, and research institutions, we continue to struggle with embracing a culture of interdisciplinary innovation in blue technology compared to places like Cambridge, Mass. or California. Some state investment to build innovation capacity has grown, however our academic institutions have not prioritized this enough, and the state has not attracted significant venture capital in order to accelerate innovation and prototype development. The private sector, state, and academia need to work together to create an environment that stimulates innovation and drives investment. Coastal and ocean resource planning must consider both today's challenges as well as future natural threats and economic opportunities.

Actions

Expand the State's Innovation Initiatives

Provide Priority Access and Investment to Innovation Hubs

- Building upon the state's existing innovation efforts, prioritize investment in places that promote blue tech innovation, such as URI's Narragansett Bay Campus, Wexford and Innovate Newport Innovation Centers, the Hope & Main culinary incubator, industry clusters, and academic and research institutions. Ensure these entities have the capacity to offer assistance to incubator users to minimize start-up barriers, generate research and development, and connect them to resources, including market access and strategic funding.

Expand Financial Investment

- Building upon the state's innovation investment portfolio, increase funds for existing state innovation programs, including the state's Industry Cluster Grants, Innovation Vouchers, Innovation Network Matching Grants, and Innovate Rhode Island Small Business Fund programs. Work to attract private venture capitalists to the state to invest in small businesses working on blue technology to respond to the issues listed above. Work with the private sector to develop an environment to accelerate innovation and demonstration opportunities.

Academic Participation

- Working with the state and private academic institutions, consider encouraging tenure-track faculty in appropriate disciplines to demonstrate formal relationships and innovation initiatives with blue economy sectors. Work with faculty to direct graduate and post-doctoral level students, with the responsibility of implementing research in partnership with the blue economy sector to respond to societal problems. Invest in university and K-12 existing programs to stimulate innovation. Teach innovation in the classroom and offer

opportunities for student, faculty, and industry interactions. Prioritize the involvement of students with diverse backgrounds.

Find Solutions to Blue Economy Challenges

Invest in multi-dimensional methods to encourage innovative techniques and technologies to respond to locally identified and global maritime issues. Some issues identified are:

Resilience

- Rhode Island's transportation infrastructure is in great danger of being significantly impacted by flooding caused by sea level rise and flooding.
- Many blue economy businesses are located in exposed coastal areas that will be repeatedly flooded or destroyed due to sea level rise and increased storms.

Food Security

- Coastal and ocean aquaculture requires labor intensive maintenance and operating tasks in order to be marketable.
- User conflict between the aquaculture industry and other resource users exists due to visual and noise impacts.
- Aquaculture can be utilized to address natural environmental problems, supply food for the growing population, provide local jobs, and stimulate the domestic economy.
- The existing marketing and processing capacity for seaweed in the state is not adequate to nurture this budding industry.
- Commercial fishing and aquaculture could be playing a greater role in supplying healthy, safe, and affordable seafood to Rhode Islanders.
- Enhance demand, including marketing opportunities, for underappreciated and emerging species.

Energy

- Commercial fishermen lack tools, vessels, and techniques necessary to safely fish within the offshore renewable energy lease blocks.
- Understanding the impacts of the growing offshore renewable energy industry on existing maritime activities and wildlife requires cost-effective monitoring.

Green, Smart, and Resilient Ports/Marinas

- Marine pollution, including plastics and waste streams from passenger and cargo ships and related infrastructure, is significantly impacting the health of our coasts and oceans.
- The increased number of decaying fiberglass boats is becoming a burden on the nation's and state's waste management industry.

- The shipping industry continues to struggle with issues including minimizing carbon solutions, ship strikes, and treating ballast water to minimize the transfer of invasive species.
- There is a need for the articulation of a vision for the establishment of green, smart, and resilient ports in the Northeast, with one goal being doubling the output of our ports while cutting emissions in half. This vision would include digital-smart Rhode Island ports, green port initiatives, innovations for a safe, secure, and resilient infrastructure of the future, and maritime cyber.
- A structure to encourage improved coordination and strategic thinking amongst the different port stakeholders would serve as a landing point for port stakeholders/investors and benefit the state and the region.

Defense

- Cyberattacks on both military and commercial targets are an accelerating threat.
- Advance artificial intelligence technologies, including the application of sensors and unmanned vehicles to respond to both military and commercial demands and needs, collecting and processing data rapidly at the source so it can be used immediately.

Strategy 4:

Prepare and integrate a diverse and increasingly capable cross-sector workforce to foster a growing and integrated blue economy.

Recommendation

Rhode Island should expand its existing workforce development model to respond to industry needs. The blue economy workforce requires additional options, like certificate and increased paid internship programs, professional master's degrees, and continued learning opportunities to develop the required skills and talent to meet growing industry demand, and continue contributing to the diversity and agility of the state's blue economy. Increased coordination between all workforce and education skill building programs is needed to minimize redundancy and allow this in-demand workforce to respond to multiple sector needs at once. At the same time, workforce wages and benefits are necessary to provide an adequate quality of life.

Rationale

The state is making great advances in developing and providing thoughtful, realistic workforce and education programming that enables a wide range of learners, children to adults, to prepare for dependable employment in blue economy areas, from traditional (boat building) to emergent (offshore

renewable energy). Rhode Island needs to retain more of its graduates and attract more people to its workforce, however, while continuing to provide training opportunities. In addition, the existing workforce, from trades to professionals, requires opportunities to learn new skills to keep up with the changing demands and technologies industries.

Actions

Build off the momentum of existing programs to build the workforce.

Bolster Innovation at Universities

- Increase opportunities for paid internships and capstone projects for university students to engage with blue economy industries. Invest in innovative opportunities for students to solve industry-based problems.

Promote STEM

- In coordination with universities, build the ability for Science, Technology, Engineering, and Math (STEM) students to direct their skills to develop innovative blue economy solutions. Pilot this effort by collaborating with the URI-led Coastal Ecology Assessment & Modeling (C-AIM) Consortium and providing its team of students with the necessary skills to bridge this gap between academia and the private sector.

Encourage Innovation within the Existing Workforce

- Keep the current workforce—especially within the government sector—knowledgeable about tools and techniques that will allow it to more successfully respond to blue economy issues. For example, train government regulators to apply the recently developed STORMTOOLS mapping application to effectively incorporate future flooding and coastal erosion into decision making.

Fisheries and Aquaculture

- Continue efforts to recruit, train, and support the next generation of fisheries and aquaculture workforce.

