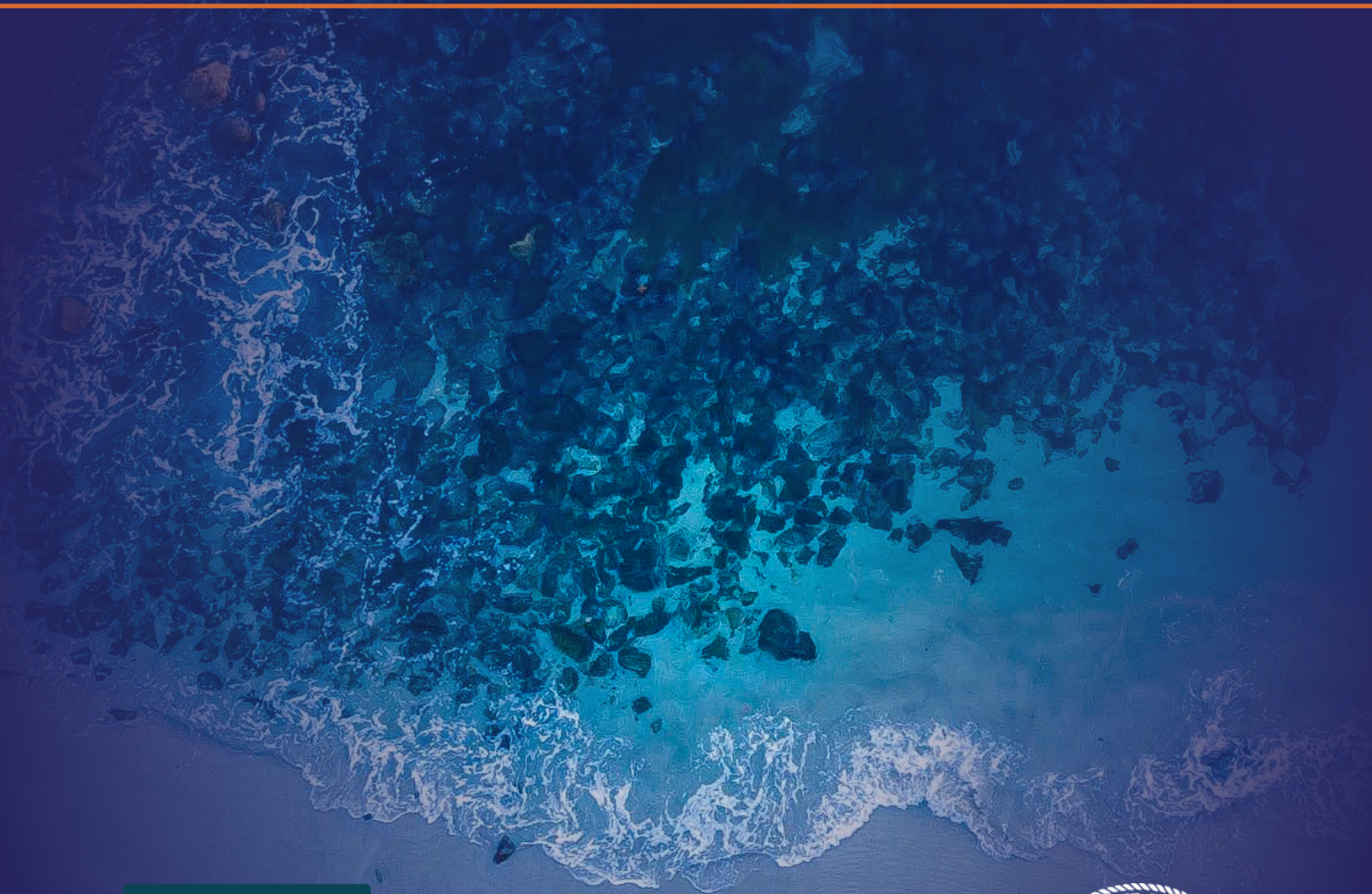
THE SAN DIEGO MARITIME, WATER, AND BLUETECH ECONOMY IN 2020



TMA BlueTech®

Promoting BlueTech & Blue Jobs®

The City of SAN DIEGO

THE NOBLEST MOTIVE IS THE PUBLIC GOOD
COUNTY OF SAN DIEGO
MDCCCLI

TBD Economics, LLC

ERISS®

University of San Diego®

This report summarizes the findings of a three-part study. One part of the study updates the findings of a 2012 study on the size and composition of San Diego's maritime, water, and BlueTech industry group. A second component of the study examines the importance of supply chains and industry clusters. The final component of the study estimates the degree to which economic activity in this industry ripples across the local economy through economic multipliers.

The study was performed by TBD Economics, LLC, ERISS, and the University of San Diego under the direction of San Diego-based TMA BlueTech. The authors would like to thank Michael B. Jones, for his vision and dedication to understanding the impacts of the BlueTech cluster in San Diego.

We also would like to thank San Diego County, and the City of San Diego, one of the largest and best known BlueTech clusters in the world, for underwriting this important work. Without their financial support, this regional study would not have been possible.

TMA BlueTech's Vision is:

Promoting economic development in the Blue Economy, allowing it to flourish and provide the foundation for sustainable growth, and international outreach which fortifies global networks spanning the breadth and depth of the oceans.

TMA BlueTech supports the following UN Sustainable Development Goals

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FOREWORD: A MARITIME VISION FOR SAN DIEGO

San Diego is a maritime city - it is a desert city that is made unique by its presence on one of the most beautiful bays and coastlines in the world. That location and the ocean are two dominating features in its past, present, and future influencing every aspect of life in the region. And it sets the stage for one of the world's great Blue Economy (ocean & water) regions and – as is fitting for such a technologically advanced county and state – an expanding, internationally active BlueTech innovation sector.

It was advanced sailing technology for its day that allowed the Spanish vessel San Salvador to visit San Diego on September 28, 1542 in search of new trade routes that would link Mexico to Asia and Europe. A depiction of the San Salvador sits at the very center of the flag and the seal of the City of San Diego underscoring that voyage of discovery but also a harbinger for the regions Blue future.

There is growing international recognition of the importance of the Blue Economy and a number of studies have been completed in the last 7-8 years including from NOAA (U.S. National Oceanographic and Atmospheric Administration) and OECD (Organisation for Economic Co-operation and Development), the Paris, France-based think tank of democracies. And there is growing awareness of the importance of BlueTech evidenced by the expanding number of BlueTech industry clusters globally most supported by national and regional governments (see "*The Blue Wave: Investing in BlueTech Clusters to Maintain Leadership and Promote Economic Growth and Job Creation*" published by The Ocean Foundation and TMA BlueTech on April 28, 2021).

This "*San Diego Maritime, Water, and BlueTech Economy in 2020*" study follows and expands on the earlier "*San Diego Maritime Industry Report 2012*", which provided groundbreaking macro-level information about the regional maritime ocean (i.e., ocean-related) economy. The 2020 study published in Feb. 2022 is broader in scope – it includes all aspects of water (ocean and fresh water/wastewater) in its definition of the Blue Economy – and then adds a deeper dive into the innovation-driven BlueTech sector with two areas of focus – the critical supply chain and the very attractive spending multiplier for BlueTech (higher than almost any other sector).

The 2012 study identified over 1,400 companies producing over $14 billion of direct sales and a workforce of almost 46,000 direct jobs spread across an array of traditional and technology-oriented sectors. The 2022 study identifies 4,320 maritime, water and BlueTech establishments generating direct revenues (i.e., not total economic benefit) of $16.2 billion and providing more than 114,000 direct jobs, an increase from 2012 driven by many small, specialized companies. That employment number is considerably greater than most other innovation sectors of the regional economy, shown in a March 2020 report https://workforce.org/news/covidimpact/ by the San Diego Workforce Partnership.

San Diego benefits by its location as the pivot point to the Pacific – the largest, deepest ocean in the world – which ties it emotionally, intellectually, and physically to the growing markets of Asia and Latin America. The oceans are the future of the world. Covering 66% of the world's surface, sustainable usage of the ocean is critical to produce the food, water, energy, medicine, and coastal "real estate" needed for the growing world population, over 60 percent of which lives near the ocean. The Pacific represents not a border but a frontier with enormous growth opportunity for San Diego. The fast-growing BlueTech sector benefits from the traditional industry's presence, and the two need to collaborate to "be all they can be". This is a massive opportunity that will require the development of a vision, education, enlightened regional leadership, a community effort and funding for BlueTech clusters to achieve the possible.

Michael B. Jones
Founder & Board Chair of TMA BlueTech

HISTORICAL CONTEXT FOR THE SAN DIEGO BLUE ECONOMY

Like most creative enterprises, ocean science and the technology it generates tend to coalesce as a regional specialty. The presence of the ocean, a major port, nearby research universities, a concentration of naval power, an entrepreneurial culture, and an investment climate, all render San Diego, and other places along the West Coast and greater Pacific with like attributes, ideal “hot spots” for the genesis of maritime science and technology.

When speaking of the Pacific seaboard we are regionally bereft in only one category – close access to the center of political and economic power – Washington D.C. However, the rising clout of California, the global shift of power from the Atlantic to the Pacific, and the tendency of communication technology to negate some limitations of distance have overcome that one geographical disadvantage with the result that San Diego possesses one of the greatest concentrations of enterprise devoted to maritime science and technology in the world. So, the conclusion naturally follows that maritime science and technology are a major (perhaps the major) and growing product of our region. In fact, so ubiquitous and intertwined are these elements within every aspect of regional life and culture that the tendency to take them for granted, to consider them as inevitable, is a natural but unfortunate consequence of their essential role to our sustainability.