Bolster Workforce Development for Defense

- Over 90% of companies in the defense industry have difficulty hiring to support their workforce areas, including undersea technology and cybersecurity (SENEDIA 2016). The development of career pathways, opportunities for work readiness/experiential learning, and workforce intelligence and system integration are in demand.

Workforce Incentives

- Consider offering other incentives, including free child care, affordable housing, and transportation stipends in addition to reasonable salaries to incentivize the workforce to participate and remain in the blue economy.

Strategy 5:

Continually engage and inform a broad constituency for stewarding our ocean resources and meeting the blue economy's education, training, and infrastructure needs.

Recommendation

Ensure Rhode Islanders have increased pride, ownership, understanding, and participation in the sustainable management and health of the state's blue economy. Offer opportunities for Rhode Islanders to "experience" and tour different infrastructure within the sectors so they have a better understanding of the value and the interconnectedness.

Rationale

The likelihood of strong resource stewardship increases when people, citizens, and leaders alike, understand the blue economy's value. Likewise, cross-sector innovation and problem solving are far more likely when key stakeholder networks come together. By engaging the public in coastal and ocean planning efforts to shape our marine environment, we establish a sense of ownership, leading to more sustainable growth and stewardship of this resource.

Actions

Solidify Understanding

Build a deeper public understanding and appreciation of the value and diversity of Rhode Island's and Southern New England's blue economies and the human connection to it, both in terms of employment and quality of life. This includes enhancing public understanding and appreciation of Rhode Island's wild-harvest fishing industry.

Communicate and Connect

Organize consistent networking opportunities for members within the blue economy to exchange ideas, build relationships, identify opportunities, and find solutions. Activities can include an annual blue economy symposium, quarterly workshops, and monthly socials to encourage networking opportunities.

Visit and Visualize the Blue Economy

Develop a more comprehensive Rhode Island blue economy tourism trail, which celebrates the different aspects of Rhode Island's blue economy, educates the public on the value of the state's working waterfront and pristine habitats, and serves as a tourism and recreation attraction for the state.

Engage Stakeholders in the Planning of Our Coasts

Ensure that the public, including underserved communities, has ample opportunity to participate in the setting of goals and policies, and access to understand complex issues as the state continues to plan and manage our coasts and oceans.

Appendix: Glossary

Annual sales

The revenue that a company derives from the sale of its products in a year. This is distinguished from sources of annual revenue like interest income and other investments. A company records its annual sales on its balance sheet. High sales are desirable, particularly when expenses are high (Farlex 2012).

Business output

Also referred to as revenue or sales volume, is the broadest measure of economic activity, as it generates the largest numbers. It includes the full (gross) level of business revenue, which pays for costs of materials and costs of labor, as well as generating net business income (profits) (Weisbrod 1997).

Data suppression

Refers to the process of withholding or removing selected information—most commonly in public reports and datasets—to protect the identities, privacy, and personal information. Data suppression is used whenever there is chance that the information contained in a publicly available report could be used to reveal or infer the identities of specific individuals (Reform 2019).

Direct economic effects

The changes in local business activity occurring as a direct consequence of public or private business decisions, or public policies and programs (Weisbrod 1997).

Economic impacts

Effects on the level of economic activity in a given area. They may be viewed in terms of: 1) business output (or sales volume), 2) value added (or gross regional product), 3) wealth (including property values), 4) personal income (including wages), or 5) jobs. Any of these measures can be an indicator of improvement in the economic well-being of area residents, which is usually the major goal of economic development efforts (Weisbrod 1997).

Farm gate value

A basic price with the “farm gate” as the pricing point, that is, the price of the product available at the farm, excluding any separately billed transport or delivery charge (World Bank 2004).

Gross Domestic Product (GDP)

The market value of the goods and services produced by labor and property located within the borders of the United States (IMPLAN 2019).

Gross revenues

Same as gross sales (Sproul 2019).

Gross sales

Total sales dollars generated by a business (Sproul 2019).

Gross State Product (GSP)

A measurement of a state’s output; it is the sum of value added from all industries in the state. GSP is the state counterpart to the nation’s gross domestic product (GDP) (KFF 2019).

Indirect business impacts

Business growth/decline resulting from changes in sales for suppliers to the directly affected businesses (including trade and services at the retail, wholesale and producer levels) (Weisbrod 1997).

Induced business impacts

Further shifts in spending on food, clothing, shelter and other consumer goods and services, as a consequence of the change in workers and payroll of directly and indirectly affected businesses. This leads to further business growth/decline throughout the local economy (Weisbrod 1997).

Indirect effects

The impact of local industries buying goods and services from other local industries (IMPLAN 2019).

Induced effects

The response by an economy to an initial change (direct effect) that occurs through re-spending of income received by a component of value added (IMPLAN 2019).

Economic output

The total value of all goods and services produced in an economy (Study 2019).

Rhode Island’s blue economy

Although there are many interpretations of the term “blue economy,” this report defines the blue economy as the economic sectors that have a direct or indirect link to Rhode Island’s coasts and ocean—defense, marine trades, tourism and recreation, fisheries, aquaculture, ports and shipping, and offshore renewable energy. Also included are higher education and research institutions, marine-focused advocacy and civic groups, and government agencies that contribute to building a strong workforce within the blue economy, invest in blue economy sustainable growth and innovation, and/or plan for and protect coasts and oceans.

Rhode Island’s blue economy enhancers

Components that increase or improve in value the quality, desirability, or sustainability of the blue economy as a whole. They are also included in this report.

Total Effects

A sum of the direct, indirect, and induced effects (Weisbrod 1997).

Economic Value Added (EVA)

A measure of an organization’s economic profit that takes into account the opportunity cost of invested capital and ultimately measures whether organizational value was created or lost (Course 2019).

Appendix: Sources

Introduction

Brookings Institute (2015). Rhode Island innovates: A competitive strategy for the Ocean State. Battelle Technology Partnership Practice and Metropolitan Policy Program at Brookings with support from Monitor Deloitte and TEconomy Partners, LLC.

Economics: National Ocean Watch (ENOW). (2019). National Oceanic and Atmospheric Administration Office for Coastal Management DigitalCoast. Web site: <https://coast.noaa.gov/digitalcoast/tools/enow.html>.

National Oceanic and Atmospheric Administration (NOAA), Office for Coastal Management. 2015. "NOAA Report on the U.S. Ocean and Great Lakes Economy." Charleston, SC: NOAA Office for Coastal Management. Available at: <https://coast.noaa.gov/data/digitalcoast/pdf/econ-report.pdf>.