Complicating efforts to gauge the true scale and significance of this enterprise, major segments within the maritime science-technology complex are traditionally not mutually aware of each other, of the scope of the entire phenomenon, or of the political and economic potential for growth that the mutual support of such awareness brings. The TMA BlueTech cluster has played a key role in creating regional awareness even as it promotes opportunities for individual companies and organizations. Without that awareness, and with so short a history despite the advantages enumerated previously, it is clear that the enterprise is yet ephemeral, something indicated in the narratives of maritime-specific companies and research programs relocated elsewhere or those that have withered away. The point is that maritime science and technology are perhaps our region’s most important intellectual and industrial specialty, but we would be more likely to sustain it if, as a community, we at least knew how transcendent it really is.

The primary mission of the Maritime Museum of San Diego is to serve as the community memory of our seafaring experience by collecting, preserving, and presenting our rich maritime heritage and connections with the Pacific world. We are the stewards of the maritime “origin story” for the San Diego region, which is critical to understand where we have come from, where we are today and to position our future in a historical context. With increased global awareness of the need to promote sustainable usage of the enormous but vulnerable ocean, San Diego and the State of California are ideally positioned to be major players to develop policies, technologies, and societal consensus to influence that effort. Only with the passage of time will be able to look back and determine if we have risen to the opportunity.

Dr. Ray Ashley
President, Maritime Museum of San Diego

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I. Executive Summary

San Diego's maritime, water, and BlueTech industry groups include over 200 types of businesses ranging from shipyards to seafood wholesalers and including manufacturers of state-of-the-art watercraft, electronics, and water treatment equipment. Many segments of this industry group are growing and evolving rapidly. Others, like naval defense contractors, are large and well-established. All are important, providing employment and generating economic impacts that extend across the entire local economy.

The analysis in this report is based on web-based surveys conducted from June through September of 2021 developed to understand changes in revenues and employment for maritime, water, and BlueTech businesses in San Diego from 2012 to 2020, and to estimate the economic impact multipliers for BlueTech in the city of San Diego, San Diego County, and California.

> As our understanding of the ocean's systems and rhythms deepens, and available space and resources on land contract, the world is increasingly looking offshore for solutions and opportunities. Coastal countries, states and communities have begun to recognize that collaboration and coordination of activities will be key to maximizing the opportunities and benefits from expanding development in the ocean.
>
> The Ocean Foundation/TMA BlueTech, "The Blue Wave."

MAJOR FINDINGS

In 2020, San Diego's 4,320 maritime, water, and BlueTech business establishments generated revenues of $16.2 billion and employed more than 114,000 persons, accounting for 5 percent of the business establishments in San Diego County and 9 percent of its total employment.

Between 2012 and 2020, revenues in San Diego's maritime, water, and BlueTech industry groups[1] increased by 18 percent; nearly two-thirds of the businesses reported that revenues were adversely affected by COVID-19. The impacts of COVID-19 are less visible in employment trends; over the same period, employment increased by 163 percent.

In 2020, San Diego's BlueTech businesses employed about 24,000 persons and generated just over $4 billion in revenues,[2] yielding a total economic impact of:

1 The current study reports figures for the year 2020.

2 The term "revenues" generally refers to funds generated by the sale of goods and services. However, San Diego's Blue-Tech sector continues to grow and includes many startups that are not yet generating revenues through the sale of final goods and services. The funds provided by investors to startups contribute to the local economy in the same ways as revenues generated from sales--they are used to purchase supplies (both goods and services) and pay employees and taxes. To measure the full impact of BlueTech in San Diego, the definition of "revenues" has been broadened to include investor funding as well as the revenue generated by the sale of products and services.

- $9.5 billion in the city of San Diego,
- $9.9 billion in San Diego County, and
- $11.3 billion in California.

Technology clusters are important to the continued growth and health of the local maritime, water, and BlueTech businesses, which have overlapping needs and, thus, share in the benefits of technological advances, the development of a labor force with specialized skills, and well-developed supply chains.

As evidenced internationally by disruptions caused by COVID-19, supply chains are vitally important to growing and maintaining the maritime, water, and BlueTech industry group. The impacts of supply chain interruptions can be mitigated by promoting and strengthening regional suppliers.

All companies benefit from the development of a skilled workforce to support maritime, water, and BlueTech companies. Educational institutions at all levels that equip residents for these jobs reduce the need to outsource for specialized skills, increasing the local economic impact.

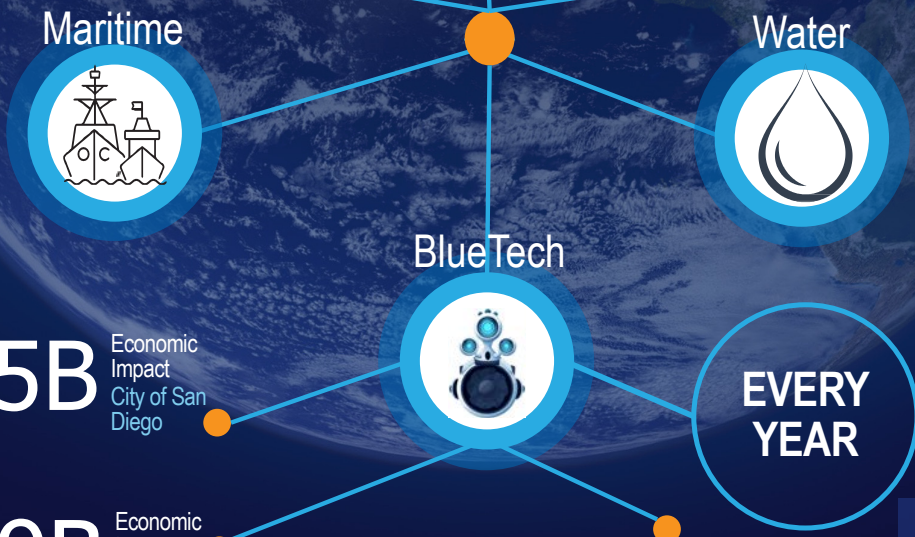
Continued research on the maritime, water, and BlueTech industry will provide better information that can drive growth, improve workforce development, and increase local economic impacts. However, BlueTech companies may need incentives to participate in these studies, including assistance in gathering data, and understanding the benefits of communicating these research results.

THE REACH OF BlueTech

4K+ Business Establishments

$16.2 Billion Revenues in 2020

9% Employment San Diego County



$9.5B Economic Impact City of San Diego

$9.9B Economic Impact San Diego County

$11.3B Economic Impact State of California

EVERY YEAR

LOCAL IMPACTS

Local spending by BlueTech companies and by their suppliers, employees, and governments are the economic ripples resulting from the initial round of revenue-generating activity. The local availability of supplies and labor increases the economic impact of BlueTech on San Diego and San Diego County. Increasing the impact of BlueTech will involve creating a business environment that is favorable not only to BlueTech but also to its suppliers and the firms with which employees and local governments spend their income.

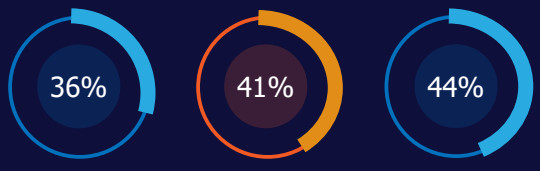
Educational institutions and the quality of life also play important roles. Local educational institutions, from elementary schools to high school, trade schools, community colleges, and universities equip local students with the skills that are needed to work in BlueTech jobs.

Place Matters:

The Advantage of Industry Clusters

- Strong clusters experience much higher growth in employment.
- The presence of several different industry clusters in a region also drives employment growth and industry growth.
- The existence of policies supportive of specific clusters has a greater impact on economic growth of the region in which the clusters are located.

Proportions of maritime, water, and BlueTech businesses with half or more of their total revenue from customers within the City of San Diego, San Diego County, and the State of California



City of San Diego | San Diego County | California

2.26
Economic multiplier for the City of San Diego. For every dollar invested in BlueTech industries, $2.26 are added to the economy.

2.34
Economic multiplier for San Diego County. For every dollar invested in BlueTech industries, $2.34 are added to the economy.

2.68
Economic multiplier for the State of California. For every dollar invested in BlueTech industries, $2.68 are added to the economy.

II. Global, National, and Local Perspectives

"In addition to its crucial role for regulating the climate and weather, the ocean is vital to the world's economy, with more than 90% of trade using sea routes and as a source of jobs for millions of people. The ocean is also the stage for a growing range of new ocean-related economic activities and constant innovations." OECD 2022.[3]

In 2016, OECD projected that the global ocean economy would double over the 20 years between 2010 and 2030.[4] Between 2010 and 2018, the U.S. ocean economy had already made significant gains, with employment increasing by 25 percent and real GDP by 31 percent.[5] Despite the dramatic impacts of COVID-19, we still look to the ocean to meet the demands of food, transportation, energy, minerals, and recreation for a growing global population.

> The global ocean economy was on the path to achieving its projected doubling in size when growth was abruptly interrupted by the global economic impacts of COVID-19. We now look to the ocean to support the recovery of the global economy while meeting the demands for food, transportation, energy, mineral, and recreation for a growing global population.