OECD (2016), The Ocean Economy in 2030. OECD Publishing, Paris. <http://dx.doi.org/10.1787/9789264251724-en>.

Introduction: By the Numbers

Dean Bruce Corliss, State of GSO presentation, October 21, 2019.

Deepwater Wind, 2019: <http://dwwind.com/project/block-island-wind-farm/>.

ILO, IMF, OECD, Eurostat, UNECE, World Bank, 2004, Producer Price Index Manual: Theory and Practice, International Monetary Fund, Washington DC.

Rhode Island Department of Environmental Management (RI DEM). Coastal Resources web page 2019. Online: <http://www.dem.ri.gov/programs/coastal/>.

Economic Effects of Allen's Avenue Businesses prepared for Providence Working Waterfront Alliance (PWVA) (June 2008). FXM Associates.

Economics: National Ocean Watch (ENOW). (2019). National Oceanic and Atmospheric Administration Office for Coastal Management DigitalCoast. Web site: <https://coast.noaa.gov/digitalcoast/tools/enow.html>.

Governor Raimondo's Plan to Invest in Success at Quonset's Port of Davisville (2016). http://www.quonset.com/_resources/common/userfiles/file/Quonset%20Port%20of%20Davisville%20Bond%20-%20Key%20Facts%206.22.16.pdf.

National Oceanic and Atmospheric Administration (NOAA) (November 2017). Frequent Questions, Economics: National Ocean Watch (ENOW) Data, NOAA Office for Coastal Management. Web site: <https://coast.noaa.gov/data/digital-coast/pdf/enow-faq.pdf>.

Quonset's Port of Davisville Infrastructure Rehabilitation/ Replacement Program (Quonset Powerpoint) (2016) http://www.quonset.com/_resources/common/userfiles/file/Quonset%20Port%20of%20Davisville%20Presentation%20Final%206.20.16.pdf.

Rhode Island Coastal Resources Management Council (CRMC) (2018). "Aquaculture in Rhode Island Online: <http://www.crmc.ri.gov/aquaculture/aquareport17.pdf>.

Rhode Island Department of Labor & Training Labor Market Information Unit (Labor). September 2018. Rhode Island Employment Trends and Workforce Issues.

Save The Bay – Narragansett (Save The Bay). Save The Bay web page 2019. Online: <https://www.savebay.org/about-us/how-we-work/>

Smith, Christine. Managing Director for Innovation (Innovation). April 26, 2018. Rhode Island Commerce Corporation.

Snyder, Peter. Vice President for Research & Economic Development, URI. Personal Communication, September 30, 2019.

Sproul, Thomas. Associate Professor, Department of Environmental and Natural Resources Economics, URI. Personal Communication, November 5, 2019.

Federal Reserve Bank of St. Louis (Reserve). 2019. Online at: <https://fred.stlouisfed.org/series/RINGSP>.

Tebaldi, Edi. The Quonset Economic Impact 2019. Bryant University. (September 2019).

The Economic Impact of Tourism in Rhode Island, 2017 Analysis, Tourism Economics. An Oxford Economics Company (Oxford).

The Southeastern New England Defense Industry Alliance (SENEDIA) (2017). The Economic Impact of the Rhode Island Defense Cluster. Online: <https://www.senedia.org/wp-content/uploads/2017/08/Economic-Impact-of-the-RI-Defense-Cluster-August-2017-FINAL.pdf>.

Utility Dive, 2019 <https://www.utilitydive.com/news/rhode-island-law-makers-extend-renewable-standard-to-385-by-2035/421511/>.

Weisbrod, G., Weisbrod, B. (1997). Measuring Economic Impacts of Projects and Programs. Economic Development Research Group and Northwestern University, Economics Department. Online: <http://edrgroup.com/pdf/econ-impact-primer.pdf>.

Sector: Defense

Congressional Budget Office (CBO) (2018). An Analysis of the Navy's Fiscal Year 2019 Shipbuilding Plan. Online: <https://www.cbo.gov/publication/54564>.

Department of Defense (DOD). (2018). Defense Spending By State: Fiscal Year 2016.

General Dynamics (Electric Boat) (2019) Web site: <http://www.gdeb.com/about/history/>.

Hagel, Chuck. (2014). "Defense Innovation Days" Opening Keynote (Southeastern New England Defense Industry Alliance). Sept. 3, 2014.

National Institute for Undersea Vehicle Technologies (NIUVT) (2019) <http://niuvt.us/about-us>.

Naval Sea Systems Command (NAVSEA) (2019) Web site: <https://www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport/>.

Naval Station Newport (NAVSTA) (2019) Web site: https://www.cnrc.navy.mil/regions/cnrma/installations/ns_newport.html.

Naval Undersea Warfare Center Division Newport (NUWC) (2019). Web site: <https://www.navsea.navy.mil/Home/Warfare-Centers/NUWC-Newport/Who-We-Are/>.

Raytheon (2019) Web site: <https://www.raytheon.com/capabilities>.

Rhode Island National Guard (The Guard) (2019) Web site: <https://www.riarmygaurd.com/>.

Ronald Vien, Technical Director, Naval Undersea Warfare Center, panelist: "Undersea Defense Research: Protecting America's Interests at Home and Abroad in Promoting the Region's Blue Economy." Event: "Accelerating the Marine Science and Technology Corridor: An Industry, Academia and Government Collaboration," University of Massachusetts/Dartmouth, November 1, 2019.

The Southeastern New England Defense Industry Alliance (SENEDIA) (2017). The Economic Impact of the Rhode Island Defense Cluster. Online: <https://www.senedia.org/wp-content/uploads/2017/08/Economic-Impact-of-the-RI-Defense-Cluster-August-2017-FINAL.pdf>.

The Southeastern New England Defense Industry Alliance (SENEDIA) (2016). Comprehensive Workforce Development Plan: 2017- 2020. Online: <http://www.dlt.ri.gov/realjobs/pdfs/compPlan17/CybersecurityPartnershipSENEDIA.pdf>.

The Southeastern New England Defense Industry Alliance (SENEDIA) (2019) Web site: <https://www.senedia.org/>.

Undersea Technology Innovation Consortium (UTIC) (2019). Web site: <https://www.underseatech.org/consortium/>.

U.S. Coast Guard in Rhode Island (Coast Guard) (2019) Web site: <https://militarybases.com/rhode-island/point-judith/>.