Advances in science and technology are essential to the sustainable use of ocean resources to recover from the economic impacts of COVID-19 and to meet the growing demands of future generations. Innovation networks are being established to leverage the capabilities of research institutions and businesses of all sizes to rapidly advance the application of science to and the development of technologies needed for marine robotics, autonomous vehicles, aquaculture, marine renewable energy, biotechnologies, and other ocean segments of the ocean economy.[6]

In 2019, according to official statistics,[7] the United States ocean economy generated $656 billion in sales, adding $397 billion to the nation's GDP[8] and employing 2.4 million full- and

3 OECD. 2022. The Ocean: Ocean economy and innovation. Available at https://www.oecd.org/ocean/topics/ocean-economy/. Accessed January 31, 2022.

4 OECD. 2016. The Ocean Economy in 2030.

5 NOAA. Economics: National Ocean Watch data, downloaded from https://coast.noaa.gov/digitalcoast/data/enow.html on January 31, 2022.

6 OECD. 2022. The Ocean: Ocean economy and innovation.

7 Bureau of Economic Analysis, 2021. Marine Economy Satellite Account, 2014-2019. Data retrieved from https://www.bea.gov/data/special-topics/marine-economy.

8 The Marine Economy Satellite Account, cited above, provides statistics for "gross receipts" and "value added." Gross receipts include sales by businesses and receipts for goods and services provided by non-business institutions, such as universities. Value added is an enterprise's contribution to the national economy and is equivalent to gross receipts minus the cost of supplies used in production; thus, value added is always less than gross receipts.

part-time employees who received $172 billion in compensation. In 2019, ocean economy sales exceeded those of public utilities in the United States. Between 2018 and 2019, the number of ocean economy jobs increased at more than twice the pace of the U.S. economy as a whole. One of the fastest-growing segments of the ocean economy was manufacturing nonrecreational ships and boats such as those that support the U.S. Naval Base in San Diego, which increased by 37 percent in 2019.[9]

TMA BlueTech has long embraced an inclusive definition of the Blue Economy as including ocean and water/wastewater as part of the inter-linked water cycle, which is implicit in its saying "If it's wet, it's blue." The *Mission Starfish 2030: Restore our Ocean and Waters* report[10] published in 2020 by the European Commission Directorate-General RTD emphasizes this concept. "The ocean, seas, coastal and inland waters form a single system – the water cycle… Without healthy ocean and waters, there is simply no life on Earth… Restoring and protecting our ocean and waters is one of the urgent and defining tasks of our time."

San Diego's maritime, water, and BlueTech industries are poised to make significant contributions to the national and global ocean economies. Despite the impacts of COVID-19, employment in 2020 was more than twice as high as in 2012. With world-renowned ocean research institutions and industry clusters that leverage the capabilities of businesses ranging from startups to large international corporations, San Diego is a major player in the global ocean economy, providing goods and services that incorporate the latest technological and scientific advances into a rich array of applications including aquaculture, the manufacture of innovative marine vessels, water/wastewater technologies, and other marine and water-related products and services.

9 Bureau of Economic Analysis. 2021. Marine Economy Satellite Account, 2014-2019.

10 Lamy, P., Citores, A., Deidun, A., Evans, L., Galgani, F., Heffernan, P., Karageorgis, A., Kauppi, L., Manakovski, D., Meissner, G. and Moldoveanu, V., 2020. Mission Starfish 2030: Restore our ocean and waters. Report of the Mission Board Healthy Oceans, Seas, Coastal and Inland Waters, p.92.

III. Maritime, Water, and BlueTech: A Large and Growing Part of the San Diego Economy

In 2020, San Diego's 4,320 maritime, water, and BlueTech business establishments generated revenues of $16.2 billion and employed more than 114,000 persons, accounting for 5 percent of the business establishments in San Diego County and 9 percent of its employment.

Despite the impacts of COVID-19, employment in 2020 was more than twice as high as in 2012.[11] Table 1 shows some of the more than 200 classes of business activity represented in San Diego's maritime, water, and BlueTech industry group.

Examples of Maritime, Water, and BlueTech Establishments in San Diego		
marinas	port authorities	seafood wholesalers
shipyards	logistics services	marine freight carriers
tugboat services	naval defense contractors	charter boats and yachts
aquaculture	boat building	wastewater technology
irrigation and water systems	manufacturers of marine and water-related products	educational establishments

Table 1. Examples of Maritime, Water, and BlueTech Establishments in San Diego

This study considers three distinct components of the maritime, water, and BlueTech enterprise in San Diego:

- pure maritime/water: businesses engaged solely in maritime and water/wastewater activities
- partial maritime/water: businesses where maritime and water/wastewater activities account for some but not all of their business activity
- BlueTech maritime/water: businesses providing the technology and technological services used in the maritime and water/wastewater industries

11 This increase is partially due to access to improved data sources in the current study.

As can be seen in the figures below, ***employment*** in maritime, water, and BlueTech is dominated by firms in the **pure maritime/water** industry group (59 percent), with the remainder divided somewhat evenly between the other two classes. The number of ***business establishments*** follows a similar but less pronounced pattern, with **pure maritime/water** accounting for 50 percent of business establishments. ***Revenues*** are somewhat more evenly distributed among the three classes with the largest share (41 percent) associated with **partial maritime/water** establishments.

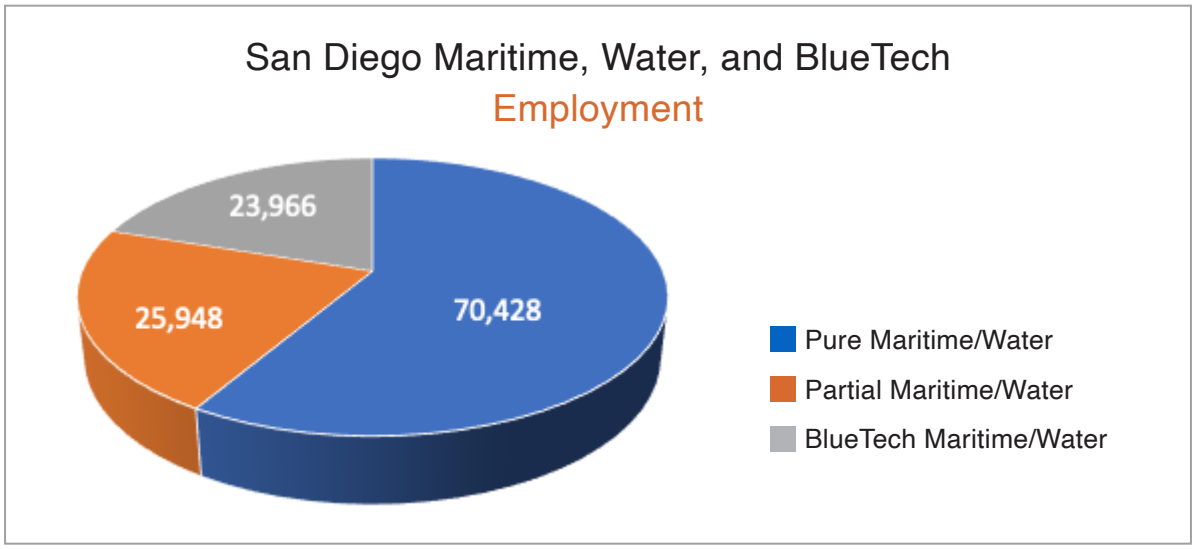


Figure 1. San Diego Maritime, Water, and BlueTech Employment, 2020

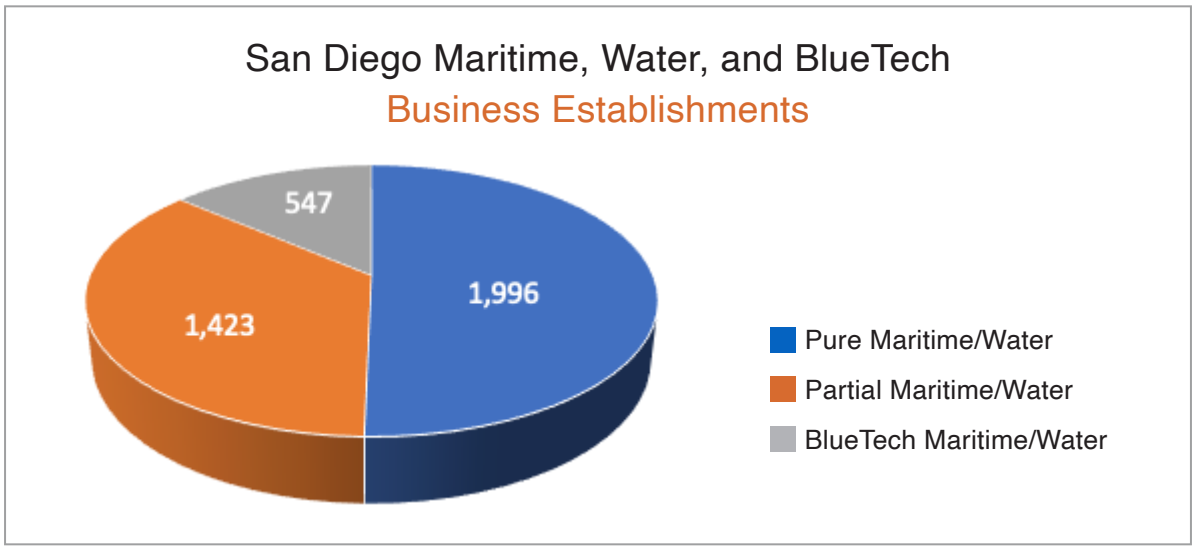


Figure 2. San Diego Maritime, Water, and BlueTech Business Establishments, 2020

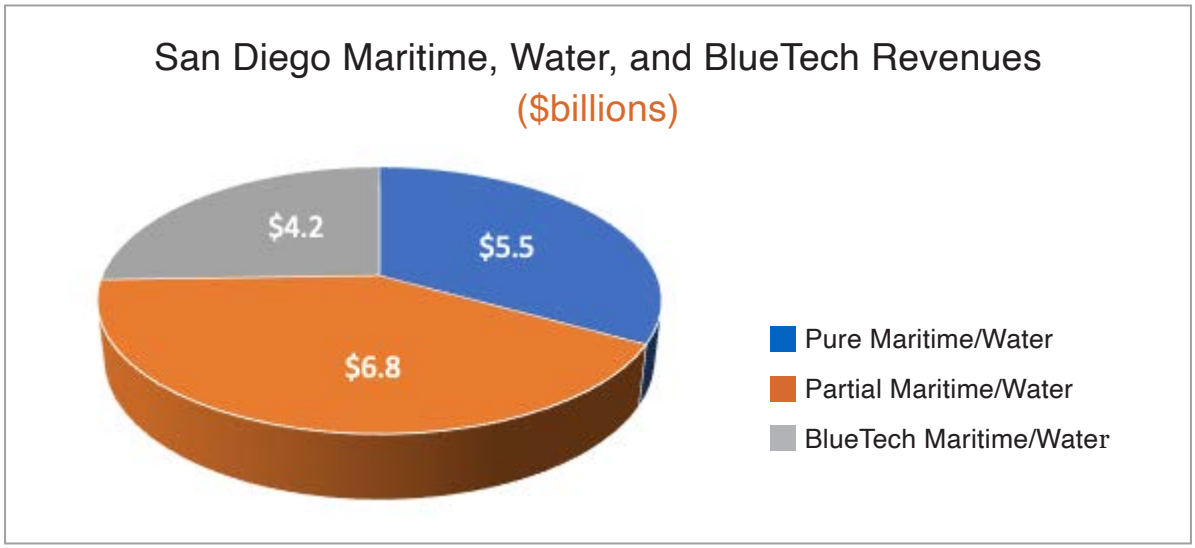


Figure 3. San Diego Maritime, Water, and BlueTech Revenues ($billions)

GROWTH IN MARITIME, WATER, AND BLUETECH INDUSTRIES SINCE 2012

In San Diego's maritime, water, and BlueTech industry groups,[12] revenues increased by 18 percent and employment increased by 163 percent in the eight years since the 2012 study. Two important factors affected these results:

- improved and more complete data collection – including more water/wastewater companies in the current study tends to overstate the degree of change
- the volume of business activity in 2020, the year for which the current survey data were collected on, was significantly reduced by the general business impacts of COVID-19

One objective of this study is to show the growth and evolution of these industry groups in comparison to the findings of a similar study conducted in 2012.[13]
Both the composition of the industry groups and our understanding of them have evolved since 2012. One significant change is that many activities that are now considered to be BlueTech activities were counted in the 2012 study as pure maritime/water or partial maritime/water.[14]

12 The current study reports figures for the year 2020.

13 San Diego Workforce Partnership, San Diego Regional Economic Development Corporation, and The Maritime Alliance. 2014. San Diego Maritime Industry Report, 2012. https://workforce.org/sites/default/files/pdfs/reports/industry/san_diego_maritime_cluster_analysis.pdf

14 For example, the 2012 definition considers the manufacture of highly innovative watercraft to be boat building, a maritime activity.

However, to allow comparison with the results of the 2012 study, this section of the study retains the use of the 2012 definitions.[15]

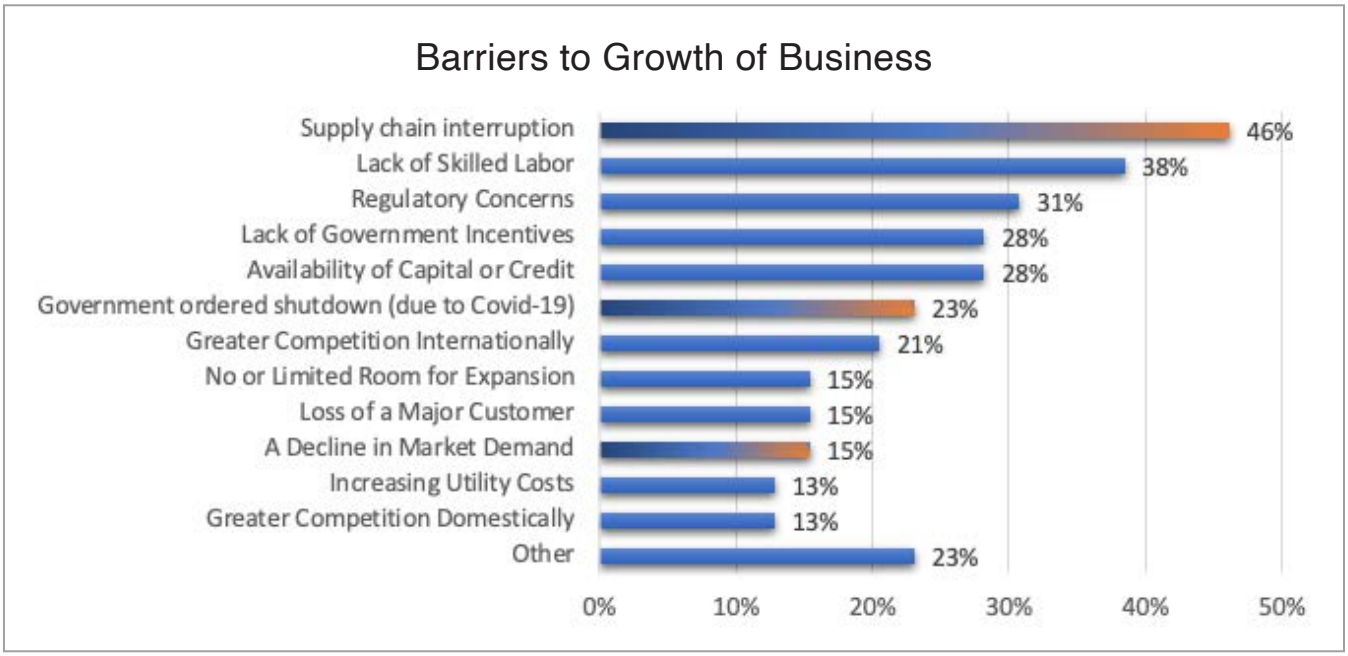


Figure 4. Barriers to Growth of Business for San Diego Maritime, Water, and BlueTech Industries

Nearly a quarter of survey respondents identified government-ordered shutdowns associated with COVID-19 as a barrier to growth. Nearly half pointed to supply chain interruption and another 15 percent to decline in market demand as barriers to growth—both are widely-noted impacts of COVID-19. Almost two-thirds of respondents indicated that COVID-19 had a negative impact on their revenues.

Businesses generally try to maintain employment during economic downturns like the one resulting by COVID-19, by eliminating overtime and reducing hours before laying off employees. Despite evidence that COVID-19 eroded some of the revenue gains in San Diego's maritime, water, and BlueTech businesses over the past eight years, the employment gains remain significant.

The impact of COVID-19 on revenues was not evenly distributed among the components of San Diego's maritime, water, and BlueTech industry group. Revenues in the **pure maritime/water** businesses nearly tripled since 2012 (see Figure 5). This offset revenue losses among **BlueTech maritime/water** businesses (32 percent lower than in 2012, as shown in Figure 5). The revenues of **partial maritime/water** businesses were only 6 percent higher in 2020 than in 2012.

15 Future studies that consider means of refining the definition of BlueTech would provide valuable insights into this important and rapidly-evolving industry group.

However, the employment gains over the past eight years are substantial (see Figure 6). Employment by **pure maritime/water** businesses increased nearly eight-fold. As noted above, some of this increase may be due to the use in this study of improved data collection methods but a significant portion of this increase is due to actual growth in both the number of business establishments and increased employment in firms that existed in 2012.