U.S. Naval War College (NWC) (2019) Web site: <https://usnwc.edu/>.

Sector: Marine Trades

National Oceanic and Atmospheric Administration (NOAA) (2015). Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Charleston, SC: NOAA Office for Coastal Management. Online: <https://coast.noaa.gov/digitalcoast/data/enow.html>.

National Oceanic and Atmospheric Administration (NOAA), Office of Coastal Management. (2018a). Coastal County Snapshots. Online: <https://coast.noaa.gov/snapshots/#/process?action=startover>.

Rhode Island House of Representatives, Special Legislative Commission to Study Methods for Growing Tourism in the State of Rhode Island. Final Report. Submitted April 17, 2019. Online at: <http://www.rilin.state.ri.us/commissions/tcomm/com-mdocs/materials/Final%20Report.pdf>.

Sproul, Thomas W. and Clayton P. Michaud, (2018a). The Economic Impact of Rhode Island's Marine Trades Sector. Kingston, RI: University of Rhode Island. Online: <http://rimta.org/wp-content/uploads/2018/09/Marine-Trades-Report.pdf>.

Sproul, Thomas W. and Clayton P. Michaud, (2018b). The Economic Impact of Rhode Island's Fisheries and Seafood Sector. Kingston, RI: University of Rhode Island. Online: <http://www.cfrfoundation.org/economic-impact-of-fisheries-in-rhode-island/>.

Sproul, Thomas W. and Clayton P. Michaud, (2018c). The Economic Impact of Rhode Island's Composites Sector. Kingston, RI: University of Rhode Island. Online: <http://www.cfrfoundation.org/economic-impact-of-fisheries-in-rhode-island/>.

Sector: Ports and Shipping

Bristol Community College, British Consulate-General Boston, the City of New Bedford, and the New Bedford Wind Energy Center (2018) The Offshore Wind Symposium: Transforming a Nascent Industry. 30 October, 2018.

Bureau of Transportation Statistics (BTS). Freight Facts & Figures 2017 - Chapter 2: Freight Moved in Domestic and International Trade. Online: <https://www.bts.gov/newsroom/freight-facts-and-figures-2017>.

Economic Effects of Allens Avenue Businesses. Prepared for Providence Working Waterfront Alliance. Prepared by FXM Associates. June 2008. Executive Summary available at <http://providenceworkingwaterfront.org/wp-content/uploads/2008/06/allens-ave-econ-impact.pdf>.