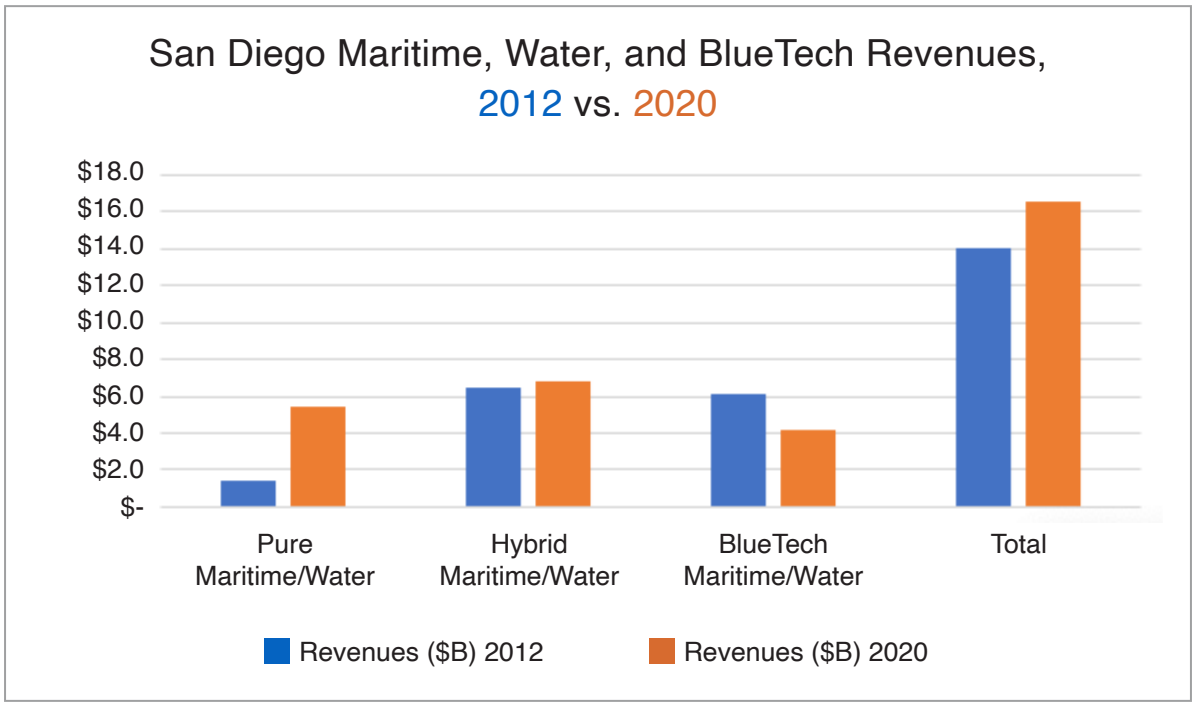


Figure 5. San Diego Maritime, Water, and BlueTech Revenues, 2012 vs. 2020

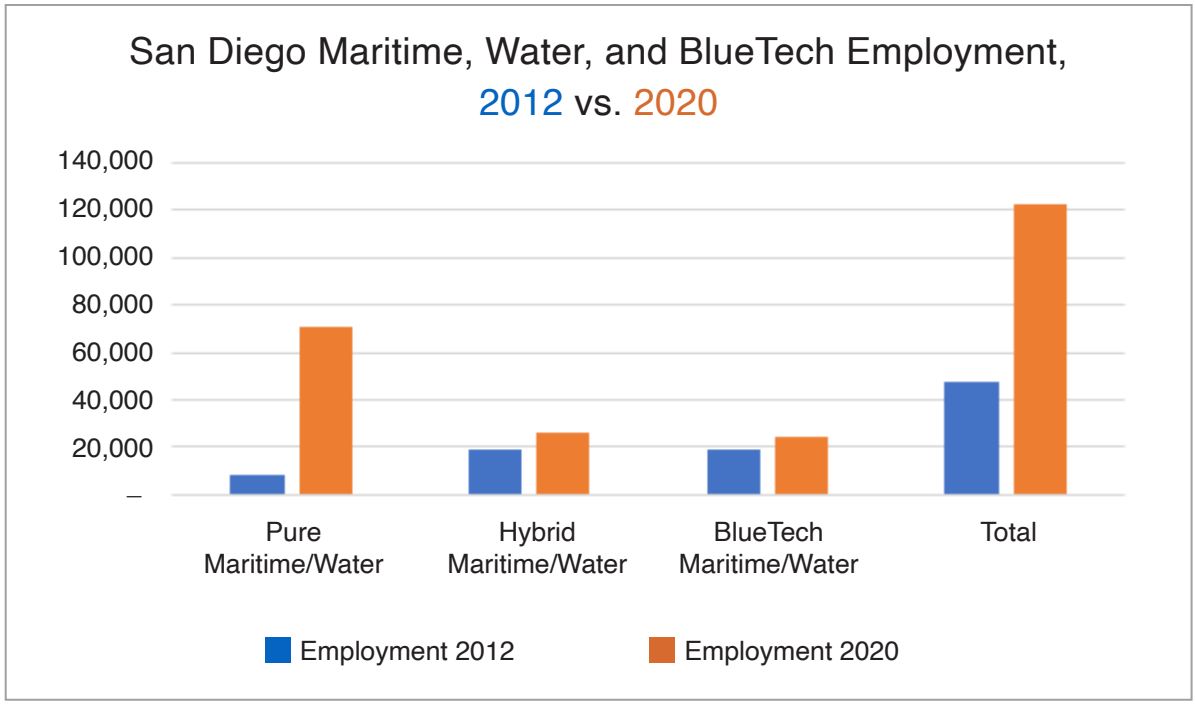


Figure 6. San Diego Maritime, Water, and BlueTech Employment, 2012 vs. 2020

IV. Strength in Numbers – the importance of industry clusters

Industry clusters like TMA BlueTech are important.

- **Strong clusters experience much higher growth in employment.**
- **The presence of several different industry clusters in a region also drives employment growth and industry growth.**
- **The existence of policies supportive of specific clusters has a greater impact on economic growth of the region in which the clusters are located.**[16]

The organizations that belong to an industry often congregate together geographically. By concentrating in a specific location, they can gain considerable benefits from the access they have to large pools of skilled labor, specific industry-related knowledge, the presence of dedicated technologies, and a culture of entrepreneurship and innovation attached to the industry. These industry-focused concentrations are known as 'clusters', and the US Department of Commerce has identified regional clusters as a '*prominent feature of successful and growing economies: they drive competitiveness and entrepreneurship and underlie new business growth.*" [17]

> In a number of cities across America public-private partnerships have sprung up, intended to ensure that marine, maritime, and freshwater-focused businesses and industries can develop and grow quickly and equitably. These partnerships have evolved using different models and means of support and coordination, and are typically referred to as BlueTech clusters—particularly when they focus on innovation.
>
> The Ocean Foundation/TMA BlueTech, "The Blue Wave."

As Figure 7 shows, there are many industries in the U.S. with a very clear geographical focus, and so clustering is a prevalent characteristic in our nation's economy. In each cluster we would expect to find a concentration of knowledge, expertise, and innovation specific to that industry. Many of the firms and organizations will also share inputs and outputs with each other, effectively being suppliers or customers to others within their cluster.

However, we also find geographic concentrations of related firms without the close connections described above. Such concentrations of related activities do not constitute an industry cluster; merely being a maritime business located near the ocean, for example, does not necessarily result in the firm becoming a close business partner with all the other maritime businesses in the

16 Delgado, M., Porter, M. E., & Stern, S. (2014). Clusters, convergence, and economic performance. Research policy, 43(10), 1785-1799.

17 https://eda.gov/about/cluster-mapping/

region benefitting from a concentration of knowledge, expertise, and innovation. Undoubtedly, functional relationships between the actors in a cluster are a powerful force for the strength of the industry.

There is growing recognition of the importance of organized, innovation clusters globally and an estimated 7,000 innovation clusters exist.[18] However, Europe is the clear leader in promoting clusters as is evident with European Commission funding of clusters, cross-cluster collaboration, and support organizations like the European Cluster Collaboration Platform (ECCP) and the European Secretariat for Cluster Analysis (ESCA).

We are now seeing more interest in the importance of regional industry clusters in the U.S. The role that local, regional, state, and national policy can play in helping to drive economic generation and growth by stimulating the activities of clusters is developing. Recent federal and state funding opportunities indicate a new interest in financially supporting strategic planning for clusters and implementation grants for key activities within a region.[19]

18 The Ocean Foundation, TMA BlueTech. 2021. The Blue Wave: Investing in BlueTech Clusters to Maintain Leadership and Promote Economic Growth and Job Creation. The Ocean Foundation.

19 A comprehensive summary of key research and theory related to clusters can be found at https://www.clustermapping.us/content/key-research-behind-project.

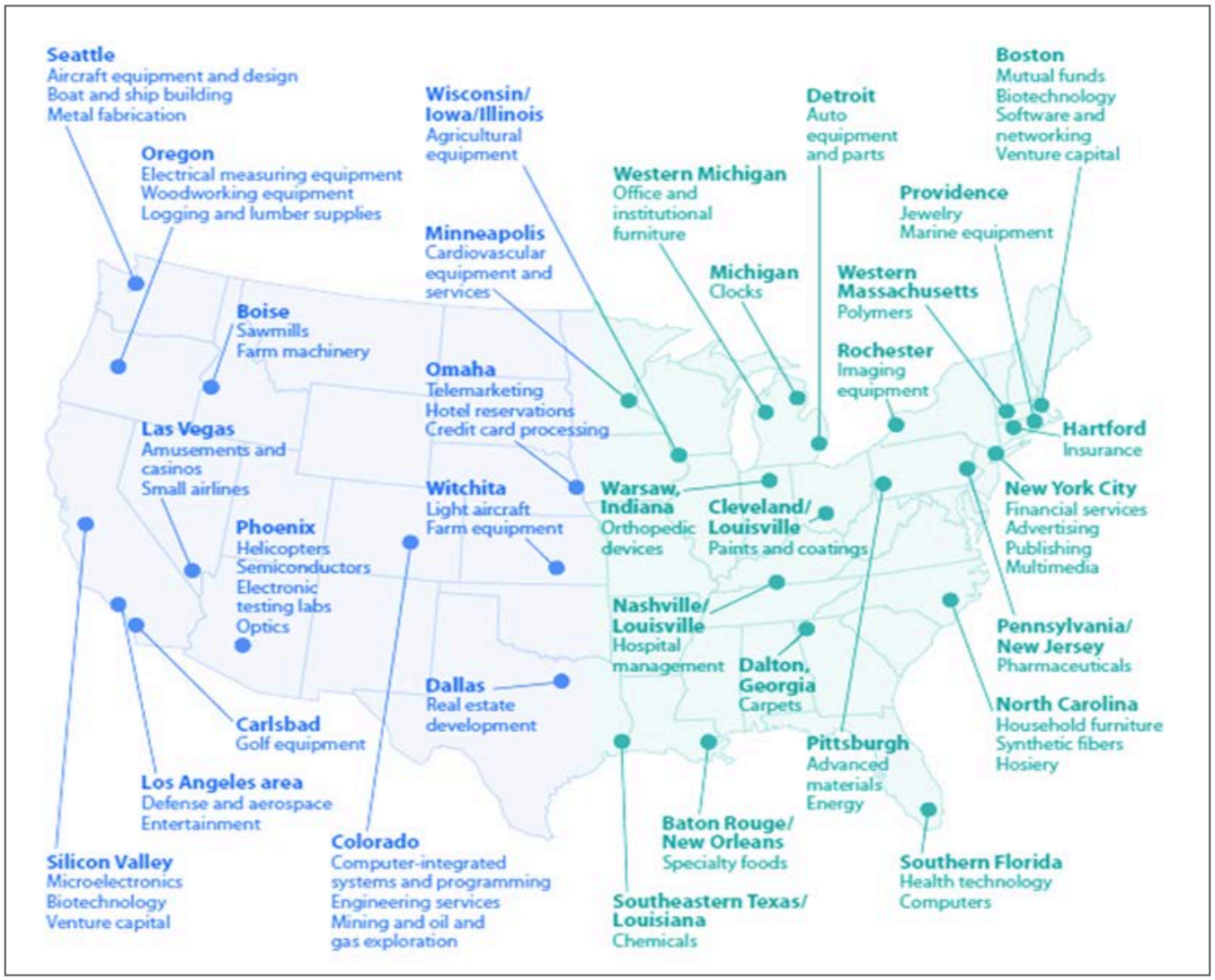


Figure 7. A Cluster map of the USA (https://www.clustermapping.us/content/clusters-101)

V. The BlueTech Economy

The importance of the global Blue Economy was starkly underlined in a 2016 OECD report,[20] which predicts that it will grow from $1.5 trillion in 2010 to $3 trillion by 2030, which will be supported in part by the growth of maritime clusters. Their report stressed the need for investment in clusters, especially as this has been a successful approach for the growth of BlueTech in China, the European Union, and Mexico. Their central argument is a simple one—growth is not achieved through individual organizations acting in isolation, but through stimulating the 'clusters' of innovators, entrepreneurs, and partners in a sector while building an infrastructure that feeds the needs of the cluster.[21] An October 2021 report on BlueTech clusters highlights the

> *opportunity to dramatically accelerate sustainable economic growth nationwide by stimulating the collaboration, innovation and entrepreneurship in BlueTech clusters, all of which are significant byproducts of the cluster model of business development that has proven successful in other fields. Bringing small innovators together with larger established entities working on an aligned set of issues and priorities spurs growth and makes the resulting business ecosystem far greater than the sum of its individual parts. It is also important to protect the vital supply chain needed for America to boost its standing as a BlueTech power".*[22]

San Diego's location on the Pacific Coastline naturally emphasizes the significance for the local economy of industries associated with the ocean. The Port of San Diego alone had a $9.4 billion overall economic impact in 2017, employing 44,300 people on the waterfront and generating 3 percent of the jobs in the county.[23] It is home to major shipbuilding, serves as a transit point for leisure cruises, is one of the nation's container ports, especially for automobile

20 OECD (2016), The Ocean Economy in 2030, OECD Publishing, Paris, https://doi.org/10.1787/9789264251724-en.

21 Porter, M. E. (1998). Clusters and the new economics of competition (Vol. 76, No. 6, pp. 77-90). Boston: Harvard Business Review.

22 Ocean Foundation, SustainaMetrix, Page, G. & Matey, S. (2021) Blue Tech Clusters of America. https://storymaps.arcgis.com/stories/3c3e46acf92f4f39bc42ca2b8307ae99.

23 San Diego Unified Port District (SDUPD) (2019). Economic Impacts of the San Diego Unified Port District in 2017. Economic Planning Systems Inc, EPS #171158

imports, houses two major Naval bases, and is a prime tourist destination with 18 hotels on land leased from the Port. All along the coast from the U.S.-Mexico border to the city of Oceanside, San Diego's economy and quality of life is tied to the ocean.

In addition to ocean-related activities and major maritime industries, often viewed as the core of the *BlueTech economy,* we define "Blue Economy" more broadly to include water/wastewater technologies in this report. With Southern California being a highly water-stressed region, many small businesses, academic institutions, and government entities have focused their efforts in water conservation, desalination, pollution reduction and wastewater treatment. Furthermore, governments at all levels (city, county, state, and federal) in coordination with local universities, engineering companies, and environmental consulting companies have designated significant portions of their operating budget costs, both human and financial, to dealing with water/wastewater issues with a particular emphasis on monitoring impacts of pollution like beach closures (major economic impacts for locals and tourists alike), public health (bacterial contamination after rains), and excess water utilization (for example, new technologies to reduce wasting water).

> While there is often differentiation between salt water and fresh water when it comes to science, policy and advocacy among key stakeholder groups, BlueTech clusters cross these traditional boundaries because the activities and technology developed by their members is agnostic when it comes to relative levels of salinity in the liquid medium in which they operate. TMA BlueTech, for example, includes ocean, freshwater and wastewater technology in its area of focus, though other BlueTech clusters are more narrowly focused on just one of these components, typically related to the focal points of economic activity in their geographic region.
>
> The Ocean Foundation/TMA BlueTech, "The Blue Wave."

The Blue Economy cluster in the greater San Diego area is important. In 2020, as noted above, it generated $16.2 billion in revenues and employed 114,000 people across its associated industries.[24]

SUPPLY CHAINS

Every product, service and experience we receive and enjoy as consumers comes to us through increasingly complex systems of producers, processors, distributors, service providers and technology networks. For many modern products, the logistics and transactions of global supply chains span many thousands of miles; supply chains for products as simple as tennis balls often extend the equivalent of one and a half times the circumference

As dramatically illustrated by the supply chain interruptions associated with COVID-19, understanding and ensuring the security of supply chains is vital to the continued growth and success of San Diego's maritime, water, and BlueTech industries.

24 ERISS (2012) The San Diego Maritime Industry Report 2012. www.eriss.com.

of the Earth. Each transaction between a supplier and its immediate customer generates revenues that are the lifeblood of supply chains. No business exists in a vacuum; another way that clusters contribute to the success of individual businesses is through the shared contributions of members to supply chain management.

In its simplest form, a supply chain looks like this: product flows downstream towards the customer and information (and money) flows upstream towards suppliers (see Figure 8).

San Diego's BlueTech cluster leverages the capabilities of innovators, entrepreneurs, and partners to promote sustainable ocean and water industries. Success depends on the continued development of the infrastructure needed to support this growth.