- J. Goodison Company Inc. Goodison Shipyard. Online: <https://www.jgoodison.com/new-shipyard/>.
- McFadden, J., Barrows, A., & Reschovsky, C. A. (2017). 2016 Highlights of Ferry Operations in the United States. Online: <https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/surveys/national-census-ferry-operators-ncfo/210441/ferry-operators-highlights-2016.pdf>.
- National Oceanic and Atmospheric Administration (NOAA) (2018). Fisheries of the United States 2017. National Marine Fisheries Service Office of Science and Technology. Silver Spring, MD.
- National Oceanic and Atmospheric Administration (NOAA) (2015). Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Charleston, SC: NOAA Office for Coastal Management. Online: <https://coast.noaa.gov/digitalcoast/data/enow.html>.
- Quonset Development Corporation (2017). 2017 Report. Online at: http://www.quonset.com/_resources/common/userfiles/file/Financial%20Stmts/FY2017/QDC%206.30.17%20Financial%20Statements.pdf.
- Reed, 2018. Reed, MARAD Administrator Meet with RI Shipbuilders to Discuss New Efforts to Support Marine Jobs & Economic Development & the Future of Our Transportation Network. Online at: <https://www.reed.senate.gov/news/releases/reed-delivers-over-855k-for-the-port-of-davisville-to-get-marine-highway-project-rolling>.
- Rhode Island Coastal Resources Management Council (CRMC). Rhode Island Ocean Special Area Management Plan. Adopted October, 2010. Online at: http://www.crmc.ri.gov/samp_ocean.html.
- Rhode Island Department of Environmental Management (RI DEM). Coastal Resources web page 2019. Online: <http://www.dem.ri.gov/programs/coastal/>.
- Rhode Island Ports and Commercial Harbors, A GIS Based Inventory of Current Uses and Infrastructure. Narragansett, RI: University of Rhode Island Coastal Resources Center. Online: https://www.crc.uri.edu/download/coast_ph_report.pdf.
- "Strengthening Skills Training and Career Pathways Across the Transportation Industry," Data Report on Future Transportation Workforce Needs. August 2015. U.S. Departments of Education, Transportation, and Labor. Online: https://www.mpsecoalition.org/uploads/6/8/6/1/68617087/reer_pathways_across_transportation_industry_data_report.pdf.
- The Southeastern New England Defense Industry Alliance (SENEDIA) (2017). The Economic Impact of the Rhode Island Defense Cluster. Online: <https://www.senedia.org/wp-content/uploads/2017/08/Economic-Impact-of-the-RI-Defense-Cluster-August-2017-FINAL.pdf>.
- Tebaldi, E., The Quonset Economic Impact 2019, The Quonset Development Corporation, 2019.
- U.S. Army Corps of Engineers (USACE), 2017. Waterborne tonnage for principal U.S. ports and all 50 states and U.S. territories; Waterborne tonnages for domestic, foreign, imports, exports and intra-state waterborne traffic. Online at: <https://usace.contentdm.oclc.org/digital/collection/p16021coll2/id/2969.%20Last%20accessed%20October%2025,%202018>.
- "U.S Maritime Workforce Grows to 650,000 Americans." Press Release, Seafarers International Union, March 4, 2019. Online at: <https://www.seafarers.org/jonesactmeansamericanjobs/>.
- Waterson. Chris (2019, May 24). Email.
- Sector: Tourism and Recreation**
- Delaware Sea Grant (2018). Overview of the Seafood Industry. Online: <https://www.seafood-healthfacts.org/seafood-choices/overview-seafood-industry>.
- Discover Newport (2018). Cruise ship activity: Newport. Evan Smith.Pers. Communication.
- McFadden, J., Barrows, A., & Reschovsky, C. A. (2017). 2016 Highlights of Ferry Operations in the United States. Online: <https://www.bts.gov/sites/bts.dot.gov/files/docs/browse-statistical-products-and-data/surveys/national-census-ferry-operators-ncfo/210441/ferry-operators-highlights-2016.pdf>.
- National Oceanic and Atmospheric Administration (NOAA) (2015). Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Charleston, SC: NOAA Office for Coastal Management. Online: <https://coast.noaa.gov/digitalcoast/data/enow.html>.
- Rhode Island Boat Registration Summary web page, MarineTitle.com website. 2019. Online: <https://www.marinetitle.com/boat-registration/RI-Rhode-Island.htm>.
- Rhode Island Coastal Resources Management Council (CRMC). Rhode Island Ocean Special Area Management Plan. Adopted October, 2010. Online at: http://www.crmc.ri.gov/samp_ocean.html.
- Rhode Island Department of Environmental Management (RI DEM). "Frequently Asked Questions Concerning Boat Registration" web page. Available at: <http://www.dem.ri.gov/programs/fish-wildlife/boating/boat-reg-faq.php>.
- Rhode Island Department of Labor and Training. (2012). Leisure, Hospitality and Tourism. Online: <http://www.dlt.ri.gov/lmi/pdf/profileleisure.pdf>.
- Rhode Island Outdoor Recreation Council. (2016). A New Vision for Outdoor Recreation in Rhode Island, A Report to Governor Raimondo From the Rhode Island Outdoor Recreation Council. Online: <http://governor.ri.gov/documents/press/ORCFinalReport.pdf>.
- Rhode Island Saltwater Anglers Association (RISAA) (2007). Rhode Island Recreational Saltwater Fishing Industry Trends and Economic Impact. Coventry, RI: Rhode Island Saltwater Anglers Association. Online: <https://www.risaa.org/EconomicStudy07.pdf>.
- Sproul, Thomas W. (2017). The Economic Impact of Rhode Island State Parks. Kingston, RI: University of Rhode Island.
- Sproul, Thomas W. and Clayton P. Michaud, (2018a). The Economic Impact of Rhode Island's Marine Trades Sector. Kingston, RI: University of Rhode Island. Online: <http://rimta.org/wp-content/uploads/2018/09/Marine-Trades-Report.pdf>.
- Sproul, Thomas W. and Clayton P. Michaud, (2018b). The Economic Impact of Rhode Island's Fisheries and Seafood Sector. Kingston, RI: University of Rhode Island. Online: <http://www.cfrfoundation.org/economic-impact-of-fisheries-in-rhode-island/>.
- "Why Aren't Millennials Buying Boats?" Fiona McGlynn for BoatUS (2017). Online: <https://www.boatus.com/magazine/2017/october/why-arent-millennials-buying-boats.asp>.
- Sector: Fisheries**
- National Marine Fisheries Service (NMFS) (2015). Fisheries of the United States. Silver Spring, MD: National Oceanic and Atmospheric Association (NOAA). <https://www.st.nmfs.noaa.gov/Assets/commercial/fus/fus15/documents/FUS2015.pdf>.
- National Marine Fisheries Service (2018) Fisheries of the United States, 2017. U.S. Department of Commerce, NOAA Current Fishery Statistics No. 2017. Online: <https://www.fisheries.noaa.gov/resource/document/fisheries-united-states-2017-report>.
- National Oceanic and Atmospheric Administration (NOAA) (2015). Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Charleston, SC: NOAA Office for Coastal Management. Online: <https://coast.noaa.gov/digitalcoast/data/enow>.
- National Ocean Economics Program (NOEP) (2016). State of the U.S. Ocean and Coastal Economies 2016 Update. Middlebury Institute of International Studies at Monterey, Center for Blue Economy. Online: http://midatlanticocean.org/wp-content/uploads/2016/03/NOEP_National_Report_2016.pdf.
- U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau. 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation.
- Rhode Island Saltwater Anglers Association (2007). Rhode Island Recreational Saltwater Fishing Industry Trends and Economic Impact. Coventry, RI: Rhode Island Saltwater Anglers Association. Online: <https://www.risaa.org/EconomicStudy07.pdf>.
- Sproul, Thomas W. and Clayton P. Michaud, (2018a). The Economic Impact of Rhode Island's Marine Trades Sector. Kingston, RI: University of Rhode Island. Online: <http://rimta.org/wp-content/uploads/2018/09/Marine-Trades-Report.pdf>.
- Sproul, Thomas W. and Clayton P. Michaud, (2018b). The Economic Impact of Rhode Island's Fisheries and Seafood Sector. Kingston, RI: University of Rhode Island. Online: <http://www.cfrfoundation.org/economic-impact-of-fisheries-in-rhode-island/>.
- The Resilient Fisheries RI project (with support from the Rhode Island Natural History Survey.) 2018. Rhode Island Commercial Fisheries Blueprint for Resilience. Available at www.resilientfisheriesri.org.
- Uchida, E., Mead., Giroux, A., & Hayden, S. (2019). The Narragansett Bay Watershed Economy: The ebb and flow of natural capital – Executive Summary. Narragansett, R.I.: Coastal Institute at the University of Rhode Island.
- Sector: Aquaculture**
- "About." Shellfish RI website. Online: <http://www.shellfishri.com/about/>.
- "Aquaculture." NOAA Fisheries web site. Online: <https://www.fisheries.noaa.gov/topic/aquaculture#overview>.
- "Aquaculture." Shellfish RI web site. Online: <http://www.shellfishri.com/the-plan/resources/aquaculture/>.
- "Aquaculture Career Options and Education Requirements. (n.d.). Online: https://study.com/articles/Aquaculture_Career_Options_and_Education_Requirements.html.
- "Aquaculture in New England and the Mid-Atlantic." NOAA Fisheries web site. Online: <https://www.fisheries.noaa.gov/new-england-mid-atlantic/aquaculture/aquaculture-new-england-and-mid-atlantic>.
- "Aquaculture in Our Region." NOAA Fisheries / Greater Atlantic Region web site. Online: <https://www.greateratlantic.fisheries.noaa.gov/sed/aquaculture/index.html>.
- "Aquaculture in Rhode Island 2017." (2018). Coastal Resource Management Council (CRMC). Online: <http://www.crmc.ri.gov/aquaculture/aquareport17.pdf>.
- "Aquaculture Salaries in the United States". (2019). Indeed. Online: <https://www.indeed.com/salaries/Aquaculture-Salaries>.
- Byron, Carrie. (2010). "Carrying capacity of bivalve aquaculture." Dissertations and Master's Theses (Campus Access). Paper AAI3451837. Online: <https://digitalcommons.uri.edu/dissertations/AAI3451837>.
- Coastal Resource Management Council (CRMC). (2018). Aquaculture in Rhode Island 2017. Online: <http://www.crmc.ri.gov/aquaculture/aquareport17.pdf>.
- Coastal Resource Management Council (CRMC). (2019). Aquaculture in Rhode Island 2018. Online: <http://www.crmc.ri.gov/aquaculture/aquareport18.pdf>.

- Cyglar, Azure (2019, March 12). Personal Interview.
- Food and Agriculture Organization (FAO). (2018). The State of World Fisheries and Aquaculture 2018 - Meeting the Sustainable Development Goals. Rome. Online: <http://www.fao.org/3/i9540en/I9540EN.pdf>.
- Lapointe, G. (2013). NROC White Paper: Overview of the Aquaculture Sector in New England. Northeast Regional Sector in New England. Online: <https://northeastcoastcouncil.org/wp-content/uploads/2013/03/Aquaculture-White-Paper.pdf>.
- National Oceanic and Administrative Association (NOAA) Aquaculture. (2018). Online: <https://www.fisheries.noaa.gov/topic/aquaculture>.
- National Oceanic and Atmospheric Administration (NOAA) (2015). Economics: National Ocean Watch (ENOW) Data. Based on data from the Bureau of Labor Statistics and the Bureau of Economic Analysis. Charleston, SC: NOAA Office for Coastal Management. Online: <https://coast.noaa.gov/digitalcoast/data/enow.html>.
- "New England/Mid-Atlantic." NOAA Fisheries web site. Online: <https://www.fisheries.noaa.gov/region/new-england-mid-atlantic>.
- U.S. Commission on Ocean Policy. Preliminary Report, Chapter 22: Setting a Course for Sustainable Marine Aquaculture. Online: <http://gov-info.library.unt.edu/oceancommission/documents/prelimreport/chapter22.pdf>.
- Sector: Offshore Wind Energy**
- AWEA. (2019). Offshore Wind. American Wind Energy Association (AWEA). Online: <https://www.awea.org/policy-and-issues/u-s-offshore-wind>.
- 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.
- "Block Island Wind Farm." Deepwater Wind, Deepwater Wind. 2019. Online: <http://dwwind.com/project/block-island-wind-farm/>.
- "Block Island Wind Farm." Power Technology, Verdict Media Limited. 2019. Online: www.power-technology.com/projects/block-island-wind-farm/.
- Business Network for Offshore Renewable Energy, 2019. Online: <https://www.offshorewindus.org/>.
- Burdock, Liz. Presentation at the Rhode Island Offshore Wind Summit July 18, 2019, Newport, RI.
- BVG Associates Limited (2017). U.S. Job Creation in Offshore Wind: A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind. NYSERDA. Online: <https://tethys.pnnl.gov/publications/us-job-creation-offshore-wind-report-roadmap-project-multi-state-cooperation-offshore>.
- Camoin Associates (2017). Wind Energy Sector in the U.S. & Rhode Island – An Overview for Creation of Workforce Development Programs. May 2017.
- CRMC, 2019. <http://www.crmc.ri.gov/windenergy/dwrevolution.html>.
- Deepwater Wind/Ørsted Website, 2019. Available at: <http://dwwind.com/project/block-island-wind-farm/>.
- Draws, Katherine. "An Ocean of Energy: Bringing Offshore Wind to America." Ocean Portal, Smithsonian's National Museum of Natural History, 9 May 2018. Online: <https://ocean.si.edu/conservation/climate-change/ocean-energy-bringing-off-shore-wind-america>.
- E.A. Willsted, S. Jude, A.B. Gill, S.N.R. Birchenough. Obligations and aspirations: a critical evaluation of offshore wind farm cumulative impact assessments. *Renew. Sustain. Energy Rev.*, 82 (2017), pp. 2332-2345.
- Faulkner (2018). *ecoRI News*. Wind Turbines Coming to R.I. Classrooms This Fall. Aug 20, 2018. Online: <https://www.ecori.org/renewable-energy/2018/8/20/sa17o6sassxnunah95b7a6uckqmo1>.
- Froese, Michelle. Windpower Engineering Development. Rhode Island regulators approve 400-MW Revolution Wind power contract. May 29, 2019. <https://www.windpowerengineering.com/business-news-projects/rhode-island-regulators-approve-400-mw-revolution-wind-power-contract/>.
- Gilman, P., Maurer, B., Feinberg, L., Duerr, A., Peterson, L., Musial, W., ... & Boren, D. (2016). National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States (No. DOE/GO-102016-4866). National Renewable Energy Lab.(NREL), Golden, CO (United States).
- "Lease and Grant Information". (2019). Bureau of Ocean Energy Management. Online: <https://www.boem.gov/Lease-and-Grant-Information/>.
- McClellan, Stephanie. 2019. "Supply Chain Contracting Forecast for U.S. Offshore Wind Power." University of Delaware.
- National Renewable Energy Laboratory (NREL) NREL Jobs and Economic Impacts models, 2019. Online: <https://www.nrel.gov/analysis/jedi/>.
- "Offshore Wind in Europe." Wind Europe, February 2019. Online: <https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2018.pdf>.
- "Rhode Island lawmakers extend renewable standard to 38.5% by 2035." *Utility Dive*, 2 June 24, 2016. Online: <https://www.utilitydive.com/news/rhode-island-lawmakers-extend-renewable-standard-to-38-5-by-2035/421511/>.
- Schlossberg, Tatiana. "America's First Offshore Wind Farm Spins to Life." *The New York Times*, The New York Times Company, 14 Dec. 2016. Online: www.nytimes.com/2016/12/14/science/wind-power-block-island.html.
- State of New Jersey Governor Phil Murphy (2019) Governor Murphy Signs Executive Order to Increase Offshore Wind Goal to 7,500 Megawatts by 2035. Online: <https://www.nj.gov/governor/news/news/562019/approved/20191119b.shtml>.
- "State Renewable Portfolio Standards and Goals." 2019. National Conference of State Legislatures. Online: <http://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx>.
- Tiffany Smythe, Hollie Smith, Amelia Moore, David Bidwell, Jennifer McCann. "Analysis of the Effects of the Block Island Wind Farm (BIWF) on Rhode Island Recreation and Tourism Activities: Draft Final Report and Technical Summary," U.S Department of Interior Bureau of Ocean Energy Management Northeast Region, August 2018.
- University of Rhode Island (URI) (2018a). Power the next wave of renewable energy. Available online: <https://www.uri.edu/features/power-the-next-wave-of-renewable-energy/>.
- "URI Ocean Engineer: Sound from Wind Farm Operations Having No Effect on Environment." *URI Today*, University of Rhode Island, 21 Sept. 2018. Online: <https://today.uri.edu/news/uri-ocean-engineer-sound-from-wind-farm-operations-having-no-effect-on-environment/>.
- "U.S. Fishermen Feel a Chill from Wind Turbines." *CBS News*, The Associated Press, 26 Dec. 2017. Online: www.cbsnews.com/news/u-s-fishermen-worry-about-wind-turbines/.
- "Wind Energy." (2019). RI Coastal Resource Management Council. Available online: <http://www.crmc.ri.gov/windenergy.html>.
- Enhancer: Quality of Place**
- "A Hidden Gem of Rhode Island." *The New York Times*. Reported by Caryn B. Davis. August 5, 2019. Accessed August 14, 2019. Online at: <https://www.nytimes.com/interactive/2019/08/05/travel/south-county-rhode-island-beaches.html>.
- Burton M. (2014) Quality of Place. In: Michalos A.C. (eds) *Encyclopedia of Quality of Life and Well-Being Research*. Springer, Dordrecht.
- HM Government, Communities and Local Government. (2009). World class places. The government's strategy for improving quality of place. London: Communities and Local Government. <https://webarchive.nationalarchives.gov.uk/20120919161225/http://www.communities.gov.uk/documents/planningandbuilding/pdf/1229344.pdf>.
- Least and most populated states per square mile web pages, *WorldAtlas.com*. Accessed at <https://worldatlas.com> August 2019.
- Rhode Island Coastal Resources Management Council web site. 2019. Accessed at <http://www.crmc.ri.gov/August 2019>.
- "Rhode Islanders, Visitors Flocked to State Beaches and Parks Over Memorial Day Weekend," press release, May 29, 2019. The Rhode Island Department of Environmental Management. Accessed at <https://www.ri.gov/press/view/35965> August 2019.
- Rhode Island Land Trust Council homepage. Accessed August 2019 at <http://www.rilandtrusts.org>.
- "R.I. voters approve \$47.3-million environmental bond," *A. Kufner*, Nov. 6, 2018. *The Providence Journal*. Accessed online at <https://www.providencejournal.com/news/20181106/ri-voters-approve-473-million-environmental-bond> August 2019.
- State Land Conservation Totals to Date. Rhode Island Department of Environmental web site. Accessed at <http://www.dem.ri.gov/maps/August 2019>.
- Enhancer: Workforce**
- "Brief History of Rhode Island" webpage, Rhode Island Farm Bureau website, 2019. Online at <https://rifb.org/aboutus/briefhistory/>. Accessed September 10, 2019.
- "Q4 2018 Current Economic Indicator Shows Stagnant Economy in Rhode Island," Publications webpage on Rhode Island Public Expenditure Council web site at <http://www.ripec.org/Publications/Q4-2018-Current-Economic-Indicator-Shows-Stagnant-Economy-in-Rhode-Island>. Accessed September 16, 2019.
- "R.I. housing market remains strong in July," *RI Realtors* web site at <https://www.rirealtors.org/r-i-housing-market-remains-strong-in-july/>. Accessed September 16, 2019.
- "The Industrial Revolution—the Big Story" webpage, Blackstone Heritage Corridor website, 2019. Online at <https://blackstoneheritagecorridor.org/learning/history-of-the-valley/the-industrial-revolution-the-big-story/>. Accessed September 10, 2019.
- "Top Ten Turning Points in Rhode Island's History" webpage, Small State Big History website, 2019. Online at <http://smallstatebighistory.com/top-ten-turning-points-rhode-islands-history/>. Accessed September 10, 2019.
- "Young College Graduates Aren't Moving Like They Used to," *January 26, 2018*. Article online at *Forbes* <https://www.forbes.com/sites/prestoncooper/2018/01/26/young-college-graduates-arent-moving-like-they-used-to/#1f41b662685f>. Accessed September 10, 2019.