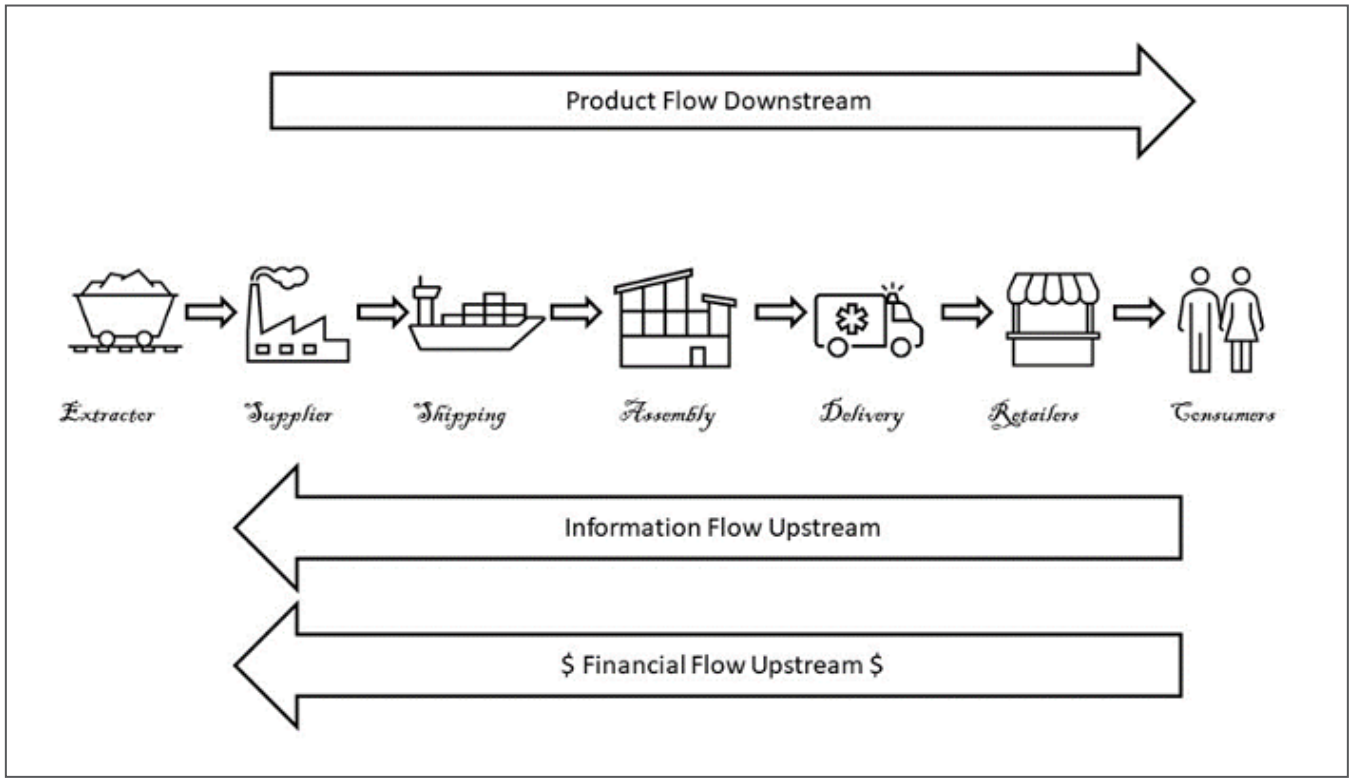


Figure 8. Schematic of a simple supply chain

It is often said that competition takes place not between firms, but between supply chains. As a result, the ability to coordinate and leverage the capabilities across a supply chain is a vital strategic force. As we go further upstream towards 2nd, 3rd, and even higher tiers, we often find common suppliers shared between very different prime companies.

Supply chains are major economic engines. The way finance flows through complex supply chains is central to how the global economy works. Policies designed to stimulate economic growth are generally based on national economies and Gross Domestic Product (GDP), rather than on how businesses operate. One of the largest costs for a business is the procurement of goods and services from its suppliers, accounting for around 65 percent of the total costs of a typical manufacturing business.

- Transportation and distribution costs can easily make up 5 percent to 25 percent of other (indirect) costs.
- Investment capital is frequently used to build new facilities, purchase machinery and equipment and support R&D.
- The people who work for a company spend their money locally, pay local taxes and support local businesses.
- If a supply chain is localized within a cluster, that economic impact is also localized.

Supply chains serve as a vital mechanism for 'multiplying' the flow of funds from end consumers. For every $1 the end manufacturer earns, approximately 75 percent of that revenue will pass upstream into its supply chain to suppliers and logistics providers. Localized supply chains have an immediate and direct benefit to the region through revenue generation, employee wages, local taxes, and the necessary investment in infrastructure to support an industry cluster. On the other hand, suppliers and other providers located outside the region mean the financial impact is dispersed.

Synthetic case study, life cycle approach

The reach of an individual BlueTech business across its supply chain can be impressive. Consider an underwater surveillance equipment provider, serving both research and military operations in the San Diego region. The design and manufacture of their equipment emerged from work they had undertaken in partnership with several fabricators, electronic imaging and engineering firms, and Department of Defense partners. Over several years, designs were developed, tested, and refined and, finally, the desired specification utilized the expertise of local businesses, university research centers, and individual contractors matched to the needs of key customers. Working locally increased the ease of communications, gave frequent access to recognized experts, and allowed multiple iterations of the design. Once in production, the manufacturer and its suppliers were able to shift gears to meet customer orders, benefiting from the local network of partners and supply chain. Only for a few specialist components was it necessary to reach beyond the county to national and global suppliers.

The firm's workers all lived locally. Recruiting took place at San Diego high schools, community colleges, and universities so employees naturally lived and went about their lives spending their money locally.

Key actors in the Blue Economy can be critical conduits for the economic impact of the sector. How BlueTech companies configure their supply chains – locally, regionally, nationally, and even globally – will define where their largest economic impact will be. Furthermore, supply chains are not confined within a single sector, they cross industries. A BlueTech

organization will often work with energy utilities, financial services providers, general engineering firms and local and national universities—all suppliers outside of maritime, water and BlueTech industries. The impact of the Blue Economy is more far reaching than simply its sector boundaries.

Seafood Supply Chain Case Study

Despite its coastal location, less than 10 percent of the 8.6 million kg of seafood purchased in San Diego's markets and consumed in its restaurants is from domestic sources. This is partly because consumption of seafood in the region is dominated by three species – salmon, tuna, and shrimp. Further, only 14 percent of the 86 seafood markets in the city occasionally carried locally caught seafood, with only 8 percent carrying such supplies regularly. In addition to the competitive pressures from imported seafood which prevail across the nation's markets, the lack of infrastructure to offload, prepare and distribute local catch mean that the local seafood supply chain is focused on the transport and distribution of imported, processed seafood (prepared, fresh, or frozen) seafood rather than local catch. However, the emergence of a few local fish markets such as the Tuna Harbor Dockside Market have begun to make inroads into developing local supply chains for seafood.

> *"Uncertain, but likely important, are the impacts of law, policy, local history, global and local economics, marketing, and zoning or land use configurations on the growth of the fishing industry, the supplies and public demand for local seafood, and on the distribution and equitable access to local seafood products."*

Talley, T. S., Warde, H., & Venuti, N. (2016). Local seafood availability in San Diego, California seafood markets. *Future of Food: Journal on Food, Agriculture and Society*, 4(2).

ECONOMIC IMPACT MULTIPLIERS

When a stone is thrown into a pond, the ripples extend far beyond the initial point of impact. In the same way, the economic effects of BlueTech ripple across the economies of the city, county, and state as BlueTech companies purchase supplies from local suppliers, purchase and maintain on-site facilities and equipment, pay wages to local employees, and pay taxes to local governments. These economic effects continue through the local spending of suppliers, employees, and governments. The full economic impact of BlueTech includes

its own economic activity and the indirect economic activity that is enabled by local spending and re-spending.

This ripple effect starts when BlueTech companies in San Diego generate revenues through the sale of final goods and services. In addition, startup companies attract investor funding that is used in the same way as revenues–to purchase supplies, pay employees, and pay taxes. When BlueTech supplies are purchased from local companies, those companies use a portion of those revenues to purchase their own supplies. For example, the inventory of retail firms that supply San Diego's BlueTech companies with goods and services is purchased from manufacturers, wholesalers, or other sources. When local sources are used by BlueTech suppliers, the impact of BlueTech on local economies increases.

BlueTech suppliers also purchase and maintain their own real estate and equipment and pay their own taxes and employees. The portion of this spending that occurs locally is an additional contribution to the total impact of BlueTech on local economies. Employees of BlueTech companies and their suppliers also contribute to the total impact values. Employees spend much of their disposable income locally and local governments tend to spend tax revenues within their own jurisdictions. Thus, employee and government spending that occurs locally adds to the total economic impact of San Diego's BlueTech businesses.

The economic effects of San Diego's maritime, water, and BlueTech industries ripple across the economies of San Diego, San Diego County, and California.

Each time money is spent locally, the local re-spending of that money represents an additional contribution to the local economy and, thus, the total economic impact of the initial revenue-generating activity.

THE LOCAL IMPACTS OF SAN DIEGO'S BLUETECH ECONOMY

In 2020, San Diego's BlueTech businesses employed about 24,000 persons and generated just over $4 billion in revenues,[25] yielding a total economic impact of:

- **$9.5 billion in the city of San Diego,**
- **$9.9 billion in San Diego County, and**
- **$11.3 billion in California.**

25 The term "revenues" generally refers to funds generated by the sale of goods and services. However, San Diego's Blue-Tech sector continues to grow and includes many startups that are not yet generating revenues through the sale of final goods and services. The funds provided by investors to startups contribute to the local economy in the same ways as revenues generated from sales--they are used to purchase supplies (both goods and services) and pay employees and taxes. To measure the full impact of BlueTech in San Diego, the definition of "revenues" has been broadened to include investor funding as well as the revenue generated by the sale of products and services.

In this study, researchers conducted surveys of BlueTech businesses in San Diego to estimate the economic impact multipliers for the city of San Diego, San Diego County, and California. However, as noted above, the composition and understanding of San Diego's BlueTech industry group has evolved over the past decade, with many BlueTech firms being classified under the current definition as pure maritime/water or partial maritime/water.

Thus, the economic impact multipliers developed in this study are directly relevant to BlueTech activities but also shed light on the potential impact of pure maritime/water and partial maritime/water activities since those business classes also include some BlueTech firms.

The economic impact multipliers estimated in this study are presented in the table below.