Enhancer: Innovation

"A Glossary of Innovation Terms and Strategies," by Pamela Bump, January 2, 2018, "Innovation Leader" website. Online at <https://www.innovationleader.com/a-glossary-of-innovation-terms-and-strategies/21-article?adiredir=1>. Accessed September 23, 2019.

"Higher Education's Role in Shaping a Workforce in Rhode Island" (with Rhode Island College Associate Professor Mikaila Mariel Lemonik Arthur) (www.collaborativeri.org). Report available at <http://www.collaborativeri.org/research/how-higher-education-shapes-the-workforce> (published Summer 2016).

Kerr, William R. "Innovation and Business Growth." In *Designing the Future: Economic, Societal and Political Dimensions of Innovation*, edited by Austrian Council for Research and Training Development, 137–156. Vienna, Austria: EChomedia Buchverlag, 2015. Accessed online at https://www.hbs.edu/faculty/Publication%20Files/Kerr-Innovation15_439c4e1b-9b5f-4565-8f22-d9ff0acfce260.pdf on September 19, 2019.

"Rhode Island Innovates: A Competitive Strategy for the Ocean State." 2016. Report by the Brookings Institute. Prepared by Battelle Technology Partnership Practice in association with the Metropolitan Policy Program at Brookings with support from Monitor Deloitte and TEconomy Partners, LLC. Online at: <http://www.rifuture.org/wp-content/uploads/2016-Brookings-RI.pdf>.

Enhancer: Resiliency

"Beach SAMP/Rhode Island Shoreline Change Special Area Management Plan" Executive Summary. 2019. Rhode Island Coastal Resources Management Council in partnership with the University of Rhode Island. Narragansett, RI. Available at: <http://www.beachsamp.org/wp-content/uploads/2019/02/RI-Shoreline-Change-Special-Area-Management-Plan.Singlepages.pdf>.

"Rising Seas Swallow \$403 Million in New England Home Values," press release, January 22, 2019. First Street Foundation, New York, NY. Available at: <https://assets.floodiq.com/2019/01/a22bd29b007a783c7d3fa7f5c-4531c9a-ne-homevalue-loss-slr.pdf>.

"Resilient Rhody: An Actionable Vision for Addressing the Impacts of Climate Change in Rhode Island." 2018. State of Rhode Island, Governor Gina M. Raimondo. Providence, RI. Available at: <http://climatechange.ri.gov/documents/resilientrhody18.pdf>.

Union of Concerned Scientists USA, Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate (June 2018), 28 pp. Available at: <https://www.ucsusa.org/global-warming/global-warming-impacts/sea-level-rise-chronic-floods-and-us-coastal-real-estate-implications>. Tools available at site for exploring locations by zip code and Congressional districts.

USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. doi: 10.7930/NCA4.2018. Available at: <https://nca2018.globalchange.gov/>.

"Vulnerability of Municipal Transportation Assets to Sea Level Rise and Storm Surge." 2016. Technical Paper 167. Rhode Island Statewide Planning Program. Providence, RI. Available at: http://www.planning.ri.gov/documents/sea_level/2016/TP167.pdf.

The Blue Economy Network

Borgatti, S. P., Everett, M., Johnson, J. C. (2013). *Analyzing Social Networks*. Thousand Oaks, CA: SAGE Publications..

Borgatti, S., P., Halgini, D.S. (2014). *Analyzing Affiliation Networks*. Chapter 28 in *The SAGE Handbook of Social Network Analysis*, J. Scott and P. Carrington, editors. Thousand Oaks, CA: SAGE Publications.

Robadue Jr., D., Kotowicz, D. (2019). Understanding resistance to resilience in coastal hazards and climate adaptation: three approaches to visualizing structural and process obstacles, opportunities and adaptation responses. In *Proceedings of the 52nd Hawaii International Conference on System Sciences*. Hawaii International Conference on System Sciences. <https://doi.org/10.24251/hicss.2019.368>

New York State Energy Research and Development Authority. (2019) National Offshore Wind Research and Development Consortium Program Opportunity Notice. https://portal.nyserda.ny.gov/CORE_Solicitation_Detail_Page?SolicitationId=a0rt00000beASkAAAM. Accessed September 18, 2019.

Composites Alliance of Rhode Island (CARI), 2019. Web site: <http://ricomposites.com/>.

Networks in Action: A Case Study

American Composites Manufacturers Association (ACMA) 2019. Industry Overview. <https://acmanet.org/composites-industry-overview/>.

Composites Alliance of Rhode Island. 2018. Composites Alliance of Rhode Island, About Us. <http://ricomposites.com>.

Composites World. 2016. New Rhode Island Composites Training Program to Launch this Fall. September 26. <https://www.compositesworld.com/news/new-composites-training-program-to-launch-in-rhode-island->

Daly, Susan 2019, August 2. Personal Interview.

Fornaro, David 2019, July 12. Personal Interview.

GoetzComposites. 2019. <http://goetzcomposites.com/>.

Herreshoff Marine Museum/America's Cup Hall of Fame (Herreshoff). 2019. The Herreshoff Family and Legacy. <https://herreshoff.org/hmm/index.html>.

International Yacht Restoration School (IYRS). 2017. Externships in Action: Systems & Composites Students. <https://iyr.edu/blog/externships-in-action-fall-2017-systems/>.

International Yacht Restoration School (IYRS). 2018. Composites Technology. <https://iyr.edu/composites-technology-program/>.

Jibotech. 2019. Snipe History. http://75.103.93.49/?page_id=48

Mackie, Wendy. 2019, June 27. Personal Interview.

Pearson-Merkowitz, S., Leedahl, S., Ley, S., Hall, B., Sodhi, K., DeOliveira, M. 2018. *Real Jobs Rhode Island: Case Studies & Process Evaluation*. Prepared for the Rhode Island Department of Labor and Training. Kingston, RI: URI Social Science Institute for Research, Education, and Policy.

Porter, Michael E. *Clusters and the new economics of competition*. Vol. 76. No. 6. Boston: Harvard Business Review, 1998.

Sproul, Thomas, and Clayton, Michaud. 2018. *The Economic Impact of Rhode Island's Composites Sector*. University of Rhode Island, Kingston, R.I. 13pp.

TEAM, Inc. 2019. TEAM Textile Engineering and Manufacturing, About Us. <http://www.teamtextiles.com/about>.

ThoughtCo. 2018. A list of composites materials in boats. October 20. <https://www.thoughtco.com/composite-materials-in-boats-820410>.

University of Rhode Island (URI). 2018a. Rhode Island Textile Innovation Network (RITIN) Launch. Event Details. September 24. https://events.uri.edu/event/rhode_island_textile_innovation_network_ritin#.XT4VSkcVipo.

University of Rhode Island (URI). 2018b. URI engineering grad students make case for composite use in R.I. bridges. URI Today. February 16. <https://today.uri.edu/news/uri-engineering-grad-students-make-case-for-composite-use-in-r-i-bridges/>

University of Rhode Island (URI). 2019. Composite materials: Research & Development Capabilities. <https://web.uri.edu/engineering/research/composite-materials-research-development-capabilities/>.

Wikipedia. 2019. Ed Adams. July 26. https://en.wikipedia.org/wiki/Ed_Adams.

Strategies and Actions: 2020-2025

Farlex Financial Dictionary (2012) Farlex, Inc. All Rights Reserved. Online at: <https://financial-dictionary.thefreedictionary.com/Annual+Sales>.

ILO, IMF, OECD, Eurostat, UNECE, World Bank, 2004. (World Bank 2004) *Producer Price Index Manual: Theory and Practice*, International Monetary Fund, Washington DC.

IMPLAN. (2019). Online: <https://implanhelp.zendesk.com/hc/en-us/articles/115009499547-Indirect-effects>.

KFF. 2019. Online: <https://www.kff.org/other/state-indicator/total-gross-state-product/>.

My Accounting Course (Course) (2019). Online at: <https://www.myaccountingcourse.com/accounting-dictionary/economic-value-added>.

Organisation for Economic Co-operation and Development (OECD). (2019) *Glossary of Statistical Terms*. Online at: <https://stats.oecd.org/glossary/search.asp>.

Sproul, Thomas. Personal Communication, May 29, 2019.

Study.com. (Study) Economic Output: Definition and Overview Video (2019). Online at: <https://study.com/academy/lesson/economic-output-definition-lesson-quiz.html>.

The Glossary of Education Reform (Reform). (2019). Online at: <https://www.edglossary.org/data-suppression/>.

Weisbrod, G., Weisbrod, B. (1997). *Measuring Economic Impacts of Projects and Programs*. Economic Development Research Group and Northwestern University, Economics Department. Online: <http://edgroup.com/pdf/econ-impact-primer.pdf>.

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