BlueTech Multipliers		
City of San Diego	**San Diego County**	**State of California**
2.26	**2.34**	**2.68**

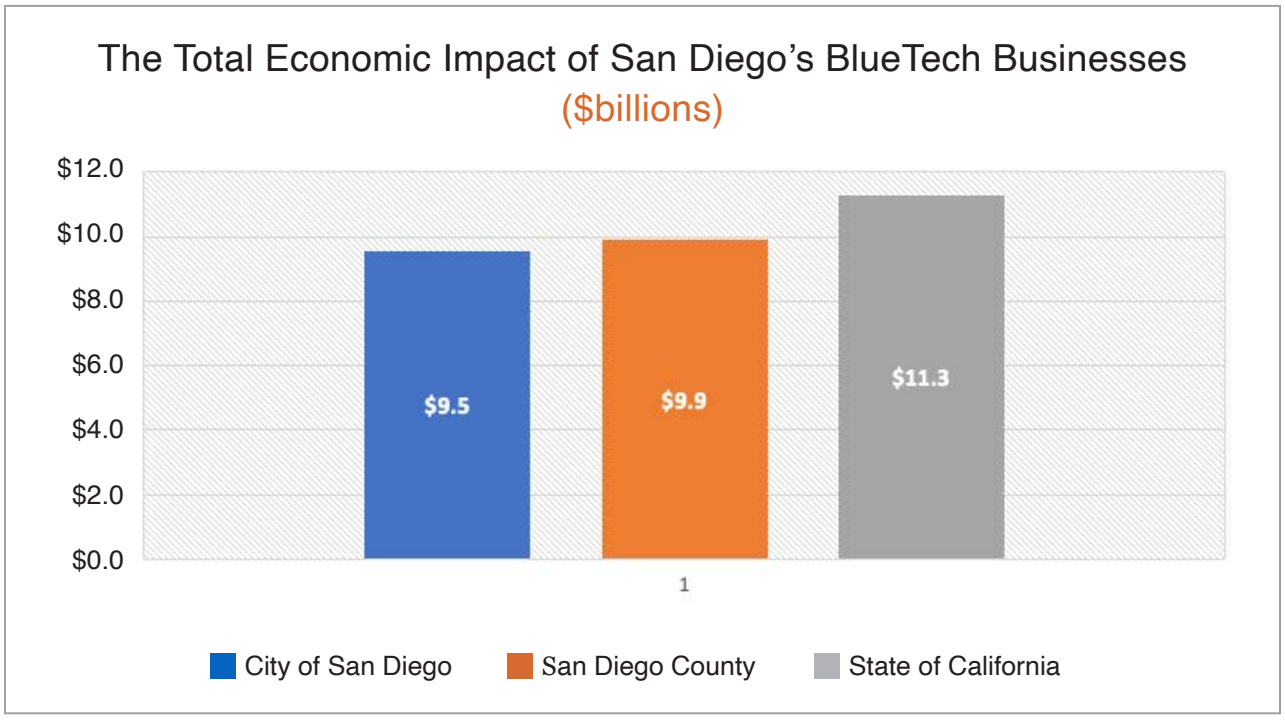


Figure 9. Total Economic Impact of San Diego's BlueTech Cluster

Most of the total economic activity that flows from BlueTech directly benefits the City of San Diego ($9.5 billion, or 84 percent), with an additional 3 percent ($.4 billion) of the impact occurring elsewhere in San Diego County. BlueTech contributes to the broader California

economy, outside of San Diego County, with an additional 13 percent, or $1.4 billion, of economic activity occurring outside the county boundaries.

The definition of "BlueTech" firms that is used throughout this report is overly restrictive. Using this definition, many BlueTech firms in San Diego have been classified as pure maritime/water or partial maritime/water.[26] At the same time, many pure maritime/water and partial maritime/water firms are not engaged in BlueTech activities–for example, marinas and seafood wholesalers. With this caveat, the BlueTech multipliers could be applied to total maritime, water, and BlueTech revenues ($16.2 billion) to provide a rough estimate of its total economic impact:

- $36.6 billion in the city of San Diego,
- $37.9 billion in San Diego County, and
- $43.4 billion in California.

The revenue multipliers estimated in this study are larger than in many other industries, as can be seen in Figure 10, which compares state-level multipliers for selected industries with those estimated in this study. Although all but the BlueTech multipliers were estimated in 2012, the underlying economic relationships (e.g., labor vs. supply spending, the availability of local suppliers, and the tendency of employees to spend their take-home pay locally) do not change rapidly; thus, this figure provides a good indicator of the relative impact of BlueTech on the state economy.

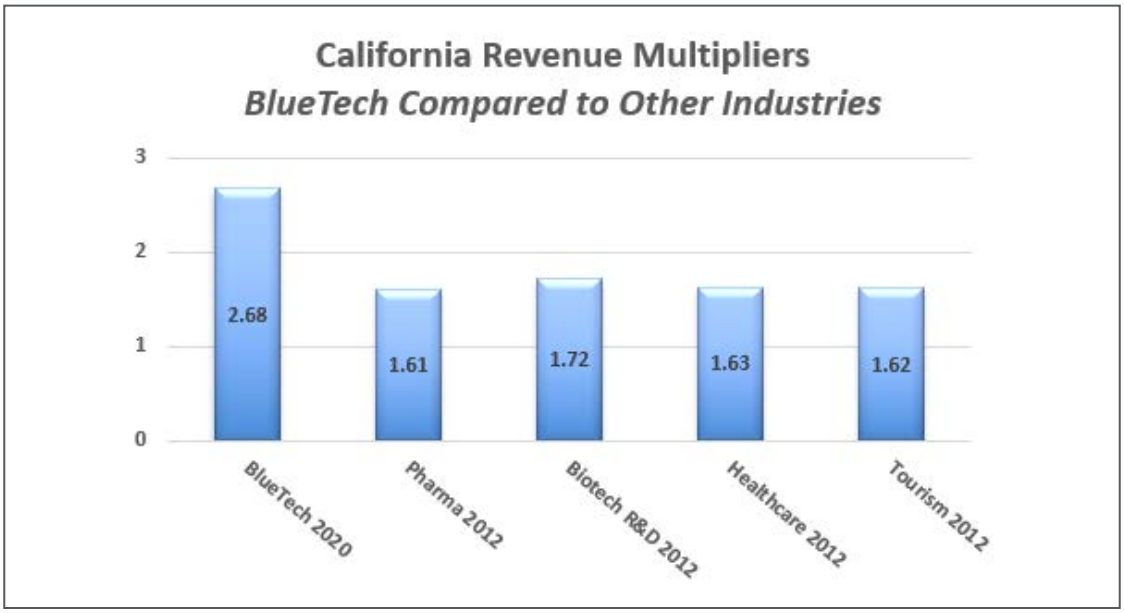


Figure 10: California Revenue Multipliers, BlueTech and Selected Other Industries[27]

26 As noted above, the use of the 2012 definition of BlueTech was required to measure growth since 2012.

27 Sources: BlueTech 2020 from the current study; other multipliers from San Diego State University. 2014. *The Maritime Alliance Research Project*.

INCREASING LOCAL IMPACTS

Local spending by BlueTech companies and local spending by their suppliers, employees, and governments are the economic ripples resulting from the initial round of revenue-generating activity. As a result, the local availability of supplies and labor increases the economic impact of BlueTech on San Diego and San Diego County. Increasing the impact of BlueTech will involve creating a business environment that is favorable not only to BlueTech but also to its suppliers and the firms with which employees and local governments spend their income.

Educational institutions and the quality of life also play important roles. Local educational institutions, from elementary schools to high school, trade schools, community colleges, and universities equip local students with the skills that are needed to work in BlueTech jobs. With the increasing availability of telework options, an educational environment that reduces the need of BlueTech companies to recruit workers from outside the area increases its local impact. Equipping local students for BlueTech jobs provides the added benefit of increasing local employment opportunities for residents of the greater San Diego area.

The local availability of supplies and labor magnifies the impact of BlueTech on the economies of San Diego and San Diego County. Increasing the impact of BlueTech will require the creation of a business environment that is favorable to suppliers and the support of educational institutions that train the BlueTech workforce.

VI. Key Takehomes

- The Blue Economy is important, strong and growing in San Diego. In 2020, San Diego's 4,320 maritime, water, and BlueTech business establishments generated revenues of $16.2 billion and employed more than 114,000 persons, accounting for 5 percent of the business establishments in San Diego County and 9 percent of its employment.
- In the eight years since the 2012 study of San Diego's maritime, water, and BlueTech industry group, revenues increased by 18 percent and employment increased by 163 percent.
- Nearly two-thirds of survey respondents indicated that revenues were adversely affected by COVID-19.
- Impediments to business growth include government-ordered business closures associated with COVID-19, supply chain interruptions, and declining market demand (the latter two factors are also likely to be at least partially related to COVID-19).
- Technology clusters are important. Local maritime, water, and BlueTech businesses have overlapping needs and, thus, share in the benefits of technological advances, the development of a labor force with specialized skills, and well-developed supply chains.
- The local economic impacts of San Diego's maritime, water, and BlueTech businesses are multiplied by local expenditures by employees and the use of local suppliers.
- Every dollar of revenues generated by San Diego's BlueTech industry leads to a total economic impact of $2.26 in San Diego, $2.34 in San Diego County, and $2.68 in California.
- San Diego's BlueTech industry group is mostly comprised of small businesses and new starts. A business climate that is attractive to small businesses and new businesses is critical to growing and maintaining BlueTech.
- As evidenced internationally by disruptions caused by COVID-19, supply chains are vitally important to growing and maintaining the maritime, water, and BlueTech industry group. Supply chain interruptions impact both production and demand. These impacts can be mitigated by using local suppliers.
- All companies benefit from the development of a skilled workforce to support maritime, water, and BlueTech companies. Educational institutions at all levels that equip residents for these jobs reduce the need to outsource for specialized skills, increasing the local economic impact.
- Continued research on the maritime, water, and BlueTech industry will provide better information that can drive growth, improve workforce development, and increase local economic impacts. However, BlueTech companies may need incentives to participate in these studies, including assistance in gathering data, and understanding the benefits of communicating these research results.

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